



RESEARCH REPORT

Analysis and Synthesizing of Marine Shrimp Research in Thailand

III : Abstracts of Marine Shrimp Research in Thailand (1987–2003)

BY

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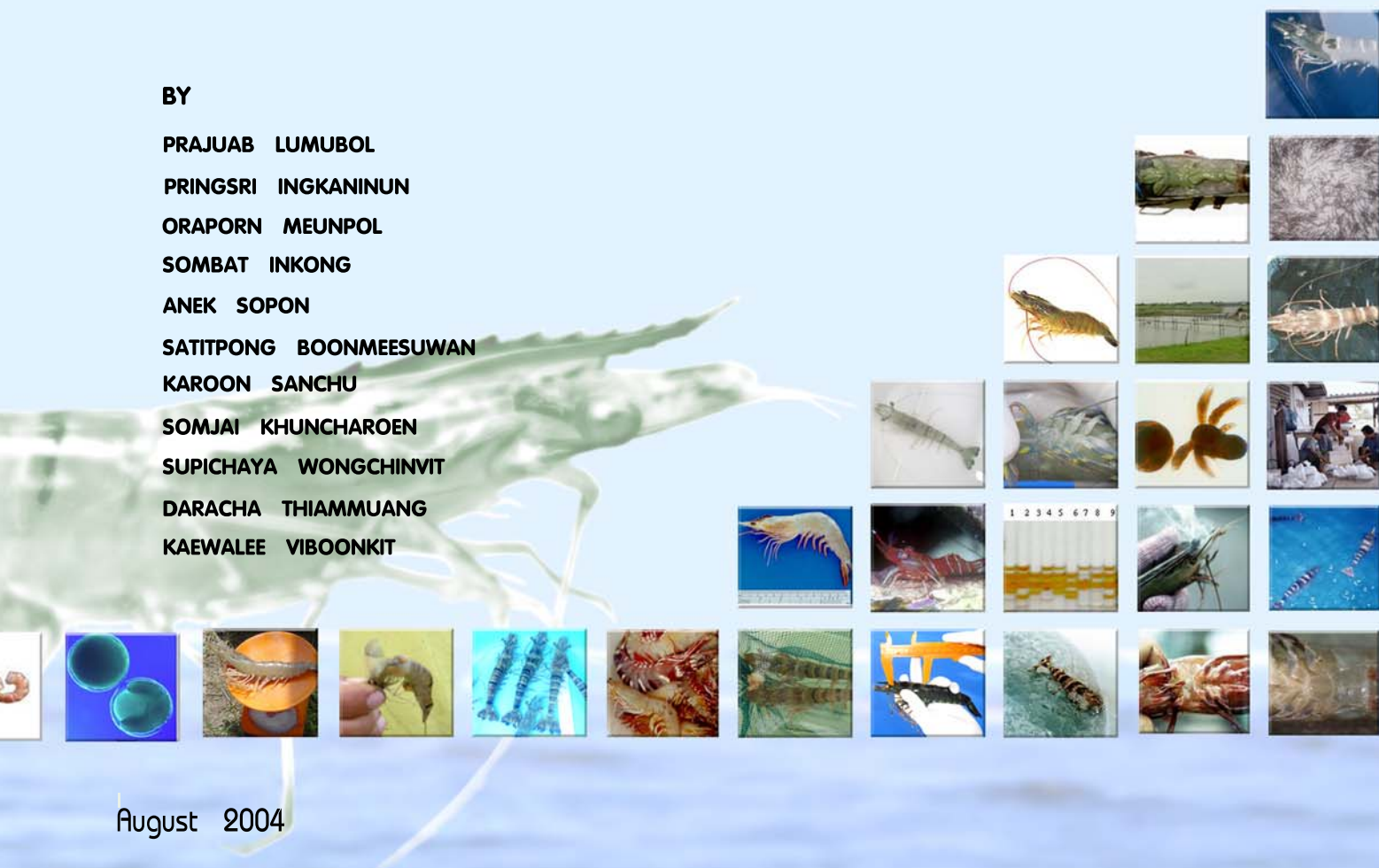
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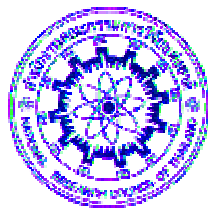
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August 2004

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By

Prajuab Lumubol

(Researcher)

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Preface

This book is an abstract of the research project on Analysis and Synthesizing of Marine Shrimp Research in Thailand. It contains English abstracts of 993 research articles on marine shrimp in Thailand published during 1987 to 2003.

Annotated bibliographic records of these research articles have been processed in digital form could be accessed at <http://www.nrct.net>.

We wish to thank the National Research Council of Thailand for their financial support.

Prajuab Lumubol
Researcher

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การรวบรวมวิเคราะห์และสังเคราะห์งานวิจัยกึ่งทะเลของประเทศไทย

II : บทคัดย่องานวิจัยกึ่งทะเลของประเทศไทย (2530-2546)

ประจวบ หล้าอุบล¹ เปล่งศรี อิงคนินันท์² การณ เสนชู² อรพร หมั่นพล³ สมใจ ขุนเจริญ¹ สติพงษ์ บุญมีสุวรรณ⁴
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1 อมรรรัตน์ พงศ์ดารา. 2545. การโคลนและหาลำดับเบสของตัวบ่งชี้ระดับโมเลกุลชนิดไมโครแซทเทลไลต์จากกุ้งแชบ๊วย (*Penaeus merguensis*, *Penaeus indicus*). รายงานการวิจัยเงินลงทุนงบประมาณโครงการวิจัยประจำปี 2543-2544. ภาควิชาชีวเคมี คณะวิทยาศาสตร์ มหาวิทยาลัยสงขลานครินทร์. 26 น.

ได้เตรียมห้องสมุดดีเอ็นเอ (DNA library) โดยวิธี subtractive hybridization เพื่อเพิ่มจำนวนเฉพาะดีเอ็นเอที่มีส่วนของ repeated unit ของ CT (หรือ GA), GT (หรือ CA) และ TAA ทั้งนี้เพื่อง่ายต่อการค้นหา ย่นระยะเวลา และงบประมาณ ที่จะต้องทำการเรียงลำดับเบสของโคลนที่ไม่เกี่ยวข้อง ในที่สุดได้ห้องสมุด 3 ชนิด แล้วทำการค้นหาจนได้โคลนที่คาดว่าจะส่วนใหญ่ น่าจะเป็น microsatellite DNA ทั้ง 3 ประเภท จำนวน 102 โคลน แต่ด้วยงบประมาณที่จำกัดและจะต้องเรียนรู้ให้ได้เสียก่อนว่าห้องสมุดที่เตรียมไว้นั้นดีหรือไม่ จึงได้สุ่มตัวอย่างไปทำการเรียงลำดับเบสทั้งสิ้น 67 โคลน พบ microsatellite DNA 37 ชุด สามารถนำไปใช้ออกแบบ primer ได้ 7 ชุด และอีก 1 ชุด ออกแบบมาจากงาน RAPD เมื่อทดสอบกับตัวอย่างที่จับได้จากแหล่งต่างๆ ของประเทศไทย พบว่า primer ACT1 และ S4 ใช้ได้ผลเพราะได้ polymorphic bands จะนำ primer ทั้งสองนี้ไปใช้ศึกษาโครงสร้างประชากรของกุ้งแชบ๊วยต่อไป

คำสำคัญ : การโคลน; ลำดับเบส; ไมโครแซทเทลไลต์; ห้องสมุดดีเอ็นเอ; กุ้งแชบ๊วย

2 อภิรักษ์ สงรักษ์. 2544. การจัดการทรัพยากรพ่อแม่พันธุ์กึ่งกุลาดำ (*Penaeus monodon*, Fabricius) : กรณีศึกษาใน

จังหวัดตรัง. วิทยานิพนธ์ปริญญาโท. มหาวิทยาลัยเกษตรศาสตร์. 165 น.

ผู้ใช้ทรัพยากรพ่อแม่พันธุ์กึ่งกุลาดำในจังหวัดตรัง มีอยู่สองกลุ่มคือ ผู้จับพ่อแม่พันธุ์กึ่งกุลาดำโดยการใช้อวนลากกุ้งและผู้รวบรวมพ่อแม่พันธุ์กึ่งกุลาดำ ชาวประมงจะออกทำการประมงทะเลละ 45-90 วัน โดยในแต่ละวันจะลากอวน 4-6 ครั้ง และแต่ละครั้งจะลากอวนนาน 3-4 ชั่วโมง ผลจับเฉลี่ยต่อเดือน ได้แม่พันธุ์กึ่งกุลาดำใหญ่ 20-50 ตัว ขนาดกลางและขนาดเล็ก 40-80 ตัว โดยขนาดใหญ่ขายได้ตัวละ 2,500-4,500 บาท ขนาดกลางตัวละ 800-1,500 บาท และขนาดเล็กตัวละ 500 บาท ชาวประมงมีความเห็นว่าในปัจจุบันทรัพยากรแม่พันธุ์กึ่งกุลาดำได้มีปริมาณลดลง

การศึกษาค่าพารามิเตอร์การเจริญเติบโตของพ่อแม่พันธุ์กึ่งกุลาดำ พบว่ามีค่าความยาวคาราเพซสูงสุด 74.0 และ 97.2 มม. ค่าสัมประสิทธิ์การเจริญเติบโตเท่ากับ 1.30 และ 1.68 ต่อปี ค่าอายุสมมติของพ่อแม่พันธุ์กึ่งกุลาดำเท่ากับ -0.003 และ -0.002 ปี โดยมีสัมประสิทธิ์การตายรวมของพ่อแม่พันธุ์กึ่งกุลาดำ 5.82 และ 10.91 ต่อปี ซึ่งเป็นสัมประสิทธิ์การตายโดยธรรมชาติ 1.71 และ 1.88 ต่อปี และสัมประสิทธิ์การตายจากการประมงคือ 4.11 และ 9.02 ต่อปี ทั้งนี้มีอัตราการใช้ประโยชน์ 0.71 และ 0.83 ต่อปี ตามลำดับ

จากการประเมินสภาวะทรัพยากรพ่อแม่พันธุ์กึ่งกุลาดำพบว่า มีประชากรพ่อแม่พันธุ์และแม่พันธุ์เข้ามาทดแทนที่ 78,779 ตัว และ 101,897 ตัว ตามลำดับ จากการวิเคราะห์ปริมาณและมูลค่าของผลผลิตในรอบปีของพ่อแม่พันธุ์และแม่พันธุ์พบว่าจุดที่ให้ผลตอบแทนทางเศรษฐกิจสูงสุดของพ่อแม่พันธุ์และแม่พันธุ์อยู่ที่ระดับ 1.7 และ 0.7 ของการลงแรงทำการประมงในปัจจุบัน จึงต้องลดปริมาณการลงแรงทำการประมงของแม่พันธุ์ลงร้อยละ 30 เพื่อให้ได้ผลตอบแทนสูงสุดและมีทรัพยากรใช้ต่อไปได้ในอนาคต

used to amplified a set of samples. At least 7 haplotypes of DNA pattern were obtained with type 1-2 found in *P. indicus*, whereas type 3-5 found in *P. merguensis* and type 6-7 occurred in samples with confused morphology, possibly hybrids and used as genetic markers.

Keywords: DNA primer; Nuclear DNA; *Penaeus merguensis*; *Penaeus indicus*; Polymerase Chain Reaction; PCR; Randomly Amplified Polymorphic; RAPD

4 Amornrat Tiptawonnukul. 1996. **Characterization of microsatellite DNA in giant tiger prawn *Penaeus monodon* genome.** Master Thesis. Chulalongkorn University. 122 p.

This research had the objectives to isolate and characterize microsatellites in the giant tiger prawn, *Penaeus monodon*, genome and to develop genetic markers for use in various applications including population genetic studies, selective breeding and genome mapping etc.

One hundred and thirty one microsatellites were isolated and characterized from partial genomic libraries of the giant tiger prawn (*P. monodon*) by screening with an oligonucleotide probe (GT)₁₅. These microsatellites were classified as perfect, imperfect and compound repeats. With 51.9%, imperfect repeats were the predominant category of microsatellites in *P. monodon* genome found in this study. A total of 97 (GT)_n microsatellites were isolated and frequency of the (GT)_n repeats in the genome was estimated. The average distance between neighbouring (GT)_n microsatellites was 92.8 kb. The most common size class in all categories contained sequences between 30-35 repeats in length. PCR primers were designed from the unique flanking sequences of 7 microsatellites, 2 pairs for (AT)_n and 5 pairs for (GT)_n microsatellites. By testing 8 individual prawns from Kuntung, the Andaman Sea and Angsila, the Gulf of Thailand with the PCR amplification, it was found that 3 of 7 microsatellite primer sets, namely, Pmo 18, Pmo 386 and Pmo 14, produced fragments whose size were in the expected range, the others gave nonspecific amplifications. Two microsatellite loci, Pmo 18 and Pmo 386, yielded scorable PCR products and showed high level of polymorphism indicating their potential use in DNA typing of *P. monodon*.

Keywords: Microsatellite DNA; Genomes; Genomic library; Genetic markers; PCR; Primers; Giant tiger prawn; *Penaeus monodon*; Kuntung; Angsila

5 Piya Chulavitayanukul, Wichain Yongprapat and Adul Mearah. 1988. **Experiment on induce-**

maturation of jumbo tiger prawn; *Penaeus monodon* (Fabricius) with different water system. Technical Paper No.33/1988. Satun Brackishwater Fisheries Station. Department of Fisheries. 7 p.

Three water changing systems were performed to induce maturation of eye-ablated Jumbo Tiger Prawn (*Penaeus monodon*) in 3 twelve-ton circular concrete tanks.

- Tank no.1 : water was totally changed once daily.
- Tank no.2 : 12 hours flowing water per day was conducted.
- Tank no.3: 24 hours flowing water per day was conducted.

The prawns in each tank (25 males and 25 females) were fed 5 % of their body weight on small shrimps, ark shell, beef liver and squid. When the experiment was terminated, 1, 3 and 1 matured females 200,000, 300,000 and 120,000 eggs and 140,000, 170,000 and 60,000 nauplius were observed from tank no.1, 2 and 3 respectively. This unfavorable result may due to the effect of fluctuation of salinity and water pH during the moonsoon season, the period when this experiment was performed.

Keywords: Induce maturation; Jumbo tiger prawn; *Penaeus monodon*; Circulation tank; Eyestalk ablation

6 Twee Chindamaikul. 1990. **Experiment on maturation of earthen pond jumbo tiger prawn (*Penaeus monodon* Fabricius).** Technical Paper No.32/1990. Phuket Aquaculture Development Center. Department of Fisheries. 19 p.

Experiment on maturation of earthen pond jumbo tiger prawn (*Penaeus monodon* Fabricius) had been done on March 1989 to January 1990. The earthen pond broodstock 12-18 months old, 850 pairs were used (100-150 pairs/one experiment). Each experiment used the period 50-70 days. The results of the experiment were found that the broodstock's age over 12 months old could matured by eyestalk ablation, but 18 months old of broodstock were best maturation by produced most of the total number of gravid female, egg and hatching rate. The suitable of the size of the broodstock were average 24 cm. and 110 g. of male and 25 cm. and 130 g. of female. The amount of the eggs were between 165,000-220,000 eggs and 9-53% hatching rate. The survival rate of the broodstock after eyestalk ablation until finished the experiment were between 53-65% (male 68-79% and female 38-53%).

Keywords: Maturation; Jumbo tiger prawn; *Penaeus monodon*; Broodstocks; Eyestalks ablation; Earthen pond; Survival rate

7 Pavinee Patanachan. 1998. **Heritability estimation on growth rate of black tiger shrimp *Penaeus monodon* Fabricius, 1798**. Master Thesis. Chulalongkorn University. 100 p.

The procedure of measuring heritability on growth in juvenile giant tiger shrimp, *Penaeus monodon*, was separately investigated in 3 parts i.e. (I) tagging experiments, (II) control mating by artificial insemination, and (III) estimation of heritability

To identify individual under pond culture condition, two types of external tag i.e. streamer and eye stalk tags were tested including, seven forms of hand-making tags and one commercial streamer tag. There were no significant different in the recovery rate between the selfmaking streamer tag and the commercial streamer tag as recovery rates of the two types are similar. Recovery rate of streamer tag (75%) was higher than eye stalk tag (20%). The most durable tag materials are polyvinylchloride and letter pumped plastic but they lost their codes shortly. Therefore, each fullsib group must be reared in separate tanks instead of the individual tagging.

The feasibility of breeding plan by half-sib mating depend on A.I. technique was investigated. Broodstock from Satun and Trad were collected and 55 females were unilaterally eye ablated. The sib families were produced by A.I. technique with 1 sire per 1 and 2 dams. During the female moult cycle, approximately 1 month, 93.36% of female were mated. Female spawned at 6-14 days after mating and produced totally 21 families. These families comprised of 10 halfsib families or only 18.2% of total female. Under this circumstance, breeding plan with half-sib mating design are high costs and demand large experiment area. Therefore, the single pair mating design was chosen for estimation of heritability on growth in black tiger shrimps.

Two experiment of estimation of heritability for growth of the black tiger shrimps were conducted using single pair matings. Two groups of shrimp in each of experiment composed of 21 and 40 families. They were produced during 20 February – 20 March, 1998 and 2-4 May, 1998, respectively. Each fullsib families was randomly reared in separate units. Total weight was recorded at the age of 60 days. Date in term of total weight and total length were recorded and analyzed for various variance components. The broad sense heritabilities were estimate at difference ages. The estimate heritabilities were lower when the animals became older. In the first group, the heritability estimates for length at 25, 65 days and weight at 65 days were 0.154 ± 0.057 , 0.010 ± 0.014 , -0.016 ± 0.004 , respectively. In the second group, the heritability for length decreased from 0.584 ± 0.099 to

0.252 ± 0.0057 at 25-90 days. The heritability for total weight were 0.414 ± 0.081 and 0.309 ± 0.067 at the age of 60-90 days, respectively.

In conclusion, this study shows the significant genetic component controls growth in the black tiger shrimp. As estimated heritabilities by total weight are generally higher than these were estimated using total length in addition, the error terms can be minimized by decreasing time differences among full-sib families. It is therefore, selective breeding program in black tiger shrimp to increase production efficiency is promised.

Keywords: Heritability; Growth; Black tiger shrimp; *Penaeus monodon*; Tag; Artificial insemination, Genetics

8 Twee Chindamaikul and Paitoon Akkayanon. 1997. **Comparison on the production of tiger shrimp (*Penaeus monodon* Fabricius) nauplii by three area spawners**. Technical Paper No. 22/1997. Phangnga Coastal Aquaculture Station. Phuket Coastal Aquaculture Development Center. Coastal Aquaculture Division. Department of Fisheries. 34 p.

The study comparison on the production of tiger shrimp (*Penaeus monodon* Fabricius) nauplii from three spawning area around Phuket island was hold through induced spawning by eyestalk ablation method. The three area was in the south, the west and the east of the island respectively. The study revealed that the number of spawners from three spawning areas were not different but the size and the production on the number of eggs, hatching and nauplius were significantly different. The production of the nauplii by the spawners from the area 1 was the highest and the following was from the area 2 and the area 3 respectively.

Keywords: Production; Nauplius; Tiger shrimp; *Penaeus monodon*; Phuket Island; Eyestalk ablation

9 Twee Chindamaikul and Thavorn Thamsavet. 1994. **Seed production from the different size of the tiger shrimp spawner (*Penaeus monodon* Fabricius) by eyestalk ablation**. In Proceeding The Seminar on Fisheries 1994 19-21 September 1994, DOF Meeting Hall. National Inland Fisheries Institute. p 103–124.

Seed production from the different size of tiger shrimp spawner (over and under 150 g.) were done with induce spawning by eyestalk ablation method for a period of 34 days. Food for the spawners were clam, swimming crab, squid and small white shrimp. The spawners could spawn 1-5 times. The products of nauplius from the 1st to 3rd spawning were used to study on the survival rate and compared with the

larvae derived from the wild spawners. The results of this studied were shown in this paper.

Keywords: Seed production; Tiger shrimp; *Penaeus monodon*; Size; Spawner; Eyestalk ablation

10 Kumthon Lertsumruaybhand. 2000. **Development of internal tag and estimation of heritability on growth of black tiger shrimp *Penaeus monodon* Fabricius, 1798 by full-sib analysis.** Master Thesis. Chulalongkorn University. 97 p.

The internal tag made from telephone cable was used to identify shrimp. The tag was injected between the integument and the muscle on the ventral surface of the fifth pleopods with a syringe 19 gauge needle. Two groups of shrimp were used to test effect of tagging on growth and survival. Experiment one tested for fit size of shrimp to tagging. Small size average body length 5.53 cm. and large size average body length 9.02 cm. The large size of shrimp had significantly high survival rate than those of the small size. Experiment two the average body length at 10.41 cm. of shrimp was used to compare tag and untag shrimp for growth rate and survival rate. No statistical difference was found between growth rate and survival rate.

Three experiments of estimation of heritabilities for growth in shrimps were conducted using single pair mating. Three groups of shrimp in each of experiment comprised of 40, 30 and 14 families. They were produced during 2-4 May 1998, 16-23 January 1999 and 26 January 2000, respectively. Each full-sib family was randomly reared in separate units. Length and weight were recorded and analyzed for various variance components. The broad sense heritabilities were estimated at difference ages. The estimated heritabilities were low when the shrimp became old. In the first group, the heritabilities estimated for length at 30-200 days were 0.24 ± 0.059 – 0.56 ± 0.099 ; heritabilities estimated for weight at 30-200 days were 0.24 ± 0.058 – 0.40 ± 0.081 . In second group, the heritabilities estimates for length at 45 and 145 days were 0.30 ± 0.075 and 0.20 ± 0.056 , respectively, and for weight at 145 days was 0.09 ± 0.032 . In third group the heritabilities estimates for length at 40-150 days were 0.029 ± 0.037 – 0.46 ± 0.162 . Genetic correlations environmental correlations and phenotypic correlations between length and weight of experiments groups one and two were ranged 0.63-1.4 and phenotypic correlations of growth at different ages was varies on different environment. In conclusion, this study shows the significant genetic controls growth in the black tiger shrimp. In addition, the heritability of body length were ranged 0.2-0.4 between at ages of 145 and 150

days. These results was similarity to the estimated of heritabilities in other aquatic animal. Therefore, these investigated will be use in selective breeding program in black tiger shrimp to increase production efficiency.

Keywords: Tag; Heritability; Growth; Black tiger shrimp; *Penaeus monodon*; Full-sib analysis

11 Pitak Soot-Anan. 1999. **Development of DNA typing kit for black tiger prawn *Penaeus monodon* Fabricius by microsatellite technique.** Master Thesis. Chulalongkorn University. 116 p.

Eight microsatellite loci, CSCUPmo1, CSCUPmo2, CSCUPmo3, CSCUPmo4, CSCUPmo6, CSCUPmo7, CSCUPmo9 and CSCUPmo11 were investigated to select suitable microsatellite loci for use in DNA typing of the black tiger prawn *Penaeus monodon*. Allelic variations were examined in 50 individuals *P. monodon* from Trat. All eight loci were be highly polymorphic which exhibited number of alleles at each locus of 29, 27, 27, 21, 29, 22, 33 and 10 alleles, respectively and heterozygosities between 0.21-0.90. Size ranges of alleles varied from 132-380 bp. Six microsatellite loci were chosen based on the level of polymorphism and the ease of allele scoring. The CSCUPmo3 and CSCUPmo7 loci that gave ambiguous allelic patterns and an excess of homozygous genotypes were discarded from further analysis. Approximate 10 mg and 5 μ l of the tissues and blood/ethanol respectively were using for DNA typing of *P. monodon* by microsatellite technique. Alkaline extraction method was the most simple and appropriate DNA isolation when dealing with a large number of specimens. Multiplex analysis was developed to provide rapid amplification of multiple loci simultaneously. Successful analyses were multiplex PCR of loci CSCUPmo1 and CSCUPmo2 and single loading of combined amplified products of paired microsatellites (CSCUPmo4+CSCUPmo9, CSCUPmo6+CSCUPmo11.) Nonisotopic method were used to detect amplified alleles by separating in 8% denaturing polyacrylamide sequencing gels and visualization of amplified alleles using silver staining. Allele difference of 3 bases such as those of the locus CSCUPmo11 could also be detected by using 15% denaturing polyacrylamide minigel. This allowed simpler and more rapid detection of microsatellite alleles. Construction of allelic ladders for use as standard DNA markers was succeeded for the locus CSCUPmo11. The allelic ladders make band scoring simple and more precise.

Keywords: DNA typing kit; Black tiger prawn; *Penaeus monodon*; Microsatellite DNA; Alleles; Heterozygosity; Genotypes; Trat; PCR

12 Chaunchom Maunpasitporn. 1998. **Isolation and characterization of dinucleotide-microsatellite DNA in *Penaeus monodon* Fabricius**. Master Thesis. Chulalongkorn University. 99 p.

Microsatellites have emerged as important source of genetic markers for eukaryotic genomes. In this study, dinucleotide microsatellite sequences were isolated and characterized from the genome of the black tiger prawn, *Penaeus monodon*. Two partial genomic libraries; Library A from digestion of *P. monodon* genomic DNA with restriction enzymes, *Alu* I, *Ras* I, *Hae* III and *Hinc* II and Library B from digestion with restriction enzymes, *Ala* I and *Rsa* I were constructed. For the Library A, 60 and 225 positive recombinants from 5,250 and 6,390 clones were found after screening with (CT)₁₅ and (GT)₁₅ probes, respectively, but no positive recombinant clones were found when (AT)₁₅ probe was used. Nucleotide sequencing of 16 (CT)_n revealed 2 perfect, 12 imperfect and 2 compound microsatellites and of 76 (GT)_n, 20 perfect, 30 imperfect and 26 compound microsatellites were found. Library B, 121 out of 2,400 colonies were positive when hybridized with (GT)₁₅ probes and 40 clones contained microsatellites. From these clones, 11 perfect, 17 imperfect and 12 compound microsatellites were found.

On average, (CT)_n and (GT)_n microsatellites occur every 164 and 42 kb. The predominant category of *P. monodon* (CT)_n and (GT)_n was imperfect repeats; 75% and 39.5%, respectively. The most common size class was an array of 12-17 repeats for (CT)_n and that of 36-46 repeats for (GT)_n. Although, positive recombinant clones were not found using (AT)₁₅ probes but the repeats of (AT)_n were found with (CT)_n and (GT)_n microsatellites. Among 6 pairs of microsatellite primers surveyed, two produced expected PCR product but alleles were ambiguously scored.

Keywords: Microsatellite DNA; Dinucleotide; *Penaeus monodon*; Genetic markers; Genomic library; Genomes

13 in Thai

14 Renu Yashiro and Saming Songtawontawe. 1996. **Cultivation of black tiger shrimp, *Penaeus monodon* broodstock by reducing stocking density and transferring pond**. Technical Paper No. 14/1996. National Institute of Coastal aquaculture, Songkhla. 9 p.

Black tiger shrimp, *Penaeus monodon* age of 4 months (23.64 g mean body weight) were cultured in earthen pond by reducing stock density and

transferring pond at National Institute of Coastal Aquaculture substation. Shrimp were stocked for 98 day in two ponds, 1,000 m² and 800 m² with the density of 3.1 ind/m² and 7.2 ind/m² respectively. After harvesting, the survival rate were 62.89% and 29.79% with mean body weight of 56.0 g. Result revealed lower stocking density gave 50% greater survival rate than the higher density. These two stocks were then mixed and transferred to 3,200 m² pond at density of 1.14 ind/m². After 80 days of cultivation, the survival rate was 70.99% with average body weight of 89.97 g. Shrimp were then restocked at 0.81 ind/m² for 70 days in another pond with the same area. Upon harvesting, survival rate was 61.71% with average body weight of 106.19 g. Throughout the total culture period (248 days), the survival was 18.10% with mean body weight gain (BW) of 83.27 g or 0.33g/day. This final size of 106.19 g BW was with mean body weight gain (BW) of 83.27 g or 0.33 g/day. This final size of 106.19 g BW was comparable to those of wild broodstock, 51.58% of female were mated and 41.67% of male with full white terminal ampullae. Harvested shrimp were transferred to landbased concrete tank for induced maturation experiment. Ovarian development was enhanced and 4,123,500 eggs were laid. Nauplii were hatched with the hatching rate of 21.75%. From this study, shrimp 4 months old at the size of 40 to 50 ind/kg. can grow up be broodstock in earthen pond within one year under gradual reduction of stocking density from 3.1, 1.1 and 0.8 ind/m² and transferring pond. Further study is being planned for shortening culture period more suitable stocking density and feed. Cost (not included pond construction, salary and equipment maintenance) of black tiger shrimp broodstock from this study was 146.81 baht.

Keywords: Culture, Black tiger shrimp; *Penaeus monodon*; Broodstocks; Stocking density

15 Supon Tansuwan. 2000. **A rearing of the 2nd filial of pond reared *Penaeus monodon* Fabricius broodstock for the 3rd generation**. Technical paper No.14/2000. Narathiwat Coastal Aquaculture Development Center. Department of Fisheries. 13 p.

To produce the 3rd generation of pond reared black tiger shrimp (*Penaeus monodon* Fabricius) broodstock, the offspring of the 2nd generation of that broodstock, aging PL-23 with an average total length of 1.95±0.41 cm and an average body weight of 0.45±0.02 g were cultured for 426 days. The cultivation was performed in the 2 ponds of 2 rai (3,200 m²) earthen pond. The shrimp density was 16,000 for each pond (5 shrimps/m²). A commercial shrimp feed was employed through the cultured period, whilst the fresh of raw fish and raw crab was supplemented for three a week when shrimp reached 300 days of age.

After the desired period, 4,000 of black tiger shrimp broodstock were received of which 2,160 males and 1,840 females. The survival rate calculated from the stocked offspring was 25%. Growth based on average total length and average body weight was 23.62 ± 1.59 cm and 142.83 ± 25.28 g for male, and 24.45 ± 1.70 cm and 158.25 ± 28.30 g for female, respectively. Only 15 female broodstocks were observed for gonad development and of which 13 female broodstocks were achieved spawning with 2,575,620 eggs (average $198,125 \pm 93,744$ eggs/female). Consequently, 14.61% of hatched nauplii were obtained from total eggs produced. Those were 51.85% hatched nauplii from fertilized eggs. Yield finally 55.62% of nauplii could reach post larva-1 stage.

Keywords: Pond reared broodstock; *Penaeus monodon*; Earthen pond

16 Tawat Sriveerachai, Somjai Vechprasit and Vichai Chaichanagasigum. 2000. **Culture of black tiger shrimp (*Penaeus monodon* Fabricius) spawner size in earthen pond.** Technical paper no.49/2000. Narathiwat Coastal Aquaculture Development Center. Department of Fisheries. 13 p.

Narathiwat coastal aquaculture development center had cultured black tiger shrimp (*Penaeus monodon* Fabricius) to spawner size in earthen pond for 3 crops.

First crop was cultured from 16 December 1993 to 5 September 1994. 8,890 individuals of black tiger shrimp at 156 days old, average length of 15.37 ± 1.38 cm and average weight of 29.31 ± 8.96 grams were used to stock the density of 6.1 individuals/m². The shrimp was fed 5 times a day. During the culture, the mud from pond bottom had not been drained. The culture had been conducted for 264 days (when the shrimp was got 420 day old). There were 848 individuals of shrimp remained. Survival rate was 9.50%. FCR was 32.4:1. The average length of male and female shrimp was 22.20 ± 0.99 and 24.19 ± 1.56 cm, average weight of 101.59 ± 11.65 and 137.50 ± 28.50 grams, respectively. The proportion between male and female were 1.31:1. Production cost/pair was 461.30 bath.

Second crop was cultured from 21 February 1995 to 12 September 1995. 9,300 individuals of black tiger shrimp at 147 days old, average length of 16.66 ± 1.22 cm and average weight of 42.92 ± 9.54 grams were used to stock the density of 6.4 individuals/m². The shrimp was fed 5 times a day. There was twice draining of the mud from the pond bottom during the culture. The culture had been conducted for 219 days (when the shrimp was

got 366 days old). There were 2,423 individuals of shrimp remained. Survival rate was 26.00%. FCR was 9.01:1. The average length of male and female shrimp was 20.56 ± 1.14 and 22.25 ± 1.36 cm, average weight of 80.90 ± 14.03 and 107.92 ± 21.21 grams, respectively. The proportion between male and female was 1.21:1. Production cost/pair was 186.37 bath

Third crop was cultured from 23 November 1995 to 25 July 1996. 8,736 individuals of the black tiger shrimp at 185 days old, average length of 16.41 ± 1.20 cm and average weight 44.09 ± 10.40 grams were used to stock the density of 6 individuals/m². The shrimp was fed 5 times a day. The culture had been conducted for 304 days. These were 3,960 individual of shrimp remained. Survival rate was 45.33%. FCR was 3.8:1. The average length of male and female shrimp was 18.66 ± 1.24 and 19.46 ± 1.52 cm, average weight of 69.65 ± 12.96 and 78.93 ± 16.28 grams, respectively. The proportion between male and female were 1.06:1. After that, 3,887 of shrimp individuals consisting of 1,996 males and 1,891 female were stocked the density of 2.7 individuals/m² to the new pond. The shrimp was fed 5 times a day. When the shrimp was got 429 days old, there were 565 shrimp individuals remained. The survival rate was 14.50%. FCR was 7.54:1. The average length of male and female shrimp was 21.21 ± 0.88 and 22.50 ± 1.22 cm, average weight of 107.06 ± 13.13 and 103.35 ± 20.86 grams, respectively. The proportion between male and female was 1.44:1. Production cost/pair was 600.39 bath

Keywords: Black tiger shrimp; *Penaeus monodon*; Spawner; Size; Earthen pond

17 Thanawut Klowklieng, Valuka Kritrachatanan, Tawutchai Thongnoi and Ismael Isman. 2000. **Culture of black tiger shrimp (*Penaeus monodon*) in earthen pond for producing spawner.** Technical paper No. 43/2000. Satun Coastal Aquaculture Development Center. Department of Fisheries. 18 p.

Postlarva (PL20) of black tiger shrimp (*Penaeus monodon*) producing from the wild-caught spawner with stocking density of 25 ind./m² (100,000 ind./pond) were conducted in the earthen pond, 40x100 m² (2.5 rai) in size, at the Satun Coastal Aquaculture Development Center. The shrimp were fed with commercial pelleted feed 4 times daily at the feeding rate of 3-7% shrimp body weight/day. After 197 days cultured period, the average weight and length of shrimp were 14.508 ± 4.151 gm. and 11.72 ± 1.07 cm. with the survival rate of 44.2%. Two thousands of male and female shrimp with the average weight and length of 23.8 ± 6.15 gm. And 13.8 ± 0.07 cm. were selected and transferred to another pond (40x72.5m² in size). Shrimp were fed

with the commercial pelleted feed 4 times daily at the same rate of the first period. After 300 day cultured period, the feeding program was then changed to the commercial pelleted feed three times/day and the fresh horse mussel one time/day at 3% body weight/day. After 363 days rearing period, size of male and female shrimp were 73.02 ± 12.50 gm. and 104.70 ± 25.09 gm. in weight and 20.2 ± 1.22 ; 22.1 ± 1.84 cm. in length with the survival rate of 32.3 and 37.8%, respectively. The estimating mated female were 47.22%. Twenty of the mated shrimp were selected and the eyestalk ablation technique were then applied. The ablation spawner were reared in 15 tons of a round cement tank and fed with polychaete worm, horse mussel meat and cockle meat 3 times/day with 10-15% body weight. After 4-20 days of eyestalk ablation, sixteen of the mated female shrimp were spawned, producing the total amount of eggs, nauplii and postlarva (PL20) of 4,653,267, 2,018,674 and 401,000 respectively. The average survival rate from nauplius to postlarva (PL20) stage was 19.86%

Keywords: Black tiger shrimp; *Penaeus monodon*; Spawner; Earthen pond

18 Supot Chungyampin and Chairat Pumchouy. 2000. Technical Paper No. 24/2000. **Culture of banana shrimp, *Penaeus merguensis*, for broodstocks in earthen ponds.** Trang Coastal Aquaculture Station. Department of Fisheries. 17 p.

Banana shrimp were cultured to be broodstocks in the earthen ponds. The shrimp were transferred to a new pond in 76, 165 and 270 days respectively. After 122 days, body length of the shrimp increased very slowly but body weight constantly increased at the normal rate when cultured 136 days, average total length of the female shrimp was 12.97 ± 0.56 cm. and average total weight was 17.35 ± 2.44 g. It was found that the females at this stage could be mating in the pond. In order to stimulate the female to spawn, eyestalk ablation was applied to three groups of shrimp after cultured in ponds for, i.e. 152, 193 and 229 days. Result showed that 229 day female shrimps were the best group for spawning. The numbers of female spawners were highest during 3 times of spawning. The average released egg/shrimp were 62,835 which was three times higher than those of the 152 day-culture shrimp. The survival rate of postlarva 2 from 229 day-culture shrimps were 64%, while 152 days and 193 days-culture shrimps were 32% and 35%, respectively.

Keywords: Banana shrimp; Broodstocks; Breeding; Nursing; Earthen pond

19 Jamjun Petsiri. 1997. **Chromosome study on two species of shrimps *Penaeus monodon* Fabricius and *Penaeus merguensis* de Man from Thailand.** Research Report. Department of Biology, Faculty of Science, Thaksin University. 27 p.

A chromosome study was conducted in two species of shrimps, *Penaeus monodon* Fabricius and *Penaeus merguensis* de Man found in Thailand. Fifty specimens of each male and female were studied. Each species average length standard 14.00 cm. and 7.00 cm. respectively, were cut off a second pair of pereopods. These mutilated specimens were kept in a small aquarium for one week to induce the regeneration blastema. The method of chromosome preparation was followed the Hayashi and Fujiwara technique (1988). The classification of chromosomes followed the method recommended by Levan et al. 1964. The results of this study are as follows :

The diploid chromosome of *Penaeus monodon* Fabricius is 88. The karyotype consists of 28 metacentric and submetacentric 16 telocentric and acrocentric pairs. The diploid chromosome of *Penaeus merguensis* de Man is 88. The karyotype consist of 10 metacentric and submetacentric, and 34 subtelocentric and acrocentric pairs.

This result might be concluded that *Penaeus monodon* were closely related to *Penaeus merguensis*. This cytogenetic data may become a basic database of cytotaxonomy study about Giant tiger prawn and White prawn in the future such as inbreeding, genetic improvement or chromosome manipulation of both shrimps or other shrimps.

Keywords: Chromosome; *Penaeus monodon*; *Penaeus merguensis*; Karyotype; Metaphase; Diploid

20 Srirat Sodsuk. 1996. **Genetic differentiation and population structure of *Penaeus monodon* in Thailand.** Technical Paper No.12/1996. National Aquaculture Genetics Research Institute. Department of Fisheries. 19 p.

Four *Penaeus monodon* Fabricius, 1978 populations from four provinces of Thailand; two from the Gulf of Thailand (Trat and Surat Thani), and the other two from the Andaman Sea (Phuket and Satun), were studied using allozyme starch gel electrophoresis. A total of 46 enzyme loci were detected from pleopod and hepatopancreas, of which 10 loci were found to be polymorphic ($p_{0.99}=13.0$). No significant differences from Hardy-Weinberg equilibrium were observed within any single population. The testing for adjacent pairwise comparisons showed that the Andaman Sea populations appeared homogeneous at all loci, but it was shown to be significantly different at *ALAT** ($P < 0.001$) between the two populations from

the Gulf of Thailand. Three loci, *ALAT**, *GPI** and *IDHP**, were significantly different ($P < 0.01$) between the Andaman Sea and the Gulf of Thailand populations. The overall value of F_{st} (0.006) is also small, suggesting low levels of population subdivision. However, the results show significant difference between the Andaman Sea and the Gulf of Thailand and between Trat and Surat Thani populations. Thus there is some genetic evidence for isolation between the sides of the sea and between different areas within the Gulf of Thailand.

Keywords: Genetic differentiation; Electrophoresis; Allozymes; *Penaeus monodon*

21 Visuth Verakulpiriya and Tanan Tattanont. 2002. **A Possibility to product broodstock of *Penaeus monodon* from concrete tank.** In the 4th National Symposium on Marine Shrimp, 18-19 November 2002, Rayong Resort, Rayong. p. 267 - 276.

From the high demand of *Penaeus monodon* broodstocks for shrimp hatchery, there are now problems from the taking lots of wild broodstock from natural sea, causing the decline of catching effort, the lack of broodstock, and low quality. A project of producing *P. monodon* broodstock from the earthen pond by Department of Fisheries (Thailand) can solve some of those problems, especially the lack of broodstock. However, a culture for those broodstock is still depending on environmental parameters which are out of control. Therefore, the new trend to produce *P. monodon* from indoor which is able to control almost of those parameters is necessary. This study was conducted to observe the possibility of producing broodstock of *P. monodon* from concrete tanks. The study started from *P. monodon* (weighing about 23.38 g) which were cultured from earthen pond for about 4 months. Those were selected to culture in 4 concrete tanks at the density of 80 shrimps/tank (6 shrimps/sq.meter) for about 10 months. All of those were fed with artificial shrimp feed and raw fresh squid.

At the end of cultured period, the respective of the averages of survival rate, body weight, and total length of those broodstock were $73.75 \pm 1.25\%$, $105.41 \pm 2.82\text{g}$, and $22.82 \pm 0.13\text{cm}$, while the daily growth rates for the whole culture period were $0.2784 \pm 0.0111\text{ g/shrimp/day}$ and $0.0380 \pm 0.0021\text{ cm/shrimp/day}$. Moreover, group of cells which will be developed to sex cells were found when broodstock of male and female were observed histological. Results from this study had clearly shown that it can culture *P. monodon* to reach broodstock size in indoor concrete tanks. The future work will deal to develop the culture

system of those broodstocks in indoor, to elevate survival and growth.

Keywords: Production, Broodstocks, Black tiger shrimp, Concrete tank

22 Wanalux Wudthijinda. 1998. **Genetic diversity of black tiger prawn *Penaeus monodon*, Fabricius in Thailand.** Master Thesis. Chulalongkorn University. 95 p.

Randomly Amplified Polymorphic DNA (RAPD) analysis was used to examine genetic population structure of *Penaeus monodon* in Thailand using three primers (UBC268, UBC273 and UBC299). Five geographic samples ; Satun, Trang and Phangnga located in the Andaman Sea and Chumphon and Trat located in the Gulf of Thailand were collected. A total of 53 RAPD fragments ranging from 200-1600 bp in size were scored. Eighty-eight RAPD patterns were observed for overall samples (30, 32 and 26 patterns from UBC268, UBC273 and UBC299, respectively). Considering private haplotypes and distribution frequencies, *P. monodon* from Trat were genetically different from the remaining samples. The primer UBC268 generated a fragment of 260 bp in length found in almost all of Trat (90.2%) and Chumphon specimens (8%) but completely disappeared in those from the Andaman Sea (Satun, Trang and Phangnga).

Dendrograms constructed using unweight pair-group method with arithmetic average (UPGMA) allocated 5 geographic *P. monodon* samples to two genetically isolated groups constituting of Trat and Satun, Trang, Phungnga and Chumphon. Geographic heterogeneity analysis using pseudo chi-square test based on Monte Carlo simulation, indicated highly significant genetic differences of *P. monodon* between the Andaman Sea and the Gulf of Thailand ($P < 0.0001$). Within the population in the Gulf of Thailand, Chumphon and Trat there was also significant genetic differences ($P \leq 0.0001$). Five geographic samples of *P. monodon* could be regarded to be 3 separated stocks ; A (Trat), B (the Andaman Sea) and C (Chumphon).

Keywords: Genetic diversity; Genetic variation; RAPD; Black tiger prawn; *Penaeus monodon*; Population structure

23 Srirat Sodsuk and Panom K. Sodsuk. 1998. **Genetic diversity of banana shrimp from three locations in Thailand.** Technical paper No. 17/1998. National Aquaculture Genetics Research Institute. Department of Fisheries. 45 p.

Banana shrimp (*Penaeus merguensis* de Man) from three locations of Thailand (Chonburi, Surat Thani and Satun) were studied using starch gel

electrophoresis. A total of 26 enzyme loci were detected from pleopod, muscle and hepatopancreas. Five loci (*ALAT**, *GPI**, *IDHP**, *MPI** and *PGM-1**) were found to be polymorphic ($P_{0.95} = 0.192$). Mean expected heterozygosity for the species was $H_e = 0.066 \pm 0.028$. A number of genetic differences evaluated, inbreeding coefficients (F-statistics), polymorphic loci differences within each pair of populations and among all populations, genetic distances between populations and dendrograms constructed using genetic distances, showed that all 3 populations studied were different populations each of which had genetic relationship separated from each other. However, the two Gulf of Thailand populations, Chonburi and Surat Thani, were related to each other more closely than to the other Andaman Sea population, Satun. Thus, there are genetic evidences from this study for isolation between banana shrimp populations in the Gulf of Thailand and the Andaman Sea, and also between population in different areas within the Gulf of Thailand.

Keywords: *Penaeus merguensis*; Electrophoresis; Population genetics; Molecular genetics; Genetic differentiation; Genetic diversity.

24 Duangkamon Siludjai. 2000. **Genetic diversity and gene flow of giant tiger shrimp *Penaeus monodon* Fabricius in Thailand using PCR-RFLP of mitochondrial DNA.** Master Thesis. Chulalongkorn University. 124 p.

Genetic diversity of five geographic samples of *Penaeus monodon* in Thailand (Satun, Trang and Phangnga located in the Andaman Sea and Chumphon and Trat located in the Gulf of Thailand) was examined using PCR-RFLP of two mitochondrial genes composing of the 16S ribosomal (r) DNA digested with *Mbo* I and an intergenic region of cytochrome oxidase subunits I and II (COI-COII) digested with *Alu* I, *Mbo* I, *Taq* I, *Hinf* I and *Dde* I. Thirty-seven mtDNA composite haplotypes were identified and could be allocated into one or the other of two mtDNA lineages, A and B joined in a UPGMA dendrogram with the sequence divergence of 2.558%. The mtDNA haplotypes generated from digestion of an intergenic COI-COII with *Alu* I and *Taq* I represented these mtDNA lineages accurately offering simpler mtDNA typing in *P. monodon*. The average haplotype diversity of *P. monodon* mtDNA was 0.8548 ± 0.0001 . The average nucleotide diversity within and between samples was 3.3283% and 3.3648%, respectively. The nucleotide divergence of five *P. monodon* samples was 0.0365% implying degrees of population subdivisions *P. monodon*. Significant geographic heterogeneity was observed between the Andaman

Sea and the Gulf of Thailand samples ($P < 0.0001$). As a result, five *P. monodon* samples were differentiated to two different populations : A (Satun, Trang and Phangnga) and B (Chumphon and Trat). Results from this study indicated that potential female mediated dispersal (biased female gene flow) may exist between *P. monodon* from Trat and Chumphon.

Keywords: Genetic diversity; Giant tiger shrimp; *Penaeus monodon*; PCR-RFLP; Mitochondria DNA

25 Junya Rungsithum. 1999. **Molecular markers for identification of *Penaeus* species.** Master Thesis. Prince of Songklanakarin University. 85 p.

Genetic markers including nuclear DNA and mitochondrial DNA were Studied. The nuclear DNA marker such as specific primer S4 was used to amplify microsatellite DNA. The primer was specific to DNA of Banana prawn and the loci were polymorphic among individual. Two mitochondrial genes, 12S rRNA and 16S rRNA were obtained by using two pairs of universal primers to amplify the third domain of ribosomal RNA. DNA patterns obtained from the restricted digestion of PCR products from 12S rDNA with *Alu* I, *Bgl* II and *Sau*3AI have shown evidence that the marker could identify the species of *Metapenaeus* sp., *P. monodon* and Banana prawn from one another. In order to differentiate *P. indicus* and *P. merguensis* the sequences of 12S rDNA were compared, and 6.9% different. The restricted digestion patterns of PCR products from 16S rDNA with *Alu* I could also be used to identify *Metapenaeus* sp., *P. monodon* and Banana prawn. The sequence of 16S rDNA of *P. indicus* was 2.7% different from *P. merguensis*.

Keywords: Genetic markers; Nuclear DNA; Mitochondria DNA; Microsatellite DNA; Identification; Penaeid

26 Supon Tansuwan and Newes Ruangpanit. 1998. **Effect of salinity on ovarian development and copulation of pond reared broodstock of black tiger shrimp (*Penaeus monodon* Fabricius).** Technical paper No.17/1998. Pattani Coastal Aquaculture Station. Department of Fisheries. 14 p.

Effect of salinity at 25,30 and 35 ppt on spawning and copulation of farmed broodstock of black tiger shrimp was conducted. Twelve broodstocks of male (average body weight : 104.20 ± 12.68 g and average total length : 21.70 ± 0.96 cm) and the same number of female (average body weight : 114.38 ± 23.22 g and average total length : 22.18 ± 1.44 cm) were stocked in the spawning tanks (2 m³), each treatment with three replications separately. Fresh clam (horse mussel) was fed to each treatment 4 times a day, at the rate of

10% of shrimp body weight for 91 days experimental period.

The investigation began 1 week after shrimp familiar to the spawning tanks. Both male and female were ablated one of eye stalk and then the assessment was initiated. Results showed that the percentages of egg formation were 44.44, 50.00 and 61.11 and the copulation were 5.56, 22.22 and 22.22 for the 25, 30 and 35 ppt groups, respectively. There were no marked difference among the groups ($P>0.05$) on the average number of spawned eggs, rates of egg formation and rates of copulation. However, significant difference ($P<0.05$) was observed for the rates of hatching. Namely, those were highest for the 30 ppt group and lowest for the 25 ppt groups. Therefore, broodstock should be kept on 30 ppt salinity in order to have a high rates of egg formation. On the other hand, high value of hatching rate will be obtained if the broods were put on 30 ppt salinity when they spawn.

Keywords: Salinity; Ovarian development; Broodstocks; Copulation; Ponds; Black tiger shrimp; *Penaeus monodon*; Eyestalks

27 Sittichoke Janyong. 2002 **Effect of salinity levels and some minerals on ovarian development and spawning of giant tiger shrimp (*Penaeus monodon* Fabricius).** Master Thesis. Kasetsart University. 104 p.

173 pond cultured Giant Tiger Shrimp (*Penaeus monodon* Fabricius) rearing at 25 ppt (aged more than 1 year, weight of male and female shrimps were 88.2 ± 18.0 grams and 117.8 ± 34.2 grams, respectively), brought to carry out artificial insemination for study of ovarian development and spawning at 10, 20 and 30 ppt in 2.8 m^2 cement tanks at Sriracha Fisheries Research Station, Kasetsart University from June 2000 to November 2001 and measured concentration of 5 importantly major minerals such as sodium, potassium, calcium, magnesium and chloride.

The results showed that artificial inseminated female broodstock reared at 10 ppt. could not develop ovary to 4th stage (spawning stage), whereas female broodstock reared at 20 and 30 ppt could have 4th stage of ovarian development and spawning of 43.6% and 50.0%, respectively. The female broodstock reared at 20 ppt. could spawn and have good quality of eggs, but they could not hatch to become nauplius larvae. Whereas female broodstock cultured at 30 ppt. could spawn and hatch into nauplius with fertilizing rate and hatching rate of 79.4% and 64.2%, respectively, and then could be nursed to become post larva 15 with 20.1% survival rate. This study found out that minimum weight of female broodstock at 86 grams

could be artificial inseminated and had ovarian development, spawning, hatching to shrimp larvae and growing to become post larva 15 with 51.2% survival rate.

The results from analysis of 5 major mineral concentration showed that their concentration (mg/l) varied in regarding to salinity level of cultured water, and in haemolymph has minimum concentration of magnesium and maximum concentration of chloride. Sodium concentration in the haemolymph of female broodstock reared in those 3 salinity levels., were significantly different when statistically-tested with T-test at $P>0.05$. The female broodstock reared at 10 and 20 ppt. had higher mineral concentration in haemolymph than in cultured water (hypertonic), whereas mineral concentration in haemolymph were similar in cultured water for female broodstock culture at 30 ppt. (isotonic) which were the level that could lead to ovarian development, spawning and hatching to become shrimp larvae.

Keywords: Salinity; Minerals; Ovarian development; Spawn; Broodstocks; Giant tiger shrimp; *Penaeus monodon*; Artificial insemination

28 Thanawut Klowklieng, Visuth Verakulpiriyaa and Tawatchai Thongnoi. 2002. **Effect of raw fresh feed on copulation rate of pond reared *Penaeus monodon* broodstock.** In the 4th National Symposium on Marine Shrimp, 18-19 November 2002, Rayong Resort, Rayong. p. 277-286.

Even though the pond reared *Penaeus monodon* broodstock have been successfully developed by Department of Fisheries for many years, however, the quality of those broodstock could not be compatible to the wild caught shrimp due to the low rate of their copulation. In this study, we aimed to increase the tendency of the copulation rate of the pond reared shrimp broodstock by introducing the raw fresh feed. The 4-month old of pond reared shrimp were selected and stocked into 2 ponds (1.5 rai) with 5,000 shrimps each. These shrimp were fed with pelleted feed up to 10 months. Shrimp were then divided into 2 groups, the pond-1 fed 4 times a day with pelleted feed 3 times and one time with raw food, the pond-2 fed with pelleted feed 4 times daily. These shrimp were raised for another two months. By the end of feeding procedure, the survival and copulation rates were checked and determined.

Results Showed that the survival rate of shrimp from pond-1 and pond-2 was not different (23.76% and 24.12%), indicating the addition of raw feed did not elevate survival rate. However, it was clearly observed that the pond-1 had higher copulation rate than the pond-2 (38.23% and 18.31%), showing the effect of raw feed on the maturation and synchronized copulation of the broodstock. Twenty copulated females were brought to induce ovarian

maturation by eyestalk ablation raising in concrete tanks (15 m³) and fed with raw feed. It was found that the ovarian maturation rate, average number of eggs per female and the hatching rate to nauplii from pond-1 were 85.00%, 240,041 eggs/female, and 61.83% respectively and the pond-2 were 55.00%, 174,030 eggs/female, and 32.86%, respectively, suggesting the role of fresh feed to the maturation and copulation in shrimp broodstock. Histological observation of the ovaries did confirm the results and support the idea previously mentioned.

Keywords: Black tiger shrimp; *Penaeus monodon*; Spawner; Earthen pond; Fresh feed

29 อัญชลี ทศนาขจร. 2540. การศึกษาความแตกต่างแปรผันทางพันธุกรรมในประชากรกุ้งกุลาดำโดยการตรวจลายพิมพ์ดีเอ็นเอ ด้วยตัวตรวจสอบที่มีลำดับเบสซ้ำแบบง่าย. รายงานวิจัยฉบับสมบูรณ์. ภาควิชาชีวเคมี จุฬาลงกรณ์มหาวิทยาลัย. 14 น.

Two molecular methods, the Randomly Amplified Polymorphic DNA (RAPD) analysis and the microsatellite technique, were used in determining genetic variations in wild populations of the black tiger shrimps, *Penaeus monodon*, Fabricius. Specimens were collected from 5 geographically separated locations of *P. monodon* consisted of Satun-Trang, Phangnga, and Medan in the Andaman Sea and Chumphon and Trad in the Gulf of Thailand.

In the RAPD analysis using 7 arbitrarily selected primers, the percentages of polymorphic bands of 5 geographic populations investigated varied from 51.5-57.7%. The average similarity index within populations across all primers ranged from 0.86-0.89. The Phangnga *P. monodon* showed the highest level of within population similarity whereas the remaining populations showed slightly lower similarity index. The genetic distance between populations and UPGMA dendrograms indicated that Medan population was genetically different from Thai *P. monodon* (Dij = 14.976%). Within Thailand, the Satun-Trang *P. monodon* was separated from the remaining geographic populations with a genetic distance of 2.632%. RAPD analysis yielded a total of 252 genotypes. A Monte Carlo analysis illustrated geographic heterogeneity in genotype frequencies within this species suggesting that genetic population structure does exist in this taxon ($P < 0.001$ for all primer). Significant differences in genotype frequencies between Thai and Indonesian (Medan) *P. monodon* were observed ($P < 0.0001$). Within Thailand, The Andaman Sea *P. monodon* was significantly different from that of the Gulf of Thailand indicating population differentiation between *P.*

monodon from these two main fishery regions of Thailand.

In the microsatellite technique, Ninety-seven (GT)_n and 16 (CT)_n microsatellites were isolated from the partial genomic library of *P. monodon*. The microsatellites sequences were classified into three categories, perfect, imperfect and compound. The predominant categories found in *P. monodon* microsatellites are imperfect repeats for both (GT)_n and (CT)_n. Very long repeat arrays with the common repeat of 30-35 were found in *P. monodon* microsatellite clones which resulted in difficulties in primer design. Four microsatellite loci, CUPmo18, CUPmo13, CUPmo195, and CUPMO386, were successfully amplified. The number of alleles of each locus ranged from 14-28 alleles. Genetic diversity among populations of Thai *P. monodon* were examined at CUPMO18 locus. Differences in allelic distribution and heterozygosity were observed in all populations. A chi-square analysis using GENEPop indicated a significant difference between the population of *P. monodon* from the Andaman Sea and the Gulf of Thailand ($P < 0.05$).

Keywords: Genetic variation; Wild population; Randomly Amplified Polymorphic; RAPD; Microsatellite DNA; Black tiger shrimp; *Penaeus monodon*; Polymorphic band; Primers

30 Boonyaruth Pratoomchart and Chalermchai Suwanarak. 1997. **Sexual dimorphism, sex ratio and gametogenesis of intensive pond-reared *Penaeus monodon* Fabricius.** Technical Paper No.15/1997. National Aquaculture Genetics Research Institute. Department of Fisheries. 35 p.

Growth, sex ratio and gametogenesis of intensive pond-reared *Penaeus monodon* Fabricius were investigate in 8 ponds at 3 provinces, Trat, Chantaburi and Petchaburi. Results showed that growth rate of males, at 66 day of age, was slightly faster than females. The difference could be observed when the shrimps were averaged 9.4 g in wet weight or 23.25 mm in carapace length. The growth disparity between sex was significantly different ($P < 0.05$) after being cultured for 116 days; females were significantly larger than males ($P < 0.05$). Females was averaged 27.12 g, while males were 21.99 g. Females retained superior growth rate than males until harvest. Growth rate of females was increased significantly better than males ($P < 0.05$). At final harvest the size distribution of females was normally distributed whereas that of males was skewed to the left which indicated that production of females was higher than that of males.

The sex ratio of pond-reared *P. monodon* was 1:1.12 males : females. From the histological study of gamete development, gametogenesis of females was found to be slower than that of males. Spermatogonia

and oögonia were found at 33 days of age. After that, male gametes developed more rapidly. At the age of 135 days-old, a large number of spermatozoa and spermatids appeared in enlarged testis of males whereas only the early mature oocyte was found in enlarged ovaries of females.

Keywords: Sexual dimorphism; Sex ratio; Gametogenesis; Intensive culture; *Penaeus monodon*

31 Sakol Sangpradub, Arlo W. Fast, Somkiat Piyatiratitivorakul and Piamsak Menasveta. 1997. **Effects of different feeding regimes on ovarian maturation and spawning of pond-reared giant tiger prawn in Thailand.** Shrimp Biotechnology in Thailand (BIOTEC Publication 2/2540). p.191-200.

Large pond-reared *Penaeus monodon* were used in three maturation and spawning trials lasting 60 days. One group of prawns was fed a fresh diet only; a second group was supplied a fresh diet combined with a formulated pelleted diet; a third group of prawns received the formulated diet only. Total maturation ($N = 66$ and 55) and spawning events ($N = 63$ and 48) were much greater for prawns receiving only the fresh diet, and the combined fresh with formulated diets, respectively. Prawns receiving only the formulated diet matured only 12 times, and spawned 11 times. Prawns fed a fresh diet produced significant differences were seen in eggs produced per spawning even, % fertilization, %hatch or %metamorphosis from egg to protozoa. Female prawns exhibited greater mortality than did males, while females on the fresh diet only had greater mortality than did other females, presumably due to greater handling and other stress factors. Female prawns on a combined diet had lower mortality than females. The formulated diet used is suitable for supplementation but not as a sole maturation food.

Keywords: *Penaeus monodon*; Feeding; Ovarian maturation

32 Paitoon Akkayanont. 1996. **Studies on culturing ablated female broodstock, *Penaeus monodon* Fabricius for maturation and mating by feeding with a mixture of fresh feed and supplemented with 4 different levels alpha-tocopherol.** In Proceeding The Seminar on Fisheries 1996 18-20 September 1996 Anon Meeting Hall. National Inland Fisheries Institute. p. 220-227.

An experiment was conducted to study the effect of diet supplement with alpha-tocopherol (VE) on maturation and mating of ablated female

broodstock by feeding with a mixture of fresh feed (10%BW) and pellet feed (5%BW), supplemented or not with alpha-tocopherol (VE), obtain 4 treatment, at the level of 0%, 0.5%, 1.0% and 1.5% of pellet weight. An experimental design by CRD, 4 treatments and 3 replications. Twenty-one of broodstocks (female:male = 2.5:1), female had average TL 25.10 ± 1.02 cm and average wt 130.4 ± 15.4 g, were cultured in each 5 tons fiberglass tank with water flow through system for 1 month. Some water quality such as temperature, salinity, pH, alkalinity and hardness were $30.4-31.4^\circ\text{C}$, 33.9 ppt, 8.0, 124.9 mg/l and 7628.2 mg/l respectively. The results of the experiment showed that the pellet feed supplement with 0.5% VE mixed with fresh feed was the best for maturation and mating of ablated female broodstock on the percentage of gravid female, the number of nauplius and the hatchability of egg (more than 0% VE 2.3, 3.9 and 1.9 fold respectively).

Keywords: Culture; Eyestalks; Females; Broodstocks; *Penaeus monodon*; Mating; Fresh feed; Maturation; Pelleted feeds; Alphas-tocopherol

33 T. W. Flegel, Thanit Kusamran, Kamthon Kiatpathomchai, Seksun Kaewklum, Sirisak Sukrasem and Tirasak Pasharawipas. 1997. **An srRNA-gene fragment for positive control in nucleic acid hybridization tests with *Penaeus monodon*.** In Shrimp Biotechnology in Thailand. (BIOTEC Publication 2/2540). p. 79-84.

Procedures for the detection of shrimp pathogens by nucleic acid hybridization in dot blot and *in situ* tests are being more widely adopted. One requirement for these tests is a standard positive control for the integrity of the assay protocol itself. This work describes the use of a such a digoxigenin labeled probe based on a DNA fragment derived from the variable region of the rRNA gene of *Penaeus monodon*. The probe was produced by polymerase chain reaction (PCR) amplification using appropriately designed primers. It was shown to work successfully with dot-blot assays using shrimp DNA and RNA extracts. It was also successful with *in situ* hybridization tests using normal shrimp tissue sections and with shrimp hemolymph smears. The protocol developed for *in situ* hybridization with shrimp hemolymph smears may prove useful for easy and rapid testing for infectious agents in field laboratories.

Keywords: DNA; srRNA-gene; Hybridization; *Penaeus monodon*; Polymerase Chain Reaction; PCR; Primers

34 Pattira Taweepreda, Pornthep Plodpai, Jittipan Chavadej, Boonyarath Pratoomchat, Prasert Sobhon and Boonsirm Withyachumnarnkul. 2001. **Cortical**

reaction in the eggs of the black tiger shrimp *Penaeus monodon*. In The 3rd National Symposium on Marine Shrimp. p. 41-47.

This report describes morphological changes of the eggs of the black tiger shrimp *Penaeus monodon* upon contact with seawater, the process known as cortical reaction. Mature wild *P. monodon* female broodstock were caught from Andaman Sea and kept in the hatchery maturation tanks under 30 ppt seawater. After eyestalk ablation and the broodstock reached Stage IV ovarian maturation, they were isolated and allowed to spawn. At time of spawning, the animals were held in a small net-cage that was immersed in a shallow container with minimal amount of seawater, sufficient for spawning. Fertilized eggs were collected at 15 sec intervals post-spawning during the first 15 min, and 15 min intervals thereafter for two more hours. The samples were fixed and processed for light microscopy, scanning electron microscopy and transmission electron microscopy. As soon as the egg (277 µm) was released into seawater, the cortical rods that appeared in the peripheral cytoplasm were released out from the egg surface. At the early stages of cortical reaction, the rods began to emerge from the cortical crypts of the egg and elevated the thin fibrous investment coat that encompassed the egg from its surface. Each rod was approximately 40 µm long with a basal diameter of 2.5 µm and an apical diameter of 10 µm. Several sperm were observed on both the egg and the surface of the investment coat. The rods protruded from the surface and were completely expelled out within 45 sec to 4 min after leaving the gonopore. After the cortical reaction was completed, a jelly layer, "hatching envelope", around the egg was formed: and it was completed within 13-15 min after spawning. The sperm were observed in closely association with the egg surface; they showed no spikes as they had undergone acrosomal reaction.

Keywords: Cortical reaction; Eggs; Black tiger shrimp; *Penaeus monodon*; Eyestalks; Microscopes

35 Srisombat Wannaying and T. W. Flegel. 2001. Development of a specific DNA probe and PCR based technique for detection of *Vibrio harveyi* in Penaeid shrimp. In The 3rd National Symposium on Marine Shrimp. p. 163-172.

Luminous *Vibrio harveyi* has been confirmed to be a pathogenic agent associated with shrimp mortality and economic loss in growout ponds throughout Asia. To identify infectious agents for chemotherapy, speed is important for making real time pond management decisions. Thus, our aim was to develop rapid, sensitive and species-specific

DNA based methods for detection of *V. harveyi* without the need for bacterial isolation and purification. Since published reports of 16S rDNA comparisons for *Vibrio* sp. showed that distinction between *V. harveyi*, *V. alginolyticus*, *V. campbellii* and *V. vulnificus* was not possible tests, we tried to derive species specific genomic DNA fragment by shotgun cloning followed by screening using DNA dot blot and Southern blot hybridization technique. Although some selected clones gave strong positive hybridization signals with *V. harveyi* and not with most other bacteria tested, they did cross react with strains of *V. vulnificus*. To overcome the problem of cross reaction, selected candidate clone was sequenced and aligned. For sequence alignment. PVH48 showed not high homology with any DNA sequence in international databases (Genbank and EMBL databases). In addition, region chosen for primers were used to search for sequence similarity against all known sequences and test the possibility that primers would be amplified the specific PCR product for identification of *V. harveyi*. The results of these tests will also be presented.

Keywords: Specific DNA probe; PCR; DNA sequence; Primers; *Vibrio harveyi*; Penaeid; Shrimps

36 Suwit Wuthisuthimethavee. 1999. DNA marker technologies for biodiversity study in shrimp. Master Thesis. Kasetsart University. 101 p.

Four DNA extraction methods were tested for isolation of high molecular weight genomic DNA from shrimp. The proteinase K method modified from McCouch *et al.* (1988) gave the higher quality and quantity than others. Furthermore, genomic DNA also can be extracted from one month old of formaldehyde or ethanol fixed tissues using this extraction method. However, formaldehyde fixed tissue gave very low DNA yield. Total genomic DNA from shrimps were used for genetic diversity evaluation using three DNA marker technologies, mitochondrial-specific markers, random amplified polymorphic DNA (RAPD) and amplified fragment length polymorphism (AFLP). For mitochondrial-specific markers, eight shrimp species were examined using specific primers for 12s and 16s rDNA. Two monomorphic products of 415 bp and 520 bp fragments were obtained from 12s and 16s, respectively. After digestion of those monomorphic fragments with nine restriction enzymes, gave the total of 77 scorable loci. Percentage of polymorphic loci and Nei and Li similarity coefficient were ranging from 33.33 – 88.74 % and 0.1026 – 0.6667, respectively. Twelve shrimp species analyzed by three RAPD primers (OPAE06, OPAE07, OPAE09) gave the total of 51 scorable loci. Percentage of polymorphic loci and the the Nei and Li similarity coefficient were ranging from 48.34 – 100 % and

0.0000 – 0.5263, respectively. For the AFLP analysis, twelve shrimp species analyzed by two primer combinations (ER-GTC, MS-ACC and ER-GTC, MS-ACT) gave 150 scorable loci ranging from 200 bp to 726 bp in size. Percentage of polymorphic loci and the Nei and Li similarity coefficient were ranging from 33.33 – 100 % and 0.0000 – 0.6667, respectively. Genetic relationship among shrimp species was clearly shown by the dendrogram generated from mitochondrial-specific markers analysis. The species belong to the same genera were clustered to the same branch, and the grouping made using this technique is similar to the morphological classification. On the other hand, RAPD and AFLP gave too many genetics details causing ambiguous result for classification analysis among shrimp species, especially the species which closely related on the morphology to one another. However, these techniques could be used to evaluate genetic variation of within species.

Keywords: DNA marker; Biodiversity; Shrimps; Mitochondria; Randomly Amplified Polymorphic; RAPD; Amplified Fragment Length Polymorphism; AFLP

37 Piamsak Menasveta, Sakon Sangpradub, Somkiat Piyatiratitivorakul, and Arlo W. Fast. 1994. **Effects of broodstock size and source on ovarian maturation and spawning of *Penaeus monodon* Fabricius from the Gulf of Thailand.** Journal of the World Aquaculture Society. 25(1):141–149.

The effects of broodstock source (Pond-reared and wild-caught from shallow waters) and prawn size (large-weight > 120 g, and small-weight <110 g) on ovarian maturation and reproductive success of *Penaeus monodon* were evaluated. Large females underwent stage IV ovarian maturation and spawned with greater success than did small prawns. Both pond-reared and wild-caught females of the same size exhibited comparable maturation and spawning success. Large females rematured and spawned more frequently than small ones. Total eggs produced by large prawns was significantly greater than for small prawns; nevertheless, prawn source and size had no significant influence on amount of eggs spawned per spawning event. Egg quality varied greatly in terms of percent fertilization, hatching rate, and metamorphosis to first protozoa stage.

Keywords: Prawn size; Broodstocks; Ovarian maturation; Spawn; *Penaeus monodon*; Gulf of Thailand; Pond reared broodstock

38 Somkiat Piyatiratitivorakul, Theeranuj Sapayasant, Arlo W. Fast and Piamsak Menasveta.

1995. **Effects of salinity and prawn size on ovarian maturation of pond-reared *Penaeus monodon* Fabricius in Thailand.** Thai Journal of Aquatic Science, 1(2): 154-166.

Effects of hypersalinity and eyestalk ablation on maturation of female giant tiger prawn *Penaeus monodon* were investigated in closed recirculating system at 30 and 40 ppt. Hypersalinity acclimation, without eyestalk ablation, could positively accelerated ovarian development of adult *P. monodon*. The results showed a significant in gonad index with acclimation time in both 30 and 40 ppt seawater. Eyestalk ablation could induce ovarian maturation in pre-adult prawn (48-60 g). Hypersaline acclimation with eyestalk ablation positively affected ovarian development. For a good result, eyestalk ablation in hypersaline condition should not exceed 30 days. Eyestalk ablation with immediate acclimation in 40 ppt salinity for 30 days and then transferred to 30 ppt for another 15 days showed the best condition for inducing ovarian development of the pre-adult prawn.

Keywords: Hypersalinity; Eyestalks; Prawn size; Ovarian maturation; Ponds; Giant tiger prawn; *Penaeus monodon*; Closed recirculating system

39 Supattra Treerattrakool, Apinun Udomkit, Lily Eurwilaichitr, Burachai Sonthayanon and Sakon Panyim. 2001. **Expression of growth-related peptide, Pem-CMG, of *Penaeus monodon* in methylotrophic yeast *Pichia pastoris*.** In The 3rd National Symposium on Marine Shrimp. p. 83-89.

Crustacean hyperglycemic hormone (CHH), molt-inhibiting hormone (MIH) and gonad-inhibiting hormone (GIH) are members of novel peptide family produced from the X-organ sinus gland complex in the eyestalk of crustaceans. This peptide family plays important roles in controlling several physiological processes such as regulation of growth and reproduction. In this study, the cDNA encoding a peptide related to the CHH/MIH/GIH family (so-called Pem-CMG) of the black tiger prawn, *Penaeus monodon*, was successfully expressed in the yeast *Pichia pastoris* by *AOX1* promotor. The recombinant Pem-CMG was secreted into the culture medium using α -factor signal sequence from *Saccharomyces cerevisiae* with an accumulated yield of 150 mg/l in the induction medium. The N-terminus of the recombinant Pem-CMG was determined and the result showed that it was correctly processed. The recombinant Pem-CMG was purified by onestep reverse phase HPLC and was used in biological assay for CHH activity. The recombinant Pem-CMG produced from *P. pastoris* demonstrated the ability to elevate glucose level in the haemolymph of eyestalk-

ablated *P. monodon* suggesting that Pem-CMG possesses the activity of hyperglycemic hormone.

Keywords: Crustacean Hyperglycemic Hormone; CHH; Molt Inhibiting Hormone; MIH; Gonad Inhibiting Hormone; Pem CMG; Giant tiger prawn; *Penaeus monodon*; Yeasts; *Pichia pastoris*

40 Piamsak Menasveta, Somkiat Piyatiratitivorakul, Sompop Rungsupa, Nudol Moree and Arlo W. Fast. 1993. **Gonadal maturation and reproductive performance of giant tiger prawn (*Penaeus monodon* Fabricius) from Andaman Sea and pond-reared sources in Thailand.** *Aquaculture*. 116: 191-198.

Broodstock trials were conducted with *Penaeus monodon* to compare the gonadal maturation and reproductive performance of four combinations of broodstock: wild-caught, pond-reared, and two groups of cross-matings between wild-caught and pond-reared. Wild-caught broodstock were captured from an off-shore area of the Andaman Sea. The average weight of wild-caught females was almost double that of pond-reared females. Wild-caught broodstock produced significantly greater numbers of eggs than pond-reared broodstock, despite comparable egg quality. Cross-matings between broodstock from the two sources did not improve gonadal maturation or reproductive performance.

Keywords: Broodstocks; Gonadal maturation; Reproduction; Giant tiger prawn; *Penaeus monodon*; Andaman Sea; Wild populations; Cross mating

41 Boonsirm Withyachumnarnkul, Pornthep Plodphai, Gary Nash and Daniel Fegan. 2001. **Growth rate and reproductive performance of domesticated *Penaeus monodon* broodstock.** In The 3rd National Symposium on Marine Shrimp. p. 33-40.

Raising domesticated specific pathogen-free (SPF) *Penaeus monodon* broodstock is the main activity of Shrimp Culture Research and Development Company Limited (SCRD) in Thailand. The project has been running continuously from 1996 to the present (2001), with F5 domesticated *P. monodon* the latest generation produced. Reared under relatively low salinity seawater (8-12 ppt), F4 domesticated *P. monodon* grew with a linear increase from PL 15 to more than one year, with a variable rate among families. The average daily growth (ADG) varied from 0.19 to 0.35 g/d. At the time of this report, the maximum day of culture (DOC) was 450; the female shrimp body weights (BW) varied from 100

to 140 g. While that of the males ranged from 80-100 g. The survival rate (SR) from PL 15 to one year was 25-40%. Most of the females of 80 g upward were naturally inseminated in the rearing ponds, with visible sperm sacs in the thelycum. The females of more than 100 g BW were unilaterally eyestalk-ablated, and about 80 % of them had certain stages of ovarian maturation. But about 50% of them spawned. The period from eyestalk ablation to the first spawning was 4-25 days, and the number of spawnings was 1-6 times, with an average of 2.5 times per spawner. The number of eggs per spawner (i.e. fecundity) was 200,000-2,100,000, or an average of 800,000 eggs/spawner. With an average 38% hatching rate, the average nauplius production was 300,000/spawner. When sperm from wild male broodstock was used for artificial insemination, the hatching rate increased to 80%, with increased nauplii production per spawner. The larvae and postlarvae were indistinguishable from those of wild broodstock, and with an average SR of 25% from nauplius to PL 15, production was about 83,000 PL 15/spawner. These results provide confidence that domestication of *P. monodon* broodstock is commercially feasible, and with ongoing research on genetic selection, the performance of domesticated broodstock should match or surpass that of wild broodstock in the future.

Keywords: Growth; Reproduction; Domestication; *Penaeus monodon*; Broodstocks; Insemination; Eyestalk ablation; Survival; Fecundity

42 Watcharasuda Hualkasin, Waraporn Wanna, Junya Rungsithum, Pairoj Sirimontaporn, Ausa Chanumpai, Wilaiwan Chotigeat, Jacopo Querci and Amornrat Phongdara. 2002. **Identification of *Penaeus merguensis* and *Penaeus silasi* by mitochondrial DNA and ITS1.** In The 4th National Symposium on Marine Shrimp, 18-19 November 2002, Rayong Resort, Rayong. p. 62-69.

The closely related species, *Penaeus merguensis*, *Penaeus silasi* and *Penaeus indicus* were genetically examined based on sequencing of cytochrome oxidase subunit I (COI) and fragment sizes variation of ribosomal rDNA internal transcribed spacer (ITS1.) The sequence divergences of COI between *P. merguensis* and other *Penaeus* species were 5.76-6.15% (*P. silasi*). 13.17-13.97% (*P. indicus*). The COI sequence alignment reported the distinction of the four monophyletic clades, one within *P. silasi*, one within *P. indicus* and two among samples referred as *Penaeus merguensis*. The results from ITS1 length variation in size between 550-621 bp were amplified using specific primers designed for each species. These results of the size variation among *P. merguensis* are polyphyletic group while *P. silasi* are monophyletic group.

Keywords: Banana prawn; COI; Internal Transcribed Spacer; ITS1; Penaeid; White prawn; Mitochondria DNA; Identification

43 Watcharasuda Hualkasin, Junya Rungsithum, Waraporn Wanna, Pairoj Sirimontaporn, AUSA Chanumpai, W. Chotigeat and A. Phongdara. 2001. **Mitochondrial COI sequence variation in samples of *P. merguensis***. In The 3rd National Symposium on Marine Shrimp. p. 179-185.

Genetic diversity and heterogeneity of the banana prawn (*Penaeus merguensis*) in Thailand was examined. Specimens ($N=289$) collected from geographically different locales in peninsular Thailand were taxonomically identified. Twenty-eight individuals representing distribution range of *P. merguensis* were genetically examined based on sequencing of cytochrome oxidase subunit I (COI). High genetic diversity of *P. merguensis* was observed from DNA sequencing analysis ($h=0.983-1.000$). Large genetic differences were observed between *P. merguensis* and other penaeid shrimps (12.061% - 18.800%) while a lower difference (0.793%) was found intraspecifically. A lack of genetic heterogeneity between *P. merguensis* from the Andaman Sea and Gulf of Thailand ($P=0.2792$) implying a high gene flow level in this important species.

Keywords: *Penaeus merguensis*; COI; Genetic diversity; Sequences

44 Chetsada Pothiratan, Sakon Panyim and Chalermpon Ongvarrasopone. 2002. **Molecular identification of an octopamine/ tyramine receptor cDNA from black tiger prawn (*Penaeus monodon*)**. In The 4th National Symposium on Marine Shrimp, 18-19 November 2002, Rayong Resort, Rayong. p. 21-30.

Semiquantitative Reverse Transcription Polymerase Chain Reaction (RT-PCR) is a sensitive and reliable method to determine variations in RNA expression levels under different conditions. The single-stand cDNA was synthesized using reverse transcriptase and the amplification was performed together with an internal control, which is a housekeeping gene, such as 18S rRNA or beta-actin genes. The PCR product ratio between the interested gene and the internal control was determined in the exponential phase of amplification for a quantitative analysis of mRNA in the sample. In this study, we used this technique for detection of a change in mRNA expression levels of 8 immune related genes: anti-LPS factor, 11.5 kDa antibacterial protein (crustin), Penaeidin, HSP 90, HSP70, lysozyme, serine protease inhibitor and prophenol oxidase, in

response to *Vibrio harveyi* infection in the shrimp, *Penaeus monodon*.

Total RNA was isolated from healthy and *V. harveyi*-infected shrimps at 0, 3, 6, 12, 24 and 48 hour post injection (h.p.i) and subjected to the RT-PCR analysis. B-actin was used as an internal control to normalize for sample to sample variations in total RNA amounts. The results showed that the expression levels of anti-LPS factor, HSP90 and lysozyme were upregulated initially after infection. The highest expression was observed at 6 and 12 h.p.i. for anti-LPS factor and HSP90, respectively, where as the expression of lysozyme was still increased during 48 h.p.i. The expression level of anti-LPS factor increased by 1.6 fold, HSP90 by 2.7 fold and lysozyme by 2.1 fold. The expression of crustin was decreased to 0.4 fold at 3-6 h.p.i. whereas penaeidin showed the lowest expression at 12 hr. The expression level of serine protease inhibitor, prophenol oxidase and HSP70 did not change significantly during infection.

Keywords: Identification; Reverse Transcription Polymerase Chain Reaction; RT-PCR; Octopamine; Tyramine; Receptors; cDNA; Black tiger prawn; *Penaeus monodon*

45 Waraporn Wanna, Jean-Luc Rolland, Francois Bonhomme, Wilaiwan Chotigeat and Amornrat Phongdara. 2002. **Population genetic of *Penaeus merguensis* in Thailand using nuclear DNA marker**. In The 4th National Symposium on Marine Shrimp, 18-19 November 2002, Rayong Resort, Rayong. p. 70-76.

We report on genetic variability and structure in natural population of *P. merguensis*. The data consisted of three molecular marker analyzed 139 individuals collected from Trad, Songkhla, Satun and Trang. The number of alleles across all loci ranged from 12 to 18 and expected heterozygosity ranged from 0.063 to 0.621. Significant genetic differentiation was observed for almost all pairwise population comparison (ranging from 0.222 to 0.334). A distance tree inferred from Reynold's coancestry coefficient showed that *P. merguensis* populations clustered into two distinct group of population, the gulf of Thailand (Trad and Songkhla) and the Andaman sea (Satun and Trang).

Keywords: Population genetics; Banana prawn; *Penaeus merguensis*; Nuclear DNA markers

46 Boonyarath Pratoomchat, Somkiat Piyatitivorakul and Piamsak Menasveta. 1993. **Sperm quality of pond-reared and wild-caught *Penaeus monodon* in Thailand**. Journal of the World Aquaculture Society. 24 (4): 530 - 540.

Sperm quality, as determined by visual examination and by reaction with “egg-water” was not significantly different ($P>0.05$) for sperm obtained by electro-ejaculation from ablated or nonablated pond-reared *Penaeus monodon*, nor was sperm quality different between pond-reared and wild-caught prawns. Normal sperm, determined by appearance, ranged from 17.1 to 21.0%, while reactive sperm ranged from 1.5 to 3.0%. There were, however, significant correlations ($P<0.01$) between spermatophore weight and prawn weight ($r = 0.73$, $N = 434$). Male prawns weighing 41-50 g produced on average spermatophores weighing 22.7 mg and containing 0.8 million sperm, while prawns weighing 61-90 g produced on average spermatophores weighing 56.6 mg. With 2.5 million sperm. Ablation did not increase spermatophores size or sperm quality, although it significantly increased mortality of ablated males. Male prawns could be re-ejaculated at about weekly intervals with no change in sperm quality. Wild-caught female prawns artificially inseminated with spermatophores from electro-ejaculated males produced normal spawns with 51% average egg fertilization, and 41% nauplii hatch success. Nauplii hatch success following spawning increased from $>60\%$ for newly inseminated females to near zero after 30 days post-insemination, indicating spermatophore depletion and/or deteriorated sperm quality during spermatophore storage in the thelycum. The findings of the present study indicate that electro-ejaculation and artificial insemination are relatively simple and practical methods for improving captive reproduction performance of closed-thelycum prawns such as *P. monodon*, and that pond-reared and wild-caught males produced sperm of similar quality

Keywords: Sperm; Quality; Wild population; *Penaeus monodon*; Eggs; Electro-ejaculation; Artificial insemination

47 Sililux Chareonpon, Visanu Boonyawiwat and Tinawat Srisuk. 2001. **The variety analysis of VP28 envelop protein gene of shrimp white spot syndrome virus.** In The 3rd National Symposium on Marine Shrimp. p. 160–162.

White spot syndrome virus (WSSV) is a new invertebrate virus family, Whispoviridae. The virus has been found in many species of shrimps and crabs that caused considerable high mortality in shrimp. WSSV virions are double-stranded viral DNA, 290 kb in size. VP28 is found associated with envelop protein, that consist of 204 amino acids. In order to analysis the VP28 variation of WSSV from the central part of Thailand, we compared the VP28 gene of WSSV from 4

infected postlarvae and 6 infected juvenile shrimps. We designed specific primers for VP28 gene amplification by Polymerase Chain Reaction (PCR). The PCR products were directly sequenced by dideoxy chain terminating method. The sequences of 550 bp. of VP28 were compared and found that the VP28 gene of WSSV in the central part of Thailand was highly conserved.

Keywords: White Spot Syndrome Virus; WSSV; VP28 envelop protein gene; Polymerase Chain Reaction; PCR; Sequences

48 Warawan Sukrarurk. 1999. **Physiological responses of postlarva black tiger prawn *Penaeus monodon* to combined effects of salinity and water soluble fraction of Dubai crude oil.** Master Thesis. Chulalongkorn University. 71 p.

A study of effects of salinity and concentrations of water soluble fraction (WSF) of Dubai crude oil on black tiger prawn *Penaeus monodon* postlarvae was divided into 2 processes; acute toxicity testing and sublethal toxicity testing. The purpose of acute toxicity testing is to determine LC_{50} of WSF to *P. monodon* after exposure of 24, 48, 72 and 96 hrs. The level of WSF concentrations (100%, 75%, 50% and 25% of WSF) and salinity (14, 21, 28 and 35 ppt) were used for LC_{50} determination. Sublethal toxicity testing was done at 4 levels of salinity (14, 21, 28 and 35 ppt) and 4 levels of WSF concentrations (0, 20, 40 and 60 $\mu\text{g/l}$) by a completely randomized design involved factorials. *Penaeus monodon* were acclimated for a week before testing. In acute toxicity testing, 96-hr LC_{50} of WSF of Dubai crude oil on *P. monodon* at salinity 14, 21, 28 and 35 ppt was 81.55, 13.56, 40.65 and 80.05 $\mu\text{g/l}$, respectively. In the sublethal testing, there were interaction between salinity and concentrations of WSF on oxygen consumption rate, ammonia excretion rate and feeding rate. The highest oxygen consumption rate was 0.008 ± 0.005 mg $\text{O}_2/\text{gdw/hr}$ found in postlarval shrimp at salinity 14 ppt and the lowest oxygen consumption rate 0.007 ± 0.006 mg $\text{O}_2/\text{gdw/hr}$ was found at salinity 35 ppt. Ammonia excretion rate was the highest in salinity 14 ppt. 1.5666 ± 1.222 mg $\text{NH}_3/\text{gdw/hr}$ and the lowest ammonia excretion rate was 0.932 ± 0.671 mg $\text{NH}_3/\text{gdw/hr}$ at salinity 28 ppt. Feeding rate was highest at salinity 14 ppt. and lowest at salinity 35 ppt. (0.809 ± 0.248 mg dry weight *Artemia*/gdw/hr and 0.354 ± 0.108 mg dry weight *Artemia*/gdw/hr, respectively). For different concentrations of WSF, the feeding rate of *P. monodon* was found the highest value in WSF concentration 20 μg hydrocarbon/l (0.543 ± 0.285 mg dry weight *Artemia*/gdw/hr) and the lowest in 0 μg hydrocarbon/l (0.422 ± 0.137 mg dry weight *Artemia*/gdw/hr), respectively. The result indicated that total energy of prawns received from food was

mainly depleted in respiratory and excretory rather than growth in contamination environment, so that scope for growth (SFG) was lower than zero.

Keywords: Physiological response; Postlarvae; Black tiger prawn; *Penaeus monodon*; Salinity; Crude oil; Acute toxicity; Chronic toxicity

49 Sompop Rungsupha, Chalida Chamanon, Pavinee Patanachan, and Padermsak Jarayabhand. 1997. **Self marking streamer tag from cheap material in black tiger prawn pond cultured.** In the 35th Kasetsart University Annual Conference 3-5 February 1997. pp 181-186.

Selfmaking Streamer Tag was made from blue vinyl plastic sheet with size as widthxlength 0.50x3.50 cm. with shape as Sompop (1991). Taged to black tiger prawn, *Penaeus monodon*, with average total length 7.85 cm. and 4.18 gram average body weight, for 727 shrimps. And commercial tag size as 0.30x3.50 cm. about 248 shrimps, total taged shrimp (2 types) was 975 shrimps. Taged and no taged shrimps, total 18,000, were reared in 4 Rais earthen pond at Chachoengsao Coastal Aquaculture Development Center from 8 August to 13 September 1996 (35 days). Sampling both taged and no taged shrimps for 197 shrimps, found 12 selfmarking taged shrimps, or 1.65% of total taged and 5 commercial taged shrimps, or 2.01% of total taged. Average total length of selfmarking taged shrimp was 11.9 cm. and 13.7 gram average body weight with 227.75% growth rate. Commercial taged shrimp was 11.6 cm. average total length and 12.2 gram average body weight with 191.67% growth rate. No taged shrimp was 11.63 cm. average total length and 12.57 gm. Average body weight with 200.72% growth rate.

Keywords: Tag; Black tiger prawn; *Penaeus monodon*; Ponds; Culture; Chachoengsao

50 Renu Yashiro. 1990. **Evaluation of external and internal criteria on ovarian maturation of *Penaeus monodon* Fabricius.** In Proceeding The Seminar on Fisheries 1990 17-19 September 1990. National Inland Fisheries Institute. p. 259-271.

Evaluated on the relation among ovary index, gonad index, size, type and percentage of each type of oocyte also level of vitellogenin, the protein in haemolymph sera of *Penaeus monodon* during ovarian maturation. The vitellogenin level is highest at stage 3 before fully matured while the ovary and gonad indexes show highest value at stage 4 prior spawning. Undeveloped ovary have only primary oocyte, vitellogenic stages (stage 1

and stage 2) have primary and yolky oocyte, stage 3 have 3 types of oocyte and fully matured stage 4 have primary and cortical rod oocytes. The percentage of cortical rod oocyte increase toward spawning. Vitellogenin is necessary for maturation of oocyte. Environmental conditions and foods are related to ovarian development, reproductive and molting cycles are also related to each other and were reviewed here.

Keywords: Ovarian maturation; Ovaries; Gonad index; Eggs; Size; Vitellogenin; Protein; *Penaeus monodon*

51 Taweep Boonwanich. 1994. **Reproduction of *Penaeus merguensis* de Man of Southern Gulf of Thailand.** Technical Paper No. 1/1994. Southern Marine Fisheries Development Center. Department of Fisheries. 26 p.

The mortality of *Penaeus merguensis* de Man was estimated based on the length composition from push net and trawler in the Southern Gulf of Thailand during 1991-1992. The total mortality (Z) is 5.43 and the fishing mortality (F) is 3.07 while the natural mortality is 2.36. The cohort analysis give 46.5×10^6 of recruitment at length 5.0 cm. The reproduction of population, by change the length at first capture to 14.6 cm which is the length at first mature female, increase 25% from present status.

Keywords: Reproduction; Mortality; Length; *Penaeus merguensis*; Gulf of Thailand; Push net; Trawlers

52 Wanida Tripanichkul, Weerachai Singhaniyom, Weerapong Vuthiphanchai and Sumol Jueng-udomcharoen. 1997. **A study on spermatogenesis of the giant tiger prawn, *Penaeus monodon* Fabricius (Decapoda).** Kasetsart J. (Nat. Sci.) 31: 192-198.

Spermatogenesis in *Penaeus monodon* Fabricius was studied using light microscopy. Only one stage of spermatogenic cell, besides spermatogonia, was consistently found in any seminiferous tubules. Primary spermatocyte in Prophase I was characterized by a single large inclusion body located at one pole of the cell. Secondary spermatocyte division resulted in the formation of spermatid. Spermatid would undergo an elaborate period of differentiation resulting in the formation of sperm which was different from those of other living organisms in the Animal Kingdom.

Keywords: Spermatogenesis; Decapoda; *Penaeus monodon*; Giant tiger prawn

53 Wanida Tripanichkul, Weerachai Singhaniyom, Noppadol Intaratat and Sumol Jueng-udomcharoen.

1997. การศึกษาขบวนการ **spermatogenesis** และ **spermatogenic cell** ชนิดต่างๆ ของกุ้งกุลาดำเพศผู้ตัวเต็มวัย ด้วยกล้องจุลทรรศน์ธรรมดา และกล้องจุลทรรศน์อิเล็กตรอนชนิดส่องผ่าน. Department of Anatomy, Faculty of Medicine, Srinakharinwirot University. 20 p.

Spermatogenesis in *Penaeus monodon* was studied by light microscopy. One to two stage of spermatogenic cell, besides spermatogonia, was consistently found in any seminiferous tubules. Primary spermatocyte in Prophase I was characterized by single large inclusion body located at one pole of the cell. Secondary spermatocyte division followed closely upon the first. Spermatid contained numerous vesicles which fuse together forming single large vesicle. Afterward, acrosomal granule was formed within vesicle. Nuclear condensation and decondensation occurred in successive. Spike projected from acrosomal granule. Vesicle greatly reduced in its volume becoming a cap like structure. Structure of mature sperm was composed of uncondensed nucleus, cap, base, and spike.

Keywords: Spermatogenesis; Seminiferous tubules; Spermatogenic cell; Spermatogonia; *Penaeus monodon*; Males; Microscopes

54 Anutra Arkarajamon. 1991. **Histology of tiger shrimp (*Penaeus monodon* Fabricius)**. Master Thesis. Kasetsart University. 168 p.

Tiger shrimp (*Penaeus monodon*) histological study. Nine systems were described histologically.

The integumentary system is composed of the cuticle which covered all the exterior surfaces. The cuticle is composed of the epicuticle, the exocuticle, the endocuticle and the membranous layer. The epidermal layer lies beneath the cuticle and consists of simple columnar cells. The tegumental glands are present beneath the epidermis which is covered by the cuticle. In the muscular system only striated muscles are found. These are composed of the A-band, I-band and Z-line. The striated muscle is located throughout the body, visceral organs, blood vessel, and heart. Muscle fibers are divided into two types : tonic fibers and phasic fibers.

The circulatory system consists of a heart, arteries, capillaries, hemal sinuses and blood cells (hyalinocyte, semigranulocyte, granulocyte). The hematopoietic tissues are intimately associated with this system because of their involvement in the production of blood cells. The oka or lymphoid organ is considered to play an important role in the shrimp internal defence response.

The respiratory system consists of the gills and mastigobranch. Each gill is composed of central axis, primary gill filament, and secondary gill filament. The mastigobranch function as a cleaning structure of the gill filament.

The digestive system includes the alimentary tract and is divided into three parts : foregut, midgut and hindgut. The accessory digestive organ is the hepatopancreas. The foregut consists of oral, esophagus, and stomach. The midgut consists of the intestine, anterior midgut ceca, and posterior midgut ceca. The hindgut is composed of rectum and anus. The hepatopancreatic tubule is made up of four type of cells : the E-cells, the F-cells, the R-cells and the B-cells.

The excretory system or antennal gland consists of three parts : the coelomosac complex, the labyrinth, and the bladder. The epithelial cell of the coelomosac complex is composed of podocyte cells, and that lining of the labyrinth and bladder are simple cuboidal cells.

The nervous system and sense organs consist of brain or supraesophageal ganglions, segmental ganglions, ventral nerve cords, eyes, statocysts, hairs and antennae. The brain is divided into protocerebrum, deutocerebrum, and tritocerebrum. The eye is a compound eye which is composed of identical multiple units of ommatidia, functional light collecting units above the basement membrane, and the ganglion part which divided into medulla interna, medulla externa and medulla terminalis.

The endocrine organs consist of X-organ and sinus gland, Y-organ, and mandibular organ. X-organ are groups of neurosecretory cells divided into the organ of Bellonci and the organ of Hanstrom. The organ of Bellonci is located opposite to the sinus gland. The "Onion body" is associated with the organ of Bellonci. The organ of Hanstrom is associated with the medulla terminalis. The sinus gland collects hormones from X-organ before they are sent to the circulatory system. The Y-organ is made up of many folded cords of oval cells. The mandibular organ is a network of folded cords of polygonal cells. The latter two organs directly produce hormone for the circulatory system.

The reproductive system consists of the gonads which are bilateral lobes of one pair of anterior lobes, five pair of lateral lobes, and one pair of posterior lobes only found in the ovary. Ovary comprises of 5 generations of developing ova : oögonias, immature oocytes, early mature oocytes, mature oocytes, and ripe oocytes. The oviduct opens at the 3rd peripods. Testis consists of many seminiferous tubules in which 5 generations of developing cells are present : spermatogonias, primary spermatocytes, secondary spermatocytes, spermatids, and spermatozoa. The vas deferens is composed of four parts : proximal vas deferens, medial vas deferens, distal vas deferens, and terminal ampoules. The vas deferens lumen is

devided by a septum into primary and secondary lumen. The oviduct wall and septum are composed of glandular epithelium.

Keywords: Tiger shrimp; *Penaeus monodon*; Integument; Muscular system; Circulatory system; Respiratory system; Digestive system; Excretory system; Nervous system; Endocrine system;

55 Boonsri Jaruthamsopon and Pairoh Sutthakorn. 1990. **Preliminary study on distribution of post larvae of *Penaeus monodon* in Chalong Bay-Phuket Harbour and Nga cape.** Technical Paper No. 7/2533. Andaman Sea Fisheries Development Center, Department of Fisheries. 7 p.

Study on post larvae of *Penaeus monodon* by plankton net was observed during March to August and November 1989. Four post larvae were collected. One in May at Phuket Harbour (Sapanhin) and three in August of which one was from Chalong Bay two from Nga Cape.

Keywords: Distribution; Postlarvae; *Penaeus monodon*; Chalong Bay; Phuket Harbour; Nga Cape; Plankton net; Larvae

56 Suwanna Worasing, Chalor Limsuwan and Nongnuch Ruksakulthai. 1993. **Factors affect blue discoloration of pond-raised tiger prawn, *Penaeus monodon* Fabricius.** In Proceeding The Seminar on Fisheries 1993 Department of Fisheries 15-17 September 1993. National Inland Fisheries Institute, Bang Khen. p. 424-443.

Blue discoloration of pond-raised tiger prawn in Chantaburi and Trad province was studied. Throughout the period of cultivation cycle found that when there was less incidence of blue discoloration, planktons frequently found were diatom : *Chaetoceros* and *Coscinodiscus*. These two genus of diatom contained high amount of carotenes and xanthophylls, which directly affected blue discoloration. Blue tiger prawn contained lower amount of carotenoids when compared to normal shrimp. Low salinity and high transparency caused blue discoloration. Protein, moisture, fat and ash contents of both blue and normal shrimp are in the same range as value found in general shrimp.

Keywords: Blue discoloration; Tiger prawn; *Penaeus monodon*; Ponds; Carotenoids; Plankton; Salinity; Transparency

57 Anutra Arkarjamorn, Chalor Limsuwan and Gary Nash. 1993. **Development of the Oka Organ in postlarval black tiger shrimp (*Penaeus monodon* Fabricius).** In the 31st Kasetsart

University Annual Conference 3-6 February 1993. p. 515-521.

The oka or lymphoid organ consists of lymphoid cells around the 2 subgastric arteries. The oka organ at the non-developing stage is a paired structure, consists of lymphoid cells with a thin connective tissue capsule which forms a sheath around the blood vessel, above the hepatopancreas. The organ at the developing stage, a paired structure runs along each side of the lateral wall of anterior midgut ceca reaching the anterior surface of hepatopancreas as flattend globes which consist of many tubular units. The study of the development of the organ showed that in postlarvae 15 and 18 there was no-development, and there was early development in postlarvae 21 and development in postlarvae 24. At 20 days and 60 days post-stocking in the pond the size of the organ.

Keywords: Lymphoid organs; *Penaeus monodon*; Postlarvae; Hepatopancreas; Larvae

58 Taweep Boonwanich. 1993. **Relation of size and maturity of *Penaeus merguensis* de Man in southern gulf of Thailand.** Technical Paper No. 5/1993. Southern Marine Fisheries Development Center, Department of Fisheries. 25 p.

The estimated growth parameters of Banana shrimp (*Penaeus merguensis* de Man) in the Southern Gulf of Thailand, Nakhon si thammarat to Narathiwat, were analyzed based on the total length frequency data. The parameters were the coefficient of growth $K=1.40$, ultimate total length $TL_{\infty} = 25.89$ cm, age at length which is zero $t_0 = -0.0048$, and ultimate weight $W_{\infty} = 142.7$ g while $W = 3.38 \times 10^{-6} TL^{3.16}$. The ultimate body length BL_{∞} was 19.87 cm from the analyzed length relationships $BL = 0.617 TL^{1.067}$. The sex ratio (SR) were related to the length (L) in equation $SR(L)=1.364 e^{-2.886/(L-20.40)}$ and the probability of mature female (P) was $P(L)= 1.158 e^{-5.263/(L-8.34)}$ which might be referred to as the Johnson-Schumacher function. The resultant leads to the asymmetric sigmoid curve that the mean length at first mature female was 14.6 cm while the minimum length at first maturity was 8.34 cm.

Keywords: Growth; Size; Maturation; *Penaeus merguensis*; Gulf of Thailand

59 Renu Yashiro. 1991. **Relationship between external and internal criteria on ovarian maturation of *Penaeus monodon* Fabricius.** Technical Paper No. 8/1991. National Institute of Coastal Aquaculture, Songkhla. Department of Fisheries. 25 p.

Evaluated on the relation among ovary index, gonad index, size, type and percentage of each type

of oocyte also level of vitellogenin, the protein in haemolymph sera of *Penaeus monodon* during ovarian maturation. The vitellogenin level is highest at stage 3 before fully matured while the ovary and gonad indexes show highest value at stage 4 prior spawning. Undeveloped ovary have only primary oocyte, vitellogenic stages (stage 1 and stage 2) have primary and yolky oocyte, stage 3 have 3 types of oocyte and fully matured stage 4 have primary and cortical rod oocytes. The percentage of cortical rod oocyte increase toward spawning. Vitellogenin is necessary for maturation of oocyte. Environmental conditions and foods are related to ovarian development. Reproductive and molting cycles are also related to each other and were reviewed here.

Keywords: Ovaries; Gonad index; Ovarian maturation; Vitellogenin; *Penaeus monodon*

60 Boonyarath Pratoomchat, Somkiat Piyatirativorakul, Piamsak Menasveta and Arlo W. Fast. 1993. **Sperm Quality of Pond-Reared and Wild-Caught**. In Proceeding The Seminar on Fisheries 1993 Department of Fisheries 15-17 September 1993. National Inland Fisheries Institute, Bang Khen. 476-486.

Sperm quality, as determined by visual examination and by reaction with 'egg-water' was not significantly different. ($P > 0.05$) for sperm obtained by electro-ejaculation from ablated or nonablated pond-reared *Penaeus monodon*, nor was sperm quality different between pond-reared and wild-caught prawns. Normal sperm, determined by appearance, ranged from 17.1 to 21.0%, while reactive sperm ranged from 1.5 to 3.0%. There were, however, significant correlations ($P < 0.01$) between weight and prawn weight ($r = 0.73$, $n = 434$) spermatophores weighing 22.7 mg and containing 0.8 million sperm, while prawns weighing 61-90 g produced on average spermatophores of 56.6 mg with 2.5 million sperm. Ablation did not increase spermatophore size or sperm quality, although it significantly increased mortality of ablated males. Male prawns could be re-ejaculated at about weekly intervals with no change in sperm quality. Wild-caught female prawns artificially inseminated with spermatophores from electro-ejaculated males produced normal spawns with 51% average egg fertilization, and 41% nauplii hatch success. Nauplii hatch success following spawning increased from >60% for newly inseminated females to near zero after 30 days postinsemination, indicating spermatophore depletion and/or deteriorated sperm quality during spermatophore storage in the thelycum. Our findings indicate that electro-ejaculation and

artificial insemination are relatively simple and practical methods for improving captive reproduction performance of closed-thelycum prawns such as *P. monodon*, and that pond-reared and wild-caught males produced sperm of similar quality.

Keywords: Sperm; Quality; *Penaeus monodon*; Wild population; Ponds; Spermatophore; Eyestalk ablation; Electroejaculation; Artificial insemination; Eggs

61 Boonyarath Pratoomchat. 1991. **Sperm quality and optimal size of mature male giant tiger prawn (*Penaeus monodon* Fabricius) from pond-reared stock**. Master Thesis. Chulalongkorn University. 113 p.

Sperm quality of pond-reared male *Penaeus monodon* Fabricius at different sizes was determined by artificial insemination. Evaluations on the percentages of morphological normality of fertilized eggs, total fertilized eggs, morphological normality of live nauplii, morphological normality of total nauplii, and total hatched nauplii were used to interpret the results. Additionally, spermatophore weight, number of sperm per spermatophore, the percentages of morphological normality of sperm and active sperm were also used for studying sperm quality of pond-reared male at different sizes, eyestalk ablated and nonablated pond-reared males, wild and pond-reared males

Productions of eggs and nauplii in artificial insemination were positively affected by male size. The percentages of morphological normality of fertilized eggs, total fertilized eggs, and total hatched nauplii in pond-reared male with size between 60 g and 70 g body weight showed significantly higher than that of small sizes (36 – 40 g and 41–50 g). The larger sizes also showed significantly higher the percentages of morphological normality of both live and total nauplii than the smallest one.

Based on sperm examination, spermatophore weight and number of sperm per spermatophore of pond-reared male size of 60 g to 80 g body weight showed significantly higher than the smaller size groups. In contrast, the percentage of morphological normality of sperm and active sperm in the smallest size (22- 40 g) showed significantly higher than the larger ones. However, the optimal size of pond-reared males that may be recommended for broodstock should to be between 60 g and 70 g body weight.

The result of sperm quality showed no significant difference with spermatophore ejaculation frequency compared either within or between nonablated and eyestalk ablated pond-reared males. Wild and pond-reared males were similar in sperm quality, except spermatophore weight of wild males showed significantly higher than pond-reared males.

The study of sperm quality between in vas deferens and terminal ampoules showed significant

difference in both organ, but the sperm in terminal ampouls is more normal than that of in vas deferens. In addition, the result of the present study estimated that pond-reared male size of 13 g body weight or 28 mm in carapace length could exhibit the initial maturation.

Keywords: Sperm; Quality; Size; *Penaeus monodon*; Maturation; Artificial insemination; Eyestalks

62 Boonsri Jaruthamsophon. 1994. **Biology of banana prawn *Penaeus monodon* in Phan-nga Bay.** In Proceeding The Seminar on Fisheries 1994 19-21 September 1994 DOF Meeting Hall. National Inland Fisheries Institute. p.586-592.

The banana prawn (*Penaeus merguensis*) was found to be dominant species in Phang-Nga Bay. Two peaks of spawning season showed during the year, first in February and second from July to August. The number of male was recorded less than female in every month and the size composition of banana prawn caught by push net, set bag net and trammel net showed different size groups depending on the gear selectivity and efficiency of each type of gear and fishing ground. The relationship between carapace length and weight of male and female are

$W = .0004 CL^{3.21}$ and $W = .00065 CL^{3.08}$ respectively.

Keywords: Biology; Banana prawn; *Penaeus merguensis*; Phang-nga Bay; Push net; Set bag net; Trammel net

63 Chinda Nakrobruh. 1992. **Biology of *Penaeus merguensis* (postlarvae) in the Donsak river and adjacent area, Surat thani province.** Technical Paper No.17/1992. Bangkok Marine Fisheries Development Center. Department of Fisheries. 31 p.

The samples for study biology of *Penaeus merguensis* (Postlarval) were conducted during night time from January, 1987 to December, 1988 by using the plankton nets with 1 mm. of mesh size at Donsak river, Klong Ban-Huay and adjacent area. All samples were sorted into *P. merguensis* (Postlarval) counted and measured of carapace length (CL).

The main recruitment into Donsak river mouth and adjacent area occurred during in May-July and September-October. They were abundance in these are their number decreased inversely proportion to distance from the river mouth. The most postlarvae were found at 1.5 m.m. CL. The size of postlarvae in the sea has smaller than that in the river. All of them were more abundance in Southwest monsoon

than Northeast monsoon. Water temperature and depth of water showed no significant effect on their distribution but their numbers decreased as the salinity decreased.

Keywords: Biology; *Penaeus merguensis*; Postlarvae; Plankton net; Recruitment; Donsak river; Surat Thani

64 Suchart Sawangarraks. 1999. **Biological parameters of juvenile and sub-adult banana prawns, (*Penaeus merguensis*), inner part of Phang-nga bay.** Technical Paper No. 5/1992. Phuket Marine Biological Center. Department of Fisheries. 20 p.

The study on biological parameters of banana prawns, *Penaeus merguensis*, was carried out monthly from January to December 1993. Prawn samples were collected by a push net in nursery area of the inner part of Phang-nga Bay. Catch percentages of juvenile, sub-adult and adult banana prawns were 35, 62 and 3, respectively. The present study mainly emphasizes on juvenile and sub-adult stages. Carapace lengths of the prawn mainly distributed in a range between 10–20 mm.

The relationships of carapace length, total length and weight of juvenile and sub-adult banana prawns were $TL = 7.1604CL^{0.8839}$, $W = 0.8491CL^{3.0159}$ and $W = 0.0027TL^{3.381}$

The estimation of growth rate of juvenile and sub-adult prawns showed the coefficient of growth (K) as 1.12 per year and the ultimate carapace length (CL_{∞}) as 34.43 mm. The growth rate of carapace length ranged from 1.09 to 3.50 mm per month.

The recruitment pattern of banana prawns elucidated two batches of identical size in carapace length-frequency modes through one year time. The major recruitment of the prawn into the nursery ground fallied between late northeast monsoon and early southwest monsoon (January to July).

Keywords: Banana prawn; *Penaeus merguensis*; Juveniles; Adolescent; Growth; Recruitment

65 Pakjuta Kheamakorn. 1996. **Fishery biology of banana prawn *Penaeus merguensis* de man from push nets in Amphur Muang, Changwat Satun.** Master Thesis. Chulalongkorn University. 60 p.

The carapace length (CL, cm), total length (TL, cm) and weight (W, g) relationships of banana prawn *Penaeus merguensis* de Man in Amphur Muang, Changwat Satun were : $CL = 0.17 TL^{1.08}$, $W = 0.73 CL^{3.20}$, $W = (2.26 \times 10^{-3}) TL^{3.5}$ for male; $CL = 0.16 TL^{1.11}$, $W = 0.78 CL^{3.08}$, $W = (2.38 \times 10^{-3}) TL^{3.48}$ for female and $CL = 0.16 TL^{1.10}$, $W = 0.75 CL^{3.13}$, $W = (2.30 \times 10^{-3}) TL^{3.49}$ for both sexes. The asymptotic carapace length (CL_{∞}), asymptotic weight

(W_{∞}) and curvature parameter of both sexes were 3.44 cm, 35.85 g and 1.54 per year, respectively. The mean sex ratio of male to was 1 : 1.07. In October 1994, March April and July 1995, the number of female was significantly higher than male, but in September 1995, the number of male was significantly higher than female. The catching rate of banana prawn was not related to catching rate of other economic aquatic animals.

Keywords: Biology; Banana prawn; *Penaeus merguensis*; Push net; Satun

66 Matana Boonyubon. 1996. **Biological and life cycle of banana prawns *Penaeus merguensis* in Bandon bay, Surat Thani province.** Technical Paper No. 28/1996. Bangkok Marine Fisheries Development Center. 61 p.

The study of the biology and life history of banana prawn, *Penaeus merguensis* in Donsak River and adjacent sea, Surat-thani Province, Bandon Bay was taken during 1987-1993. The climate of the southern Thailand displays seasonal fluctuations due to the effect of the Southwest Monsoon (May-August) and Northeast Monsoon (October-December/January) which bring rain to this area for at least 8 months of the year. The monthly rainfall over 5 years average were in the range from 2.3 mm in February to 332.5 mm in November. The salinity of water in Donsak River fluctuated due to the amount of rainfall ranged from 15 ppt. in November to 31.5 ppt. in April. The surface water temperature ranged from 27.5°C in January to 31.5°C in April.

Planktonic postlarval banana prawns, *Penaeus merguensis* were found at Donsak River mouth throughout of the year with the most confined to the period preceeding to the beginning of the two monsoons. Incoming postlarvae settled out in the shallow water along the bank of the Donsak River within 10 m. from the bank, aged about 1 month and passed through the juvenile. They moved to the deeper area as they grew, so larger juveniles found in deeper area, aged about 2-3 months. Emigration of prawns from river occurred throughout of the year with peaks in the monsoons period.

After leaving the river, prawns passed through the sub-adult, stayed in the shallow coastal sea in a short period, aged about 3-4 months, then they moved to the deeper sea to spawn. They spawned all year round, found mature females more in the period August to January than February to June.

Length-frequency analysis and model progression were used to derive growth rate during the estuarine phase of the life cycle. 14 cohorts of prawns were identified. The coefficient of growth (K) was 4.62 per year, ultimate carapace length (L_{∞}) was 37.43 mm.

Combining seasonal abundance of various life history stages as well as size-frequency distribution from postlarvae, juveniles, sub-adults and adults and growth rate, it is possible to obtain the generation time of each group to be about 6 months. Since the survival of juveniles and the emigration of the prawns depended largely on the rain, so with the two rainy seasons (from two monsoons) coupled with the two peaks of spawning activities each year will result in two main generations or groups each year. Juveniles of both generations contributed directly to a year-round offshore fishery.

The study on the environmental factor effective to the prawns recruitment has been done and found that the amount of recruitments in coastal area varied with the amount of rainfall.

Since the report indicated the importance of the coastal resources in making the life cycle of *Penaeus merguensis* completed. Therefore, protecting the juveniles in their mangroved nursery area as well as the parental stock in their spawning grounds and seasons were suggested, such that the enforcement of the existing conservation measures should be concentrated to the very most sensitive areas.

Keywords: Biology; Life cycle; Banana prawn; *Penaeus merguensis*; Bandon Bay; Surat Thani; Monsoons

67 Pensri Boonruang and Suchat Sawangareruks. 1996. **Ecology of postlarvae and juvenile of penaeid shrimp in a mangrove estuary and adjacent area in Phang-nga bay.** In Proceeding the Seminar on Fisheries 1996 Department of Fisheries 18-20 September 1996. National Inland Fisheries Institute 320-332.

The study of shrimp larvae and environmental factors in the mangrove estuary at Marui River and adjacent area in Phang-nga Bay was carried out during February 1991 to December 1993. The environmental factors at Marui River has an influencing from freshwater runoff from land during the south-west moonsoon period from May to September. This cause the salinity decrease to 0.26% in September, October and November 1993 at the inner part of the river, but near the mouth of the river, salinity ranged from 22.75% to 33.44% in 1993.

The most abundant species of penaeid larvae found during the south west moonsoon period were *Penaeus merguensis* and *Metapenaeus* sp. and during the north-east moonsoon period were *Parapenaeopsis* sp. and *Metapenaeopsis* sp. The other kind of shrimp such as *Acetes* sp. was also found maximum during the south-west moonsoon period.

The relationship of salinity and the number of shrimp larvae was found that the *Penaeus merguensis* and *Parapenaeopsis* sp. inhabitat in the

area where there is a wide range of salinity from 2.3% to 33.4% but the other kind of shrimp larvae was found less at the area where the salinity was low. The immigration of shrimp larvae *Penaeus merguensis* and *Parapenaeopsis* sp. into the mangrove estuary were recorded in maximum number at the time of high tide and also abundant during the south-west monsoon period. The other kinds of shrimp were found less abundant in mangrove estuary but found more abundant at the infront of mangrove area. This suggested that this area was the main nursery area for economically important of shrimp larvae in Phang-nga bay.

Keywords: Ecology; Environmental factors; Abundance; Salinity; Postlarvae; Juveniles; Penaeid; Mangroves; Estuaries; Phang-Nga Bay

68 Jaruwan Mahitthi. 1998. **Effect of varying salinity levels on osmoregulation of giant tiger prawn *Penaeus monodon* Fabricius.** Master Thesis. Chulalongkorn University. 105 p.

Effects of salinity, eye ablation and L-carnitine feed supplementation on osmoregulation of subadult *Penaeus monodon* were studied with 4 levels of salinity (5, 17, 30 and 42 ppt) Effects of salinity on sodium, potassium and magnesium concentration in haemolymph were at different salinities while calcium concentration were not different in all salinities. The isoionic crossover medium was 19.84 ppt for sodium ion, 23.45 ppt for potassium ion and 22.18 ppt for calcium ion. Sodium, potassium and magnesium ions in the haemolymph were hyperionic regulation to medium at below isoionic concentration and hypoionic regulation at above. Magnesium ion was hypoionic regulation to those of the medium at all salinities. Eye ablation seemed to have no effect compare to the intact prawn on osmoregulation. When they were transferred from 17 ppt to 5 ppt or 30 ppt to 42 ppt. L-carnitine supplementation seem to have higher survival rate than control group when rearing in 30 ppt but more experiment must be confirmed. This study showed that subadult *Penaeus monodon* can regulated themselves to environmental effect in the type of osmoregulation.

Keywords: Salinity; Osmoregulation; Giant tiger prawn; *Penaeus monodon*; Eyestalks; L-carnitine; Feed supplementation

69 Vira Jareonpak and Chaiwat Vichaiwattana. 1999. **Effect of temperature change on spawning of banana shrimp (*Penaeus merguensis*).** Technical Paper No. 8/1999. Nakornsrihammarat Coastal Aquaculture Station, Surattani Coastal Aquaculture. Department of Fisheries. 21 p.

An experiment on the effect of temperature on the spawning of Banana Shrimps was carried out. The shrimps were treated in 3 sets of temperature including 28, 25 and 22°C. The experiment was divided into 2 periods. In the 1st period, the shrimp spawners were stocked individually into plastic bags insulated in foamed boxes at 20:00 pm and survival percentage was observed at the 6th hours thereafter. In the 2nd period, the spawners were released from the plastic bags into spawning tank filled with 31 °C water temperature. The results revealed that all of the spawners were survived and without spawning during the 1st period and were totally survived and spawned during the 2nd period at 31 °C water temperature. The pre-spawning periods (account from 20:00 pm to the occurrence of the spawning) were 8.00±1.17, 9.30±1.10 and 10.10±1.22 hours, respectively. Statistically, the pre-spawning periods of the shrimps treated in 25 and 22 °C were not different (P>0.05) but both of them were significantly different (P<0.05) from those treated in 28 °C. The average spawning percentages of the eggs were 71.84±22.00, 75.71±19.66 and 78.74±20.46%, respectively, in which no statistically different (P>0.05) were computed. It was found that each batch of eggs from each spawner were hatched. The average hatching percentages of the eggs were 46.09± 20.35, 53.32±22.23 and 42.68±21.68% respectively, in which no statistically (P>0.05) were computed. The average hatching periods were 10.20±1.06, 10.20±1.07 and 13.14±1.35 hours, respectively. The average hatching periods of the eggs of the shrimps treated in 28 and 25 °C were not significantly different (P>0.05) but both of them were significantly different from those treated in 22 °C (P<0.05).

Keywords: Banana shrimp; *Penaeus merguensis*; Temperature; Spawning; Spawner; Hatch

70 Thanom Pimoljinda and Nanthawan Santisathitkul. 2001. **Effect of nereids on maturation and production of *Penaeus monodon*.** Andaman Marine Shrimp Research and Development Center, Phuket. Department of Fisheries. 10 p.

The aim of this experiment was to find the effect of nereids (*Perinereis* sp.) on maturation and production of *Penaeus monodon*. The first experiment group, the prawns came from private hatchery, total length about 25.7 centimeters, already ablated eyestalk and spawned in one month. After 18 days in experimental period, broodstocks fed with nereids, had three spawns but none in feeding with squid (control). The second group, the prawns came from a wild near Phuket Islands, total length about 22 centimeters and made them ablation after 20 days of experiment. It showed that on 50 days of testing, all of broodstock neither feeding with nereids nor squid, form eggs completely before or after eyestalk

ablation. The last group, the prawns came from the same place of the second, total length about 23 centimeters and made all females to be ablated on time. After 6 days, there were eight spawners in nereids and three spawner in squid. From the results of three groups, it seemed that broodstocks fed with nereids formed eggs better than squid.

Finally showed that good spawner of prawns must be suitable size and making ablated eyestalk, eating good food and the important thing is sperm that to be good and enough for the reproduction.

Keywords: Nereids; Maturation; Production; *Penaeus monodon*, Eyestalks

71 Jiraporn Trisak. 1990. **Molthing periods of *Penaeus monodon* Fabricius and the experiments on molting stimulation by water changing, salinity control, eyestalk ablation and application of teaseed cake.** Master Thesis. Kasetsart University. 56 p.

Intermolt periods of *Penaeus monodon* Fabricius increased with the increasing in size of the experimental shrimps. Average intermolt periods were 2.6 days for postlarval stage 20-25, 5.2 days for 1.5-1.7 inches shrimp, 14.8 days for 3-4 inches shrimp, 20.4 days for 4.4-4.8 inches shrimp, and 26 days for 5.2-5.8 inches shrimps.

Neither increasing of the rate of daily water changing from 20% to 60% nor decreasing water salinity in the range of 10-30 ppt has any significant effects on molting cycle of *Penaeus monodon*. Treatment of teaseed cake at the concentration of 5, 10, 15, and 20 ppm has no significant effects on molting period of the shrimp. Eyestalk ablation also has no significant effects on molting period of 3.3-3.4 inches *Penaeus monodon*.

Keywords: Moulting; *Penaeus monodon*; Salinity; Eyestalk ablation; Teaseed cake

72 Pirote Pongladar. 1995. **Molting periods of black tiger shrimp (*Penaeus monodon*) in culture pond.** Master Thesis. Kasetsart University. 113 p.

Molting periods of black tiger shrimp (*Penaeus monodon*) were studied in intensive cultured ponds. Water qualities during culture period were as followed: temperature 27-28°C, pH 7.7-8.4, salinity 9-18 ppt. and transparency 25-50 cm. The molting periods of shrimp weight 3.8-7 g, 6.7-9.5 g, 8.4-14.3 g, 10.4-18.2 g, 12.6-20 g, 15.3-23.7 g, 17.3-22.3 g and 20-28.3 g were 6, 7, 8, 9, 10, 11, 12 and 14 days, respectively.

Feeding rates of shrimp during and after molting period were also studies. The feeding rate of

molting shrimp weight 3.8-28.6 g, decreased 16-21 percent and after molting the feeding rate increased 16-22 percent. Size and weight of hepatopancreas of nearly molted shrimp was less than hard shell shrimp of the same size. The cuticle of nearly molted shrimp is composed of the epicuticle, the exocuticle, the endocuticle, the membranous layer and the new cuticle under the old one but in newly molted shrimp there are only epicuticle and exocuticle.

Keywords: Moulting; Black tiger shrimp; *Penaeus monodon*; Culture pond; Feeding; Cuticles

73 Umporn Thongkukiatikullplew. 1997. **รายงานการวิจัยเรื่องศึกษานิตของเอนไซม์ในกระเพาะอาหารกุ้งกุลาดำ.** Department of Bilology, Faculty of Science, Burapha University. 23 p.

Results on enzymic activity of post-larvae (P_5) of *Penaeus monodon* showed that cellulase and amylase activity were low at 37 °c. The activity revealed the peak when the shrimp was about two months. The activity of protease was high in juvenile shrimp and was low in matured organism. The activity of cellulase, amylase and protease at different pH levels was investigated and the result showed that pH 6 was optimal.

Keywords: Cellulase; Amylase; Protease; Stomach; *Penaeus monodon*

74 Nongnuch Tangkerkolan and Worawith Cheewaporn. 2001. **Study on adaptive physiology of *Penaeus monodon* as an indicator of heavy metal pollution in the marine environment.** Department of Aquatic Science, Faculty of Science, Burapha University. 53 p.

Study on the effects of cadmium and mercury on percentage of survival and LC_{50} was done in shrimp *Penaeus monodon*. It has been found that percentage of survival of shrimps in seawater with cadmium concentration 0.0, 1.0, 1.5, 2.0, 2.5, 3.0, 3.5 and 4.0 ppm within 96 hours were 100%, 100%, 90%, 67%, 17% and 0% respectively, and LC_{50} -96h was 2.42 ppm. The percentage of survival of shrimps in seawater with mercury concentration 0.0, 0.1, 0.2, 0.3, 0.4 and 0.5 ppm. within 96 hours were 100%, 80%, 40%, 17% and 0% respectively, and LC_{50} -96h was 0.25 ppm. Rates of oxygen consumption of shrimps reared in seawater with cadmium concentration 0, 0.1, 0.5 and 1.0 mg/l were 6.21 ± 1.53 , 6.92 ± 1.21 , 4.87 ± 1.24 and 4.37 ± 12.8 $\mu\text{mol.g}^{-1}.\text{h}^{-1}$ respectively. Rates of oxygen consumption of shrimps reared in seawater with mercury concentration 0, 0.01, 0.05 and 0.1 mg/l were 6.14 ± 1.33 , 5.56 ± 1.03 , 5.07 ± 0.80 and 4.17 ± 1.13 $\mu\text{mol.g}^{-1}.\text{h}^{-1}$ respectively. For osmoregulation study, it

has been found that osmolality of blood of shrimp reared in seawater with cadmium and mercury decreased with the increase concentration of both heavy metals. Osmolality of blood of shrimp reared in seawater with cadmium concentration 0, 0.1, 0.5 and 1.0 mg/l were 636.50 ± 10.33 , 628.21 ± 8.66 , 591.29 ± 7.37 and 559.93 ± 7.94 respectively. Osmolality of blood of shrimp reared in seawater with mercury concentration 0, 0.01, 0.05 and 0.1 mg/l were 686.71 ± 7.23 , 626.0 ± 13.48 , 573.25 ± 14.38 and 536.71 ± 7.25 respectively. The analysis of cadmium and mercury in the reared shrimps found that the concentration of cadmium and mercury in the head region of shrimp was higher than in the body and the concentration found in both regions increased with the concentration of both cadmium and mercury.

From the results, it is indicated that shrimps may not abruptly died after exposed to cadmium and mercury. But both heavy metals may accumulate in shrimps and result in the change of their physiology. The changes in the rates of oxygen consumption and the osmolalities of shrimps may reflect the change in environmental of habitat in which shrimps live.

Keywords: Physiology; *Penaeus monodon*; Indicators; Pollution loading; Heavy metals; Cadmium; Mercury; Oxygen consumption; Osmoregulation; LC₅₀

75 Manoch Roongratri and Wanchai Laitim. 1992. **Spawning seasons and some biological aspects of banana prawn (*Penaeus merguensis*) along the Eastern coast of the Gulf of Thailand.** Technical Paper No. 33/1992. Eastern Marine Fisheries Development Center. Department of Fisheries. 33 p.

Banana prawn in the eastern coast of the Gulf of Thailand spawn all year round. Four peaks of spawning seasons occur annually; January, June, September and December. The adult females banana prawn are found off-shore with all four gonad developmental stages, while the juveniles with the gonad developmental stage I are found near-shore. The average size at first maturity is 15.25 cm. To determine the carapace-length and total length relationship by least square method, the relationships for males and females were found to be represented by the equations of $y = 11.5134 + 4.40311x$ and $y = 24.9078 + 3.81219x$ respectively. To relate carapace length to total weight by allometric equations for males and females, the equations giving the best fit to the data were found to be $W = 0.000688658 CL^{3.07083}$ and $W = 0.001125765 CL^{2.002313}$ respectively. The larval development of Banana prawn were consisted 12 stages and they spend the time from first nauplius

stage to first postlarva stage approximately 10 days. The character of each stages of larval development was described.

Keywords: Spawning season; Biology; Banana prawn; *Penaeus merguensis*; Coast; Gulf of Thailand

76 Renu Yashiro. 1990. **Methods for molt and ovary staging in marine shrimp.** Technical Paper No. 9/1990. National Institute of Coastal Aquaculture, Songkhla. Department of Fisheries. 12 p.

Molt and ovary staging for marine shrimp were described. Practical 2 methods for determination of molting stages are presented. Firstly, the cutting method which cut at endopodite and examined under light microscope. Staging based on Smith and Dall (1986). Secondly, roughly method by examination at the tip of uropod and pleopod including observed color of body. The postmolt, intermolt/early premolt and late premolt were identified roughly. The ovary staging from outline of ovary was made quantification by using ovary index, actual identification of ovary stages 1 to 4 based on tiger prawn (*Penaeus monodon*).

Keywords: Moulting; Ovaries; Marine shrimps

77 Renu Yashiro and Pitsanu Na-anan. 1997. **Reproductive performance, moulting interval and artificial insemination of *Penaeus monodon* from Andaman sea.** Technical Paper No. 7/1997. National Institute of Coastal Aquaculture. Department of Fisheries. 16 p.

Reproduction, moulting interval and artificial insemination (AI) of *Penaeus monodon* broodstock from the Andaman coast were studied. The results showed ovarian maturation in ablated female was superior to unablated female broodstock both in term of spawning frequencies and number of spawned eggs. Number of spawned eggs (but not nauplii) from ablated females was significantly higher ($P < 0.05$) than from unablated females. Furthermore, number of spawned eggs and nauplii from broodstock fed with ecdysone feed (monosex stocking) were not significant different ($P > 0.05$) from group fed normal food (mixed sexes stocking). Percentage of mated females was decreased from 73.3% to 20.2% within 18 days in pond stocked all female, 80% to 40% within 19 days and 100% to 40% within 21 days from ponds stocked with both sexes. Among male broodstock from empty to full terminal ampoules (TA) took 20 days in pond fed food without MT, and took 4-23 days in pond fed with MT mixed food, 63.6% of studied males had full TA within 23 days, 18.2% in 11 and 4 days. However, no significant different ($P > 0.05$) on percentage of full sacs males

each check among groups tested for effect of MT and stocking style within 73 days. Moulting interval in female broodstock was significantly longer ($P < 0.05$) than the male. Moulting interval in the monosex ponds was rather shorter than in mixed sex ponds with no statistical different ($P > 0.05$). Total production of $5,913.25 \times 10^3$ eggs and $1,144.3 \times 10^3$ nauplii were hatched from this experiment and 96.57% of nauplii were resulted from AI. Eggs from the AI females gave significantly higher ($P < 0.05$) hatching rate than the non-AI. Successful AI was obtained from insemination in the same day of moulting or less than 2 days after moulting, AI after moulting more than 2 days resulted in no hatching. However, percentage of successful AI still low (25%), therefore, improvement of AI method would be an interesting topic to research in the future.

Keywords: Reproduction; Moulting; Artificial insemination; Broodstocks; *Penaeus monodon*; Andaman Sea; Methyltestosterone; Sperm sac; Eyestalks

78 Rungcharoen Kanchanomai, Malinee Limpoka, Naroumol Klangkaew, Napasorn Paochoosak and Kanokwan Bangnoi. 2001. **Bioavailability of predigestible multi-grain supplement in black tiger shrimp (*Penaeus monodon*)**. In The 3rd National Symposium on Marine Shrimp. p. 132 - 139.

The bioavailability of predigestible supplement from multi-grain was investigated in black tiger shrimp (*Penaeus monodon*). Haemolymph samples were randomly collected from each shrimp at 0, 15 min, 30 min, 1, 1.5, 2, 3 and 4 hours following single oral administration at the dose levels of 0.2 gm/kg, 0.5 gm/kg and 0.75 gm/kg of shrimp and following mixing in feed at the rate of 10% for 12 weeks. The rate and amount of digestion and absorption of supplement under studied was evaluated by means of glucose, total protein and albumin levels in haemolymph comparing to those of normal feed trial and glucose D-Solution trial. Peak glucose value was found within 15 min to 1 hour and returned to the normal range by 3 to 4 hours period. The rate of appearance of glucose was comparable to that of glucose-D solution trial. The haemolymph glucose profile found indicated that supplement under studied is in highly digestible form. It is rapidly and completely absorbed into the haemolymph system by the shrimp. Also, the range of total protein levels appeared to be higher than those of glucose-D solution and normal feed trial.

In conclusion, predigestible multi-grain concentrate would be valuable alternative supplement from natural products for shrimp.

Keywords: Digest; Supplement; Haemolymph; Black tiger prawn; *Penaeus monodon*

79 Yaowaluck Roshorm, Chetsada Pothiratanana, Sakol Panyim and Chalermpon Ongvarrasopone. 2002. **Characterization of a novel serotonin receptor from *Penaeus monodon***. In The 4th National Symposium on Marine Shrimp, 18-19 November 2002, Rayong Resort, Rayong. p. 31-41.

Serotonin (5-HT, 5-hydroxytryptamine) is a neurotransmitter that has a variety of functions both in vertebrates and invertebrates. In crustacean, it has been proposed to stimulate the release of gonad stimulating hormone from brain and thoracic ganglia and resulted in an induced ovarian maturation and spawning. Serotonin modulates its various physiological functions by interacting with different serotonin receptors (5-HT receptors) which most of them are members of a G-protein coupled receptor family. The purpose of this project is to isolate the full length cDNA of a putative 5-HT receptor in *Penaeus monodon* (black tiger prawn). Total RNAs isolated from an ovary (stage III) of a wild broodstock, and brain and thoracic ganglia of juvenile prawns were reverse transcribed by using an oligo (dT) primer and Impromp-IITM reverse transcriptase. The double stranded cDNAs were amplified by using two degenerate primers corresponding to the conserved amino acid sequences in the third (TM III) and seventh (TM VII) transmembrane domains of 5-HT₁ receptors from invertebrates species. The PCR product of 800 base pairs was cloned and sequenced. Deduced amino acid sequences were blasted in GENBANK database and showed high amino acid sequence identities with invertebrates and showed high amino acid sequence identities with invertebrates and vertebrates 5-HT₁ receptors. In order to get the full length cDNA of this 5-HT receptor, 3' and 5' end cDNAs were amplified by 3' and 5' Rapid Amplification of cDNA End (RACE) method. PCR products of 400 and 600 base pairs were obtained from 3' and 5' RACE, respectively. The nucleotide and deduced amino acid sequences obtained from 5' end, transmembrane domains and 3' end were combined and blasted in GENBANK database. The results showed high amino acid sequence identities with invertebrates and vertebrates 5-HT₁ receptors, especially 5-HT₁ receptors. The sequence analysis showed that this 5-HT receptor contained seven transmembrane domains, a characteristic of G-protein coupled receptors. Moreover, it presented a large third intracellular loop, a short carboxy tail and several conserved amino acids which are characteristic of 5-HT₁ receptor family. Sequence comparisons revealed that this receptor shared amino acid sequence identity (86% to 53%) to the following 5-HT receptors: 5HT-Dros2A > 5HT-Bom > 5HT-Lym1 > 5HT-Ap2 > 5HT-Hum1

>5HT-Dro7> 5HT-Dro2. From these information implied that this *P. monodon* 5-HT receptor may be a 5-HT₁-like receptor.

Keywords: Serotonin; Receptors; *Penaeus monodon*; PCR; Primers; Sequences

80 Theeranuj Sapayasant, Somkiat Piyatiratitivorakul and Piamsak Menasveta. 1991. **Effect eyestalk ablation on osmoregulation of *Penaeus monodon* Fabricius.** In Proceeding the Third Technical Conference on Living Aquatic Ressources 17–18 January 1991. p. 230-240

Study of hypersalinity and eyestalk ablation effects on osmoregulation of subadult giant tiger prawn, *Penaeus monodon* Fabricius was performed in closed recirculating water system. The results indicated that subadult *P. monodon* is hypohyperosmoregulation in salinities range 20 ppt to 45 ppt. The isosmotic point for this animal was 28ppt. Eyestalk ablation influenced osmoregulation significantly. Haemolymph concentration of the ablated prawn was lower than the unablated one. After hypersaline acclimation at 30 and 40 ppt for 1, 2, 7, 15, 30, and 45 days, haemolymph concentration of subadult prawn had no significant difference between the two groups.

Keywords: Hypersalinity; Eyestalks; Osmoregulation; Giant tiger prawn; *Penaeus monodon*; Closed recirculating system

81 Pongthep Chonchoochati. 1993. **Microanatomy of the optic ganglia and the neurosecretory cells in the eyestalk of adult giant tiger prawn *Penaeus monodon* Fabricius.** Master Thesis. Kasetsart University. 101 p.

The microanatomy of the optic ganglia of *Penaeus monodon* Fabricius was examined by reconstruction from stained serial sections. There are four optic ganglia arranged in a consecutive manner : a distal lamina ganglionaris followed by a medulla externis, medulla internis, and medulla terminalis. Typically, the major components of ganglia are present : cell rind, neurosecretory cells, blood sinuses and glial cells.

The optic ganglia neurosecretory cells are distinguishable into six types based on size, location and presence of secretory material in the perikaryon. They are found within each of the ganglia, except in the lamina ganglionaris. They are collected into ganglionic X-organs in the other three ganglia : three medulla externis X-organ groups (MEX1, MEX2, MEX3), one medulla internis X-organ group (MIX), and two medulla terminalis X-organ groups (MTGX1 and MTGX2). All ganglionic X-organ groups send their combined

fiber tracts into the sinus gland. The MEX1 group send its fiber tract into the lamina ganglionaris. The common crustacean eyestalk structure, the organ of Bellonci, is wholly contained within the dorsal surface of the medulla terminalis. It is a group of onion body cells.

Keywords: Microanatomy; Neurosecretory cells; Eyestalks; Giant tiger prawn; *Penaeus monodon*

82 Manoch Roongratri. 1993. **Spawning seasons and some biological aspects of green tiger prawn, *Penaeus semisulcatus*, western king prawn, *P. latisulcatus*, and banana prawn, *P. merguensis*, along the Eastern coast of the Gulf of Thailand.** In Marine Fisheries Research Bulletin Vol. 4 June 1993, Eastern Marine Fisheries Development Center (EMDEC) Rayong. p. 37–43.

The spawning seasons and some biological aspects of Green Tiger prawn, *Penaeus semisulcatus*, Western King prawn, *P. latisulcatus* and Banana prawn *P. merguensis*, which are the major economically important penaeid prawns found along the eastern coast of the Gulf of Thailand were studied. All have similar peak spawning seasons which occur in January to May and August to December. Females are found sexually matured primarily in February and September for Green Tiger prawn; February and March for Western King prawn; and January, June, September and December for Banana prawn. The average sizes for sexually mature females of Green Tiger prawn, Western King prawn, and Banana prawn occur at 14.83, 16.21 and 15.25 cm, respectively.

Keywords: Spawning season; Biology; Green tiger prawn; *Penaeus semisulcatus*; Western king prawn; *Penaeus latisulcatus*; Banana prawn; *Penaeus merguensis*; Gulf of Thailand; Coast

83 Boonyarath Pratoomchat, Somkiat Piyatiratitivorakul and Piamsak Menasveta. 1991. **Sperm quality of male *Penaeus monodon* Fabricius from pond-reared stock.** In Proceeding the Third Technical Conference on Living Aquatic Resources 17–18 January 1991. Chulalongkorn University, p.241 - 255

Sperm quality of pond-reared male *Penaeus monodon* Fabricius at different sizes was evaluated by the method of artificial insemination. The percentages of morphologically normal fertilized eggs, total fertilized eggs, morphologically normal live nauplii, morphologically normal total nauplii, and total hatched nauplii were used to interpret the results.

The production of eggs and nauplii resulted from artificial insemination was positively affected by

male size. The percentages of morphologically normal fertilized eggs, total fertilized eggs, and total hatched nauplii in pond-reared male with size between 60–70 g body weight showed significantly higher than that of small sizes (36–40 g and 41–50 g). The larger sizes also showed significantly higher the percentages of morphologically normal live and total nauplii than the smallest one.

The optimal size of pond-reared males that may be recommended for broodstock should to be between 60 g and 70 g body weight. This size class shows full maturity and high sperm quality.

Keywords: Sperm; *Penaeus monodon*; Artificial insemination; Size

84 Boonsri Jaruthamsopon and Thawatchai Janthawong. 1990. **Distribution of *Penaeus* spp. in Phangnga bay- Krabi bay and the west coast of Phuket island.** Technical Paper No. 5/1990. Andaman Sea Fisheries Development Center. Department of Fisheries. 16 p.

There are seven adult species belonging to the genus *Penaeus* around Phangnga Bay–Krabi Bay and the west coast of Phuket Island, viz. *P. monodon* Fabricius, *P. semisulcatus* de Haan, *P. canaliculatus* Olivier, *P. merguensis* de Man, *P. japonicus* Bate, *P. latisulcatus* Kishinouye, and *P. longistylus* Kubo. From 4 cruises survey in February, April, June and September 1988, only 3 species are found on the west coast of Phuket Island, viz. *P. semisulcatus*, *P. monodon* and *P. canaliculatus* while all 7 species have been detected in Phangnga Bay – Krabi Bay.

Keywords: Distribution; Penaeid; Phang-Nga Bay; Krabi Bay; Phuket Island

85 Wiwattanachai Promsakha na Sakonkakhon and Somporn Losawatkul. 1998. **Distribution and relative abundance of shrimp resources in the Gulf of Thailand.** Academic Report of Resourced Survey Group No.2/1998, Marine Fisheries Division. Department of Fisheries. 64 p.

This paper reviews from the economic and biological perspectives the importance of marine shrimps in The Gulf of Thailand. Data from the Research Vessels Pramong 4 and Pramong 5 during the period 1976–1986 which are summarized in this paper, provided an excellent baseline for comparison with information from other sources.

Of 9 major species of marine shrimps, regarded here as “large shrimp”, the infrequent spawning of members of Genus *Penaeus* limited by their hard thelycum plate except the time following molting could be one of the reasons for their decline in the

heavily exploited Gulf of Thailand. The other three large shrimp species and small shrimps have withstood the heavy fishing pressure well as their soft thelycum plates readily permit deposit of sperm sac without undergone molting.

The Gulf of Thailand is a small body of water, oceanographically speaking. With the intricate and uncertain patterns of flow of the surface currents, all marine shrimps are believed to belong to the same population. Their relative abundance revealed by earlier investigations perhaps attributes to the inshore conditions which influence the survival of shrimp juveniles carried in by the prevailing oceanic current. The large volume of freshwater from the Gulf’s terrestrial border on the three sides, and the surge of sea water from the South China Sea create periodic “up welling” and “down welling” in the Gulf. The survival and abundance of the shrimps depend on how well they can take the oceanography of the Gulf to their advantage.

Over the period of almost three decades of heavy rates of exploitation, the Gulf of Thailand has seen a steadily declining catch per effort reduction in standing crops, alteration in species composition, catch of younger and smaller marine animals, and sensitive species facing unfortunate risk of extinction.

Keywords: Distribution; Abundance; Shrimps; Resources; Gulf of Thailand; Economics; Biology; Upwelling; Downwelling

86 Wudthichai Wungkahart. 1998. **Study on gears efficiency of trammel net for banana prawn (*Penaeus merguensis*) in Phang-nga bay.** Master Thesis. Kasetsart University. 101 p.

Study on gear efficiency of trammel net for banana prawn (*Penaeus merguensis*) in Phang-nga Bay deployed at the depth of 9–11 meters near Ko Nakhae, Ko Nakaya and Ko Yai which is the fishing ground for trammel net fishery of fishermen in Ban Hin-rom Thumbon Klong kaen Amphor Takuathung Phang-nga Province. The experiment was carried out in May to August 1977. Completely randomized design was planned at different 3 mesh size of inner net 37, 40 and 43 mm. Total aquatic animal caught were 100 species with 57 species of fishes, 11 species of shrimps, 13 species of crabs, 6 species of stomatopods, 5 species of cephalopods, 5 species of mollusk and 3 species of other fauna. Most of the catches (41.75% of the total catch) were fish, while the target species (*P. merguensis*) was caught at 24.46 percent of the total catch. There were non-significant different on the catchability of total catch among three mesh size of the inner net ($P > 0.05$), but significant different on the catch ability of *P. merguensis* ($P < 0.05$) in mesh size of inner net 37 mm. lower than that of 40 and 43 mm. there were

non-significant different on size of *P. merguensis* between three mesh size of inner net ($P>0.05$).

The results of income and profit analysis from three mesh size of inner net of trammel net such as : gross revenue, cash income, household income, net income and net profit from the total catch were non-significant different ($P>0.05$), but significant different on the income from the caught of *P. merguensis* ($P<0.05$) in mesh size of inner net 37 mm. lower than that of 40 and 43 mm.

The most suitable mesh size for the inner net of the banana prawn trammel net in Phang-nga bay is 43 mm. It should be promoted through extension to the fishermen, because it guarantees a good catch rate of banana prawn of suitable size and a good economic return.

Keywords: Efficiency; Trammel net; Banana prawn; *Penaeus merguensis*; Phang-Nga Bay; Gross revenue; Household income; Profits

87 Peera Aosomboon and Therapat Supasiripong. 1996. **Study on efficiency of trammel net with different mesh depths.** Technical Paper No. 41/1996. Andaman Sea Fisheries Development Center, Phuket. Department of Fisheries. 26 p.

Experiment on the efficiency of trammel nets which have three different mesh depths: 30, 40 and 50 meshes, was carried out in Phang-nga Bay at depth between 6–18 meters. In the total catch, fishes were the highest portion with a figure of 65.53 % while the target shrimps comprised 14.09% and among these *Metapenaeus sp.* and *Penaeus merguensis* were the major groups. Differences of shrimp catch rate by three different nets were not significant. However, significance was found in the total catch, The trammel net of 50 meshes depth showed highest catch rate and differed significantly with the other two. Total catch rates from 30 and 40 meshes depth did not differ significantly.

Keywords: Efficiency; Trammel net; Mesh depth; Catch rate

88 Pensri Boonruaing and Suchart Sawangarreraks. 1990. **Abundance and distribution of Penaeid postlarvae and other larvae in Phang-nga bay and adjacent area.** In Proceeding the Seminar on Fisheries 1990 Department of Fisheries. 17-19 September 1990 National Inland Fisheries Institute, Bang Khen. p. 148–164.

This study on abundance and distribution of penaeid postlarvae and other larvae was conducted in Phangnga Bay and adjacent area during January–December 1987–1988. The samples were

collected by a larval net and a small beam trawl. 13 stations along the coast-line with water depth of 1–4 m were sampled. Many Kinds of economically important penaeid postlarvae utilized the sheltered Phangnga Bay as nursery ground. They were *Penaeus merguensis* (De Man, 1888) *P. semisulcatus* (De Haan, 1844) *P. latisulcatus* (Kishinouye, 1896) *P. monodon* (Fabricius, 1798) *Metapenaeus sp.* *Parapenaeopsis sp.*, *Metapenaeopsis sp.* *Trachypenaeus sp.* and other kinds of shrimp such and Mysid, *Acetes sp.* and Caridea.

It was found that the maximum abundance of penaeid postlarvae occurred during the south-west moonsoon period between May–October. Many species of penaeid postlarvae were widely distributed in the bay. Only some species were concentrated the inner part and along the west coast of the bay such as *P. merguensis* while *P. semisulcatus* and *P. latisulcatus* were concentrated near the seagrass beds along the west coast of the bay and the east coast of Phuket Island. The abundance of other groups such as Mysid, *Acetes sp.* and Caridea were recorded in the paper.

Keywords: Abundance; Distribution; Penaeid; Postlarvae; Beam trawler; Nets; Trawlers; Phang-Nga Bay

89 Thumronk Amornsakun. 1989. **Study on *Penaeus merguensis* in Pattani Bay.** Department of Fisheries Technology, Faculty of Science and Technology, Prince of Songkla University. 7 p.

Study on *Penaeus merguensis* in Pattani Bay during the period October 1988. September 1989. I studied the distribution of *Penaeus merguensis* in relation to other aquatic animals every months. It was found that showed the minimum number of *Penaeus merguensis* in Pattani Bay was 5.53 % and maximum in June was 53.40 % of the aquatic animals. The average annual salinity in the bay was 25.4 ppt (14.5–30.0 ppt.) and the average annual transparency was 30.75 cm. (24.0–41.5 cm.)

Keywords: Population; Banana prawn; *Penaeus merguensis*; Pattani Bay

90 in Thai

91 Wiwattanachai Promsakha Na Sakonnakhon and Saramison Uraiwan. 1987. **Trawling survey of Ko Samui and Ko Phangan fishing grounds after 3-month closure to fishing in the three province.** Academic Report of Resources Survey Group No.4, Division of Marine Fisheries, Department of Fisheries. 41 p.

The Ministerial Directive issued by Ministry of Agriculture and Co-operative to effect closure of the

fishing ground within the provincial boundary of Prachuab Kirikhan, Chumphon, and Surat Thani on the Gulf of Thailand's western coast aims at giving economic marine animals a chance to breed and their young to grow. The enforcement period from February 15 to May 15 each year is suggested by a number of investigation findings as a peak of breeding season of a majority of marine animals. The Directive took effect from the 1985 breeding season.

This report is the result of the trawling experiments carried out in 1981 and 1986 by the Research Vessels Pramong 4 and Pramong 5 in around Ko Samui and Ko Phangan area within Surat Thani province. The data from the two investigations permit a direct comparison of the catch per unit of effort that could have been influenced by the fishing regulation.

The night time catch per unit of effort of the Research Vessels for 1986 was lower than that of 1981. The members of "trashfish" group was the least affected with the reduction of 18 percent in weight. The large economic shrimps (comprising 5 *Penaeus* and 3 *Metapenaeus* species) registered a precipitated reduction of 63 percent, and the small economic shrimps 34 percent. However, *Metapenaeus affinis* a member of large economic shrimps, did not show any decrease in the subsequent catch, while *Penaeus latisulcatus* which contributed a small proportion to the large shrimp catch, showed an increase. The depths did not show a noticeable difference in the shrimp catches.

It is quite logical that marine shrimps as a whole derive a minimal benefit from the Ministerial Directive as most of them spawn almost throughout the year at various depths. The non-fishing period could, on the other hand, allow the natural shrimp enemies to propagate, thus the Directive could worsen the situation for young marine shrimps. The sustenance in the catch of certain shrimps could attribute to the possible protection from fishing by the Directive of their brood stocks that subsequently bred successfully.

In absence of the information on the enforcement of the Directive, it is not possible to conclude that fishing pressure did reduce during the closed season. Most, it not all, marine animals are influenced by oceanographic factors which largely follow lunar periodicity. Local fishing communities, despite the popular use of the Gregorian calendar, still adhere to their lunar calendar for the purpose of fishing. It is therefore suggested that future directives be timed by lunar cycles that concur more closely with the marine animals behaviours. Communication with fishing communities about time on lunar calendar is believed to be more effective.

Keywords: Surveys; Ko Samui; Ko Pha-ngan

92 Tawatchai Chantawong, Praulai Chantawong and Chairat Suksawat. 1994. **Shrimp monitoring survey off the North of Phang-Nga province.** Technical Paper No. 31/1994, Resources Survey Group, Andaman Sea Fisheries Development Center, Marine Fisheries Division, Department of Fisheries. 48 p.

Shrimp resource monitoring was carried out by the Mexican trawl net at Ko Phra Thong and its adjacent area, Phang-Nga Province, during NE and SW monsoon in 1992 – 1993. Fifty-six night hauls from 5 cruises were operated. The average catch rate (CPUE) was 66.75 kg/hr, which composed of demersal fish, trash fish, shrimps, cephalopods, other invertebrates and pelagic fish with figures of 33.99, 22.87, 6.09, 2.43, 0.70 and 0.67, respectively. The total biomass from all areas was 3,252.9 tonnes which averaged 810.27 kg/km². The average catch in SW monsoon (111.98 kg/hr) showed higher than that in NE monsoon (53.06). The most productive fish appeared to be at the depths 26–35 m and a distance less than 10 Nautical miles from shore lines. In addition high fish production was also found at Ko La.

Six species of *Penaeus* sp. were identified, i.e. *P. semisulcatus*, *P. latisulcatus*, *P. canaliculatus*, *P. monodon*, *P. longistylus* and *P. japonicus*. Two species of *Metapenaeus* sp. were found, i.e. *M. ensis* and *M. anchistus*. Size distribution of economically important species were reported. A total of 67 families were found, including rays, shark and mantis shrimp. Diversity of organism appeared to be high at the upper portion of the study areas and decreased in the south direction. Space distribution was illustrated into 3 patterns.

Keywords: Shrimps; Mexican trawl net; *Penaeus monodon*; *Penaeus latisulcatus*; *Penaeus longistylus*; *Metapenaeus*; Phang-nga

93 Kaewalee Viboonkit. 2002. **Species diversity of penaeid shrimps genus *Penaeus* found in upper Gulf of Thailand.** Master Thesis. Kasetsart University. 217 p.

Study on species diversity of Penaeid shrimps, the genus *Penaeus* were collected from fish ports, fish landing places and fish markets as well as from eleven Provinces in the Upper Gulf of Thailand i.e. Trat, Chanthaburi, Rayong, Chonburi, Chachoensao, Samutprakhon, Samutsakhon, Samutsongkhram, Petchaburi, Prachuap Khiri Khan and Bangkok. Seventy-eight positions of the microsatellite markers of *Penaeus monodon* (Fabricius) have been used for identification the DNA pattern, morphology characters and morphometric measurement of these

specimens. The results showed that these specimens were identified into 8 species and can be divided into 3 groups. The first group is consisted of *Penaeus monodon* (Fabricius) and *P. semisulcatus* (De Haan) which can be distinguished by DNA pattern at the position DFUPm316. The second group is composed of *P. indicus* (H. Milne Edwards), *P. merguensis* (De Man) and *P. silasi* (Muthu and Motoh). The results showed that *P. indicus* is more genetically similar to *P. merguensis* than to *P. silasi*. It was found that, *P. indicus* and *P. merguensis* can be distinguished from *P. silasi* at the position DFUPm130 and DFUPm316, however, *P. indicus* is more morphological characters similar to *P. silasi* than to *P. merguensis*. The third group is composed of *P. japonicus* (Bate), *P. latisulcatus* (Kishinouye) and *P. longistylus* (Kubo). It was found that, *P. latisulcatus* is more genetically similar to *P. japonicus* than to *P. longistylus* which can be distinguished at the position DFUPm118. However, the results from morphological study showed that, *P. latisulcatus* is more morphological characters similar to *P. longistylus* than to *P. japonicus*. The results from analyzed DNA comparing with the morphological characters (adrostral carina and sulcus length and hepatic carina) can be applied to improve morphological character key, establishment of DNA pattern key be using microsatellite markers and morpho-genetic key for species identification of these shrimps.

Keywords: Species diversity; Penaeid; Gulf of Thailand; Microsatellite markers

94 Kesaya Nilvanich. 1999. **Community structure of prawns in Tha Chin mangrove estuary, Samut Sakhon province.** Master Thesis. Chulalongkorn University. 152 p.

Community structure of prawns in the Tha Chin mangrove estuary, Samut Sakhon province, was investigated on bimonthly schedule of the total 7 stations from May 1997 to May 1998. Prawn samplings were conducted twice by a small push net in each sampling period during day and night. The total of 18 species from 9 genera and 5 family were recorded: Two snapping shrimp. *Alpheus euphrosyne* and *Alpheus rapacida* in the family Alpheidae. *Latreutes mucronatus* in the family Hippolytidae. *Exopalaemon styliferus*. *Macrobrachium equidens* (brackish water prawn) *Macrobrachium milabala*, *Macrobrachium rosenbergii* (giant fresh water prawn, *Palaemon semmelinkii* brackish water prawn, and *Palaemon sewelli* in the family Palaemonidae. *Metapenaeus affinis* (jinga shrimp). *Metapenaeus brevicornis* (yellow shrimp). *Metapenaeus ensis* (school

prawn). *Parapenaeopsis hungerfordi* (dog shrimp). *Penaeus merguensis* (banana prawn) and *Penaeus monodon* (giant tiger prawn) in the family Penaeidae. Three planktonic shrimp. *Acetes indicus*, *Acetes japonicus* and *Acetes vulgaris* in the family Sergestidae. *Penaeus merguensis* (banana prawn) was the dominant group. *Macrobrachium equidens* (brackish water prawn) *Parapenaeopsis hungerfordi* (dog shrimp) and *Metapenaeus ensis* (school prawn) were common in respective order. Two planktonic shrimp, *Acetes indicus* and *Acetes vulgaris* were dominant in the night catches. Prawn standing crop during day and night catches were significantly different with higher values during night catches. High abundance and standing crop of prawn were found in the mangrove forest along Bang Ya-Preak coastline. Salinity was the most importance parameter determining the abundance and distribution of prawn in this area. Lowest prawn abundance and standing crop were recorded during the wet season 1997. From length frequency distribution data, most prawns were in the juvenile to matured stages. This indicates that the Tha Chin mangrove forest is the important nursery ground and shelters for prawns.

From the stomach content analysis in several economically important prawns revealed that these prawns were omnivorous with detritus as their major food items. Plant materials comprised 63.74 in percentage while the animal tissues were approximately 36.26. The average C : N ratio in foods found in the prawn stomach content were 5.63. The Tha Chin mangrove forest also serves as the feeding grounds for prawn populations. These prawns showed niche partitioning in order to reduce competitions by specialized feeding. They also feed on the bottom substrate and in the water column.

Keywords: Community structure; Distribution; Abundance; Shrimps; Prawns; Mangroves; Stomach contents; Tha Chin; Samut Sakhon

95 Somchai Bussarawit. 1990. **Preliminary study on Penaeid shrimps on seagrass on the west coast of Thailand Andaman sea.** In Proceeding the Seminar on Fisheries 1990 Department of Fisheries. 17-19 September 1990 National Inland Fisheries Institute, Bang Khen. p. 117-132.

The seagrass beds along the Andaman sea coast of Thailand (Phang-nga-Satun) were preliminary surveyed under ASEAN-Australia project during 11 January-24 March 1989 for associated fauna using a beam trawl of 2 mm. Mesh size. Faunal Group were collected and preserved for analyses. In this paper Penaeid shrimps were studied and presented.

Eight species of Penaeid shrimps were found from the seagrass beds namely, *Penaeus* (*Penaeus*) *semisulcatus* (De Haan), *P. (Melicertus) latisulcatus* Kishinouye, *Metapenaeus tysianassa* (De Man), *M.*

moyebi (Kishinouye), *M. anchistus* (De Man), *Metapenaeopsis hilarula* (De Man), *M. stridulus* (Alcock), *Parapenaeopsis cornuta* (Kishinouye). Majority of the collected specimens were of juveniles. The roles of seagrass beds for fishing nursery grounds are discussed.

Keywords: Penaeid; Sea grass; Shrimps; Beam trawler; Andaman Sea

96 Somnuk Chaitiamvong. 1990. **Species of white prawn in Thailand**. Technical Paper No. 31/1990. Bangkok Marine Fisheries Development Center. Department of Fisheries. 8 p.

There are three species of white prawn which are found in Thailand : *Penaeus (Fenneropenaeus) merguensis* De Man, *P. (F.) silasi* Muthu and Motoh and *P. (F.) penicillatus* Alcock. The first two species are common species found in shrimp farms and the sea both the Gulf of Thailand and the Andaman Sea. The last species is found in Andaman Sea only.

Keywords: White prawn; *Penaeus fenneropenaeus*, *Penaeus merguensis*; *Penaeus silasi*; *Penaeus penicillatus*; Gulf of Thailand; Andaman Sea

97 Supot Sangmanee. 1987. **Mangrove Decapod Crustacean and Stomatopod Crustacean in Changwat Chumphon and Changwat Ranong**. Master Thesis. Chulalongkorn University. 578 p.

Magrove decapod crustacean and stomatopod crustacean in changwat Chumphon and changwat Ranong were collected and studied during October 1985–September 1986. Their habitats and distributions were recorded. All the specimens were preserved in 70% alcohol and deposited in the Invertebrate Museum of the Biology Department, Faculty of Science, Chulalongkorn University

From the results of this study, 22 Families, 52 Genera and 116 species were reported.

Order Decapoda: Family Penaeidae 8 species, Family Sergestidae 2 species, Family Palaemonidae 6 species, Family Alpheidae 5 species, Family Thalassinidae 1 species, Family Callinassidae 2 species, Family Upogebiidae 3 species, Family Paguridae 4 species, Family Porcellanidae 2 species, Family Dorippidae 1 species, Family Calappidae 2 species, Family Leucosiidae 1 species, Family Majidae 1 species. Family Hymenosomatidae 1 species, Family Portunidae 7 species, Family Xanthidae 5 species, Family Goneplacidae 2 species, Family Pinnotheridae 1 species, Family Ocypodidae 26 species and Family Grapsidae 31 species.

Order Stomatopoda : Family Harpiosquillidae 1 species and Family Squillidae 4 species.

At the zone lower than the lowest neap tide level which contained soft muddy bottom, 53 species of mangrove decapods and stomatopods were found; while 32 species were found at the zone between the highest neap tide level to mean sea level which contained muddy or sandy mud bottom. There were 19 species found at the zone higher than the highest neap tide level containing rather hard muddy or sandy mud bottom and only 12 species were recorded at the zone between mean sea level to the lowest neap tide level, containing rather soft muddy bottom. There were 17 species distributed locally to Changwat chumphon, while 60 species distributed locally to changwat Ranong and 39 species distributed both in changwat Chumphon and changwat Ranong.

Keywords: Stomatopod; Crustaceans; Habitats; Distribution; Mangroves; Chumphon; Ranong

98 Suchat Sawangareeraks and Pensri Boonruang. 1990. **Studies of abundance and distribution of Penaeid shrimps in Pangnga Bay and adjacent areas**. In Proceeding the Seminar on Fisheries 1990 Department of Fisheries. 17-19 September 1990 National Inland Fisheries Institute, Bang Khen. p. 237–252.

The studies of annual abundance and distribution of penaeid shrimps in Phang-nga Bay and adjacent areas were conducted for two-years period during January 1987–December 1988. The samples were collected along the coastline by using push net. The total numbers of penaeid shrimps were recorded 28 species. The most abundant shrimp was *Metapenaeus moyebi* which was found 55% in 1987 and 31% in 1988 of total number of penaeid shrimps. The next abundant species were recorded from 2-7% as followed *M. lysianassa*, *Penaeus semisulcatus*, *P. latisulcatus*, *P. merguensis* and *Parapenaeopsis cornuta* respectively and the other species of shrimps were found less than 2% of total penaeid shrimps.

The distribution of penaeid shrimps in Phang-nga Bay were found scattered except *P. semisulcatus* and *P. latisulcatus* were found aggregate at the seagrass areas. *P. merguensis* was found more abundance in the inner part of Phang-nga Bay and Phuket Bay. In conclusion the abundance of total penaeid were recorded maximum at the east coast most than the west coast and inner part of Phang-nga Bay. The relationship between the abundance of shrimps and environment condition were discussed.

Keywords: Abundance; Distribution; Penaeid; Push net; Phang-nga Bay

99 Sirilak Chuaypanang. 1998. **Zooplankton in mangrove forest at Sikao District, Trang province**

with Emphasis on Shrimp and Crab larvae. Master Thesis. Chulalongkorn University. 185 p.

Study on zooplankton community in mangrove forest at Sikao District, Trang Province with emphasis on shrimp and crab larvae, was carried out bimonthly from May 1996 to May 1997. Zooplankton samples were taken from 6 stations along the canal by horizontal net towing (103µ) during the in-coming high tide and highest stagnant period. The zooplankton found in this mangrove consisted of 42 group with the relative abundance of 57.87-87.55% of total zooplankton density in each sampling period. Nauplius larvae, pelecypod larvae, gastropod larvae, larvacea and sergestidae were important group collected frequently in the mangrove but the relative abundance of each group was usually less than 20% of total density. The result also showed the diverse trophic groups of zooplankton i.e. the herbivorous copepod and *Lucifer*, the carnivorous chaetognath and the mucous net feeding larvacea. This indicates the diversity of food chain and energy cycling in this ecosystem. Besides, the diversity and abundance of planktonic larvae also suggests the ecological important role of zooplankton in recruitment of aquatic animals.

Shrimp and crab larvae were the minor zooplankton group in Sikao mangrove forest. Shrimp larvae were composed of 16 species from 5 families. Average density of shrimp larvae was 42-2,401 ind. 100 m⁻³. The most abundant shrimp larvae was in family Alpheidae followed by family Hippolytidae and family Palaemonidae, respectively. Other shrimp larvae found were in family Penaeidae and family Processidae. On the other hand, 41 species from 12 families of crab larvae were recorded from this area. The range of average density found was 543-27,906 ind. 100 m⁻³. The first three families found in abundance were Grapsidae, Ocypodidae and Xanthidae. Besides the role as important food sources for fish and other aquatic organisms, shrimp and crab larvae found especially alpheid shrimp, grapsid and fiddle crab also supported the recruitment of benthic animals in the mangrove.

The distribution pattern of zooplankton particularly, the copepod showed the tendency of high density in the inner part of the mangrove forest, while the reverse trend was noticed from the other zooplankton groups, such as pelecypod larvae, gastropod larvae, foraminifera, cerripedia larvae and sergestidae. There was a significant relationship between the density of zooplankton and the salinity of seawater, besides zooplankton density also exhibited a positive relationship with the abundance of phytoplankton in this area. The results from this study indicates that the Sikao

magrove forest is one of the pristine and productive nature mangrove in Thai water.

Keywords: Zooplankton; Mangroves; Shrimps; Larvae; Crabs; Sikao District; Trang

100 นงนุช สีสานิช. 1991. **Taxonomic studies of some marine shrimps found in along the East coast of Thailand.** Final Report. Faculty of Science, Burapha University. 48 p.

Taxonomic study of marine shrimps collected from the morning and fishing-ports of four provinces (Chonburi, Rayong, Chantaburi and Trad) along the coast of Thailand were carried out during March 1990 to February 1991. From the result of study 30 species of 7 genera of family Penaeidae were reported :

Penaeus (*Marsupenaeus*) *japonicus*, *P. (Melicertus) latisulcatus*, *P. (Penaeus) semisulcatus*, *P. (P.) monodon*, *P. (Funneropenaeus) merguensis*, *P.(F.) silasi*, *Metapenaeus intermedius*, *M.brevicornis*, *M. ensis*, *M. conjunctus*, *M. affinis*, *M.moyebi*, *Parapenaeus longipes*, *Parapenaeopsis tenella*, *P. hungerfordi*, *P. maxillepedo*, *P. cornuta*, *Metapenaeopsis stridulans*, *M. palmensis*, *M. barbata*, *M. toloensis*, *M. lamellata*, *Atypopenaeus stenodactylus*, *Trachypenaeus malaianus*, *T. pescadorensis*, *T. sedili*, *T. curvirostris*, *Sicyonia lancifera* and *ommanneyii*

Keywords: Taxonomy; Marine shrimps; Coast

101 Atchara Vibhasiri. 1993. **Penaeid shrimp resources in the upper West coast, Gulf of Thailand.** Technical Paper No. 4/1993. Bangkok Marine Fisheries Development Center. Department of Fisheries. 24 p.

The paper presents the status of shrimp resources and fisheries in the upperwest coast, Gulf of Thailand. The catch per unit of effort and mean length of shrimp species by main gears from five sampling piers in Chumporn and Surat Thani provinces during 1987-1991 are provide. The catch per unit of effort of shrimp species caught by otterboard trawlers, push netters and shrimp gill net vessels are 3.4, 8.8 and 0.9 kg/hr and the shrimp composition in the total catch are 13.6, 36.8 and 68.6 percent respectively. The mean length of large-sized species shrimp caught by small otterboard trawlers and push netters (<14 m) are lesser than the first mature size but not for those caught by shrimp gill net vessels. The stock evaluations show that the maximum sustainable yield of large-sized species shrimp has been exceeded.

Keywords: Penaeid; Resources; Fishery; Gulf of Thailand; Coast

102 Chinda Nakrobruh and Matana Boonyubol. 1993. **Preliminary study of shrimp larvae abundance in seagrass bed at Pha-Ngan Island, Surat Thani province.** Technical Paper No. 24/1993. Marine Fauna Life History Section. Bangkok Marine Fisheries Development Center. Department of Fisheries. 8 p.

Preliminary results on shrimp larvae abundance was studied in seagrass bed at Pha-ngan Island, Surat-Thani Province on April 5, 1992. The seagrass bed was divided into 10 stations. Samples were collected by a small beam trawl fitted with a net mesh size of 1 mm. Seagrasses in this area are dominant by *Enhalus acoroides*. Three groups of shrimp larvae were found namely, *Penaeus semisulcatus*, *Sicyonella antennata* and Caridean shrimps. *Penaeus semisulcatus*, the only commercially important shrimp species, was found predominantly in postlarval stage. The most abundant shrimp was Caridean shrimp larvae accounting for 78% of the catch. The water temperature and salinity ranged from 27 to 28 °C and 30 to 31 ppt, respectively. Water depth was between 0.70–0.75 meters.

Keywords: Shrimps; Larvae; Abundance; *Penaeus semisulcatus*; *Sicyonella antenna*; Caridean shrimp; Sea grass; Pha-Ngan Island; Surat Thani

103 Suchat Sawangarreruks and Nozomu Iwasaki. 2003. **Abundance and biomass of shrimp and prawn larvae in the Andaman sea, Thailand.** Thai Fisheries Gazette 56(1): 23-27.

Three transect lines of shrimp and prawn larvae were investigated in two different monsoons of 1996–1997 from the Andaman Sea, Thailand, ranging from 09° 14'N to 07° 45'N and 96° 41' E to 98° 15'E during 4 research cruises. Samples were collected by using 2 m ring net (MIK) with a mesh opening 1 mm.

The mean total shrimp and prawn larvae abundance and biomass, including Penaeidea and Caridea, ranged between 7.81–248.64 ind./1000 m³, and 0.082–0.757 g wet weight/1000 m³, respectively. The most abundance and biomass distribution occurred in northeast monsoon, and showed a common trend peak at the shelf front area. The highest abundance and biomass were observed in transect 1.

Keywords: Zooplankton; Shrimps; Prawns; Larvae; Abundance; Andaman Sea

104 Pornpoj Kantamaturapoj. 1999. **Guideline for inspection of live giant tiger prawn (*Penaeus monodon*) larvae.** Technical Paper No. 1/1999,

Fisheries Resources Conservation Division. Department of Fisheries. 66 p.

Importing of live giant tiger prawn (*Penaeus monodon*) requires the permission from the Department of Fisheries (DOF) according to the Decree Prohibition of Certain Aquatic Animal Import to the Kingdom of Thailand B.E.2525 (1982). Exporting of live giant tiger prawn (*Penaeus monodon*) requires the permission from the Department of Fisheries (DOF) according to the article 5(2) of the Export and Import Act B.E. 2522(1979). Permit document indicate the details on size and weight of prawn and inspection process need to be done prior to shipping.

Giant tiger prawn is developing into 8 stages; 1) Embryo 2) Nauplius 3) Protozoa 4) Mysis 5) Postlarva 6) Adolescent 7) Subadult and 8) Adult. The Department of Fisheries prohibit the exporting of prawn with sizes less than stage 5. This measure is pertinent to the notification of the Department of Fisheries issued on 17 January 1995. Tiger prawn that classified as stages 7 and 8 and those with length and weight of above 7.5 inches and 70 g., respectively, required the export permission from the authorities. Although it is prohibited by law, tiger prawn at post-larva stage are frequently illegally exported. This lead to the challenge task for the inspecting officials to properly identify the postlarva stage of prawn, particularly in the genus *Penaeus* which is the economic important. The criteria for identification can be prawn morphology and chromatophore pattern. Using of these characteristics would accelerate the inspection and would increase efficiency in monitoring and control the illegal importing and exporting. However, the control and suppression process needs to be done in collaboration with the related-authorities concerned.

Keywords: Inspection; Giant tiger prawn; *Penaeus monodon*; Larvae; Exports; Imports

105 Thon Thamrongnawasawat and Parinya Limviriyakul. 2001. **The biodiversity of commensal shrimps and crabs in Thai coral reef and adjacent water (Myanmar).** In the 39th Kasetsart University Annul Conference. 1-4 February 2001. p 3-11.

The result of studying, biodiversity of commensal shrimps and crabs in Thai Coral Reef and adjacent water (Myanmar) by SCUBA diving. There are totally 43 genera 59 species found in Thailand and Myanmar, 22 genera 34 species of commensal shrimps which are 22 new records and 21 genera 25 species of commensal crabs which are 16 new records. There is 47 species of commensal shrimps and crabs found in Myanmar, 47 species found in North Andaman Sea, 15 species in South Andaman Sea, 10 species in upperpart of Gulf of Thailand and

20 species in lowerpart of Gulf of Thailand. The result indicates that North Andaman Sea contains the highest diversity, especially at Surin Island. Nevertheless there are higher diversity in Myanmar. And also the *Stenopus hispidus* can be found both in Gulf of Thailand and Andaman Sea.

Moreover, the studying shown that the host and the depth also effect the distribution of shrimps and crabs which type of host effect the commensal organisms and the depth effect the type of host.

Keywords: Biodiversity; Shrimps; Crabs; Commensalism; Thailand; Myanmar; Surin Island

106 Theeranuj Sapayasant. 1991. **Effect of hysaline acclimation on osmoregulation and maturation of giant tiger prawn (*Penaeus monodon* Fabricius).** Master Thesis. Chulalongkorn University. 126 p.

A study of hypersalinity and eyestalk ablation effects on osmoregulation and maturation of subadult and adult giant tiger prawn, *Penaeus monodon* Fabricius was performed in closed recirculating water system. The results indicated that subadult *P. monodon* is hypo-hyperosmoregulative in salinities range from 20 to 45‰. The isosmotic point for this range was about 28‰. Eyestalk ablation influenced osmoregulation significantly. Haemolymph concentration of the ablated prawn was lower than the unablated one. After hypersaline acclimation in separated groups at 30 and 40‰ for 1, 2, 7, 15, 30, and 45 days, haemolymph concentration of subadult prawns had no significant difference between the two groups.

Without eyestalk ablation, hypersaline acclimation could accelerate ovarian development in adult *P. monodon*. There was a linear correlation between ovarian index and acclimation time.

In the case of subadult *P. monodon*, responses on eyestalk ablation depended on their size groups. Eyestalk ablation could induce ovarian maturation only in the large-size group (48–60 g) which had high condition index. Hypersaline acclimation and/or eyestalk ablation resulted in ovarian development. Nevertheless, for a good result, eyestalk ablation in hypersaline condition should not exceed 30 days. Eyestalk ablation and immediately acclimated in 40‰ for 30 day and then transferred to 30‰ to acclimate again for another during 15 days was the best condition for ovarian development of subadult prawns. Ovarian developmental stages based on histological examination could be classified into six stages; undeveloped, developing, nearly gravid, mature or gravid, inactive, and redeveloping. In addition, hypersaline condition and eyestalk ablation had no effect on morphology and size of oocyte, molting interval and condition index of the broodstocks.

Keywords: Hypersaline; Eyestalk ablation; Osmoregulation; Maturation; Giant tiger prawn; *Penaeus monodon*; Closed recirculating system

107 Sakon Sangpradub. 1991. **Effects of diets, sources and sizes of broodstock on ovarian development and spawning of giant tiger prawn (*Penaeus monodon* Fabricius).** Master Thesis. Chulalongkorn University. 106 p.

This study was carried out to determine the effects of diets, sources and sizes of broodstock on ovarian development and spawning of giant tiger prawn (*Penaeus monodon* Fabricius). The study was divided into two experiments. Experiment 1 comparatively studied the effects of broodstock sources, i.e. pond-reared and shallow waters wild-caught *P. monodon* and different sizes, i.e. large size prawn (weight 120 g.) and small size prawn (weight 110 g.), on ovarian maturity and reproductive success. Experiment 2 studied the effect of the different diets on ovarian maturity and reproductive success of *P. monodon*. The three treatment diets were 1. fresh natural diets, 2. combined diets (fresh natural diets plus artificial diets) and 3. artificial diets.

The results showed that large female prawns could undergo stage IV ovarian maturity and spawning better than the small ones. Both wild-caught and pond-reared females of the same size seemed to undergo comparable maturity and spawning success. The prawns fed with fresh natural diets and those fed with combined diets could undergo comparable stage IV ovarian maturity and spawning success. Whereas, the prawns fed merely artificial diets underwent the least stage IV ovarian maturity and spawning. Large females could remature and spawn more frequently than the small ones. The prawns fed with natural diets and the prawns fed with combined diets could remature and spawn more frequently than those fed with artificial diets.

Diets, sources and sizes of broodstocks did not significantly affect the elapsed time between the eyestalk ablation and the first stage IV ovarian maturity as well as the elapsed time between two consecutive stage IV ovarian maturities. The elapsed time between two consecutive stage IV ovarian maturities was significantly shorter than the elapsed time between the eyestalk ablation and the first stage IV ovarian maturity. Diets, broodstock sources and sizes had no effect on the elapsed time between the eyestalk ablation and the first spawning as well as the elapsed time between the two consecutive spawnings.

The average number of eggs spawned per female of the large prawns was significantly greater than that of the small ones. The average number of eggs spawned per female of the prawns fed with natural diets was significantly greater than that of the prawns fed with artificial diets. Sources of broodstocks did not significantly affect the egg production of the

prawns. Diets, sizes or sources of broodstocks did not produce significant effect on egg quality in terms of percent fertility, hatching rate and percent metamorphosis from eggs to the first protozoa stage.

In addition, large ablated female prawns had a moulting period longer than the small ones.

Keywords: Diets; Size; Broodstocks; Ovarian development; Spawning; Giant tiger prawn; *Penaeus monodon*

108 Benjamas Chuntapa. 1996. **Protein-energy ratio in artificial diet for juvenile, black tiger prawn *Penaeus monodon***. Master Thesis. Chulalongkorn University. 78 p.

The aims of the present study is to determine optimal protein energy ratio (P/E ratio) on growth and survival of juvenile prawn, *Penaeus monodon*. Two experiments with a completely randomized design was done using semi-purified diet. A semi-closed recirculating water system was used to raise prawn of initial size 0.4-0.8 g, 4-5.5 cm. with density of 40 individuals/m².

The first experiment was designed to determine optimal lipid and carbohydrate levels using isonitrogenous (35%) and isocalories (330 kcal/100g) diets with 5 lipid and carbohydrate levels; 4:38.5, 7:31.75, 10:25, 13:18.25 and 16:11.5 (% W/W). The lipid and carbohydrate level of 7:31.75 gave the best specific growth rate ($P < 0.05$). The survival of all diet treatment group was similar. Thus optimal lipid and carbohydrate ratio for the juvenile tiger prawn was approximately 1 : 4.5.

In the second experiment, optimal protein energy ratio (P/E ratio) was studies using 5 protein level diets (25, 30, 35, 40 and 45%) with fix lipid and carbohydrate ratio (1:4.5 result from experiment I). Different 9 levels of energy content (203–459 kcal/100g) and 9 levels of protein energy ratio (63–171 mg. protein/kcal). Prawn fed diet containing 35-45% protein and energy content 223-371 kcal/100g gave the best specific growth rate ($P < 0.05$). A regression analysis indicated that optimal P/E ratio for the best growth and survival of juvenile tiger prawn range 140 to 150 mg. protein/kcal.

Keywords: Protein-energy ratio; Artificial diets; ; Lipids; Juveniles; Black tiger prawn; *Penaeus monodon*

109 สุรเสน ศรีวิภานนท์. 2541. การศึกษาการเลี้ยงกุ้งกุลาดำ (*Penaeus monodon*) ในกระชังด้วยอัตราความหนาแน่นต่างกันในคลองสีเกา จ.ตรัง. ทุนอุดหนุนการวิจัย

งบประมาณผลประโยชน์ ประจำปี 2541. คณะวิทยาศาสตร์และเทคโนโลยีการประมง. สถาบันเทคโนโลยีราชมงคล. 42 น.

Experiment were conducted to Giant Tiger Prawn production in cage culture with the three stocking densities. Three replication of stocking rate of 40, 80 and 120 juveniles/m², in the 3X3X2 m net cage, for 90 days, feed with pellet. The results showed that mean weight, mean length, food conversion rate of all stocking density were non significant. By mean weight were 10.53±2.01, 9.67±0.77 and 7.56±2.05 grams, mean length were 11.49±0.55, 10.72±0.24 and 9.82±0.90 centimeter, food conversion rate were 2.27±0.36, 2.74±0.51 and 3.23±1.02 for 40, 30 and 120 juveniles/m² respectively, and survival rate of all stocking density were significant. At the stocking density 80 juveniles/m² was the optimum stocking density. By survival rate were 34.82±6.04, 21.50±5.23 and 18.67±5.34 percent for 40, 80 and 120 juveniles/m² respectively. The pH, temperture, salinity and turbidity were between 7.1-7.7, 28-30° C, 17-27 ppt and 50-70 centimeter during 90 days of experiment.

Keywords: Net cages; Culture; Giant tiger prawn; *Penaeus monodon*

110 Chokchai Luangthuvapranit, Pun Yeesin and Somgai Pachmano. 2000. **Nursing experiment on tiger prawn, *Penaeus monodon* Fabricius with various density rates**. Prince of Songkla University, Pattani Campus. 149 p.

Three density rates of nursing experiment on tiger prawn, *Penaeus monodon* Fabricius were set up at 70, 140 and 210 nauplii/litre. Larvae were reared from the nauplii stage to the 16th post larval stage within 24 days. Four parameters, varing with these density range, were carried out; average length of larval growth, average growth rate, average% survival rate, and return over cash costs. The average length of larval growth showed no significant ($P > 0.05$) relationship with the variation of density rate. The average length of the 16th post larvae, varying with three density rates, were 12.65, 12.41 and 12.22 mm, while the average growth rates were 0.497, 0.457 and 0.489 mm/day, respectively. The average% survival rate were 66.55, 53.83 and 43.19% corresponding to those three density rates, respectively. The highest average% survival rate indicated at 70 nauplii/litre with a significant ($P < 0.05$) different from 170 and 210 nauplii/litre. The return over cash costs of production were 48,460 baths, 104,960 baths and 121,760 baths, varying with those density rates. There was clearly significant ($P < 0.05$) higher return over cash costs of the density of 140 and 210 nauplii/litre than that of 70 nauplii/litre.

Keywords: Nursing; Tiger prawn; *Penaeus monodon*

111 Sansern Chorcheng, Sukit Rattanavinitkul, Thavee Rojanasarpakait and Pin Polchai. 1989. **Experiment on nursing giant tiger shrimp, *Penaeus monodon* Fabricius P₂-P₁₅ in outdoor type by having the black cloth and non.** Technical Paper No.22/1989. Nakornsrihammarat Brackishwater Fisheries Station. Brackishwater Fisheries Division. Department of Fisheries. 7 p.

Giant tiger prawn (*Penaeus monodon* Fabricius) postlarva P₂-P₅ were nursing in outdoor concrete tanks. Survival rate of the larvae from the tanks that were covered with black cloth and open tanks were 88.82% and 88.47%, total length were 1.35 cm. and 1.40 cm. respectively. pH 7.53-8.04, temperature 27.6-29.4 °C and salinity 31.3-32.0 ppt the water quality parameter of all tanks.

Keywords: Giant tiger shrimp; *Penaeus monodon*; Postlarvae

112 Wichit Semachai, Suthin Somboon and Ampond Buartee. 1999. **Effect of zooplankton and adult *Artemia* population in shrimp pond on growth and survival of *Penaeus monodon* postlarvae.** Research Report. Kasetsart University. 9 p.

The water preparation to produce natural feed in ponds before stocking shrimp larvae by fertilizing with fine rice bran 4 kg/rai (2 kg at first application, the rest was daily applied) mixed with minced trash 2 kg/rai for 3 weeks was found that there was an increasing trend of macrobenthos in 3 weeks higher than that non fertilizer 8%, with not deterioration of all water qualities, indicating that it could add more fine rice bran and minced trash fish. The density of macrobenthos in unfed pond was more rapidly decreased than that in fed pond there for, the first week was recommended as the critical period to determine the quality of natural feed. The density of macrobenthos increased with a period of water preparations; 84-86% higher in the third week than in the second week, recommended that water preparations should be at least 3 weeks. Unfed to shrimp larvae for 3 weeks result in low survival and production than fed shrimp larvae at a time of stocking. Zooplankton was found such as rotifer nauplii, copepod, and arrow worm. Macrobenthos were chironomids, polychaeta, amphipod, and larvae insects, respectively. Introduction of *Artemia* during water preparation as shrimp larvae feed was found that they could not either growth or propagate at salinity of 20-30 ppt.

Keywords: *Artemia*; *Penaeus monodon*; Survival

113 Sukit Rattanavinitkul, Sansern Chorcheng and Thavee Rojanasarpakait. 1989. **Experiment on nursering giant tiger shrimp *Penaeus monodon* Fabricius in the different density and frequency of feeding in tanks.** Technical Paper No.21/1989. Nakorn Si Thammarat Coastal Aquaculture Station. Brackishwater Fisheries Division. Department of Fisheries. 9 p.

Giant tiger shrimp (*Penaeus monodon* Fabricius) post larvae P₂-P₁₅ were nursing at densities 10/litre and 20/litre and 20/litre these density were fed 3, 4, 5 times/day. The percents of survival were 75.16, 92.75, 92.50 and 78.43, 83.38, 83.08 respectively. Nursery at low density and feeding 4-5 times/day gave better survival.

Keywords: Giant tiger shrimp; *Penaeus monodon*; Stocking density

114 in Thai

115 Somprasong Kanthom. 1996. **Effect of low salinity on the survival rate of tiger prawn (*P. monodon*).** Technical Paper No.8/1996. Chumphon Coastal Aquaculture Station. Prachuap Khiri Khan Coastal Aquaculture Development Center. Coastal Aquaculture Division. Department of Fisheries. 8 p.

Tiger prawn (*Penaeus monodon*) post larvae average 3.3 cm in length and 0.26 gm in weight were reared in 7 litres each glass container at the different salinity. The experiment was conducted around 20 days. The results of rearing as follow.

1.The post larvae reared in salinity 0 ppt all died in 11 day of rearing.

2.The post larvae reared in salinity 1 ppt had 86.7% survival rate in 11 days and they all died in 18 days.

3.The post larvae reared in salinity 3 ppt had 46.7% survival rate.

4.The highest survival rate (93.3) occurred in the post larvae reared in salinity 5 ppt.

Keywords: Low salinity; Survival; Tiger prawn

116 Thanya Panritdam. 1998. **Use a closed recirculating seawater system with a denitrification unit for the culture of black tiger shrimp *Penaeus monodon*.** Master Thesis. Chulalongkorn University. 115 p.

A closed recirculating seawater system with a denitrification unit was developed for the long-term culture of black tiger shrimp. The system comprised of a circular rearing tank with the loading capacity of 9 m³. Used seawater from the rearing tank was treated by a stationary filaments biofilter "BIO-POLYMA" with a dimension of 1.98x1.88x1.7m³.

The recirculating rate was controlled at approximately 7.125 times per day. A denitrification unit which comprised of a deoxygenated column, a bacterial substrate column, and an aerated column, was attached to the biofilter tank. The flow rate in the denitrification unit was controlled at 40-110 ml/min. This recirculating seawater system was run to evaluate its efficiency in controlling the water quality by comparing this system with system of the same design but without a denitrification unit. The experimental period was 305 days. Mangrove surface soil was used as a source of denitrification bacteria during the first period of the experiment. Later a strain of laboratory cultured denitrifying bacteria was used. The results showed that both recirculating seawater system could control water quality parameters namely ammonium, nitrite, nitrate and DO, with the normal ranges. The nitrate of both systems however elevated to a certain point then started to level off. A strain of denitrifying bacteria showed the ability to reduce nitrate level in both bacterial substrate column and the recirculating seawater system ($P < 0.05$). Nevertheless, the nitrate levels in both recirculating seawater systems did not exceed the threshold toxic level of 50 mg/l. The biological data showed that these recirculating seawater systems could support the growth and survival of the shrimps. The effects of water quality in both recirculating system on growth and survival of the shrimp were discussed.

Keywords: Closed recirculating system; Black tiger shrimp; *Penaeus monodon*

117 Panya Asawangkoon and Chatree Tarasang. 2001. **Experimental on rearing of tiger shrimp *Penaeus monodon* in closed system.** Extension Paper No.1/2001. Samut Songkhram Coastal Aquaculture Station. Samut Songkhram .6 p.

The experiment was conducted at Samut Songkhram Coastal Aquaculture Station by Rearing tiger shrimp in earthen pond using closed system. Six ponds, one rai each were use for the system, 2 ponds planted sea weed (*Caulerpa macrophyssa*) used as treatment pond, 4 ponds were used for rearing shrimp. The experiment was conducted 2 time, first, stocking rate 50,000, second 30,000 PL18 per rai (1.600m²). During the experiment, no exchange water, just only use the water in treatment pond for adjust the water level in rearing pond. Formalin, chlorine and lime were used for control water quality, without applied antibiotic or any drugs, culture period was 103-127 days. The result showed production of 488.5 kg/rai with FCR 1:1.8 and 479.3 kg/rai with FCR 1:1.5 in the pond that stock 50,000 and 30,000 PL per rai, respectively for the economical aspect, the stocking

rate of 30,000 PL per rai give a better result than 50,000 PL per rai, not only perfit per kilogram, rate of return but also pay back period.

Keywords: Closed system; Tiger shrimp; *Penaeus monodon*

118 Anand Tunsutapanich, Tanan Sanggontangit, Supis Thongrod and Charoen O-manee. 1996. **Improvement technique for tiger shrimp, *Penaeus monodon*, culture in closed and recycled system: 3rd trial.** Phetchaburi Coastal Aquaculture Station. Samutsakorn Coastal Aquaculture Center. Coastal Aquaculture Division. Department of Fisheries. 14 p.

Succeeding to the previous shrimp cultured in closed recycled system, this 3rd trial culture was aimed to endure the system and to improve a better technique. Heavy load of sludge and sediment from previous shrimp cultured was remained in the pond while the used seawater was drained off and be kept in ponds of poly culture area. Both sediment and seawater were left for self purification through the biological process or biological treatment before reused.

This experiment was also planed to observe the suitable stocking density to the growth as well as the survival rate of shrimp at harvest. Four of 1,600 m² (40 x40 x2 m) earthen ponds and previously used equip8232ments were repaired and eliminated pathogens following the treatment techniques. Earthen ponds were then filled with recycled seawater from biological treatment ponds to 1 m in depth and treated with Ca(OCl)₂ at the rate of 20-30 ppm. Post larva (PL-15) were stocked to the ponds at 50,000 (low density) and 100,000 (high density) fry per pond with 2 replicates each. Feed with 3 hours stables in water was given 4-6 meals per day, by casting it into the pond 15 minutes prior to stop the paddle wheel. Water quality was daily monitored and maintained by using some chemical without water exchange or sediment removal. The experiment was terminated after 4 months feeding. Shrimp size harvested from the ponds with low and high stocking density was varied between 30-35 and 44-60 tails/kg, and the average total production was 1,275 and 1,660 kg., respectively. Average feed conversion ratio was 1.35 (1.16 and 1.53) and 1.60 (1.59 and 1.61), and average survival rate was 83.6 and 82.3% from the low and high stocking density, respectively.

Results of the third trial cultured shrimp in closed and recycle system confirm the possibility of sustainable shimp farming and the possibility to improve the formerly abandoned shrimp farms.

Keywords: Improvement; Techniques; Tiger shrimp, *Penaeus monodon*;

119 Anand Tunsutapanich, Supis Thongrod, Tanan Sanggontangit, Thongchai Permngarm and Aree Channark. 1995. **A new technology for nursing giant tiger shrimp (*Penaeus monodon*) larvae in closed system.** In the 33rd Kasetsart University Annul Conference. 30 January- 1 Frabuary 1995. p. 114 – 120.

A development of closed system nursing technique for giant tiger shrimp larvae, by using combination of biological, physical and chemical to treat and control the environment inside the nursing pond as well as water treatment pond. This technique are operating in both hatchery (concrete tank) and earthen pond without removing sediment and water changiong. More over, the artificial diet is introduced to substitute phytoplankton in the feeding regime in the hatchery. Nursing technique is then changed by transferring post larvae stage 1 from the concrete tank to continue in the earthen pond.

The survival rate of shrimp nursing in concrete tanks of capacity 5 tons (4 tanks) from stages of nauplii to PL1 is in range of 80-85% (400,000-425,000 shrimp per tank, total 1,645,000 PL1 shrimps) and from PL1 to PL15 is in range of 40-60% (150,000-250,000 shrimp per tank). The results of nursing in 1,600 sq meter earthen pond (from PL1 to PL15) show the survival rate of 55-70% (550,000-700,000 shrimps per pond). The total of 1,880,000 PL15 shrimps were obtained from three earthen ponds.

Keywords: Nursing; Tiger shrimp; Closed system; Larvae

120 Anand Tunsutapanich, Tanan Sanggontangit, Supis Thongrod and Charoen O-manee. 1997. **Culture of (virus infected) *Penaeus monodon* (test by PCR technique) in recycle system.** Phetchaburi Coastal Aquaculture Station. Coastal Aquaculture Division. Department of Fisheries. 11 p.

Since the PCR (Polymerase Chain Reaction) technique was introduced to detect virus-infected postlarvae (PL), many farmers had paid a great deal on the postlarval quality. They were convinced to believe that viral-free postlarvae (screening by PCR technique) were strong and will not to lead to the failure of shrimp farming. As a consequence of thoes convincing, many shrimp hatcheries were having difficult time selling their PL when PL samples were found virus infected. This study was aimed to test whether those virus infected shrimp PL can be cultured in the recycle system. Virus infected postlarvae of *Penaeus monodon* were stocked into 3 earthen ponds, 1600, 3200 and 6400 m² at the stocking rate of 100,000 shrimp / 1600m².

The period of culture was 135, 105 and 110 days, respectively. Survival rate was varied between 53.7-67.4 % with the total yeild of 8,050 kg (average 1,150 kg/1600m²) and shrimp size at harvest was between 35 - 70 tails/kg. Result of this study revealed that only PCR test for virus infection cannot verify the quality of PL.

Keywords: *Penaeus monodon*; PCR; Viruses

121 in Thai

122 Supis Thongrod, Anand Tunsutapanich, Tanan Sanggontangit and Pranee Srabua. 1995. **Larviculture of *Penaeus monodon* using dry formulated feed supplement fish oil and compare with live food.** Thai Fisheries Gazette. 48 (3): 241-248.

An experiment was conducted to determine the feasibility of substituting dry formulated feed for live feed and to examine the dietary lipid requirement of *Penaeus monodon* larvae. Six dry formulated feeds were prepared to contain 16.5, 21.6, 25, 24, 24.9 and 27% lipid which giving n-3 HUFA 0.2, 1.1, 2.5, 4.5, 6.4 and 8.1% in feed from diet 1 to diet 6, respectively. *Chaetoceros* sp. and *Artemia* were used together as a live feed control group. Three hundred thousand nauplii of *P. monodon* were released in each 4 ton fiber glass tank containing 3 tons of sea water (30 ppt). 600 mg of dry formulated feed were fed in each of 9 to 10 meals per day. Survival of larvae, development rate and water parameters were monitored daily. Results showed satisfactory survival rate of 58, 85, 81, 77, 69, 75 and 65% from diets 1 to 6 and the live feed group, respectively. Although the developmental rate from the live feed group was faster than others when *Chaetoceros* sp. was applied, it was parallel to others when fed with just *Artemia*. There was no effect of lipid levels in feeds on the accumulation of lipid levels in shrimp. However, results indicated the accumulation of n-3 HUFA in shrimp larvae as its level increased in feed. This level almost reached a plateau when adding n-3 HUFA to the diet at a level of more than 2.5%.

Keywords: Larviculture; Formulated feed; Lived feeds; Fish oils; *Penaeus monodon*

123 Khamjut Ruenreungdee and Chaichan Mahasawase. 2003. **Monoculture of black tiger prawn (*Penaeus monodon*, Fabricius) by changing of net cages.** In the 41st Kasetsart University Annual Conference. 3-7 February 2545. p. 404-410.

Black tiger prawn (*Penaeus monodon*, Fabricius) were cultured in net cages by three type of net cages. The first type of net cages used fine net and cultured black tiger prawn until 120 days. The

second type of net cages used fine net cultured black tiger prawn for 60 days, then changed to new fine net cages and cultured prawn until 120 days. The third type of net cages used fine net cultured black tiger prawn for 60 days, then changed to new net cages Thai used of net about 1 centimeter and cultured prawn until 120 days. After 120 days, the average growth rate of black tiger prawn cultured in three type of net cages was 0.180, 0.152 and 0.179 gram/day, the average of survival rate was 66.78%, 78.67% and 68.41%, the average product of black tiger prawn was 12.95, 13.07 and 13.17 kilogram/cages respectively. There were not statistical differences in growth rate, survival rate, food conversion rate and product of prawn in three type of net cages.

Keywords: Net cages; Culture; Black tiger prawn; *Penaeus monodon*

124 in Thai

125 Somprasong Kanthom. **Experiment on intensive culture of *Penaeus merguensis* (de Man) in earthen pond.** In Proceeding the Seminar on Fisheries 1991 Department of Fisheries. 16-18 September 1991. National Inland Fisheries Institute. Bang Khen. p. 121-124.

The pond culture of the white shrimp, *P. merguensis* was demonstrated at Samut Sakhon Coastal Aquaculture Development Centre (SCADEC), for two periods of three months and 36 days. *P. merguensis* postlarvae (P15) from SCADEC'S hatchery were stocked in the earthen pond at density of 8,000 indiv/rai (5 indiv/m²) and fed daily formulated pellets. At the end of the first period, the result showed that the average total length and average weight were 12.00 cm and 13.94 gm respectively, the total production of the pond was 17.80 kg. Male and female ratio were 1.3:1.0, and 7.63 percent of female were mature. The second period of the project, was the polyculture between white shrimp and green mussels, 224,000 indiv/pond and 143 kg of mussels were stocked in 7 rai earthen pond. The result showed that, after 36 days of the experiment, there were no survival of shrimp, and finished the project.

Keywords: Intensive culture; *Penaeus merguensis*; Shrimps

126 Pornthep Wiracharong. 1995. **Plankton management in tiger Prawn (*Penaeus monodon* Fabricius) culture ponds.** Master Thesis. Kasetsart University. 167 p.

Investigations of species composition and abundance of plankton in tiger prawn (*Penaeus monodon* Fabricius) culture ponds were made during May 1994 to August 1994. The plankton we always found were diatom : *Navicula*, *Nitzshia*, *Pleurosigma*; and blue green algae *Oscillatoria*. Zooplankton were copepod nauplius; and ciliate protozoa *Tintinnopsis*. Abundance of phytoplankton were related to physical parameters: transparency, temperature; and chemical parameters: salinity, dissolved oxygen, pH, nitrite, nitrate, silicate, phosphate, ammonia and alkalinity. Abundance of phytoplankton were also related to that of zooplankton, chlorophylls or water color.

Diversity index values of plankton in 1-7 ponds were 0.0284-2.1527, 0.2299-1.4892, 0.0847-1.9377, 0.1032-2.3380, 0.1797-1.8126, 0.2273-1.9260 and 0.0698-2.0067, respectively.

Water quality values in 1-7 ponds were: transparency 11-135 cm; salinity 22-31 ppt ; dissolved oxygen 3.8-7.3 mg/l ; pH 7.8-9 ; temperature 27.50-34.15 °c ; nitrite 0.0014-0.0169 ppm ; nitrate 0-0.0318 ppm ; silicate 0.0130-3.7638 mg/l ; phosphate 0.0001-0.1692 mg/l ; ammonia 0-1.2521 ppm ; alkalinity 75-212 mg/l ; and chlorophylls 0.5151-141.047 mg/m³.

According to the result of this investigation, diversity index value were highly related to species composition and abundance of plankton. Therefore, diversity index value could be used as guideline to manage plankton in shrimp ponds.

Keywords: Plankton; Water quality; Shrimp ponds; Management

127 Wichain Yongprapat, Thawee Rojanasarnpkit, Supon Tansuwan, Sanit Chanachoo, Chantima Ouppathump, Kanchana Tongsan. 1993. **Experiment on banana shrimp (*Penaeus merguensis*) intensive, culture at the different stocking densities.** In Proceeding the Seminar on Fisheries 1993 Department of Fisheries, 15-17 September 1993. National Inland Fisheries Institute. Bang Khen. p. 341-348.

Experiment on intensive monoculture of Banana Shrimp (*Penaeus merguensis*) was conducted in six earthen ponds of area 0.5 rai each, at Songkhla Coastal Aquaculture Station. P18 larvae were stocked at the density of 20, 30 and 40 inds./m² and cultured for 112 days. The productions were 82.25, 75.3 and 79.45 kilograms/0.5 rai and the averaged survival rate were 83.32, 77.6, 63.52 % respectively. The food conversion rate were calculated to be as 1.98, 1.89 and 2.2 respectively. The growth rate and water qualities was also investigated in this study.

Keywords: Banana shrimp; Intensive culture; Stocking density

128 Boonchai Chiampreecha, Chareon Reonghahaitham and Nives Ruagpanit. 1987. **Development on breeding and rearing of the banana shrimp (*Penaeus merguensis*) in small-size hatcheries using water from mangrove swamp.** Technical Paper No. 21/1987. Samutsakorn Brackishwater Fisheries Station. Department of Fisheries. 20 p.

The Banana shrimp (*P. merguensis* de Man) larvae were reared from the nauplii to post-larval stage (PL₁₅) in small-size hatcheries, using water from mangrove swamp which are highly variation in is prioperty throughout the year, at Samutsakorn Brackishwater Fisheries Station during May 1985 to September 1986. The study comprised 2 groups with the number of 6 groups each.

The results shows that the average survival rates in metamorphosis phase (N-PL₁) and post-larval stage (PL₁- PL₁₅) of shrimp in first and second groups were found to be 30.59 and 50.33 %, and 15.01 and 76.00 % respectively.

The yeilds from both groups were 1,067 x 10³ individuals in the first group and 4,880 x 10³ individuals in second group.

Keywords: Breeding; Banana shrimp; *Penaeus merguensis*

129 in Thai

130 Tawat Sriveerachai, Zulkiflee Hajiyosof, Anupong Boupeich and Niwes Ruangpanit. 2001. **A proper stocking density for culturing of banana shrimp (*Penaeus mreguensis*) in earthen pond.** Narathiwat Coastal Aquaculture Development Center. Department of Fisheries. 10 p.

Culture of Banana (*Penaeus merguensis*) was conducted in 800 m² earthen pond at Narathiwat Coastal Aquaculture Development Center. The culture divided to 3 treatments by stocking rate of 65, 75 and 85 shrimp fry/m² by 2 replications. The shrimp was started from PL20 of the shrimp fry that average length and weight was 1.09±0.14 cm and 0.005±0.001 g. The commercial black tiger shrimp pellets were fed to the shrimp at the rate of 3-7 % of body weight/day throughout this study. Duration of culture was 2 months.

Results showed that growth , survival rate, food conversion rate and production cost of all treatments were non significantly difference (P<0.05). The average lengths of the shrimp at stocking rate of 65, 75 and 85 shrimp fry /m² were 7.19 0.10, 7.07±0.06 and 7.15±0.55 cm. Average weights were 2.88±0.18, 2.74±0.14 and 2.76±0.45 g. Average daily growths were 0.048±0.003, 0.046±0.002 and 0.046±0.007 g/day. Average

survival rates were 96.27±3.89, 95.37±6.27 and 83.59±21.80%. Average of food conversion ratios were 0.99±0.03, 0.94±0.02 and 1.06±0.16. Average productions were 294.0, 313.0 and 308.6 Kg/Rai. The production costs were 113.10, 108.91 and 116.48 baht/kilogram, respectively.

Keywords: Culture; Banana shrimp

131 Sopon Onkong, Tanawat Klowklieng and Pisanu Na-anan. 1996. **Continuously intensive cultured of tiger shrimp, *Penaeus monodon* Fabricius.** Technical Paper No. 22/1996. Satul Coastal Aquaculture Development Center. Department of Fisheries. 11 p.

Continuously intensive culture of Black Tiger Shrimp, (*P. monodon*) were conducted in earthen pond (2,800 m².) at Satul Coastal Aquaculture Development Center, during December 1991 - September 1992. Two crops were cultured in this study. The first crop was conducted during December 1991 - May 1992 (125 days), 23 ids/sq.m. of PL-8 were stocked. The second crop was conducted during May 1992 - September 1992 (117-days) and the stocking rate was 20 ids/sq.m. of PL-15. For both crops were fed with a commercial formulated diet 4 times per day. Feeding rate of fist, second, third and after third month were 50%, 7%, 5% and 3% of body weight respectively. During the cultured period, growth rate and water qualities were determined twice a month.

The results shown that production of the first crop was 1,162 kgs, mean body weight was 27.8±2.6 gms, survival rate was 64.3% and food conversion rate (F.C.R.) was 1.62. And production of the second crop was 976 kgs mean body weight was 28.6±4.7 gms, survival rate was 62.3% and F.C.R. was 1.58 the average growth rate of the first and second crop was 0.22 and 0.24 gms/day respectively. The water qualities of both crops were suitable for shrimp culture. In this study, cost of production was 75.15 and 80.98 baths/kg of shrimp respectively and return value not so difference between each other crop.

Keywords: Intensive culture; Tiger shrimp, *Penaeus monodon*

132 Supon Tansuwan and Tawat Sriverachai. 1989. **Experimental on nursing tiger prawn (*Penaeus monodon* Fabricius) protozoa-post larvae 7 in various stocking densities.** Technical Paper No. 16/1989. Songkhla Brackishwater Fisheries Staion. Brackiswater Fisheries Division. Department of Fisheries. 19 p.

Experimental on Nursing Tiger Prawn (*Penaeus monodon* Fabricius) Protozoa-Post larvae 7 in various stocking densities. The first experiment on

February 1989–March 1989 and the second on March 1989–April 1989. Four treatment of 3 replication at stocking rate of 40, 60, 80 and 100 perlitre were reared in 1,500 litre Galveston tank. This experiment fed with Diatom (*Skeletonema* sp.) custard and brine shrimp nauplii.

The results of the experiment were as follows; the average production were 37, 38 perlitre (at stocking rate 40 perlitre) 52, 53 perlitre (at stocking rate 60 perlitre) 66, 66 perlitre (at stocking rate 80 perlitre) and 84, 82 perlitre (at stocking rate 100 perlitre) respectively. The average survival rate were 93.61%, 94.36%, (at stocking rate 40 perlitre) 86.09%, 87.84% (at stocking rate 60 perlitre) 82.58%, 82.30% (at stocking rate 80 perlitre) and 84.48%, 82.07% (at stocking rate 100 perlitre) respectively.

Keywords: Nursing; Tiger prawn; *Penaeus monodon*; Postlarvae; Stocking density

133 Wiwat Singthaweesak and Titima Thongsriphong. 2000. **Polyculture of agarophyte, *Gracilaria fisheri* (Xia & Abbott) Abbott, Zhang & Xia, with tiger shrimp, *Penaeus monodon* (Fabricius) in earthen ponds.** Technical Paper No. 40/2000. Chanthaburi Coastal Development Center. Department of Fisheries. 18 p.

The Seaweed, *Gracilaria fisheri*, cultivated in 3 squaremeter net frames at stocking density 500 grams per squaremeter with 60 net frames total 90 kilometers, average weight 0.0021 grams. It was carried out in 4 earth ponds, area 800 squaremeters, at Chanthaburi Coastal Aquaculture Development Center for 22 weeks, The result revealed the seaweed total weight of 60 net frames were reduced to 69.17, 10.25, 83.66 and 40.70 kilograms respectively. The tiger shrimp grow to average total length 18.15, 13.89, 14.00 and 11.58 centimeters, average body weight 44.67, 17.96, 18.63 and 10.83 grams. The shrimp production were 137.0, 179.4 and 32.6 kilograms respectively.

Keywords: *Gracilaria*; Tiger shrimp, *Penaeus monodon*; Polyculture

134 Supon Tansuwan *et al.* 1990. **Nursing of Tiger Prawn (*Penaeus monodon* Fabricius) at Songkhla Backishwater Fisheries Station.** Technical Paper No. 16/1990. Songkhla Backishwater Fisheries Station. Department of Fisheries. 19 p.

Nursing of prawn (*Peaeaus monodon* Fabricius) at Songkhla Backishwater Fisheries Station study on survival rate and quality of post larvae in 1989. Food and feeding on nursing of

tiger prawn from Zoea stage-Post larvae 18 with diatom, egg-custard, brine shrimp nauplii and artificial pellets. Salinity of sea water 28-32 ppt and temperature control 29-31°C. The densities of rearing tank (1.7 x 7.8 x 1 m) 401,600-695,100 per tank in 1988 and 543,200-952,000 per tank in 1989 respectively.

The results on nursing tiger prawn in 1988 were as follows; The total of 24,021,880 nauplii were reared to average 8 were 54.79% and 48.92% respectively. In 1989 the total of 37,887,580 nauplii were reared to post larvae 8 were 26,467,300 and post larvae 18 were 23,246,000. The average of survival rate were 69.86% and 61.36% respectively.

Keywords: Nursing; Tiger Prawn; *Penaeus monodon*; Songkhla

135 Khorkiat Koolkaew and Sapon Onkong. 1997. **Intensive Culture of Black Tiger Shrimp, *Penaeus monodon*, Semi-Closed System on Earthen Ponds.** Technical Paper No.10/1997. Satul Coastal Aquaculture Development. Department of Fisheries. 20 p.

The experiment on black tiger prawn, *Penaeus monodon*, intensive culture in semi-closed system was done in two earthen ponds each 2-rai in size. Before the study the sea water was treated with the chlorine powder. (calcium hypochlorite 60%). After that the *Chlorella* was added to the culture ponds. The water quality control was done by replacing the treated sea water at infrequent intervals and little in amount (compared with opened-system). Furthermore, the paddle wheel aerator management need to control the dissolved oxygen sufficiently. The results showed that the production was 1,501.4 and 1,663 kgs/rai; the survival rate was 60.28 and 64.75%; the average daily growth (ADG) was 0.205 and 0.211 gm/day; the food conversion rate (FCR) was 1.63:1 and 1.52:1 of pond No. 1 and pond No. 2 respectively.

Keywords: Intensive culture; Black tiger shrimp; *Penaeus monodon*, Semi-intensive system; Earthen pond

136 Tanawat Klowklieng, Piya Chulavitayanukool, Somboon Laoprasert and Amporn Potiya. 1990. **Net Cages Culture of Jumbo Tiger prawn *Penaeus monodon* Fabricius, Diffrence Density at Klong Takbai, Narathiwat.** In Proceeding the Seminar on Fisheries 1990 Department of Fisheries. 17-19 September 1990. National Inland Fisheries Institutes, Bang Khen. p. 272-283.

Experiment were conducted to jumbo Tiger Prawn production in net cage culture with the three stocking densities. Three replication of stocking rate

of 50, 150 and 250 juveniles/m², in the 2 x 2 x 2 x 1.5 m³ net cage, for iii days, feed with pellet. The results showed that mean weight, survival rate, food conversion rate of all stocking density were significant. At the stocking density 50 juveniles/m² was the optimum stocking density. By mean weight were 24.14±1.43, 22.21±1.02, 15.81±0.33 grams, survival rate were 2.70±0.08, 2.91±0.02, 2.56±0.07 for 50, 150 and 250 juveniles/m² respectively. The temperature, ps Salinity, DO and turbidity were between 26.1-29.6 °C, 45-8.64, 12-14 ppt, 6.15-8.56 ppm, 60-80 cm. During iii days of experiment.

Keywords: Net cages; Tiger prawn; *Penaeus monodon*

137 Suchat Tachanaravong and Boon Boonruang. 1989. **Experiment on the Polyculture of *Penaeus monodon* and *Polycavernosa fisheri***. Technical Paper No. 10/1989. National Institute of Coastal Aquaculture Songkhla. Department of Fisheries. 12 p.

An experiment on the growth performance of *Penaeus monodon* cultured singlu and in polyculture with the seaweed *Polycavernosa fisheri* is described. The research was conducted from April 10 to September 10, 1987 in two earhponds at the NICA shrimp farm located in Phawong Village, A. muang, Songkhla Province.

The salinity of the pond seawater during the diration of the experiment ranged between 29-38 ppt. Thirty two thousand P₃₀ *P. monodon* fry were stocked in each pond. The seaweed was cultured in 20 bamboo net cages measuring 1x2x0.3 m. The stocking rate was 1 kg of seaweed/cage. At the end of the research period the following results were obtained : shrimp in monoculture yeilded 627.5 kg compared to the 416.0 kg in polyculture with the seaweed . The size and weight of the harvested shrimp did not vary considerably between the two ponds, values being 14.40 cm and 24.65 gm when cultured singly and 14.38 cm and 24.30 gm when polycultured. The survival rate was slightly higher in monoculture compared to polyculture with values being 79.5 and 52.92% respectively. The production seaweed was 59.5kg.

Keywords: Polyculture; *Penaeus monodon*;

138 in Thai

139 Sompong Suwannatous, Worawut Chutchawan chaipan. 1988. **Net cage culture of giant tiger prawn (*Penaeus monodon*)**. In Proceeding the Seminar on Fisheries 1988 Department of Fisheries, 21-23 September 1988. National Inland Fisheries Institues, Bang Khen. p. 10-12 .

Cage culture of tiger prawn is one kind of prawn cultivation which are able to increase the production and minimize the production cost. 300 cages were set up at the mouth of Bangpakong River. The size of the cage is 25-36 m² and 3,000-5,000 PL40 were stocked in one cage. After 3-4 months, the prawn was harvested with the production 80-120 kg/cage.

Keywords: Net cages; Giant tiger prawn

140 Kanokporn Boonsong. 1998. **Integrated management framework for sustainable development of shrimp farming in Kung Krabaen bay, Chanthaburi province**. ใน การสัมมนาระบบนิเวศป่าชายเลนแห่งชาติครั้งที่ 10 “ การจัดการและการอนุรักษ์ ป่าชายเลน : บทเรียนในรอบ 20 ปี “ วันที่ 25-28 สิงหาคม 2541. คณะกรรมการทรัพยากรธรรมชาติป่าชายเลนแห่งชาติ สำนักงานคณะกรรมการวิจัยแห่งชาติ. IV-4.

Kung Krabaen Bay, Chanthaburi province, a semi-enclosed bay of about 640 ha, is under the control and supervision of the Kung Krabaen Bay Royal Development Study Centre which promote small-scale intensive shrimp farming since 1986 in order to increase farmers' income which simultaneously undertaking both the conservation and restoration of the deteriorated mangrove forests. Following the success of shrimp farms under the Centre, many more private individual farms emerged. As an outcome of over expansion of the shrimp farm given these limited land and water resources and unsustainable shrimp farming practices, a set of interrelated problems have occurred which need be addressed and remedied, for instance, the nearshore water quality deterioration, the frequent occurrence of shrimp diseases, low production and the salinization of paddy fields. This study assess and reviews the current situation of shrimp farming practices, relevant bio-physical environmental aspects and the socio-economic setting in the study area, particularly inherent potentials and problem. Based on the findings from such review and assessment, various recommendations for integrated planning and management of shrimp farms have been proposed for their sustainable development, is minimize waste loading into coastal environment by means of development of pond management and waste handling practices and the implementation of the waste treatment system; usage of mangrove forest for the wetland treatment of shrimp pond waste coupled with mangrove conservation and restoration; and increasing in the level of shrimp farmer's awareness on environmental aspects of shrimp farming.

Keywords: Shrimp farm; Shrimps

141 Niwes Ruangpanit, Supot Chungyampin, Janejit Kongkumnerd and Renu Yashiro. 1991. **Intensive culture of tiger shrimp (*Penaeus monodon* Fab.) in cement ponds.** Technical Paper No.4/1991. National Institute of Coastal Aquaculture, Songkhla. Department of Fisheries. 20 p.

Experiment on culturing tiger shrimp (*Penaeus monodon* Fab.) was done in three cement ponds with area of 300 m² each. The purpose of studying is to find out the growth, survival rate, production, food conversion ratio, some water qualities during cultured period and some operating cost. Post larvae 27 days old were stocked at the density of 75 ind/m² in each pond. They were fed with artificial pellet 5 times a day. Water exchange was done depending on the water quality in the cultured ponds about 12.12% of water changing in the first

month and the highest 54.5% in the last month of culture. The shrimp were reared for 110-112 days. The average harvest size was 27.40 grams and survival rate was 78.38-109.9% (average 95.11%). The production was 486.9-664 kg/pond (average 586 kg) or 1.62-2.21 kg/m² (average 1.95 kg/m²) and food conversion ratio was 2.07. Some water quality such as DO, pH, NO₂, salinity and temperature were 5.56 mg/l, 7.66, 0.046 mg/l, 31 ppt and 29.5 °C respectively. The operating cost was 69.44 bath/kg.

Keywords: Intensive culture; Tiger shrimp; *Penaeus monodon*

142 Somyot Garseevong. 2000. **Nursing of black tiger prawn larvae (*Penaeus monodon* Fabricius) in artificial seawater.** Master Thesis. Kasatsart University. 57 p.

Nursing of black tiger prawn larvae (*Penaeus monodon* Fabricius) in artificial seawater by using natural seawater as a control treatment and the 6 different formulae of artificial seawater. Each treatment has 4 replications. Each jar contains 10 l of seawater and 1,000 nauplii were stocked. Growth was determined by basing on frequency of molting from nauplius up to PL1 stage and the survivors were counted at harvest. The results of the study revealed that PL group 3 was the highest molting rate (13.01 days) followed by group 1, group 5, group 4, group 2, group 6 and group 7 (13.07, 13.07, 13.18, 13.37, 13.96 and 14.20 days, respectively). The percentage survival revealed group 1 was the highest (37.10 percent) followed by group 5, group 3, group 2, group 4, group 7 and group 6 with 23.85, 21.50, 14.68, 10.25, 7.13 and 0.85 percent of survival, respectively. The total cost of chemical used for preparing 100 artificial

seawater from formulae 2-7 were 59.75, 72.51, 80.30, 104.81 and 78.96 bath, respectively and the expenses per 100 liters natural seawater collected from Tumbon Samsan, Aumphur Suttaheb, Chonburi Province to Kasetsart University was 30 bath. Based on the results, indicated that group 3 and group 5 could be used for nursing the black tiger prawn larvae but the cost of chemical used for preparing artificial seawater was rather high.

Keywords: Nursing; Black tiger prawn; Artificial seawater

143 Tawat Sriveerachai and Tanan Tattanont. 1995. **Intensive culture of *Penaeus merguensis* (de Man) in earthen pond.** Technical Paper No.44/1995. Narathiwat Coastal Aquaculture Station. Department of Fisheries. 20 p.

Narathiwat Coastal Aquaculture Station had conducted the intensive culture of *Penaeus merguensis* (de Man) in earthen pond during March–August 1994. 210,000 individuals of the shrimp larvae (P-18) had been stocked into the 2,146 m² earthen pond (98 individuals/m²) Minced fish and shrimp pellets had been used to feed the shrimp during the culture. For the culture period of 164 days, the shrimp had the average total length of 11.49 centimeters, average body weight of 13.05 grams or 77 individuals/kilogram. Average Daily Growth (ADG) was 0.079 grams/day. Food Conversion Rate (FCR) was 3.16:1 and survival rate was 36.00 %. The final production of the shrimp was 732.70 kilograms/rai. There was no sign of any water qualities problems shown during the culture. The details of water qualities during the culture had been stated in the paper.

Keywords: Intensive culture; *Penaeus monodon*

144 Vira Jarearnpak. 1990. **Intensive-culture of giant tiger prawn (*Penaeus monodon*).** In Proceedings the Seminar on Fisheries 1990. Department of Fisheries 17-19 September 1990. National Inland Fisheries Institutes, Bang Khen.. p.284-288.

There are five earth ponds. A corner of every pond is a rectangular-pens which has been made of polyethylene. *P. monodon* post-larvae (P₁₈) were nurseried in these ones with 130/m². All of larvae were calculated from culture pond-areas. They were 157,588/3 raise-pond (density:32.3/m²); 157,500/3 raise-pond (32.8/m²); 130,000/3 raise-pond (27.1/m²). After *P. monodon* post-larvae were nurseried for 15 days, polyethylene would be picked up. So, they would have distributed to culture pond-areas and culture for 87-95 days. The following results have been recorded: productions of 822-1,036 kgs/rai/102-110

days, average weight of 25.7-31.8 gm/shrimp, survival rate of 59.6-81.95% and food conversion ratio of 1.9-2.5

Keywords: Intensive culture; Giant tiger prawn; *Penaeus monodon*

145 Prajuab Leeruksakiat, Niwat Suthemechaikul and Yanyont Saranrom. 1989. **Intensive tiger shrimp (*P. monodon* Fab) culture demonstration around Kung Krabaen bay**. Technical Paper No.2/1989. Kung Krabaen Bay Development Study Center. Department of Fisheries. 30 p.

In 2532 BC, The Farmers have been lost benefit because of the shrimp prices have grew down but the operation cost was very high. In this case, Kung Krabaen bay development and study centre had held intensive tiger shrimp culture demonstration for the decreasing cost of shrimp culture. Three demonstrated ponds from the master project were No 9, No 49 and No 50. Each of ponds has 2,800 m². Density were 55,000 (19 Postlarva/m²), 60,000 (21 Postlarva/m²) and 70,000 Postlarva 20 (25 Postlarva/m²) respectively. The result were

- 1.Survival rate 38.9, 48.3 and 59%
- 2.The productions 600, 1,000 and 1,380 Kgs
- 3.Feed conversion 1:1.4, 1:1.5 and 1:1.3
- 4.The benefit 9,382.34, 38,033.34 and 59,609.34 Bhts.per 3.5 months

The problem was the 3-4 weeks tiger shrimps dead but the reason did not know certainly.

Keywords: Tiger shrimp; *Penaeus monodon*

146 Boonsong Sirikul, Choomjet Karnjanakesorn, Chaiwat Vichaiwatana and Nirun Phoottarn. **Experiment and demonstration on intensive monoculture of *Penaeus monodon* Fabricius at Kung kraben in Chanthaburi**. Kung Krabaen Bay Development Study Center. Department of Fisheries. 16 p.

Experiment on culture of tiger prawn (*Penaeus monodon* Fabricius) was carried out in earthen pond at the size of 1.25 rai during May 7, 1985 to November 23, 1985. The pond was set at Kung Kraben where is in King's Project area. Initial stocking rate was 24,000 larvae/rai or 15 larvae/m² at the total length (tip of the rostrum to the end of telson) of 2.5 cm and weight of 0.15 g. The food for feeding was pellet and sometimes trash fish green mussel and cerithidae were added. When the population was harvested 390.4 kg per rai and 53.42 % had survived for a period of 6½ months. The conversion value of feed was 1:2.69. The average harvested prawn size was 15.21 cm in length and 30.95 g in wight. Overall growth rate

for this experiment was 4.67 g/month or 0.16 g/day. The gross net income was 43,112.00 baht or 34,489.60 baht/rai.

Keywords: *Penaeus monodon*

147 Khorkiat Koolkaew, Potjane Auttagitmongkon and Surachai Hemmapatana. 1988. **Experiment on *Penaeus monodon* culture in the different density**. Technical Paper No.15/1988. Songkhla Brackishwater Fisheries Station. Department of Fisheries. 13 p.

Experiment on Tiger Prawn (*Penaeus monodon* Fabricius) culture in the 25 and 20 prawn per square meter. The result showed that the harvest production are 628.1 and 536.8 kilogram from each two earthen pond half rai in size. The survival rate are 95.89% and 91.60%. The FCR are 1.63 and 1.71. The most size of prawn is 26.30 prawn per kilogram are 47.142% and 49.162%. The author show the growth rate in weight and length and water quality from the experiment in this report.

Keywords: *Penaeus monodon*

148 Pitsanu Na-anan and Manop Hendeen. 2000. **Culture of tiger shrimp, *Penaeus monodon* by close-recycled system**. Technical paper No.14/2000. Songkhla Marine Shrimp Research and Development. Department of Fisheries. 30 p.

The experiment on culturing black tiger shrimp (*Penaeus monodon*) using close-recycled system was carried out in 3,220 m² earthen pond. The postlarvae (PL) 17 day-old were stocked in rearing pond at a stocking rate 100,000 individual/rai. The pond was aerated by paddle wheels on the water surface and air blower at the bottom. Earthen pond with area of 810 m² was used for the biological treatment unit and 1.7 m³ at sand-filter tank was used as physical treatment unit. Shrimps were reared for 147 days. Water reclamation pass through treatment pond was 3,020 m³, which is equivalent to 90% water volume of rearing pond. The average harvested size of shrimp was 15.38 g and survival rate was 73.5%. The production was 2,245 kg (average 1122.5 kg/rai) and food conversion ratio was 2.08. From the results indicated that the close-recycled system is able to developed shrimp culturing to have a good harvest, good quality-production and could reduction of environmental impact from shrimp farming.

Keywords: Tiger shrimp; *Penaeus monodon*; Close-recirculating system

149 Thongchai Nitiratsuwan. 2003. **Sustainable of shrimp culture management in Trang province.** In the 41st Kasetsart University Annual Conference, 3-7 February 2003. p.155-162.

Efficiency and sustainable of shrimp culture management at Trang province to be necessary study on shrimp cultured activity and concerning organizer. To interviewed 30 shrimp farmers owner between September to December 2001, all feed drug and chemical store and concerning organization between July to September 2002 at Trang province. This result showed that shrimp farmers had varied basic; experience, acknowledge occupation. Each farm site were far and spread cover coastal area. Shrimp culture method was similar and highly risk. Feed drug and chemical store is the best potential organizer. Recommendation for sustainable shrimp culture management at Trang province as follow 1) co-operate shrimp organization and shrimp farmers 2) study on increase yield from decrease risk and able to operate in business 3) examined this cases and informatory to shrimp farmers for solved antibiotic residue problem by process.

Keywords: Shrimp culture; Management; Trang

150 Niwut Whangchai, C. Alfafara, N. Nomura, H. Young, VP. Migo, M. Matsumura. 2001. **Effect of electrolytic treatment of shrimp pond water on phytoplankton-bloom control.** In Proceedings: Symposium on Aquatic Resources and Environment : Integrated Management and Utilization 6-8 December 2001. p.13-16.

This study investigated the control of phytoplankton over bloom by electrolytic process. The study was conducted in artificial seawater containing phytoplankton. *Skeletonema* sp. was used as representative phytoplankton. Electrolysis, using iridium (electro-oxidation) or aluminum alloy (electroflotation) as anodes could effectively remove more than 98% of phytoplankton. As using aluminum alloy as anode, phytoplankton was removed by the combination of floc formation and flotation, while using iridium as anode, phytoplankton was removed by oxidation with oxidants produced from anode reactions. Comparing the energy consumption of electroflotation and electro-oxidation on phytoplankton removal in artificial seawater, electro-oxidation consumed lesser energy than electroflotation.

Keywords: Phytoplankton; Artificial seawater

151 Phichet Ungsakun. 2001. **Variations in nutrient concentration in the open and close**

systems for intensive culture of tiger prawn, *Penaeus monodon*, in low salinity area. Master Thesis. Burapa University. 110 p.

Variations in the water quality and nutrient concentration and the correlation between them were studied in the intensive culture of black tiger prawn (*Penaeus monodon*) during a 4-month culture period. The experiment was conducted in an open system at Amphur Bor Thong, Chonburi province and in a closed system at Amphur Plang Yow, Cha Choeng Sao province. In each system, water samples were collected every two weeks from one storage pond and two culture ponds for assessment of water quality. It was found that water quality and nutrient concentration of both systems changed throughout the culture period. In the closed system, the average variations in temperature (31.2°C), and transparency (33.72 cm) were higher than those of the open system, but the pH (8.40) was lower than that of the open system. The DO of both systems increased in the first quarter of the culture period and decreased in the last month. The BOD of both systems increased throughout the culture period. The chlorophyll a of both systems increased throughout the culture period but decreased in the last week. The concentration of PO_4^{3-} of both systems fluctuated throughout the culture period. The levels of NH_3 , NO_2^- , and NO_3^- in the closed system increased during the last month whereas these parameters in the open system remained stable throughout the culture period. The concentration of SiO_3^{2-} decreased during the culture period in both systems. There was a significant difference ($P < 0.05$) in the suspended solid, temperature, pH, DO, NH_3 , NO_2^- , NO_3^- , PO_4^{3-} , SiO_3^{2-} and chlorophyll a between the open and closed system. However, no significant difference ($P > 0.05$) in the BOD and transparency was observed between the two systems. There was a positively correlation between pH and BOD, DO and chlorophyll a, and negatively correlation between pH and PO_4^{3-} , SiO_3^{2-} . The transparency correlated negatively to suspended solid, chlorophyll a, temperature. The chlorophyll a correlated negatively to NH_3 , NO_2^- , NO_3^- .

Keywords: Intensive culture; Nutrients; Opened system; Closed system

152 Thanom Pimoljinda. 1999. **Biological of Nereids (Annelida) for shrimp cultured.** Technical Paper No. /1999. Marine Shrimp Research and Development Institute. Department of Fisheries. 13 p.

Perinereis sp. and *Diopatra* sp. are familiar polychaet of the seashore on phylum annelida. In Phuket Island, *Diopatra* sp. was observed on muddy sediment and mangroves and when the tide was lowest, these worms observed on account of their tubes sticking out of the sediment. They make

excellent live food for shrimp in aquaculture, containing 58.37% protein. *Perinereis* sp. was the most widespread species on sheltered beaches with coarse sand and shells, near the water line at about midtide level, containing 45.32% protein. These species are used for bait and now has been used as food in shrimp culture with the result that some beaches on Phuket Island have been overexploited. So the Andaman Marine Shrimp Research and Development Center made preliminary studies into the prospects of mass culture of *Perinereis* sp. in tanks, but only limited culture about them is to mature stages, because larvae did not develop under these conditions.

Keywords: Shrimp culture

153 Niwat Suthemechaikul and Aujchara Wongsangchan. 1995. **Study on the possibility of using sea cucumber to improve the quality of sludge from intensive marine shrimp farm.** Technical Paper No.11/1995. Coastal Aquaculture Division. Department of Fisheries. 13 p.

On the study of reproductive biology of sea cucumber (*Holothuria atra*) in 1993, the peak of gonadosomatic index (GSI) was found during April up to September. The experiment on the improvement of bottom mud sediment of intensive marine shrimp farming using sea cucumber in captivity indicated that one sea cucumber absorbed the nutrient and organic matter as the average absorptive efficiency of 51.34%. It can be concluded that there was the potential using sea cucumber to improve the bottom mud sediment from shrimp farm. It also recommend further research on polyculture of shrimp and sea cucumber would be conducted in order to improve have the aquatic environment condition in shrimp pond.

Keywords: Intensive culture

154 Sinthi Dangsakul and Lila Ruangpan. 1998. **Efficiency of probiotics produce from *Bacillus* for culture *Penaeus monodon*.** Thai Fisheries Gazette 51(5): 446-456.

Six strains of *Bacillus* were isolated from mud water interface of shrimp ponds located in the south of Thailand. To evaluate the efficiency of those strains used as probiotics for feeding to postlarvae of *Penaeus monodon*, experiment were carried out for 15, 25, 35, 45 and 55 days. After the experimental shrimps were harvested, survival rate, relative percent survival (RPS) weight, length and growth rate were analysed using paired samples t-test. Results indicated that among the control and the treated groups, *Bacillus* strain PO27 enhanced

the survival of shrimp consistently at the highest rate. The survival rate achieved by PO27 were 95.32, 92.00, 82.00, 76.66 and 75.33% in 15, 25, 35, 45 and 55 days, respectively with RPS ranging from 25.00-53.26%. PO26 and PO25 achieved lower survival rate than PO27 but higher than the other strains. The efficiency on increasing weight and growth were found in the groups feeding with PO26 and PO27. The shrimp received probiotics in long period exhibited higher growth rates than those received in short periods. This investigation shows the potential of using *Bacillus* as probiotics in intensive shrimp culture system. Further study should be conducted to determine site effect and harmful of the excess probiotics product, and method for mass production.

Keywords: Probiotics; *Bacillus*; *Penaeus monodon*

155 Chaichan Mahasawasde and Khamjut Ruenreungdee. 1990. **Types of net-cages for prawn culture.** Research Report 1990. Faculty of Fisheries, Kasetsart University. 15 p.

Tiger prawn, *Penaeus monodon* Fabricius, have been raise as a representative of prawn in three types of net cage, square, round and hexagonal. Post larvae at the 0.24 grams initial average weight were fed up to 120 day. The analysis of variances of mean weight, growth rate, gained weight per cage, survival rate, food conversion rate and prawn production showed no significant different in three types of net cage.

Keywords: Net cages; Prawn culture

156 Ong-ard Lawhavinit, Saipin Khumsap, Niramol Upramai and Wanida Passadurak. 1993. **Improved water quality of black tiger shrimp *Penaeus monodon*, culture by bacterial augmentation.** Kasetsart University. 11 p.

The addition of bacterial seed stock into waterbodies of aquaculture is the technique of water pyrifying has brought to use in black tiger shrimp *Penaeus monodon* ponds. The total plate count of 5 products, 3 powder form and 2 liquid suspension form, were 2.8×10^6 , 1.5×10^8 , 2.3×10^9 , 3.0×10^8 and 1.1×10^9 CFU/ml, respectively. *Bacillus subtilis*, *Enterobacter aerogenes* and *Pseudomonas stutzeri* were isolated. NaCl tolerance of the isolated bacteria show that *B. subtilis* could grow but *E. aerogenes* and *P. stutzeri* could not grow in 2, 3 and 4% NaCl nutrient broth. However, all of the isolated bacteria were able to grow in 7.2-9.5 pH levels nutrient broth. In the black tiger shrimp ponds test, the products were applied in 4 ponds, 2 ponds for powder and 2 ponds for liquid suspension form, and were compared with the untreated ponds as a control pond. As the results show that, the mean of the production (4,605.05 and 4,574.00 kgs) and the percentage of

survival rate (56.33 and 76.24%) in the treated ponds had increased by 125%, 123% of the production and 70%, 130% of the percentage of survival rate more than the control pond (2,045.56 kgs and 33.07%) when the powder and liquid suspension form products were used, respectively. It due to the water quality, especially the dissolve oxygen in the control pond was less than the treatment ponds.

Keywords: Black tiger shrimp; *Penaeus monodon*; Bacteria

157 Piamsak Menasveta, Arlo W. Fast, Somkiat Piyatirativorakul and Sompop Rungsupa. 1991. **An improved, closed seawater recirculation maturation system for giant tiger prawn (*Penaeus monodon* Fabricius).** Aquacultural Engineering. 10:159-167.

A large, closed seawater recirculation system for maturation of giant tiger prawns is described. The system consisted of a circular, 7-m diameter, flat-bottom maturation tank (1.4 m water depth), and a separate bio-filter tank. During operation, water recirculation was four times daily. The system was housed in a building with light intensity 5% of ambient. Eight prawn maturation trials were conducted with this system. Each trial normally ran for three months with stocking densities of 3 prawns/m². Prawn sizes ranged from <100 to 200 g water quality was maintained at optimal condition throughout the trials. Maturation and spawning success appeared dependent on prawn quality and food quality provided.

Keywords: Closed recirculation system; Maturation; *Penaeus monodon*

158 Anand Tunsutapanich, Siri Tookwinas, Nopadol Phuwakpanish, Somboon Laoprasert, Tanan Sanggonta nakig and Tongchai Permwarm. 1992. **Improved culture techniques of *Penaeus monodon* Fabricius integrated with *Artemia* farming.** Technical Paper No.1/1992. Coastal Aquaculture Division. Department of Fisheries. 15 p.

Unproper management shrimp farming in the areas of Gulf of Thailand caused a huge environmental problem resulted in inability to proceed farming during 1987-1990. A new technique dealing with better management to maintain good hygiene and precaution in every steps of pond preparation without exchange the water resulted in satisfactory result. The total production was between 0.942-2.627 tons/rai. The shrimp weighed about 24-43 tails/kg and survival rate was 52.74-92.85% with the FCR = 1.2-2.

Upon draining the ponds it was found a little accumulation of organic matter. Therefore, this technique could be applied for shrimp and/or *Artemia* farming with some degree of success.

Keywords: Improvement; *Penaeus monodon*; *Artemia*; Farming

159 Yang Yi, Potjanee Nadtirrom, Vinit Tansakul and Kevin M. Fitzsimmons. 2002. **Current status of tilapia-shrimp polyculture in Thailand.** In the 4th National Symposium on Marine Shrimp. p.77-92.

The survey was conducted in 12 provinces of Thailand during March-June 2002 to assess the current status of farmers practice on tilapia-shrimp polyculture. Sixty-one farmers who culture fish in their shrimp farms were selected and interviewed using a structured checklist and open-ended type of questionnaires. Results showed that three versions of tilapia-shrimp polyculture, namely simultaneous, sequential and crop rotation systems, are practiced by Thai shrimp farmers. Among all interviewed farmers, 42.6%, 34.4% and 6.6% use simultaneous, sequential and crop rotation polyculture systems, respectively, while the remaining 16.4% just stock fish in reservoir ponds and use monoculture system for shrimp. Among the farmers who adopt the simultaneous polyculture system, 76.9% release tilapias directly into shrimp ponds, and 23.1% stock tilapias in cages suspended in shrimp ponds. The survey revealed that shrimp production and economic returns in the two simultaneous polyculture systems and sequential polyculture system were higher than those in their respective shrimp monoculture practiced before, and also higher than those in the crop rotation polyculture system and in the currently practiced monoculture system. Many farmers responded that the tilapia-polyculture could improve water quality in shrimp ponds, reduce diseases and use of chemicals. It can be concluded from the survey that tilapia-shrimp polyculture may provide an alternative approach for shrimp farming, which could ultimately lead to a more sustainable shrimp industry. However, further research is needed on merits for converting from monoculture to polyculture of shrimp.

Keywords: Polyculture; Shrimp

160 Wanwisa Saelee, Yang Yi and Kevin M. Fitzsimmons. 2002. **Stocking densities of Nile tilapia in Tilapias-shrimp polyculture at low salinity.** In the 4th National Symposium on Marine Shrimp. p.93-107.

This experiment was conducted in nine 200-m² earthen ponds at the Asian Institute of Technology (AIT), Thailand for 65 days from 20 February to 23 May 2002 to investigate the growth performance of

shrimp (*Penaeus monodon*) and Nile tilapia (*Oreochromis niloticus*) and water quality in tilapia-shrimp polyculture ponds at different stocking densities of Nile tilapias. There were three treatments in triplicate each: shrimp alone at 30/m² (T1); shrimp at 30/m² and Nile tilapia at 0.25/m² (T2); shrimp at 30/m² and Nile tilapia at 0.50/m² (T3). Growth performance of shrimps was not significantly different ($P>0.05$) among all treatments. Although FCR of shrimps was not significantly different among all treatments ($P>0.05$), shrimp monoculture had significantly lower feed input than tilapia-shrimp polyculture ($P<0.05$). Growth and survival of Nile tilapia was not significantly different between the low (T2) and high (T3) tilapia density treatments ($P>0.05$), while fish yields were significantly higher in the high tilapia density treatment than in the low tilapia density treatment ($P<0.05$). Salinity was 5 ppt initially and decreased quickly to 0 ppt within 3 weeks in all treatments. Overall mean values of all water quality parameters except TAN and SRP were not significantly different among all treatments ($P>0.05$), while the final values of all water quality parameters except Secchi disk visibility were not significantly different among all treatments ($P>0.05$). Final values of Secchi disk visibility were significantly greater in the tilapia-shrimp polyculture than in the shrimp monoculture ($P<0.05$). All treatments resulted in positive net returns with significant differences among all treatments ($P>0.05$). The highest net return was achieved in the shrimp monoculture, intermediate in the high tilapia density treatment, and lowest in the low tilapia density treatment. The present study showed that tilapia-shrimp polyculture is feasible technically, but may not be attractive economically. More research needs to optimize the feeding management in the tilapia-shrimp polyculture.

Keywords: Nile tilapia; Polyculture

161 Putth Songsangjinda, Khorkiat Koolkaew and Siri Tookwinas. 2001. **Efficiency of Sludge Removal System (SRS) on removal and transformation of the wastes in sludge effluent from pond bottom of re-circulating shrimp culture.** In the 3rd National Symposium on Marine Shrimp. p.67-73.

The previous results from the Sustainable Shrimp Aquaculture Project (SSAP), the cooperative project between Thailand and DANCED using Danish biological technology for the effluent quality improvement in the re-circulation shrimp culture, indicated that designed biofilters of the Sludge Removal System (SRS) had insufficient efficiency to remove nitrogen from the sludge effluent from pond bottom due to the

sunlight exposure and improper operation. This study aims to evaluate the modified trickling filter of the SRS on the removal efficiency and transformation of BOD, particulate organic carbon (POC) and various parameters of nitrogenous and phosphorus compounds. The results showed that the removal efficiency during sedimentation was low in almost parameters except the production of nitrite and dissolved organic phosphorus (DOP). The oxygen in sedimentation tank indicated an anoxic environment of the effluent removed from the center of the pond by SRS. In addition, the reduction of nitrate in the sedimentation tank probably indicated the demand of nitrate in the denitrification process. The nutrients and organic wastes removed as a condensed sludge were about 14.7, 14.1, 14.5 and 14.9% of the inlet for the BOD, POC, total nitrogen (TN) and total phosphorus (TP), in respectively. The trickling filter plays significant roles on the transformation of nitrogenous compounds, reduction of oxygen demand, and the degradation of organic matter. The accumulation of nitrite and nitrate probably suggested the occurrence of the nitrification process in the modified trickling filter of the SRS. The removal efficiency of BOD, POC, TN and TP were about 578.9, 128.8, 5.5 and 3.11 g/operation, in respectively.

Keywords: Sludges; Shrimp culture

162 Chanin Sangrungruang and Niwat Suthemechaikul. 1992. **On improvement of benthic quality of shrimp pond using sea cucumber, *Holothuria atra*.** Technical paper No.7/1992. Laem Sadet Coastal Fisheries and Environment Research Center. Coastal Aquaculture Division. Department of Fisheries. 8 p.

Sea cucumber, *Holothuria atra*, was used to study its benthic layer consumption in order to get the task for improvement of benthic quality in shrimp, *Penaeus monodon*, culture pond. Benthic sample before and after consumption of sea cucumber was analyzed to determine the difference. Calcium decreased most for 59.33% and nitrogen decreased only 9.67% carbon decreased 29.23%.

Keywords: Shrimp ponds

163 Kriengsak Phadetphai and Pholphot Kittisuwan. 1997. **Culture of tiger shrimp (*Penaeus monodon*) in low salinity.** Technical Paper No. 6/1997. Chachoengsao Coastal Aquaculture Development Center. Coastal Aquaculture Division. Department of Fisheries. 23 p.

Culture of tiger prawn, *Penaeus monodon*, in low salinity water was conducted at Tumbon Wangtakian, Amphoe Muang, Chachoengsao Province. 3 earthen

ponds were used: No.1 with area 2.50 rai and 150,000 post larvae were stocked (37 ind/sqm), No.2 with area 2.75 rai and 160,000 post larvae were stocked (36 ind/sqm) and No.3 with area 3.75 rai and 300,000 post larvae were stocked (50 ind/sqm). The post larvae in this study were acclimatized for salinity in hatchery, from 25 ppt to 8-10 ppt. The average initial weight, of post larvae, was 0.004 g and average initial length was 1.45 cm. The water in this study was freshwater from the canal mixed with the high salinity water from salt pan (50-60 ppt). At the end of the study: pond No.1, shrimps were reared 110 days with the production 772.72 kg/rai, the average size of shrimp was 55 ind/kg and the survival rate was 62.23%, pond No.2, shrimps were reared 110 days with the production 608.69 kg/rai, the average size of shrimp was 56 ind/kg and the survival rate was 49.00% and pond No.3, shrimps were reared 92 days with the production 939.39 kg/rai, the average size of shrimp was 80 ind/kg and the survival rate was 82.66%.

Keywords: Tiger shrimp; Low salinity

164 Sansern Chorcheng, Sukit Rattanavinitkul, Thavee Rojanasarpakait and Pin Polchai. 1988. **Experiment on nursing white shrimp, *Penaeus merguensis* de Man in different density and frequency of feeding in painted and non-painted epoxy tanks.** Technical Paper No. 14/1988. Nakorn Si Thammarat Brackishwater Fisheries Station. Brackishwater Fisheries Division. Department of Fisheries. 9 p.

This experiment compared 3 stocking densities of white shrimp, *Penaeus merguensis* de Man. P₂-P₁₅: 10-15/litre; 15-20/litre, and 20-25/litre. The experiment also investigated the effect of frequency of feeding on the survival rates of shrimps. Frequencies of feeding used in the experiment were 3 times/day and 4 times/day. Furthermore compared the survival rates of shrimps nursed in epoxy painted tanks and non painted tanks. The results of the experiment were as follows; the average survival rates under different stocking densities were 48.99% and 38.68% respectively. No results were available for 20-25/litre stocking density. The average survival rates for the different frequencies of feeding were 42.60% and 45.13% respectively. The average survival rates in epoxy painted and non painted tanks were 51.26% and 51.36% respectively.

Keywords: White shrimp; *Penaeus merguensis*; Feeding; Cement tank

165 Supon Tansuwan and Wichain Yongprapat. 1993. **Technique development of intensive tiger-**

shrimp (*Penaeus monodon* Fabricius) nursing in cement pond. Technical Paper No. 14/1993. Songkhla Coastal Aquaculture Station. Coastal Aquaculture Division. Department of Fisheries. 20 p.

Larvae of tiger-shrimp (*P. monodon* Fabricius) were nursing at Songkhla Coastal Aquaculture Station. From zoea stage to post larvae were fed with diatom (*Skeletonema* sp.), egg-custard, artificial food, *Artemia* and artificial pellets. The salinity of seawater was about 29-31 ppt, and water temperature in nursing pond control 29-32°C. The densities of nauplii in rearing tank (1.7x7.6x1 m) were 133.2, 122, 136.6 and 133.2 perlitre, respectively. The survival rate from nauplii to post larvae 7 were 73.67%, 86.93%, 84.82% and 78.27%, respectively and were not significant different of survival rate at densities of nauplii 130±6.67 perlitre (P>0.05). Technique for nursing larvae of tiger-shrimp were water system, feeding, aeration and temperature control.

Keywords: Tiger shrimp; *Penaeus monodon*; Cement tank

166 Tawee Chindamaikul. 1990. **The studies on comparison between nursing *Penaeus monodon* Fabricius by control temperature and uncontrol temperature.** Technical Paper No.33/1990. Phuket Coastal Aquaculture Development Center. Coastal Aquaculture Division. Department of Fisheries. 18 p.

The studies on comparison between nursing *P. monodon* by control temperature and uncontrol temperature had been done 2 times in winter season (November 1989-December 1989) and rainy season (May 1990-June 1990). The twenty tons with 1,000,000 nauplius were used and fed with diatom, *Artemia* and artificial feed until PL₇. The control temperature tanks were covered with black canvas and controlled the temperature (32°C) by heater and uncontrol temperature tanks were covered with bamboo sheet. The results of experiments; for the control temperature, the development stages (nauplius, zoea, mysis) of *P. monodon* were developed quickly than the uncontrol temperature about 8, 12 and 24 hrs respectively. The period stages of zoea and mysis for the control temperature were 3 days but for the uncontrol temperature were 4-5 days (normally period stage were 4 days). The period of nursing to harvesting; for the control temperature were less than the uncontrol temperature about 3 days. The survival rates of nauplius, zoea, mysis, postlarva 1-7 and N-P₇ on control temperature in winter season were 97.78, 90.91, 90.00, 94.44 and 75.56 percentage respectively and in rainy season were 82.50, 86.26, 84.31, 57.76 and 34.67 percentage respectively. For the uncontrol temperature, the survival rate of nauplius, zoea, mysis, postlarva 1-7 and N-P₇ in winter season were 94.44, 88.24, 86.00,

93.03 and 66.00 percentage respectively and in rainy season were 81.00, 75.52, 68.42, 50.22 and 21.00 percentage respectively. The survival rate of each stages on the control temperature in winter and rainy season were highly than uncontrol temperature.

Keywords: *Penaeus monodon*; Temperature; Nursing

167 Chotima Vanagosoom and Jarurinth Gunthnuth. 1988. **Experiment on rearing of *Penaeus monodon* by *Chaetoceros* using GML (ami ami) as fertilizer.** Technical Paper No. 8/1988. Rayong Brackishwater Fisheries Station. Brackishwater Fisheries Division. Department of Fisheries. 6 p.

In experiment of using *Chaetoceros* from organic fertilizer and Ami as fertilizer in rearing of *Penaeus monodon* larvae we found that, the result in growth are not different. The developing of larvae from zoea stage to mysis stage are in the same time but the survival rate are quite different. As in the first time of experiment, the survival rate of the larvae reared with *Chaetoceros* from organic fertilizer is 68.40% whereas in rearing by *Chaetoceros* using Ami as fertilizer, the survival rate 74.17%. In the second time, the survival rate of each treatment are 37.74 and 57.93% and the third time of experiment, the result are 55.29 and 63.03% in each. We may say that, using *Chaetoceros* grown from Ami Ami can be take to the better result than using *Chaetoceros* from organic fertilizer especially in the high density.

Keywords: *Penaeus monodon*; *Chaetoceros*

168 Kanit Chaiyakum, Putth Songsangjinda and Dusit Tunvilai. 1992. **Variation of physico-chemical properties of water and phytoplankton abundance in intensive shrimp ponds at Amphoe Ranod, Songkhla province.** Technical Paper No. 4/1992. Songkhla National Institute of Coastal Aquaculture. Department of Fisheries. 46 p.

Study on variation of physico-chemical properties of water and phytoplankton abundance in intensive shrimp ponds at Amphoe Ranod, Songkhla province. Fifteen intensively cultured shrimp ponds, size of pond varied between 0.91-6.0 rais stocking rate 25-103 pcs/m², cultured day 101-179 days, production was 381.60-2,527 kilograms/rai. The results shown that the most variable parameter of water quality of dissolved oxygen, salinity, ammonia-nitrogen, orthophosphate, BOD, total suspended solids and chlorophyll a which varied between 3.5-13.5 mg/l, 15.42 ppt, 0.000-4.268 mg/l, 0.000-0.1755 mg/l,

1.02-17.97 mg/l, 24.792 mg/l and 7.52-679.3 ug/l respectively. Phytoplankton 59 species was found during the study period. The most abundance and dominant species of phytoplankton in phylum cyanophyta (blue green algae) are *Trichodesmium* sp. especially the production in the shrimp pond 2,527 kilograms/rai was 11,937,000 cells/litre and diversity index 0.0001 in twelfth week. The other shrimp pond, 381.60 kilograms/rai was 5,408,000 cells/litre and diversity index 0.0027 in eighth week. This phenomenon shown that happening Eutrophication in the shrimp ponds. Salinity and chlorophyll a shown correlation with abundance of phytoplankton was significant (P<0.05).

Keywords: Physicochemical property; Phytoplankton; Shrimps

169 Tida Pechmanee and Mavit Assavaaree. 1995. **Flocculation of marine *Chlorella* for cultivation in shrimp farms.** Technical Paper No.10/1995. National Institute of Coastal Aquaculture. Songkhla. Department of Fisheries. 7 p.

Study on flocculation of marine *Chlorella* sp. to decrease volume during transportation for culture in shrimp farms was conducted by using 50, 100, 150, 200 and 250 ppm of Al₂(SO₄)₃.16H₂O and K₂SO₄Al₂(SO₄)₃.24H₂O for 15, 30 and 60 minutes. The result showed that the flocculation was increased by time. It was observed that using 50 ppm of Al₂(SO₄)₃.16H₂O or 100 ppm of K₂SO₄Al₂(SO₄)₃.24H₂O for at least 1 hr was suitable for *Chlorella* flocculation. The culture of flocculated *Chlorella* showed good population growth. However, after kept flocculated *Chlorella* sp. in refrigerator (5-7°C), then cultured the growth became poor.

Keywords: Flocculation; *Chlorella*; Shrimp farm

170 Supot Chungyampin and Chairat Phumchuai. 2000. **Breeding of Banana shrimp, *Penaeus merguensis* de Man, from earthen ponds.** Technical Paper No. 24/2000. Trang Coastal Aquaculture Station. Department of Fisheries. 13 p.

Banana shrimp were cultured to be broodstocks in the earthen ponds. The shrimp were transferred to a new pond in every 3 months. After 122 days, body length of the shrimp increased very slowly but body weight constantly increased at the normal rate. When cultured 136 days, average total length of the female shrimp was 12.970.56 cm and average total weight was 17.352.44 g. It was found that the females at this stage could be mating in the pond. In order to stimulate the female to spawn, eyestalk ablation was applied to three groups of shrimp after cultured in ponds for, i.e. 152, 193 and 229 days. Result shows that 229 days female shrimp was the best group for

spawning. The number of female spawners was highest during 3 times of spawnings. The average released eggs/shrimp were 62,835, which was three times higher than those of the 152 days-culture shrimp. The survival rate of postlarva 2 from 229 days-culture shrimp were 64%, while 152 days and 193 days-culture shrimps were 32% and 35%, respectively.

Keywords: Banana shrimp; Broodstocks; Breeding; Nursing; Earthen pond

171 Duangjai Kittipreechakul. 2002. **Effects of astaxanthin from yeast (*Phaffia rhodozyma*) on coloration, growth, survival, disease resistance and tolerance to salinity change in black tiger prawn (*Penaeus monodon* Fabricius).** Master Thesis. Kasetsart University. 100 p.

Effects of astaxanthin from yeast (*Phaffia rhodozyma*) on coloration, growth and survival in black tiger prawn (*Penaeus monodon* Fabricius) were studied. Experimental shrimps with average weight of 2.50 gm were fed with diets containing four concentrations of astaxanthin from yeast (*P. rhodozyma*) at 0, 39.00, 78.65 and 161.60 mg/kg for ninety days. There were no significant differences of average weight, average daily growth, specific growth and survival rate at any concentration of astaxanthin. The color of exoskeleton and flesh of shrimps after boiling for 5 minutes were compared. There were significant differences of color between shrimps fed with diets mixed with astaxanthin from yeast (*P. rhodozyma*) and control. The intensity of reddish color was found to be correlated with the concentration of astaxanthin. Effect of same concentrations of astaxanthin on resistance to pathogenic bacteria *Vibrio harveyi* was also studied. After sixty days of feeding, shrimps with average weight of 11.08 gm were challenged by intramuscular injection of *V. harveyi* suspension. The shrimps fed with every concentration of astaxanthin showed significantly higher survival rate than control. Effect of same concentrations of astaxanthin on tolerance to salinity change in black tiger prawn was studied. After forty days of feeding, shrimp was stressed by sudden salinity change. There were no significant differences of survival rate amongst any experimental and control groups ($P > 0.05$). Results from this study indicated that *P. rhodozyma* can serve as a good source of astaxanthin to increase coloration and disease resistance in black tiger prawn.

Keywords: Astaxanthin; Black tiger prawn; *Penaeus monodon*; Yeasts

172 in Thai

173 Mali Boonyaratpalin. Jaruratt Wannagowat. Chusak Borisut and Sujin Boonchuay. 1994. **Effect of various dietary canthaxanthin and astaxanthin levels on pigmentation of giant tiger shrimp.** Technical Paper No.18/1994. Songkhla National Institute of Coastal Aquaculture. Department of Fisheries. 11 p.

The effects of various dietary canthaxanthin and astaxanthin levels on pigmentation in juvenile giant tiger shrimp, *Penaeus monodon*, at 3.7-4 g were studied in an indoor hatchery. Supplementary feeds with canthaxanthin at 50 and 100 mg/kg diet and astaxanthin at 25, 50 and 75 mg/kg diet were tested with control feed without the pigment substance for 8 weeks. All pigment supplementary feeds improved shrimp pigmentation and decreased the number of blue shrimp. Astaxanthin showed pigment improvement efficiency 2.8 times higher than canthaxanthin. Dietary astaxanthin and canthaxanthin were deposited in shrimp body tissue mainly as astaxanthin. Supplementation with astaxanthin at 50 mg/kg diet for 4 weeks resulted in natural-looking colours in the tested shrimp. Experimental feeding with canthaxanthin and astaxanthin pigments did not affect growth or feed efficiency of shrimp.

Keywords: Canthaxanthins; Astaxanthin; Pigments; Giant tiger shrimp

174 Narongsak Puanglap. 1990. **An application of *Spirulina* sp. as a source of carotenoid pigment for the tiger prawn (*Penaeus monodon* Fabricius) diet.** Master Thesis. Kasetsart University. 112 p.

The experiment on an application of *Spirulina* as a source of carotenoid pigment for the prawn diet. The prawn with average initial weight of 0.05 g were fed on control formula with seven different diets containing 0, 1, 5, 10, 15, 20 and 25 percent by weight of *Spirulina* for ten weeks. The maximum growth rate of the prawn experiment showed that the diet formula containing 10 percent of *Spirulina* is the most highly effective while the lesser growth rate of the prawns that fed on the following diet formula are 1, 5, 15, 20 and 25 percent of *Spirulina*. The minimum growth rate is obtained while the prawn which fed on the diet formula without *Spirulina*. The study on the survival rate, protein efficiency rate and feed conversion ratio was found that the prawns which fed on the diet containing *Spirulina* had given better result than the diet without *Spirulina*. The experimental study on the quantity of carotenoid in prawns was found that the quantity of carotenoid didn't increase with the prawn that fed on diet containing without *Spirulina* while the increasing carotenoid quantity of the prawns that fed on the containing the amount of *Spirulina* and the period of rearing.

Keywords: *Spirulina*; Carotenoid; Tiger prawn; *Penaeus monodon*

175 Manop Kanjanaburangkura. 2001. **Use of water flea as the supplementary feed to brine shrimp for nursing on giant tiger prawn, *Penaeus monodon*.** ใน รายงานการประชุมสัมมนาทางวิชาการสถาบันเทคโนโลยีราชมงคล ครั้งที่ 18 วันที่ 15-17 กุมภาพันธ์ 2544 ณ หอประชุมใหญ่ ศูนย์กลางราชมงคล. p.312-325.

The efficacy of water flea, *Moina* sp. as the supplementary feed to brine shrimp, *Artemia salina* for nursing on giant tiger prawn, *Penaeus monodon* (PL₅-PL₂₅) were studied at the Department of Fisheries, Faculty Agriculture at Bangphra, Chonburi during October 8, 1998 – April 30, 1999. After the static bioassay test, the salinity of 8-10 ppt, 6-4 hrs LC₅₀ for water flea were used as rearing salinity. At the end of experiment, it was found that supplementation of water flea at 0, 30, 50 and 100 percent of brine shrimp to PL₅ of PL₂₅ did not show the differences in total lengths, 1.45, 1.52, 1.58 and 1.48 centimeter (P>0.05) but the average final weight and survival rates were significantly different, 28.5, 40.1, 35.4 and 33.0 milligram and 58.62, 49.50, 56.53 and 38.58 percent respectively (P<0.05). The shrimp fed on 100 percent of water flea turned blue-green and showed the lowest survival rates, 38.58 percent due to cannibalism in molting periods. However, the color was disappeared after the shrimp were fed on complete feed for 45 days in closed system pond. The results recommended that substitution of water flea to brine shrimp could be done up to 100 percent, but the ration above 50 percent will effect the colouration and survival rate of the shrimp.

Keywords: Water fleas; Brine shrimp; Giant tiger prawn

176 Nontawith Areechon, Duangjai Kittipreechakul and Chumpol Srithong. 2003. **Application of astaxanthin from yeast *Phaffia rhodozyma* in black tiger shrimp *Penaeus monodon* Fabricius.** In the 41st Kasetsart University Annual Conference, 3-7 February 2003. p.137-145.

Effects of astaxanthin from yeast (*Phaffia rhodozyma*) on pigmentation, growth and survival in black tiger shrimp *Penaeus monodon* Fabricius were studied. Shrimps were fed with diets containing four concentrations of astaxanthin at 0, 39.00, 78.65 and 161.60 mg/kg feed for ninety days. No significant differences of growth and survival rate were detected (P>0.05). All concentrations of astaxanthin could significantly

enhance the pigmentation of the shrimp after boiling for 5 minutes. Same concentrations of astaxanthin significantly enhanced the resistance against pathogenic bacteria *Vibrio harveyi* after 60 days of feeding (P<0.05). Effect of astaxanthin from *P. rhodozyma* on tolerance to salinity change (20 to 0 ppt) in black tiger shrimp was studied. No significant differences of survival rate amongst experimental and control group were found (P>0.05). Results from this study indicated that *Phaffia rhodozyma* can be a good source of astaxanthin that had significant impact on pigmentation and disease resistance of black tiger shrimp.

Keywords: Astaxanthin; Yeasts; Black tiger shrimp; *Penaeus monodon*

177 Sukit Rattavinitkul and Poonsin Parnichsuke. 1995. **Effect of supplementary *Spirulina* and marigold in diets on pigmentation of giant tiger shrimp.** Technical Paper No. 3/1995. Nakorn Sri Thammarat Coastal Aquaculture Station. Coastal Aquaculture Division. Department of Fisheries. 9 p.

The effects of supplementary *Spirulina* and marigold in diets on pigmentation in juvenile giant tiger shrimp, *Penaeus monodon*, at 3.8 g were studied in an indoor hatchery. Supplementary feed with *Spirulina* and marigold at 85 g/kg diet were tested with control feed without the pigment substance for 45 days. Marigold showed pigment improvement more efficiency than *Spirulina*. Supplementation marigold at 85 g/kg diet for 1 month resulted in natural-looking colours in the tested shrimp. Experimental feeding with *Spirulina* and marigold pigments did not affect growth, feed conversion rate of survival of shrimp.

Keywords: *Spirulina*; Marigold; Pigments; Giant tiger shrimp

178 Niti Chuchird. 1995. **Effects of astaxanthin on growth survival rate and tolerance to pathogenic bacteria of black tiger shrimp in low salinity conditions.** Master Thesis. Kasetsart University. 95 p.

The effects of astaxanthin on growth and survival rate in black tiger shrimp *Penaeus monodon* Fabricius culture in low salinity (0-5 ppt) was studied. Shrimps fed with pelleted feed mixed with astaxanthin (0.625 g per kg of feed) for 112 days had significantly (p=0.05) higher growth rate of 22.6 g compared to 20.58 g of control shrimps. However, astaxanthin had no effect on the survival rate in all groups of the experimental shrimps. Efficacy of astaxanthin on survival rate of black tiger shrimp after experimental infection was studied. Shrimps weight 15-20 g were fed with pelleted feed mixed with astaxanthin (0.625

g per kg of feed) for seven days before intramuscular injection with *V. alginolyticus* and *V. parahaemolyticus* at the dosage of LD₅₀ level (9.03×10^6 cells per ml) and (10.11×10^7 cells per ml) and the survival rate was observed. There was no significantly differences between the shrimps fed with pelleted feed mixed with astaxanthin and control groups.

Keywords: Astaxanthin; Growth; Survival; Pathogenesis; Black tiger shrimp; Low salinity

179 Nittaya Chaiyanate. 1995. **Supplement of astaxanthin vitamin c, and fish oil in feed for increased resistance to yellow-head disease in juvenile giant tiger prawn.** Master Thesis. Chulalongkorn University. 97 p.

Two experiments were conducted to study the effect of micro-nutrients supplement on yellow-head disease resistance in *Penaeus monodon* postlarvae. In experiment 1, the post-larvae 15 (PL-15) were fed with a commercial basal diet and a number basal diet factorially supplemented with choline, astaxanthin (AS), ascorbic acid (VC), and fish oil (OIL) at the concentrations of 600, 200, 2,000 ppm and 3%, respectively. After 30 days of feeding, these groups of prawns were challenged with yellow-head disease infected shrimp meat. The results showed that the groups fed with micro-nutrients supplemented basal diets showed a tendency in increasing the resistance to this disease.

In experiment 2, two sizes of PL-30, i.e. big (1.01 gm avg wt) and small (0.02 gm avg wt), were fed with 5 diets. These five diets are basal a commercial basal diet and 4 basal diets supplemented with AS, AS+EGG, VC, and Oil, at the same concentration as experiment 1. Feeding rates are 5 times a day. The result showed no difference on growth among the five diet groups of the two sizes after 45 days of feeding. Challenging the prawns by co-habitation technique revealed that the group of big prawns fed with diet BA (basal diet) started to die earlier than the other groups. Nevertheless, the small prawn groups did not show the same pattern (motility rates were somewhat comparable).

Keywords: Diets; Vitamin C; Fish oils; Astaxanthin; Yellow Head Disease; Disease resistance; *Penaeus monodon*

180 Chalee Paibulkichakul. 1996. **Optimal levels of lecithin and cholesterol in diet for black tiger prawn *Penaeus monodon* larvae.** Master Thesis. Chulalongkorn University. 84 p.

Present study aims to determine optimal levels of lecithin and cholesterol for black tiger prawn *Penaeus monodon* larvae for growth, survival and salinity resistant. The study was designed using CRD involved factorial. Semipurified diets containing 4 levels of lecithin (0, 0.5, 1.0 and 1.5%) and 3 levels of cholesterol (0, 0.5 and 1.0%) were used. Three larval stages (zoea, mysis and postlarva) of *Penaeus monodon* were used to determine the effect of tested diets. Results of the study indicated a non-interactive effect between lecithin and cholesterol on growth and survival of shrimp larvae. Shrimp fed diets containing 1% and 1.5% of lecithin showed no significant difference on growth and survival. Both of these groups showed significant higher growth and survival than those of the control and 0.5% lecithin groups. For the shrimp receiving diet with 1% of cholesterol, growth and survival were comparatively higher than 0 and 0.5% cholesterol ones. On salinity stress test of postlarvae stage, only shrimp fed diets containing cholesterol 1% could provide better survival rate when they exposed to low salinity.

Keywords: Diets; Lecithin; Cholesterol; Larval feeds; *Penaeus monodon*

181 Tarika Phatai. 2000. **Effects of ω -3HUFA on growth and survival rate of giant tiger shrimp (*Penaeus monodon*).** Master Thesis. Kasetsart University. 87 p.

Effects of ω -3HUFA on growth and survival rate of giant tiger shrimp (*Penaeus monodon*) was studied. The first experiment, postlarvae 15 were fed with pelleted feed supplement HUFA 5 cc/kg feed, HUFA 10 cc/kg feed and control no supplement for 8 weeks. Results show no significant difference ($P > 0.05$) in growth and survival between postlarvae fed two different levels of HUFA and control. The second study was designed to determine the effect of ω -3HUFA on growth and survival rate of giant tiger shrimp in growout pond. Eight earthen ponds in Ratchaburi province were used in this study. Postlarvae 15 were stocked at 100,000 shrimp/rai in each earthen ponds. Shrimp fed pelleted feed supplement HUFA 10 cc/kg feed compare to control for 120 days. Shrimp were sampled every 10 days and measured for length and weight throughout the growing period. After harvest, total production and survival rate were recorded. Results indicated that shrimp fed with supplement HUFA 10 cc/kg feed had higher production and survival rate than control. The different size of shrimp were collected for histological examination. Small size shrimp was slightly infected with monodon baculovirus (MBV) and hepatopancreatic parvovirus (HPV). No MBV and HPV were found in medium and large sizes shrimp in this study.

Keywords: HUFA; Giant tiger shrimp; *Penaeus monodon*

182 Pokpong Umyoo. 2000. **Effect of highly unsaturated fatty acid (Omega 3; n-3 HUFA) with different ratio of Eicosapentaenoic Acid (EPA) and Docosahexaenoic Acid (DHA) on stress and disease resistance of black tiger prawn larvae (*Penaeus monodon* Fabricius) applied by *Artemia* enrichment.** Master Thesis. Kasetsart University. 101 p.

Penaeus monodon Fabricius postlarva 10 (PL10) were raised with *Artemia* enriched with highly unsaturated fatty acid (HUFA) at different ratio of eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA) of 1:1, 1:2 and 1:5 for 5 days. Then they were stressed and challenged with pathogenic *Vibrio parahaemolyticus*. Acute toxicity test of ammonia revealed the better tolerance of treated shrimp over the control with 24 hr- LC₅₀ values of 50.00, 56.00, 53.00 and 53.50 ppm (TAN) for control, 1:1, 1:2 and 1:5 treated shrimp had significantly lower mortality rates than the control (P<0.05). Salinity changes from 30 to 0 ppt caused similar result which 1:1 and 1:2 treated shrimp had significantly lower mortality rate than the control during the first 40 minutes. Transfer from 30 to 5 ppt caused the significant differences throughout the trial which 1:2 and 1:5 had lower mortality rates than the control (P<0.05). However, enriched *Artemia* with HUFA did not enhance the tolerant level to 200 ppm formalin nor the resistance against pathogenic *Vibrio parahaemolyticus*. It is shown from this study that HUFA could elevate the tolerant level to some stressful conditions that are commonly found during shrimp culture especially at the early stage. The optimum ratio of EPA:DHA from this study was inconclusive.

Keywords: Fatty acids; Black tiger prawn; *Penaeus monodon*

183 In Thai

184 Chote Sahakichrungruang. 1990. **The effects of an application of several dietaries on some properties of water quality and the survival rate of the tiger prawn larvae (*Penaeus monodon* Fabricius).** Master Thesis. Kasetsart University. 85 p.

Chaetoceros, microparticulated A, microparticulated B and dry frozen *Spirulina* were fed on by the zoea stage of the tiger prawn (*Penaeus monodon* Fabricius). The lowest concentration of ammonia and the highest concentration of nitrite including the highest

survival rate of the tiger prawn larvae are observed by feeding on *Chaetoceros*. Whereas the highest concentration of nitrite is lower than safe concentration. The amount of ammonia concentration on the microparticulated B application is higher than safe concentration starting from the second day through the end of the study while the lower nitrite concentration is found in *Chaetoceros* application. Survival rate of microparticulated A and B applications are not showed any signification. Development period of the zoea stage to the first stage of mysis on microparticulated A and B application are longer than *Chaetoceros* application. All of the zoea stage of the tiger prawn that feed on dry frozen *Spirulina* were died out. Living *Artemia*, frozen *Artemia*, microparticulated A, microparticulated B, dry frozen *Spirulina* and boiled chicken yolk were used as food of the mysis stage of the tiger prawn. The lowest ammonia concentration is found in boiled chicken yolk application while the highest is found in microparticulated B application. The amount of ammonia concentration starting from the third day through the end of the study while the highest nitrite concentration is found in the first and the second day of the experiment. The highest nitrite concentration on the third and the fourth day of the experiment is found in frozen *Artemia* application. Through out the studies, it is found that all of nitrite concentration is lower than safe concentration. There is no significant of survival rate from mysis stage to the first stage of post development period and the active movement of the larvae were found in *Chaetoceros* application.

Keywords: Water quality; Survival; Tiger prawn; *Penaeus monodon*

185 Jitkasem Chanpong. 1990. **Effects of various types of feed and stocking densities on survival rate, bacteria and water quality in nursing of the tiger prawn (*Penaeus monodon* Fabricius).** Master Thesis. Kasetsart University. 92 p.

Effects of three different types of feed and stocking densities on the survival rate, water quality and number of bacteria during the nursery of tiger prawn were studied. Natural feed, natural feed mixed with microencapsulated diet and mixed microencapsulated diet yielded average survival rates of post larvae 5 of 6.8, 11.0 and 12.6% respectively. However these differences were not significant. Natural feed mixed with microencapsulated diet caused the highest total number of *Vibrio* sp. enumerated from the sea water. Mixed microencapsulated diet caused higher total ammonia and unionized ammonia than the other two types of feed. Average survival rate from zoea 1 to zoea 3 are related to total count of bacteria and total count of *Vibrio* sp. while the average of survival rate from

mysis to post larvae 5 are related to the concentration of un-ionized ammonia and nitrite. Survival rate of post larvae 15 at stocking densities of 100,000, 150,000, 200,000 nauplius per m³ were 38.25, 55.7 and 63.85% respectively. Stocking density at a rate of 200,000 nauplius per m³ resulted in lower number of *Vibrio* sp. than the other stocking rate. Concentration of total ammonia and nitrite of stocking rate at 200,000 nauplius per m³ were lower than the other densities except during the stage of zoea 2 to mysis 3. Important factors to give good production from high stocking densities of tiger prawn during nursing were good management consisting of feed quality, feeding technique and water quality management.

Keywords: Bacteria; Water quality; Tiger prawn; *Penaeus monodon*

186 Thammanoon Nganwisuthiphan. 1988. **Experiment on the improvement of feeding schedule and the use of *Artemia* containing highly unsaturated fatty acid in rearing of *Penaeus monodon* Fabricius larvae.** Master Thesis. Kasetsart University. 70 p.

When *Chaetoceros* sp. was fed to *Penaeus monodon* larvae at second day of nauplius stage, no improvement of survival rate of the larvae reaching protozoa stage was observed. However, survival rate of two days old protozoa were significantly higher comparing to control which start feeding at first day of protozoa. Application of *Chaetoceros* sp. as supplementary feed to the main diet did not result in better survival rate of the larvae in mysis and post larva stage as well as the addition of rotifer to the main diet of protozoa and mysis stage which did not show any significant effect on survival rate of the larvae. Increasing HUFA in *Artemia* nauplii either by incubating with Selco or feeding with *Chaetoceros* sp. had no significant effect on survival rate of mysis and post larva.

Keywords: *Artemia*; Fatty acids; *Penaeus monodon*

187 Orrapim Mongkolkaha. 2001. **A study on using chitosan to increase water stability of black tiger prawn feed.** Master Thesis. Mahidol University. 141 p.

The water stability of prawn feed is an important feature to insure that prawn receive the nutrients from feed. This study aims to use chitosan to increased water stability of black tiger prawn feed. Chitosan was used on 3 levels of Degree of Deacetylation (%DD) and on 4 levels of percentage of weight by weight (% w/w). Commercial feed was blended and repelleted using a blender and mincer, respectively. The repelleted feed was used

for the control treatment and the coated treatment, which was coated with chitosan. Chitosan was also mixed with the blended commercial feed and then repelleted; this was used as the mixed treatment. The experiment was carried out according to a Completely Randomized Design : CRD. This study was investigated the effects of the Degree of Deacetylation (3 levels of %DD), chitosan percentage of weight by weight (4 levels of % w/w), 2 methodologies (coated/mixed) and types of water (freshwater/seawater) on the water stability of black tiger prawn feed. The Thailand Industrial Standard (TIS) method of testing (1198-2536 for prawn feed), was applied to test the prawn feed developed in this study. The treatments were soaked in freshwater and seawater for a period of 2 hours. The percentage of water stability of the treatments after soaking was calculated from the remaining average weight. The results showed that in freshwater, for coated treatments, the highest stable feed was 80% DD: 1.5 and 2.0% w/w and 85% DD: 1.0, 1.5 and 2.0 % w/w. The highest stable feed of mixed treatments in freshwater was 90% DD: 2.0% w/w. In seawater, for coated treatments, the highest stable feed was 80% DD: 1.5 and 2.0% w/w and 85% DD: 1.0, 1.5 and 2.0% w/w, the same as in freshwater. For mixed treatments, in seawater the water stability of 85 and 90% DD (1.5 and 2.0% w/w) was highest. At the higher % w/w of chitosan, there was higher feed stability. All treatments tested in seawater showed higher stability than in freshwater. The minimum additional cost per 1 kilogram of feed is 18.63 baht which can be calculated from the condition coated feed by chitosan 85% DD: 1.0% w/w. The results of this study suggest that chitosan is a feasible ingredient to increase the stability of prawn feed.

Keywords: Chitosan; Water; Black tiger prawn; Feed

188 Nattaporn Chaisakchatri. 1998. **Comparative effects of different vitamin c forms in black tiger shrimp (*Penaeus monodon* Fabricius) feed.** Master Thesis. Kasetsart University. 80 p.

Comparative effects of different vitamin c forms in black tiger shrimp was studied by using 4 formulated feeds. Diet 1 no supplement ascorbic acid. Diet 2 contained silicone coated ascorbic acid 143 ppm, diet 3 added ascorbyl-2-sulfate 271 ppm and diet 4 added ascorbyl-2-polyphosphate 237 ppm. This study was design to determine the comparative digestibility of different vitamin c forms, as measured by analysis of ascorbic acid and two derivatives from faeces on four different diets, in black tiger shrimp. Results show no significant different ($P > 0.05$) in the levels of ascorbic acid and its derivative levels. The second study was designed to determine the comparative biological efficacy, as measured by tissue deposition levels of ascorbic acid in

hepatopancreas. Shrimp 5-8 g and 15-17 g were fed for 14 days on the different vitamin c forms. Every two days, hepatopancreatic tissues were analysed for ascorbic acid. Results indicated that shrimp both of 5-8 g and 15-17 g in were fed for 14 days on the different vitamin c forms. Every two days, hepatopancreatic tissues were analysed for ascorbic acid. Results indicated that shrimp both of 5-8 g and 15-17 g in size fed with diet 4 had significantly higher ($P<0.01$) hepatopancreatic ascorbic acid than those fed either the diet 1, 2 and 3. Comparative growth and survival of black tiger shrimp fed four different diets for 8 week was studied. Result show no significant difference ($P>0.05$) in growth and survival between black tiger shrimp fed four different diets. Shrimp fed four different diets for 8 week were injected intramuscularly with *Vibrio parahaemolyticus* at a dose of 3.27×10^6 CFU. The survival rate of shrimp fed four different vitamin c diets were not significant difference ($P>0.05$) after 7 days post injection.

Keywords: Vitamin C; Black tiger shrimp; *Penaeus monodon*

189 Somsak Rayun. 1997. **Effect of vitamin c on stress and growth of *Penaeus monodon* (Fabricius) larvae.** Master Thesis. Kasetsart University. 107 p.

Effect of vitamin c (L-ascorbyl dipotassium-2-sulfate dihydrate) on physiological responses stressful conditions in *Penaeus monodon* Fabricius larvae was investigated. Vitamin c was added directly in sea water to raise *P. monodon* nauplius till postlarval stage at concentrations of 0, 50, 100 and 150 mg/l. Then postlarva (PL) were stressed with ammonia, methyl parathion, salinity change and no dissolved oxygen. Acute toxicity test of ammonia and methyl parathion revealed the LC_{50} at 24 hrs of 53.50, 59.00, 57.00 and 63.00 ppm (as total ammonia nitrogen); 2.70, 3.40, 3.65 and 3.15 ppb for PL raised with 0, 50, 100 and 150 mg/l vitamin c respectively. Sudden change of salinity from 30 to 0 ppt caused significantly less mortality in PL 17 raised with 100 and 150 mg/l vitamin c during the forty-five minute period ($P<0.05$), however, mortality rates amongst all experimental and control groups were not significantly different afterwards. There was no difference of mortality rates when salinity was changed from 30 to 5 ppt. Similar result was found when PL was stressed by water containing no dissolved oxygen in which PL raised with 100 and 150 mg/l vitamin c had significantly less mortality during the first fifteen minute period. However, after raising PL from all experimental group for 60 days with regular pelleted feed, there were no significant differences

of the growth and survival rates. Results from this study indicated the beneficiaries of vitamin c as an anti-stress agent in *P. monodon* larvae especially at the early stage of stressful conditions.

Keywords: Vitamin C; Feed; Stress; Growth; *Penaeus monodon*; Shrimps

190 Jetsada Ishak. 1993. **Effect of varying dietary protein levels on growth and survival rate of *Penaeus monodon* Fabricius juveniles in rock salt water with different salinity levels.** Master Thesis. Kasetsart University. 145 p.

The effect of varying dietary protein levels on growth and survival rate of tiger prawn juveniles were conducted in rock salt water with different salinity levels. The sources of rock salt water were Amphoe Chaturat, Changwat Chaiyaphom and Amphoe Boraboe Changwat Mahasarakham. The dietary protein levels were 30, 40 and 50%. The water salinity were ranging from 5 to 15 in increment of 5 ppt. The first experiment with the rock salt water from Changwat Chaiyaphom showed very low survival rate and had the total mortality within 7 weeks. The result of the experiment with rock salt water from Changwat Mahasarakham showed the highest growth rate of tiger prawn fed with 40 and 50% protein diets at 5 ppt water salinity. The best survival rate was obtained from the 50% protein diet with the water salinity at 10 and 15 ppt. The tiger prawn fed with 40% protein diet in 10 ppt rock salt water had the best feed conversion rate.

Keywords: *Penaeus monodon*; Juveniles; Growth; Survival; Salinity

191 Tanuttha Suyawanish. 2000. **Enrichment of *Artemia* with L-ascorbyl dipotassium-2-sulfate dihydrate to elevate the resistance to *Vibrio* sp. and stress tolerance in *Penaeus monodon* (Fabricius) postlarva.** Master Thesis. Kasetsart University. 79 p.

Stress tolerance was studied in *Penaeus monodon* (Fabricius) postlarva (PL) raised with *Artemia* enriched by vitamin C (L-ascorbyl-dipotassium-2-sulfate dihydrate) at concentrations of 0, 50, 100 and 150 mg/l (ppm). Acute toxicity test of ammonia and methyl parathion revealed the 24-hr LC_{50} values in PL23 and PL21 of 34.00, 35.00, 37.00 and 40.00 ppm (total ammonia nitrogen) and 2.15, 2.25, 2.10 and 2.50 ppb respectively. Transfer from 30 to 0 ppt sea water of control and experimental PL18 caused significant differences of mortality rates during the first 45 minutes ($P<0.01$), however, all PL died after 2 hrs of transfer. Transfer from 30 to 5 ppt sea water also caused significant differences ($P<0.01$) in which PL raised with enriched *Artemia* at every

concentration had lower mortality throughout the experimental period. With depleted-oxygen condition, PL raised with 100 and 150 ppm vitamin c had significantly lower mortality rates ($P<0.01$) than control and 50 ppm PL, however, all PL died after 4 days. Stress with 200 ppm of formalin for 2 hrs did not cause any significant difference of mortality rate except at the early stage of exposure in which minor mortality was observed in control. Resistance to *Vibrio harveyi* was also investigated. PL raised with 100 ppm vitamin c did show the best resistance to this pathogenic bacteria ($P<0.05$). There were no significant differences amongst the growth and survival rates of control and experimental PL after 60 days. This study clearly indicated the beneficiaries of vitamin c applied by *Artemia* enrichment on shrimp postlarva in term of stress tolerance and disease resistance.

Keywords: *Artemia*; *Vibrio*; *Penaeus monodon*

192 วัฒนา วัฒนกุล และ อุไรวรรณ โพธิ์นาถ. 2542. การศึกษาประสิทธิภาพของวิตามินซีในน้ำฝักรับต่อการเจริญเติบโตและอัตราการรอดตายของกุ้งกุลาดำ. ทุนอุดหนุนการวิจัยประจำปีงบประมาณผลประโยชน์ 2542. สถาบันเทคโนโลยีราชมงคล. 31 น.

The experiment on the nursing of Giant Tiger Prawn (*Penaeus monodon* Fabricius) of postlarva 14 (P14) with vitamin c in guava juice and premix (powder) in order to find the approximately concentration for growth and survival. This experiment was conducted by control, 2 and 5 ppm. in vitamin c premix, 1, 3, 5 and 10 ml. in guava juice for a period of 6 weeks (42 days) by baths. Show that Giant Tiger Prawn the group receiving 5 ppm. concentration of vitamin c premix was significantly different ($P<0.01$) from the last weeks (P56). While the group was not significant different ($P>0.05$) when received 10 ml of concentration guava juice with this group. There was not significant different ($P>0.05$) between average survival rate 11.3, 13.6, 18.1, 14.6, 12.1, 16.2 and 15.4% for the group control, 2, 5 ppm, 1, 3, 5 and 10 ml respectively.

Keywords: Vitamin C; Growth; Survival; Giant tiger prawn; *Penaeus monodon*; Guavas

193 Panida Ruwattanakul. 1996. **Effects of c-vitamins on development growth and survival of *Penaeus monodon* larvae.** Master Thesis. Chulalongkorn University. 74 p.

The present study is to compare the efficiency of five c-vitamins (~200 ppm of ascorbic acid equivalent) on development, growth, survival and

salinity stress resistance of black tiger prawn *Penaeus monodon* larvae. Six semi-purified diets including ascorbate-2-monophosphate diet (M), ascorbate-2-polyphosphate diet (P), non vitamin c supplemented diet (N), ascorbate-2-sulfate diet (S), L-ascorbic acid diet (A) and coated ascorbic acid diet (C) were fed to three larval stages (zoea, mysis and postlarva). The larvae fed with diet P showed the highest growth and survival rate of postlarva stage. The zoea fed with diets M, P and S and the mysis fed with all c vitamin supplemented diets showed no significant difference on survival rate ($P<0.05$). The larvae fed with non vitamin c supplemented diet had the lowest survival rate for all stages. The diet S showed the highest ascorbic acid (AA) content but the larvae fed with this diet had the AA content in tissue less than those of the larvae fed with diets P and M. The diets C and A had low AA content, and the larvae fed with these diets also had low AA content in tissue. Moreover, the tolerance in 0 ppt salinity stress test of the P group was better than those of the M, S, C, A and N groups, respectively.

Keywords: C-Vitamin; *Penaeus monodon*

194 Saweit Chaimongkol. 1992. **Vitamin c in tiger prawn *Penaeus monodon* (Fabricius) feed.** Master Thesis. Kasetsart University. 46 p.

Effect of vitamin c on tiger prawn (*Penaeus monodon*) was studied by using 4 formulated feeds. Diet 1 contained no vitamin c, Diet 2, 3 and 4 contained 0.2% crystalline vitamin c, 0.2% fat coated vitamin c and 0.01% vitamin c phosphate respectively. Prawn were reared for 14 weeks in 160 litre glass aquaria equipped with flow through system of seawater. Prawns fed with vitamin c deficient diet showed lower survival rate (68%) whereas the higher survival rate were obtained from prawns fed with vitamin c supplemented diet (88, 80 and 80% in diet 2, 3 and 4 respectively). No significant difference between average weight for diets 1,2,3,4 were observed. Vitamin c content in hepatopancrease of prawn from each diet showed no significant difference (725.30 mg/1000 g of hepatopancrease wet weight in diet 1 and 955.02, 812.50 and 727.70 mg/1000 g hepatopancrease wet weight in diet 2, 3 and 4 respectively). A relationship between vitamin c in diet and hydroxyproline in prawn was observed. Vitamin c deficient diet show O hydroxyproline in prawn.

Vitamin c-deficient prawn showed some histological changes e.g. disorder arrangement of primary and secondary lamella of gill filament and dilation of blood lacunae. Normal gill were observed from prawn fed with vitamin c supplemented diet. No pathological changes were observed in other organ examined both in vitamin c-deficient prawn and vitamin c supplemented prawn.

Keywords: Vitamin C; Tiger prawn; *Penaeus monodon*

195 ประจวบ หล้าอุบล, อีระ เล็กชุลยพ และ สมโภชน์ นิ่มสันติเจริญ. 2531. ผลของกรดอะมิโนต่อการเจริญเติบโตของกุ้งกุลาดำ (*Penaeus monodon* Fabricius). รายงานผลการวิจัย. มหาวิทยาลัยเกษตรศาสตร์. กรุงเทพฯ. 26 น.

Effect of essential amino acids on growth of the green tiger prawn were conducted on April to November 1987 at the Klong-wan fisheries research station, Prajuaab Kirikhan province, Thailand. The average body length of postlarvae is 0.914 centimeter while the body weight is 0.015 gram. The twelve concrete tanks with 3 cubic meters of seawater each were used in the experiment. One thousand pastlarvae were reared in each tank and three kinds of the artificial diets with trace fish were used twice daily for 30 days. The results were shown that the percentage of survival rate of postlarvae fed on artificial diet formulae I, II, III and trace fish are 81, 89, 80, 86 while the percentage of growth rate are 16.67, 19.67, 13.00 and 19.00 respectively. The percentage of survival and growth rate of diet formula II was the best result, but the trace fish have shown no significant. Both diet formula II and trace fish were shown significant with diet formula I and III ($P < 0.05$). *Penaeus monodon* juvenile were reared continuously in two earth ponds with 1/2 rai each. Eight thousand juveniles in each pond with average body length is 3.35 centimeters while the body weight is 0.35 gram were fed on diet formula II and trace fish, twice daily for 112 days. The result was that *P. monodon* fed on the diet formula II and trace fish for the period of 60 days were shown significance. The percentage of weight gain of the prawn fed on diet formula II after 60 days were significantly increased ($P < 0.05$). The increasing weight average in gram of the prawn fed on diet formula II and trace fish within 112 days were 22.15 and 14.73 respectively.

Keywords: Diets; Growth; Green tiger prawn; *Penaeus monodon*

196 Juadee Pongmaneerat, Mali Boonyaratpalin and Shosak Borisut. 1997. **Effect of different Thai fishmeals on growth and feed performance of *Penaeus monodon***. Technical paper no.1/1997. Songkhla National Institute of Coastal Aquaculture. Department of Fisheries. 16 p.

The effect of different Thai fishmeals on growth and feed performance of *Penaeus monodon* was studied. Six fishmeal samples from Songkhla (2 samples) and Pattani (4 samples) were used as the main protein source in each diets which

containing 39-40% dietary protein level. Shrimp with average body weight about 0.5 g were fed each diet *ad libitum*, five times a day for the period of 10 weeks. Growth, survival rate, feed conversion ratio, protein efficiency ratio were not significantly different among the groups. The values ranged between 1055-1177%, 82-96%, 1.75-1.94 and 1.34-1.45, respectively. Protein retention ranged between 21.86-25.41%. The retention was highest in shrimp fed diet 4 and lowest in shrimp fed diet 1. The carcass composition was not influenced by dietary fishmeal except for protein which was slightly higher in shrimp fed diet 4. Moreover, all the shrimp showed the good appearance with no any adverse effects. It was suggested that the quality of fishmeals which producing in Songkhla and Pattani was comparable in terms of growth, survival and feed performances, and they can be used as the good protein sources in diets for *Penaeus monodon*.

Keywords: Fish meal; Growth; Feed; *Penaeus monodon*

197 Nakarin Ruangpanit. 1997. **Uses of soybean meal and corn gluten meal replacing shrimp head meal and squid meal in presence of feeding attractants for *Penaeus monodon* Fabricius**. Master Thesis. Kasetsart University. 111 p.

Soybean meal and corn gluten meal at the ratio of 5:3 were used to replace shrimp head meal and squid meal in presence of two attractants extracted from beet root and from squid liver oil in diets for *Penaeus monodon* shrimp, averaging 0.944-0.956 g in body weight, stocked at 30 shrimps in a 500 ml water fiber glass tank. Three groups of shrimp with 3 replications each were fed with 6 isonitrogenous and isocaloric diets for 8 weeks. Results indicated that weight gain (WG), feed intake (FI), feed conversion ratio (FCR), survival rate (SR), protein efficiency ratio (PER), energy retention (ER) of shrimps received soybean meal and corn gluten meal diets were similar ($P > 0.05$) to those received the control diet with shrimp head meal and squid meal. The protein retention (PR) of shrimp fed soybean meal and corn gluten meal diets was significantly lower ($P < 0.05$) than that fed the control diet. Values of WG, FI, FCR, SG, PER, PR and ER shown by shrimps fed two diets with different attractants were identical but were significantly higher ($P < 0.05$) than those of shrimps fed the control diet. The results from this study revealed that soybean meal and corn gluten meal could substitute for shrimp head meal and squid meal in shrimp diets and that the use of attractants increased the production performances in shrimp.

Keywords: Soybean meal; Corn gluten meal; Shrimp head meal; Squid meal; *Penaeus monodon*

198 Nopadol Phuwapanich and Tanan Sanggontanagit. 1995. **A study on use of shellfree *Artemia* cysts for nursing of black tiger shrimp (*Penaeus monodon*) postlarvae.** Technical Paper No. 61/1995. Phetchaburi Coastal Aquaculture Station. Coastal Aquaculture Division. Department of Fisheries. 12 p.

Nursing of black tiger shrimp *Penaeus monodon* postlarvae (PL) from PL5 to PL15 by using 3 kinds of diet was conducted. The diets consisted of dried and decapsulated cysts (shellfree *Artemia* cysts), newly hatched *Artemia* and a mixture of both shellfree *Artemia* cysts and newly hatched *Artemia*. The survival rate were 54.5, 59.0 and 62.0% for the postlarvae fed with shellfree *Artemia* cysts, newly hatched *Artemia* and a mixture of both shellfree *Artemia* cysts and newly hatched *Artemia* respectively. There was no difference of survival rate among all diets. Application of shellfree *Artemia* cysts was also observed from 5 private shrimp hatcheries. These hatcheries used only shellfree *Artemia* cysts for feeding of shrimp postlarvae from PL4–PL6 to PL12–PL17. The data showed average survival rate of 81.7% and shellfree *Artemia* cysts average dry weight of 2,609 g were used for nursing of 1 million postlarvae.

Keywords: Diets; *Artemia*; Shrimp performance; *Penaeus monodon*

199 Boonyarath Pratoomchat and Kongsak Ruangboonsong. 2003. **Nursery of *Penaeus monodon* post larvae using frozen *Artemia*, frozen *Moina*, *Artemia* flake and artificial feed.** In the 41th Kasetsart University Annual Conference, 3-7 February 2003. p.187-194.

The post larva (PL5) of *Penaeus monodon* with 7.15 mm in total length and 0.89 mg in body weight were raised in 250L fiberglass tanks at a density of 8 PL/L. They were fed with frozen *Artemia*, frozen water flea, *Artemia* flake and artificial feed. Salinity was decreased during 14 days of experimental period. The results indicated that the frozen *Artemia* was the most suitable diet for *P. monodon* larva. The specific growth rate in weight (17.4%) and length (4.1%) weight gain (2190%) length gain (110%) brown color (100%) and survival rate (79.5%) of larva fed by frozen *Artemia* was significantly higher ($P < 0.05$) than those of the other diets.

Keywords: *Penaeus monodon*; *Artemia*

200 Somprasong Kanthom, Buakam Limsurat, Vichai Chaichanagasigum. 2000. **Comparison on nursing of black tiger shrimp postlarvae**

(*Penaeus monodon* Fabricius) by feeding with brine shrimp (*Artemia salina*) and water fleas (*Moina macrocopa* Straus). Technical Paper No.1 /2000. Chumphon Coastal Aquaculture Station. Prachuap Khiri Khan Coastal Aquaculture Development Center. Department of Fisheries. 19 p.

3 different feeding groups were investigated on growth, survival of black tiger shrimp postlarvae from stage 5 to 14. The first feeding was *Artemia*, as a control. The second was fed *Artemia* and alternated with water flea and the third group was fed only with water flea. 9 of 5 m³ round concrete tanks, 3 tank for each group, were filled with sea water. Then 150,000 shrimp larvae, PL5, was stocked into each tank, or at stocking density of 30 shrimp/liter. Average length and body weight of PL5 were 0.80 ± 0.08 cm and 0.0014 ± 0.0005 gm, respectively. During feeding trial, water parameters were monitored daily, while average survival, length, and body weight were checked at termination, PL14. Results showed that average survival rate were significantly different ($P < 0.05$) among the feeding groups. They were 78.0, 83.8 and 86.0% from the group fed *Artemia*, *Artemia* and water flea and water flea alone, respectively. The average total length and body weight of PL14 were highly significant different ($P < 0.01$). The average total length obtained from the group fed *Artemia*, *Artemia* and water flea and water flea alone were 1.24, 1.22 and 1.09 cm, respectively, and the average body weight were 0.0045, 0.0036 and 0.0026 gm, respectively. Feed cost of the experiment of treatment 1, 2 and 3 were 0.0166, 0.0088 and 0.0010 Bath per shrimp, respectively.

Keywords: Larvae; Brine shrimp; *Artemia*; Water fleas; *Moina macrocopa*; *Penaeus monodon*

201 Khorkiat Koolkaew. 1995. **Comparison on nursing of tiger shrimp (*Penaeus monodon*) P₁–P₁₅ with artificial feed and *Artemia*.** Technical paper no.49/1995. Satul Coastal Aquaculture Development Center. Department of Fisheries.12 p.

Comparison on nursing tiger shrimp (*P. monodon*) postlarvae (PL) from P₁–P₁₅ with artificial feed and *Artemia* was done in 1.20x3.00x0.60 m cement ponds (trial1) and 1,000-L fiberglass tanks (trial 2), respectively. In each trial, the stock density was 30 PL/litre. It was found that survival rate, production and total length of shrimp fed on artificial feed and *Artemia* in the first trial were 19.87 and 26.83%, 5,962 and 8,050 PL/ton and 11.22 ± 0.07 and 11.92 ± 0.18 mm, respectively. These figures for the second trial were 51.43 and 84.16%, 15,424 and 24,348 PL/ton and 11.21 ± 0.06 and 11.94 ± 0.17 mm, respectively. The statistical analysis of both trial indicated that survival rate, production and total length were highly significant ($P < 0.01$). The feed cost

for nursing individual PL in the first and second trial were 0.022, 0.021 baht fed on artificial feed and were 0.028, 0.027 baht fed on *Artemia*.

Keywords: Nursing; Tiger shrimp; *Penaeus monodon*; Artificial diets; *Artemia*

202 Aduan Mearah. 1999. **Nursing of black tiger shrimp (*Penaeus monodon*) postlarvae with different feeds.** Technical Paper No. 6/1999. Satul Coastal Aquaculture Development Center. Department of Fisheries. 13 p.

Nursing of Black Tiger Shrimp (*Penaeus monodon*) Postlarvae with different feeds. First is control group that was fed only with *Artemia*, the second was fed with steam chicken egg and *Artemia* and third treatment was fed with powder feed and *Artemia*. The experiment started at PL3 stage of *Penaeus monodon* fry that was 0.776 ± 0.043 cm in total length. The shrimps were stocked at a density of 30 PL/liter and further reared until the shrimp reached to PL15 stage. At the end of the experiment, survival rate of shrimp fry of treatment 1, 2 and 3 was 69.83, 68.46 and 68.60 percent respectively, there is no difference in survival rate among treatments. Mean total length of shrimp fry of treatment 1, 2, and 3 was 1.373 ± 0.070 , 1.152 ± 0.074 and 1.127 ± 0.083 cm respectively, with highly significant difference ($P < 0.01$). The best growth rate was the shrimp fry of first treatment, whereas the second and third treatment was not different in growth rate. Feed cost of the shrimp nursing of treatment 1, 2 and 3 was 0.0172, 0.0044 and 0.0058 Bath per PL respectively.

Keywords: Feed; Eggs; *Artemia*; *Penaeus monodon*

203 Pornthep Wirachwong. 2003. **Use of estuarine cladoceran (*Diaphanosoma celebensis* Stingelin) for nursing black tiger prawn (*Penaeus monodon* Fabricius) post-larvae.** In the 41st Kasetsart University Annual Conference, 3-7 February 2003. p.3-9.

A preliminary study on the biology of estuarine cladoceran (*Diaphanosoma celebensis*) was conducted using *Tetraselmis gracilis* as feed at salinity of 15 ppt and temperature of $27-28^{\circ}\text{C}$. The neonate production and life span of adult females were 12 ± 1.5 neoanates/female and 7.5 ± 1.5 days. Use of estuarine cladoceran for nursing black tiger prawn (*Penaeus monodon*) post-larvae. The CRD (Completely Randomized Design) experiment was carried out to compare weight, length and survival rate of black tiger prawn post-larvae (PL1-15) using an estuarine cladoceran, *Artemia* nauplii and a combination of steamed chicken egg and *Artemia*

nauplii. The weight and length of larvae were not significantly different ($P > 0.05$) between estuarine cladoceran and *Artemia*. Significantly higher ($P < 0.05$) weight and length were obtained for the larvae fed with estuarine cladoceran and *Artemia* than with the combination of steamed chicken egg and *Artemia*. Survival rate among treatments were not significantly different ($P > 0.05$).

Keywords: Estuaries; Cladocera; *Artemia*; Black tiger prawn; Postlarvae

204 สุทิน สมบูรณ์ และ วิจิต เสงชัย. 2541. การใช้ไข่อาร์ทีเมียฟลอกเปลิอิก อาร์ทีเมียแห้งชนิดแผ่น และตัวอ่อนอาร์ทีเมียในการอนุบาลลูกกุ้งกุลาดำวัยอ่อน. รายงานผลการวิจัยประจำปี/รายงานผลการวิจัยฉบับสมบูรณ์ทุนอุดหนุนวิจัย มก. ประจำปี 2541 โครงการวิจัยรหัส ท-ม 6.41. ศูนย์พัฒนาเทคโนโลยีอาหารสัตว์น้ำ, คณะประมง มหาวิทยาลัยเกษตรศาสตร์. 15 น.

An experiment was carried out to compare survival and growth rates of tiger prawn (*Penaeus monodon* Fabricius) post larvae (PL2-20) using *Artemia* decapsulated cysts, *Artemia* flakes and *Artemia* nauplii. Feeding regimes were as follows 1) *Artemia* nauplii, 2) *Artemia* decapsulated cysts, 3) *Artemia* flakes, 4) decap+nauplii (1:1), 5) decap+flake (1:1), and 6) nauplii+flake (1:1). The larvae were fed 5 times a day until they reached PL20. No significant differences in survival rate were detected in shrimp fed with 1, 4, 5 and 6 (86.45-89.14%). Survival rate was highest in larvae fed with *Artemia* nauplii (89.14%). Larvae fed with *Artemia* decapsulated cysts (2) and *Artemia* flakes (3) had survival rate of 78.33% and 75.11% respectively. Growth rate of larvae fed with *Artemia* flakes showed lower than the other regimes. The results indicated that *Artemia* decapsulated cysts can be used as feed for *P. monodon* larvae. *Artemia* decapsulated cysts and *Artemia* flakes can be considered for the culture of shrimp PL4-5 and PL6 onwards. Using *Artemia* flakes can be get better result when used together with *Artemia* nauplii and *Artemia* decapsulated cysts.

Keywords: *Artemia*; Nauplii; Tiger prawn; *Penaeus monodon*

205 Chandet Wangsaweeboon. 2000. **Effect of using *Chlorella* in nursed postlarval (P5-P15) of black tiger shrimp (*Penaeus monodon* Fabricius) fed by living and nonliving food.** Master Thesis. Kasetsart University. 71 p.

Effect of using *Chlorella* in nursed postlarval (P5-P15) of black tiger shrimp had been performed in order to find out the survival rate and growth rate and also to obtain the strong and healthy postlarvae as well. These larvae were fed by living organisms

(*Artemia*) and nonliving food (egg custard) in the water with and without *Chlorella* and effects on the black tiger shrimp postlarvae were also compared. This study was done at the National Institute of Coastal Aquaculture, Songkhla province. Result of the study showed non significant in with and without *Chlorella* those fed by *Artemia* were survival and healthiness. But significantly difference between with and without *Chlorella* were final growth, the body length in with *Chlorella* (1.23 ± 0.001) was higher than without *Chlorella* (0.019 ± 0.014 cms). Result also showed those larvae fed by the egg custard in water with *Chlorella* had survival rate and growth rate were significant higher than without *Chlorella*. Survival rate of with *Chlorella* and without *Chlorella* were 90.63 ± 2.15 and $64.12 \pm 3.14\%$ respectively. While body length and weight were 1.42 ± 0.023 cm, 23.3 ± 1.24 mg for with *Chlorella*, and without *Chlorella* were 1.183 ± 0.047 cm, 16.66 ± 1.24 mg respectively. Moreover, the survival after stress test with formalin 200 ppm at an hours, salinity change test and challenge test with bacteria (*Vibrio harveyi*) for 96 hours of with *Chlorella* were significant higher than without *Chlorella*. For with *Chlorella* were 84.24 ± 2.98 , 93.05 ± 1.10 and $96.33 \pm 3.94\%$ respectively while without *Chlorella* were 55.37 ± 3.37 , 79.83 ± 1.77 and $32.33 \pm 3.54\%$ respectively. Ammonia and nitrite of with *Chlorella* were significant lower than without *Chlorella*. The number of *Vibrio* in the studies were also lower in the water *Chlorella* than those without.

Keywords: Feed; Plankton; *Chlorella*; *Artemia*; Stress test; Challenge test; Water quality; Shrimps; Postlarvae; *Penaeus monodon*

206 in Thai

207 Prapathpong Phechrat, Sakon Sangpradub, Ratchadaporn Aeumsumang and Phanarat Sonsuksai. 2002. **Effect of feeding frequency on growth rate of banana shrimp (*Penaeus merguensis* de Man)**. Technical Paper No.24/2002. Coastal Aquaculture Division. Department of Fisheries. 13 p.

This study was carried out to determine the effect of feeding frequency on growth rate of banana shrimp (*Penaeus merguensis*). The experiment was done at Prachuab Khiri Khan Coastal Aquaculture Development Center during December 1999- March 2000. The experiment consisted of 3 treatments with 5 replicates. Each 20 banana shrimp (Shrimp fry was stocked at the rate of 31.44 PL/m^2), post larvae 30, (average weight 0.39 gm) were stocked in round-shaped concrete tanks, diameter 90 cm, depth 60 cm, containing

286 litre sea water, were equipment with aeration. They were fed with experimental diet at frequency rate 4, 6 and 8 times daily for 14 weeks. The results showed that growth, food conversion ration and survival of banana shrimp fed at different feeding frequency (4, 6 and 8 time daily) were not significantly different ($P > 0.05$). Average total length of 8.18 ± 0.55 cm, 8.44 ± 0.25 cm and 8.20 ± 0.89 cm, body weight of 3.50 ± 0.68 gm, 3.76 ± 0.27 gm and 3.58 ± 1.20 gm, weight gain of $796.61 \pm 176.39\%$, $863.23 \pm 69.74 \%$ and $817.66 \pm 308.12 \%$, specific growth rate of $2.22 \pm 0.21\%/day$, $2.30 \pm 0.36\%/day$ and $2.21 \pm 0.36\%/day$, food conversion rate of 1.11 ± 0.40 , 1.00 ± 0.23 and 1.48 ± 0.41 , survival rate of $77.68 \pm 11.26\%$, $73.33 \pm 15.85 \%$ and $76.08 \pm 5.77 \%$ were obtained, respectively.

Keywords: Feed; Growth; Banana shrimps; *Metapenaeus*

208 Thanom Pimoljinda. 1998. **Growth and survival rate of mysis stage *Penaeus monodon* feeding with supplementary diets**. Technical Paper No.4/1998. Andaman Marine Shrimp Research and Development Center, Phuket. Department of Fisheries. 7 p.

The aim of this experiment was to find the suitable feed of mysis stage for *Penaeus monodon*, 2 formula of commercial feed and one control zooplankton, rotifer were tested until they metamorphosed to postlarvae. In 6 days the result showed that shrimp larvae fed the feed formula I, II and the control (rotifer) had the survival rate of 42%, 58% and 50% respectively. The survival rate was nonsignificant. The shrimp larvae feed by formula II and the control (rotifer) were very healthy and fully stomach. But for formula I larvae showed rather weak and not so clean. It is considered that, the best feed for mysis stage is alive zooplankton such as rotifer. Even the ingredients are near-by in feed formula I and II but good survival rate and healthy showed in formula II. So this experiment showed that the feed formula II is suitable for supplementary diet for mysis stage, feeding only the night time or all the period.

Keywords: Growth; Survival; Mysis; *Penaeus monodon*; Supplemented diets

209 Somprasong Kanthom, Vitaya Havanont and Pongthorn Inaugsom. 1999. **Comparison on nursing jumbo tiger shrimp (*Penaeus monodon* Fabricius) larvae with microencapsulated and live feeds**. Technical Paper No.4/1999. Chumphon Coastal Aquaculture Station. Prachuab Khiri Khan Coastal Aquaculture Development Center. Department of Fisheries. 33 p.

The experiment was conducted to determine the feasibility of substituting live food (*Skeletonema* and *Artemia*) with microencapsulated feeds. Five hundred and four thousand nauplii of *Penaeus monodon* were nursed in each 13 tons round concrete tank containing 6 tons of seawater and fed with microencapsulated and live feeds 5 meals per day. Survival of larvae were checked at zoea 3, mysis 3 and postlarva 6 and water parameters were monitored daily. Result showed that average survival of zoea 3, 81.4 and 55.2% were significantly different ($P < 0.05$). Mysis 3, 55.6 and 50.9% were not significantly different ($P > 0.05$). Postlarva 6, 24.5 and 38.1% were not significantly different ($P > 0.05$) from microencapsulated and the live feeds, respectively. Simple linear correlation values were -0.02 and -0.63, respectively.

Keywords: Feed; Nursing; Microencapsulated diets; Lived feeds; *Skeletonema*; *Artemia*; *Penaeus monodon*

210 Tawat Srivachai, Supon Tansuwan, Therapong Krainara. **Experiment on nursing post larvae stage 2-18 of tiger prawn (*Penaeus monodon* Fabricius) with three kinds of feed.** In Proceeding the Seminar on Fisheries 1991 Department of Fisheries, 16-18 September 1991. National Inland Fisheries Institute, Bang Khen. p.159-165.

Experiment on nursing of *Penaeus monodon* Fabricius P2-P18 was done by two times. Using 9 fibreglass tanks (1,000 litres); 20,000 each at the stocking rate of 20 per litre. To compare the following formula feeds; A "Egg custard at daytime, *Artemia* at night"; B "Egg custard with fish meal at daytime, *Artemia* at night"; C "Squid meat at daytime, *Artemia* at night". The results of experiment are nonsignificantly. The average survival rates were 54.33%; 62.44%; 57.83%. The average productions were 10,867; 12,488; 11,567 inds/ton. The average length were 13.95; 13.75; 14.34 mm and average weight were 12.85; 10.95; 13.35 mg respectively.

Keywords: Feed; Nursing; *Penaeus monodon*

211 Tawat Srivachai and Supon Tansuwan. 1989. **Experiment on nursing protozoa 1-mysis 3 of tiger prawn (*Penaeus monodon* Fabricius) by various feeds.** Technical Paper No.14/1989. Songkhla Coastal Aquaculture Station. Brackishwater Fisheries Division. Department of Fisheries. 7 p.

Experiment for nursing of *Penaeus monodon* Fabricius at the stocking rate of 50 per litre was held from protozoa 1 to mysis 3 to compare the

following formula feeds; 1/ "Diatom (*Skeletonema* sp.)+*Tetraselmis* sp. + *Artemia* nauplii; 2/*Tetraselmis* sp. + custard + *Artemia* nauplii"; 3/ "Yeast + *Tetraselmis* sp. + custard + *Artemia* nauplii"; 4/ "Diatom (*Skeletonema* sp) +custard +*Artemia* nauplii". The survival rates were 68.16, 66.96 and 55.97%, meanwhile the average production were 34.0, 33.5 and 28 per litre respectively.

Keywords: Feed; Nursing; *Penaeus monodon*

212 Niwes Ruangpanit, Janejit Kongkumnerd and Pramuan Onlamai. 1990. **Experiment on nursing postlarva stage 4-15 of tiger shrimp (*Penaeus monodon* Fab.) with two kinds of feed.** Technical Paper No.7/1990. Songkhla National Institute of Coastal Aquaculture. Department of Fisheries. 8 p.

Nursing tiger shrimp (*Penaeus monodon*) postlarvae 4-15 was done in 6 cement tanks (1.6x9.6x0.8 m) 300,000 each with 2 different feeds. The first 3 tanks were fed with artificial feed and the others were fed with steam mixed of eggs and milk powder. The results showed production of the first group were 260,000, 153,000 and 206,000, the survival rate were 86.7%, 57.0% and 68.7%, growth in length were 9.7, 9.5 and 9.0 mm. And the weight were 6.0, 5, 8 and 4.2 mg respectively. The average production was 17,194 individual/ton and the average survival rate was 68.8% while the production of the second group were 249,000, 270,000 and 285,000 the survival rate were 83.0%, 90.0% and 95.0%, growth in length were 9.3, 9.6 and 9.2 mm and weight were 6.8, 5.4 and 4.0 mg respectively. The average production was 22,333 individual/ton and the average survival rate was 89.3%. The cost of artificial and steam feed was 0.00295 Baht and 0.0009 Baht/postlarva or 2950 Baht and 914.6 Baht/1 million postlarvae respectively.

Keywords: Feed; Nursing; Shrimps; *Penaeus monodon*

213 Supot Chungyampin, Chairat Phumchuai. 2000. **Nursing banana shrimp (*Penaeus merguensis* De Man) by using automatic feeder.** Technical Paper No.12/2000. Trang Coastal Aquaculture Station. Department of Fisheries. 16 p.

Study on nursing Banana shrimps from nauplius stage to postlarva 1 by using automatic feeder. Three treatments of nursing shrimps, 100, 200, 300, shrimps/liter, were fed by automatic feeder in every hour. Result showed that survival rates were 55.73%, 64.70%, 61.87%, respectively. Analysis of variance showed that no significant at 95% in every treatment. But the numbers of variance showed that no significant at 95% in every treatment. But the numbers of survival shrimps were 55,730; 129,400; 185,630 shrimp/ton respectively. The analysis of

variance showed that number of survival shrimps were significant at 95% in every treatment. In summary, automatic feeder can nurse shrimps from nauplius stage from 100 shrimps/liter to 300 shrimps/liter. The production of postlarva 1 was increased 3.33 times of 100 shrimps/liter.

Keywords: Nursing; Banana shrimp; Automatic feeder

214 Supot Chungyampin and Chairat Phumchuai. 2000. **Study on nursing shrimp by using automatic feeder.** Technical Paper No.12/1999. Trang Coastal Aquaculture Station. Department of Fisheries. 17 p.

Study on nursing shrimps from nauplius stage to postlarva 1 by using automatic feeder. Three treatments of nursing shrimps, 100, 200, 300, shrimps/liter, were fed by automatic feeder in every hour and the controls, 100 shrimps/liter were fed by men in every 4 hours. Result showed that survival rates were 55.73%, 64.70%, 61.87%, respectively and the control was 71.76%. Analysis of variance showed that no significant at 95% in every treatment. But the numbers of survival shrimps were 55,730; 129,400; 185,630 shrimp/ton respectively and the control was 71,760 shrimps/ton. The analysis of variance showed that numbers of survival shrimps were significant at 95% in every treatment. In summary, automatic feeder can nurse shrimps from nauplius stage from 100 shrimps/liter to 300 shrimps/liter. The production of postlarva 1 was 2.58 times of the normal method (control).

Keywords: Nursing; Automatic feeder

215 Supot Chungyampin and Chairat Phumchuai. 2000. **Nursing postlarva of tiger shrimp (*Penaeus monodon*) by using automatic feeder.** Technical Paper No.48/2000. Trang Coastal Aquaculture Station. Department of Fisheries. 13 p.

Efficiency of automatic feeder and operator in nursing shrimps from postlarva stage 1 to postlarva stage 15 compared shrimps in the treatments with different densities of 20, 30, 40 shrimps/liter were fed *Artemia* nauplii through automatic feeder in every hour while those in the control, 20 shrimps/liter, were given the same live feed by operator in every 4 hours. Result showed that the survival rates of shrimp in the treatments using automatic feeder were 67.64, 75.63 and 80.08 percentages, respectively and that of the control was 69.35 percentages. Analysis of variance showed that there was no significant at 95% in every treatment. The numbers survival shrimps were 13.53, 22.68, and 32.03 shrimps/liter and the

control was 13.87 shrimps/liter. The analysis of variance showed that the numbers survival shrimps were significant at 95% in every treatment that using automatic feeder. There was no significant at 95% in the survival number of shrimps between fed by automatic feeder at the density of 20 shrimps/liter and the controls. The analysis of variance on growth rate of shrimps (length weight) were no significant at 95% in every treatment. In conclusion, this automatic feeder can be used to nurse shrimp from postlarva state 1 to postlarva state 15, and can increase stocking density from 20 shrimps/liter to 40 shrimps/liter. The production of postlarva state 15 was 2.31 times of the normal method (control).

Keywords: Nursing; Automatic feeder

216 Supis Thongrod, Anand Tunsutapanich, Tanan Sanggontanagit and Teerawat Jarit-ngam. 1999. **Growth and survival of larval shrimp (*Penaeus monodon*) reared on an artificial diet with and without the utilization of mechanical mixer.** Thai Fisheries Gazette 52(4): 439-449.

The study was to compare growth and survival of *Penaeus monodon* larvae reared in tanks with and without mechanical mixing devices. Two experimental systems were used, one full scale comprising 8 concrete tanks of 12 m³, and one small scale comprising 8 fiberglass tanks of 500 litres. Half of each system was wet up with automatic mechanical mixer and aeration, while the remaining were set up with only aeration system, as is normal rearing technique. Sterilized seawater was used to fill each concrete tank to a depth of 60 cm and each fiberglass tank at 100 larvae/litre and each fiberglass tanks at 200 larvae/litre. Artificial feed was given 10 times/day at a rate of 2.5-4.0 g/100,000 larvae/day. Then from mysis-1 to postlarval stage 3, artificial feed was given during the day time and it was substituted with *Artemia* nauplii at night. The water was not changed, but its quality was maintained by adding chemicals through the feeding period. Growth and survival of larvae from the system using mechanical mixer showed significantly improvement ($P < 0.05$) compared to the traditional aeration only rearing system. Average survival at postlarval-3 stage from the tanks using mechanical mixer was 30.69% and 56.35% from the concrete and fiberglass tanks, respectively, while it was 8.70% and 25.05% from the aeration only system. The respective values for the total length (mm) were 7.13 ± 0.81 and 7.12 ± 0.283 for the mechanical mixing tanks and 5.81 ± 0.4 and 6.40 ± 0.504 for the aeration only tanks. The results showed that employing automatic mechanical mixer for rearing shrimp larvae with artificial feed can significantly improve the survival rate and growth rate.

Keywords: Growth; Survival; *Penaeus monodon*; Artificial diets

217 Banchong Tiensongrussmee and Thongchai Sil-udom. 1997. **New feeding concept for sustainable shrimp culture beyond the year 2000.** In the 35th Kasetsart University Annual Conference, 3-5 February 1997. p.68-77.

The new concept of feeding is based on feeding behavior of shrimp and the ability of shrimp in consuming feed of less than 3 pieces of pellet within 2 hours. In order to wean the shrimp to pelleted feed, the feed is given 2 times/day at 06.00 hr and 18.00 hr during the first 15 days. After 15 days, feed is given according to the feed-consuming ability of shrimp which was assessed from feeding trays at 06.00 hr, 14.00 hr, 18.00 hr and 22.00 hr. Feed is given 6 times/day at 06.00 hr, 10.00 hr, 14.00 hr, 22.00 hr and 02.00 hr. The efficiency in feed-utilization of the new feeding technique is as high as 78% while the efficiency of traditional technique is only 59%. For 3 rai shrimp pond with the stocking rate of 30 pieces/m², during 120 days culture period more than 15% of feed which cost about 21,000 Baht per crop could be saved with the yield of 1,231 kg/rai/crop. Despite the high efficiency in feed-utilization of the new feeding technique, the daily feeding data can also be used for good pond management in assessment of the required aeration, survival rate, amount of feed required, optimum rearing period, and yield of the crop.

Keywords: Shrimp culture; Shrimps

218 รุ่งจิรฐ หุตะเจริญ, ธนากร อ้วนอ่อน, เสาวภา เขื่อนจิต, สุมิตต์ ปุจฉาการ และ ชุตินธร มูลทองนํ้า. 2532. การศึกษาความเป็นไปได้ในการใช้พืชพรรณพื้นเมืองของไทยที่มีสารโหมลลอกคราบ ผลิตภัณฑ์อาหารสำหรับเร่งการลอกคราบของกุ้งกุลาดำ. รายงานการวิจัย/ทุนอุดหนุนการวิจัย. สำนักงานคณะกรรมการวิจัยแห่งชาติ. 19 น.

The feasibility study on using pellets mixed with crude extract from nature moulting period of *Penaeus monodon* is initiated in responding of the national policy which aimed at reducing shrimp cultivation area in coastal zone of Thailand, especially in mangrove area. The study found that molting hormone (ecdysone) extracted from *Vitex glabrata* (Khai Nao) give the highest concentration of hormone at 2.6×10^4 gm/gm (dry weight). As *Morus alba* (Morme) live the lowest concentration of hormone at 9.7×10^4 gm/gm (dry weight). The molting period can accelerate by diet mixed ecdysone. The optimal dose of 0.2 mg/gm diet mixed, molting period was reduced from normal

molting of 3.0 days to 4.9 days. The diet mixed give the better growth rate and food conversion ratio. In the economics aspects, diet mixed with molting hormone to variable cost in shrimp cultivation. The diet mixed with hormone will give the quite useful if feeding at the dose of 0.2 mg/gm of diet mixed at the 60 day old of cultivation crop.

Keywords: Diets; Moulting hormones; Ecdysone; *Vitex glabrata*; *Morus alba*; Shrimps; *Penaeus monodon*

219 Renu Yashiro. 1987. **Effects of feeding different strains of brine shrimp (*Artemia* sp.) on survival and growth of *Penaeus monodon*.** Technical paper no.9/1987. Rayong Brackishwater Fisheries Station. Brackishwater Fisheries Division. Department of Fisheries. 23 p.

Experiment on culturing of *Penaeus monodon* Mysis I to Postlarva V by using different strains of *Artemia*, i.e. Italy (ITL), Brazil (BRZ356), China (CHN) and America (GLS-NA, GSL-SA, SFB845, SFB1429 and SPB1628). There experimental sets were concluded and discussed. There is no significant different ($P > 0.05$) on survival (%) in the first experiment but have different in the other 2 experiments. However, the growth always show significantly different. China strains seems to be the best, give highest survival (67.8%, 62.0% and 48.5%) and good growth (6.05, 6.4 and 6.7 mm) possibly because of high total ω 3HUFA (11.5%) and high in 20:W3 (9.1%). Sanfrancisco Bay (SFB845) and Brazil (BRZ macao356) *Artemia* are also high in total ω 3HUFA and 20:5 ω 3 compared to other 4 strains from America. Anyhow, results from some feeding test showed irregular, the better results in the 2nd experiment obtained from GSL-SA and poor result from BRZ356 *Artemia* assumming from the effect of *Tetraselmis* and Rotifer given previously before feeding test with *Artemia* and about BRZ356 the contamination of empty cyst shells might be one of the cause. Sizes of *Artemia* used, their hatching efficiency and way to improve nutritional quality of *Artemia* for Penaeids are shown.

Keywords: Diets; Hatcheries; Natural diets; Rotifer; *Tetraselmis*; HUFA; Growth; Survival; Shrimps; *Penaeus monodon*

220 Jerawon Boonsri. 1990. **Potential of some aquatic weeds as composition for the compounded diet of the black tiger prawn (*Penaeus monodon* Fabricius).** Master Thesis. Prince of Songkla University. 70 p.

The potential of water hyacinth (*Eichhornia crassipes* Solms), hydrilla (*Hydrilla verticillata*) and hornwort (*Ceratophyllum demersum*) as composition

of compounded diet for black tiger prawn (*Penaeus monodon*) was evaluated. Growth, survival rates and the feed conversion ratios of animals of initial mean weight 0.06 g (body length of approximately 1 inch) fed on 7 formulated diets and reared under laboratory conditions for 10 weeks, were compared. All the formulated feeds were composed of 40% protein, and had an energy content of 350-450 kcal kg⁻¹. The three formulated diets mixed with the different aquatic weeds at the level of 8% dry weight. Protein content of the other 4 formulae was principally composed of shrimp meal alone, shrimp meal mixed with squid meal, fish meal, and soybean meal, respectively. No differences in growth were found among the prawns fed on the three aquatic weeds diets ($P>0.05$), but growth was significantly lower than those of the other 4 diets ($P<0.01$). After 10 weeks, mean weights of prawns fed on the weed containing diets ranged from 1.2-1.4 g, compared with 2.2 to 3.3 g for prawns fed on other diets. Feed conversion ratio of hornwort diet was 4.45:1, and fish meal feed, 2.65:1 ($P<0.05$). However, all groups of the experimental animals had similar survival, 82-97% ($P>0.05$). On the basis of retail prices, the costs of producing 1 kg of prawn using any of the 3 kinds of aquatic weeds were estimated at 133-148 bath, which is similar to that of producing prawn using shrimp meal alone. Production costs using the other formula feeds were evaluated at 64-99 bath/kg. The poor quality of compounded diets containing aquatic weeds may associate closely with physical properties such as the rapid dispersion of food pellets in seawater rather than imbalance of nutritional values.

Keywords: Diets; Aquatic weeds; Water hyacinths; Hydrillas; Horn worts; Shrimp performance; Feed cost; Shrimps; *Penaeus monodon*

221 Jenjira Jomsawat. 2000. **Screening of photosynthetic bacteria and its application in black tiger shrimp (*Penaeus monodon*)**. Master Thesis. Prince of Songkla University. 128 p.

Photosynthetic bacteria seven strains, SR2a, SR15a, SR15b, SR16a, SR16b and SK99 were isolated from mud and water samples of shrimp cultivation farm in the South of Thailand. All of them were halotolerant photosynthetic bacteria. They did not inhibit growth of *Vibrio harveyi*. They grew at temperature up to 40°C under anaerobic-light conditions. Only SR15b could assimilate and dissimilate nitrate when it grew under anaerobic-light and aerobic dark conditions. The strain grew at temperature and pH ranges of 30-45°C and pH 7.0-9.0, with optimum temperature and pH of 30°C and pH 8.0. Moreover, it can grow and survive in seawater medium better and longer than *V. harveyi*. The strain could utilize

malic acid, glucose and sucrose as carbon source. Glutamic acid, monosodium glutamate and yeast extract were nitrogen source of the strain as well. Nutritional quality of cell after cultivation in various kinds of media test were 42.62-54.14% protein, 35.00-42.30% total sugar and 3.07-8.96% fat. The carotenoids and bacteriochlorophyll were 42.16 (OD_{480nm}/g biomass) and 34.60 (OD_{770nm}/g biomass) respectively. In comparison with normal diet, supplementation of lyophilized SR15b1% to normal shrimp diet could increase total hemocyte and phenoloxidase activity and enhance the color of shrimp tested.

Keywords: Diets; Bacteria; Shrimps; *Penaeus monodon*

222 Apaporn Muengkerd. 1989. **Growth of tiger prawn (*Penaeus monodon* Fabricius), fed with mixed diets of different amounts of shrimp head and ascorbic acid**. Master Thesis. Prince of Songkla University. 64 p.

Growth of tiger prawn (*Penaeus monodon* Fabricius) fed with mixed diets of 3 levels of shrimp head 0, 7 and 15%, and 3 levels of ascorbic acid, 0, 2000 and 5000 mg/kg, was studied. Each diet contained 40% protein. Twenty prawns of body length approximately 1 inch and weight 0.06-0.07 g were placed in 100 l seawater in cylindrical fiberglass tanks of 500 l capacity and 120 cm diameter. Seawater was filtered and salinity adjusted to between 15-20 ppt. Every morning, before feeding, faeces and other remains in each tank were siphoned out and about 30% of the water changed. Prawns were fed three times daily at a rate of 10% of mean body weight in each tank for 8 weeks. The inclusion of only shrimp head or ascorbic acid had no significant effect on growth rate of prawn. However, prawns fed with a mixture of shrimp head and ascorbic acid showed improved growth. Prawns fed on the diet of 15% shrimp head and 5000 mg/kg ascorbic acid had the highest mean weight of 1.45±0.06 g, significantly greater than those on control diet ($P<0.01$). Prawns fed with formula diets had survival rates between 65.0% and 86.7% and food conversion ratios of 1.65:1-3.05:1. None of the differences was significant ($P>0.05$). Cost of diet giving the highest growth rate was 33.75 baht/kg and the diet feeding cost 5.05 baht/100 g prawn. Production of this diet on a commercial scale is expected to involve lower costs, and its use in a prawn farm setting to give better growth rates, food conversion ratios and survival rates than were obtained under the conditions of this experiment.

Keywords: Diets; Vitamin C; Shrimps; *Penaeus monodon*

223 Raweewan Suwanich, Somkiat Piyatiratitivorakul, Prasat Kittakoop and Piamsak Menasveta. 1996. **Effects of highly unsaturated fatty acids and ratio of Eicosapentaenoic to Docosahexaenoic Acids on growth and survival of black tiger prawn *Penaeus monodon* postlarvae.** Thai J. of Aqua. Sc. 2(2): 91-105.

The effect of n-3 highly unsaturated fatty acids (HUFAs) and the ratio of eicosapentaenoic acid to docosa-hexaenoic acid (EPA/DHA) on growth and survival of black tiger prawn *Penaeus monodon* postlarvae was studied. A completely randomized design experiment with 7 diets (treatments) was used. Six experimental diets contained two levels (1.0 and 1.5%) of n-3 HUFAs, with 3 ratios (1:3, 1:2, 1:1) of EPA/DHA in each level. The control diet contained 0.35% n-3 HUFAs with the EPA/DHA ratio of 1:3. Three replicates (100 postlarvae m⁻³) were used in each treatment, except the control (two replicates). Postlarvae were fed 5 times a day, and the feeding period lasted 30 days. There was an interaction between n-3 HUFAs quantity and the EPA/DHA ratio on growth and osmotic resistance of postlarvae. The better growth rate was observed in shrimps fed on diets containing 1% and 1.5% of n-3 HUFAs with the EPA/DHA ratio of 1:1 and 1:2, respectively. However, the diets providing shrimp better osmotic resistance were composed of 1% and 1.5% n-3 HUFAs with the EPA/DHA ratio of 1:2 and 1:3 respectively. Neither quantity of HUFAs nor the EPA/DHA ratio had effect on survival rate. Dietary fatty acids had an influence on the fatty acid profile in tissue of the experimental shrimp. Polar lipids had more n-3 HUFAs than non-polar lipids. The present work suggests that the diet containing n-3 HUFAs 1.5% with the EPA/DHA ratio of 1:2 is recommended for normal growth and osmotic resistance in *P. monodon*.

Keywords: Diets; Fatty acids; HUFA; Growth; Survival; Shrimps; *Penaeus monodon*

224 Jintana Youngyuan, Boonsong Sirikul and Chumporn Tongprasom. 1987. **Experiments on nursing tiger prawn larvae (*Penaeus monodon* Fabricius) with 4 types of feed.** In Annual Report 1985-1986 Chuntaburi Brackish Water Fisheries Station. Brackish water Fisheries Division. Department of Fisheries. p.37-66.

The P15 of *Penaeus monodon* (Fabricius) were fed with type of feed in 1.5 m diameter tank for 8 weeks to observe the difference on growth rate, survival rate and food conversion ratio. Significantly difference were found in the case of growth rate and food conversion ratio. For artificial diet, fish meat, cockle meat and squid meat; the

growth rate were 16.1, 6.5, 4.4 and 3.5 mg/week; the survival rate were 82.73, 76.07, 75.4 and 70.1%; and food conversion ratio were 2.11, 4.61, 5.17 and 7.74 respectively.

Keywords: Nursing; Feed; *Penaeus monodon*

225 Twee Chindamaikul and Thanom Pimoljinda. 1990. **The Studies on comparision of nursing *Penaeus monodon* Fabricius with difference feed.** Technical Paper No.34/1990. Phuket Coastal Aquaculture Development Center. Department of Fisheries. 19 p.

The comparision studies on the *P. monodon* nursing between feeding with natural feed, artificial feed and artificial feed plus natural feed had been done two times on December 1989-February 1990 and May 1990-June 1990. The twenty tons outdoor tanks with the cover black canvas had been used for the one million larvae per tank and nursing the larvae until PL15. The results of the experiments; for the feeding with natural feed, the survival rate of nauplius, zoea, mysis, postlarvae and nauplius to PL15 were 80.95, 73.50, 58.81, 59.51 and 20.77 percentage respectively. For the feeding with artificial feed, the survival rate of nauplius, zoea, mysis, post larvae and nauplius to PL15 were 72.17, 39.58, 45.08, 38.03 and 4.63 percentage respectively. For the feeding with natural feed plus artificial feed, the survival rate of nauplius, zoea, mysis, postlarvae and nauplius to PL15 were 85.16, 81.16, 75.94, 69.05 and 36.60 percentage respectively. The survival rate on nursing of *P. monodon* with natural feed plus artificial feed was the highest than the nursing with natural feed or artificial feed only.

Keywords: Diets; Supplemented feeds; Nursing; *Penaeus monodon*

226 Wannipa Phianphak. 1999. **Use of bacteria as probiotics supplement in shrimp feed.** Master Thesis. Chulalongkorn University. 123 p.

Total bacterial count from Gastrointestinal tract (GI tract) of Black tiger shrimp and their culture water were 1.2×10^6 - 3.4×10^7 cfu/gm and 1.0×10^4 - 4.4×10^5 cfu/ml, respectively. Bacterial flora of their GI tract found were *Bacillus* sp., *Vibrio* sp., *Aeromonas* sp., *Pseudomonas* sp., *Klebsiella* sp. and *Staphylococcus* sp. Among them only *Bacillus* S11 has the ability of inhibiting some strain's growth of pathogenic bacteria to human; such as, *Bacillus cereus*, *Bacillus subtilis*, *Bacillus megaterium*, *Listeria monocytogenes*, *Staphylococcus aureus* and *Escherichia coli* and pathogenic bacteria to shrimp; such as, *Pseudomonas aeruginosa*, *Aeromonas hydrophila*, *Vibrio alginolyticus*, *Vibrio anguillarum*, *Vibrio harveyi*, *Vibrio parahaemolyticus* and *Vibrio*

cholera. *Bacillus* S11 clearly produced antimicrobial substance starting from the late log to stationary phases of their growth. After the examination of morphology and biochemical test, *Bacillus* S11 was tentatively identified as *Bacillus mycoides*. Being probiotics, *Bacillus* S11 was mixed in shrimp feed for feeding black tiger shrimp in closed recirculating water system and it was found that growth and survival rate of shrimp fed with probiotics were higher than those without probiotics feeding significantly at the level of $P < 0.05$. The growth rate of shrimps in control group and treated group of *Bacillus* S11 in the pattern of Fresh cells, Fresh cells in NSS and Lyophilized cells within 21 days were 0.73, 1.29, 1.17 and 1.16 grams, respectively. Whereas, their survival rate at the end of the experiment were 15.8, 38.3, 31.6 and 30.0%, consecutively. After challenging the control and the treated group with *Vibrio harveyi* 10 day their survival rate were 26% and 100%, respectively, with the significant difference of $P < 0.05$ by Duncan's multiple range test.

Keywords: Diets; Bacteria; Probiotics; *Bacillus*; Growth; Survival; Shrimps; *Penaeus monodon*

227 Chaipayorn Lusawatdigul. 1999. **Effect of alpha-tocopherol supplementation on growth of juvenile giant tiger prawn *Penaeus monodon* Fabricius**. Master Thesis. Chulalongkorn University. 81 p.

Effect of alpha-tocopherol (vitamin E) on growth of juvenile giant tiger prawn *Penaeus monodon* Fabricius (average weight 15 g) was studied using RBD for experimental design. Shrimps of each sex were reared separately. Shrimps were fed artificial diet supplemented with dl-alpha-tocopherol acetate form (0, 150, 500 and 2500 mg/kg diet). Shrimp were reared at density of 30 individuals per pond and reared for 8 weeks. Feeding regime was five times at 06.00, 10.00, 14.00, 18.00 and 22.00 hr. Level of alpha-tocopherol and sex exhibited no effects on survival rate, molting period frequency, %ash, %organic, and %water content in the shrimp muscle ($P > 0.05$). Level of alpha-tocopherol also showed no effects on growth, but affected %protein, % total lipid and hepatopancreas weight. Hepatopancreas weight of shrimp decreased as level of alpha-tocopherol in diet increased. Sex exhibited effect on weight significantly. Female was larger than male ($P < 0.05$), but had lower protein. Total lipid and hepatopancreas weight showed no difference between sexes.

Keywords: Diets; Vitamins; Alphetocopherol; Growth; *Penaeus monodon*

228 Pimporn Innopakun. 1998. **Effect of omega-3 fatty acid containing lecithins on production of larvae black tiger prawn. *Penaeus monodon***. Master Thesis. Chulalongkorn University. 117 p.

The aims of the present study are to produce n-3 fatty acids-lecithins and to evaluate their effects on growth, survival and low salinity stress of *Penaeus monodon* larvae. Lecithins extracted from Danish fish meal, Thai local fish meal and soybean shows different composition of fatty acids. Danish and local fish meal lecithin had higher EPA and DHA, whereas soybean lecithin had higher linoleic and alpha-linolenic acids. Phospholipid content in lecithins derived from soybean, Danish fish meal and local fish meal were 50, 25 and 20 g/100 g. Four diets; soybean lecithin-added diet (SAD), Danish fish meal lecithin-added diet (DAD), local fish meal lecithin-added diet (LAD) and free lecithin-added diet (control diet, CD) formulated from purified diets were used to feed shrimp larvae at different stages (zoea, mysis and postlarvae). The amount of lecithin in lecithin added diets was 1.5% of the total ingredient. Shrimp larvae fed SAD showed the highest growth rate in both salinity 25 and 30 ppt. Shrimp larvae fed CD also showed the high growth rate without significant difference at 25 ppt. The shrimp larvae survival rate in all diets was not significant different. Regarding stress test, shrimp postlarvae fed all lecithin added diets showed more tolerance to low salinity compared to that of lecithin-free diet (CD). Moreover, the larvae fed LAD accumulated HUFA in tissue higher than those fed other diets.

Keywords: Lecithin; Omega 3; Production; *Penaeus monodon*

229 Raweewan Suwanich. 1996. **Quantity and ratio of Eicosapentaenoic acid/Docosahexaenoic acid on growth and survival of black tiger prawn (*Penaeus monodon*) postlarvae**. Master Thesis. Chulalongkorn University. 75 p.

The aim of this study is to determine quantity and ratio of eicosapentaenoic acid (EPA)/docosahexaenoic acid (DHA) on growth and survival of black tiger prawn (*Penaeus monodon*) postlarvae. A completely randomized design experiment was used for this study. In this experiment, six diets contained two levels of % n-3 HUFAs (1.0, 1.5) and each level contained 3 EPA/DHA ratios (1:3, 1:2, 1:1). A control diet containing 0.35% n-3 HUFAs with the ratio EPA/DHA of 1:3 was use for comparison. Three replicates (100 postlarvae/m²) were used in each treatment. Postlarvae were fed 5 times/day. Results of 30 days feeding experiment showed an interaction between quantity n-3 and ratio of EPA/DHA on growth and the osmotic resistance of postlarvae. The EPA/DHA ratio in the diet that

improved growth of postlarvae was 1:1 at 1% n-3 HUFAs and 1:2 at 1.5% n-3 HUFAs, and 1:3 at 1.5% n-3 HUFAs provided the high osmotic resistance of postlarvae. There were no effect of quantity and EPA/DHA ratio on survival of postlarvae. The dietary fatty acids have influence on the fatty acid composition in shrimp tissues. Polar lipids have more n-3 HUFAs than non-polar lipids in the tissues of shrimp. And the ratio of EPA/DHA in diet also has an influence on the ratio of EPA/DHA in polar lipid more than non-polar lipids. The suitable amount of n-3 HUFAs and the ratio of EPA/DHA recommended for normal growth and osmotic resistance of *P.monodon* postlarvae was 1.5% and 1.2 respectively.

Keywords: Diets; Fatty acids; HUFA; Growth; Survival; Shrimps; *Penaeus monodon*

230 Mali Boonyaratpalin, Juadee Pongmaneerat, Shosak Borisut and Sujin Boonchuay. 1994. **The Effect of various supplemental methionine sources on growth and feed performances of shrimp (*Penaeus monodon*)**. Technical Paper No.14/1994. Songkhla National Institute of Coastal Aquaculture. Department of Fisheries. 10 p.

A 9-week feeding experiment was conducted with shrimp (*Penaeus monodon*) to determine the efficacy of various supplemental methionine sources. The basal diet (38% crude protein) supplemented with 0.23% and 0.58% DL-2-hydroxy-4-(methylthio) butanoic acid (MHA), 0.5% micro-encapsulated methionine and 0.5% crystalline methionine was tested in comparison with commercial shrimp feed and the basal diet without methionine supplementation as the negative control. The results indicated that supplementing methionine slightly improved growth, feed and protein utilization. Although, there was no significant difference among these dietary treatment but addition of 0.58% MHA trend to improve feed conversion efficiency and survival rate. Therefore, supplementation of 0.58% MHA is economically promote growth and feed performances for *Penaeus monodon*. The carcass composition was not influenced by various forms of methionine supplementation. Methionine is the first limiting amino acid in commercially used alternative protein sources. Supplementation of methionine are commonly used in poultry and broiler diets to over come a deficiency of this amino acid. However, it was reported that supplemented crystalline amino acids were absorbed much more rapidly from the intestine tract than those from intact protein resulting in poorer utilization of dietary amino acids (Plakas and Katayama, 1981; Plakas et al., 1980; Murai et al., 1986). On the other hand, the growth

improvement of carp fed diet supplemented with methionine coated with aldehyde treated casein compared to the group fed a diet with uncoated methionine has been reported (Murai et al., 1984). In addition, DL-2-hydroxy-4-(methylthio) butanoic acid (MHA^R) are used as sources of methionine in broiler, and it was found to be nutritionally effective in corn-soy diet on an equimolar basis with other forms of supplemental methionine (Cited by Dibner and Knight, 1984). On the other hand, channel catfish can utilize methionine hydroxy analogue calcium only about 26% as effective in promoting growth as L-methionine (Robinson et al., 1978). In bird, the only form of methionine that can be used in intermediary metabolism or incorporated into protein is L-methionine, supplemental sources must be converted before they can be used (Dibner and Ivey, 1992). Therefore, the relative value of the supplemental methionine sources for shrimp was determined on the basis of weight gain and feed conversion. Three forms of methionine, DL-2-hydroxy-4-(methylthio) butanoic acid (MHA^R), Micro-encapsulated and crystalline methionine were used in this study.

Keywords: Growth; Feed; Shrimps; *Penaeus monodon*

231 Orapint Jintasataporn. 1988. **Oxygen consumption of banana shrimp (*Penaeus indicus*)**. In Proceeding the Seminar on Fisheries 1988 Department of Fisheries, 21-23 September 1988. National Inland Fisheries Institute, Bang khen. p.108-116.

Oxygen consumption of *Penaeus indicus* was studied using flow-through system. Oxygen consumption per individual of every tested shrimp increased with size but oxygen consumption per unit weight decrease when the size of tested shrimp increased. Oxygen consumption rate was 1.56-4.87 mgO₂/hr for 1-20 g *P. indicus*. Lethal concentration of dissolved oxygen was also studied in closed system. The death point was between 0.40-0.80 mgO₂/l for 2-24 g *P. indicus*. The estimation of oxygen level in *P. indicus* pond was more than 3.5 mgO₂/l.

Keywords: Oxygen consumption; Banana shrimp

232 Supis Thongrod, Anand Tunsutapanich, Mali Boonyaratpalin and Teerawat Jarit-ngam. 1995. **A Comparison of development stage, survival rate and stress of shrimp larvae, *Penaeus monodon* fed dry formulated feeds and commercial feeds**. Thai Fisheries Gazette. 48(3):249-254.

Five experimental groups were designed to investigate and determine the nutrition value of dry

formulated feed for *Penaeus monodon* larvae by comparing with other commercial feeds, on its growth in terms of development stage, survival rate and stress. Commercial feeds were imported and labeled as Commercial-1, Commercial-2 and Commercial-3. Including was a group of experiment used Commercial-1 plus *Artemia* (live feed). Fifteen circular concrete tanks, each with 1.8 m diameter and 1.5 m in depth were filled with recycled seawater at a depth of 0.60 m. One hundred thousands of newly hatched *P. monodon* larvae were released in each tank. As soon as the larvae metamorphosed to sixth substage of nauplius stage, dry formulated feed and commercial feeds with 250 mg were fed separately to each group. Feeds were applied every two hours from 6.00 am to 10 or 12.00 pm (8-10 meals a day). Survival, growth in terms of development stage and water parameters were monitored daily. The result indicated that all groups gave satisfactory survival rate and non-significant difference at $P>0.05$. However, development stage was significantly different among groups. Dry formulated feed and commercial-3 gave the fastest growth. While the groups fed commercial-1 and commercial-2 were found to delay larval development. Substitution of commercial-1 with *Artemia* after larvae metamorphosed to Zoea-3 resulted in improving faster development. Stresses of shrimp were tested by abruptly transferring 100 larvae (with 3 replicates each) from 30 ppt to 5 ppt seawater. The result indicated the highest survival rate counting after 90 and 120 minutes from the group fed with dry formulated feed.

Keywords: Survival; Stress; *Penaeus monodon*

233 Procham Aranyakananda, Piamsak Menasveta, Nudol Moree, Sompop Rungsupa and Pornsilp Pholpunthin. 1987. **Larviculture of giant tiger prawn (*Penaeus monodon*) by artificial diets.** Reseach Report. Chulalongkorn University p.118-124.

Larviculture of Giant tiger Prawn (*Penaeus monodon*) by 4 brands of artificial diet was conducted to compare with diatom (*Chaetoceros calcitrans*). Feeding of artificial diets began when the larvae were nauplius 6; protozoa 1 and protozoa 2. Substitution of diatom by artificial diets when the larvae were protozoa 2 only made the larvae become postlarvae.

Keywords: Larviculture; Giant tiger prawn; *Penaeus monodon*

234 Pantipa Jantawat, Chaiyut Thunpitayakul, Uchukorn Pluckponggrat and Piamsak Menasveta. 1987. **Production of the squid meal as a**

component in shrimp feed. Reseach Report. Chulalongkorn University. p.127-152.

The general objectives of this study covered the development of squid meal processing techniques and the incorporation of squid meal into the compound feed for raising jumbo tiger prawn (*Penaeus monodon* Fabricius). Squid meal processing techniques composed of preparation of raw materials, steam cooking, milling and drum drying. Four formulas of the experimental compound diet were set up. The first formula used fish meal as a protein source (control). The second formula used squid meal which was processed from the whole body of squid as a protein source. The third formula used squid meal which is processed from the squid wastes (visceral mass, skin, and head at the ratio 1:1:1) as a protein source. The fourth formula used fish meal and squid wastes meal at the ratio of 1:1 as a protein source. Protein levels of these four formulas were adjusted at approximately 35%. The feeding trials were conducted with P-15 jumbo tiger prawn for a period of 12 weeks. The results showed that the fourth formula gave the best performance in terms of growth, survival, food conversion ratio and production, followed by formula 2,3 and 1. The production costs of formula 1, 2, 3 and 4 were approximately 12.19, 12.06, 5.44 and 8.81 baht/kilogram, respectively.

Keywords: Squid meal; Shrimps; Feed

235 J.F. Rees, K. Cure, Somkiat Piyatiratitivorakul, P. Sorgeloos and Piamsak Menasveta. 1994. **Highly unsaturated fatty acid requirements of *Penaeus monodon* postlarvae: an experimental approach based on *Artemia* enrichment.** Aquaculture 122 (1994). p.193-207.

Penaeus monodon postlarvae (PL-5 to PL-15) were fed 5 different diets consisting of enriched *Artemia* nauplii with a specific n-3 HUFA content. Although the postlarvae grew well on an *Artemia* diet with low HUFA-content, the ability of PL-10 to endure osmotic stress remained low. Feeding *Artemia* enriched with medium levels of n-3 HUFA (Σ n-3 HUFA=12.55 mg/g DW) for days considerably enhanced the resistance of PL- to osmotic stress and their survival recorded 5 days later. However, very high dietary levels of n-3HUFA (mg/g DW) did not have any growth-promoting effect, thus suggesting that an excessive supply of n-3 may not be beneficial to the shrimp. Our data demonstrate that subjecting postlarvae to reduced salinities for 2 h provides a simple and rapid test for assaying the physiological condition of postlarval shrimp.

Keywords: Fatty acids; *Penaeus monodon*; *Artemia*

236 J. Choosuwan, Piamsak Menasveta, I. I. Buhler, W. Schierle and T. Latscha. 1991. **Effect of dietary astaxanthin and canthaxanthin on the pigmentation of giant tiger prawn (*Penaeus monodon* Fabricius)**. In Proceeding the Third Technical Conference on Living Aquatic Resourced, 17-18 January 1991. Chulalongkorn University. p.431-446.

Juvenile giant tiger prawns were fed with nine diets containing astaxanthin or canthaxanthin i.e. 25 ppm, 50 ppm, 75 ppm, and 100 ppm astaxanthin or 50 ppm, 100 ppm, 150 ppm, and 200 ppm canthaxanthin, and the control diet containing none of the two carotenoids. The results showed that the addition of astaxanthin in the feed at the level between 50 ppm and 100 ppm and the addition of canthaxanthin in the feed at the level 100 ppm and 200 ppm resulted in the improvement of pigmentation of the giant tiger prawn, *Penaeus monodon*. Astaxanthin was more effective than canthaxanthin in pigmenting the prawns. In addition, growth improvement was observed at the higher dietary inclusion levels of astaxanthin and canthaxanthin. The level of carotenoids deposited in the body of prawns was directly related to the duration of feeding the carotenoid enriched feed and the amount of carotenoids in the diet.

Keywords: Astaxanthin; Canthaxanthins; Giant tiger prawn; *Penaeus monodon*

237 Tanom Pimoljinda. 1987. **Mixed feed for some economic brackish water fishes**. Technical Paper No.8/1987. Phuket Brackishwater Fisheries Station. Brackishwater Fisheries Division. Department of Fisheries. 23 p.

Dry pellets of different protein levels 45%, 50% and 55% for feeding to the fingerlings of Grouper and Seabass using fish meal and rice bran as the protein sources and the constant amount of vitamin-mineral (for poultry), vegetable oil, bread yeast and binder as the other sources were produced. The cost of pellets was computed 12-16 baht/kg. Mixed pellets and mince fish of 1:1 was fed to the fingerlings twice a day. For *P.monodon*, 40% protein level of fish meal, rice-bran, shrimp head meal and Ipil-ipil leave including the same vitamin-mineral and oil but different binder were used. The cost was about 10 bath/kg and feeding only pellets were conducted twice a day. Dry pellets used in this experiment seem to be appetizing for fish and shrimp.

Keywords: Diets; Proteins; Feed cost; Fishes; Shrimps; *Penaeus monodon*

238 Piamsak Menasveta, Nitaya Chaiyanetr, Somkiat Piyatiratitvarakul and Prasat Kittakoop. 1997. **Dietary prophylaxis against yellow-head disease in black tiger shrimp (*Penaeus monodon*)**. Shrimp Biotechnology in Thailand (BIOTEC Publication 2: 1997). p.61-69.

Two experiments were conducted to study the effect of micro-nutrient supplementation on yellow-head disease (YHD) resistance in *Penaeus monodon* postlarvae. In Experiment I, postlarvae 15 (PL-15) were fed with a commercial basal diet with and without factorial supplements of choline, astaxanthin, ascorbic acid, and highly unsaturated fatty acids (HUFA) in fish oil at concentrations of 600, 200, 2,000 ppm and 3% respectively. After feeding for 30 day, these groups of prawns were fed with meat from shrimp infected with yellow-head. The results showed that the groups fed with micro-nutrient supplemented feeds showed a tendency for increased disease resistance. In Experiment 2, PL-15 were fed with 5 diets including a commercial basal diet and the basal diet supplemented with vitamin c, astaxanthin+egg, and fish oil at the same concentrations as Experiment 1. Feeding rates were 5 times a day, and the shrimp were fed for 45 days. After this, the prawns were challenged with YHD by co-habitation with diseased prawns. Results showed that the control group fed with a basal diet died earlier than the other groups, suggesting that it was more sensitive to the yellow-head virus than the micro-nutrient treated groups. In summary, the results of these two experiments suggested that supplementation with the three micro-nutrients (vitamin c, astaxanthin, and HUFAs) had a prophylactic tendency YHD.

Keywords: Dietary prophylaxis; Yellow Head Disease; Shrimps; *Penaeus monodon*

239 Pornsri Prarakkamo. 1998. **Effect of dietary protein contents and water salinities on ammonia and urea excretion of different sizes giant tiger prawn (*Penaeus monodon* Fabricius)**. Master Thesis. Kasetsart University. 132 p.

Three different sizes of giant tiger prawns (*Penaeus monodon* Fabricius), feeding on different dietary protein contents and water salinity levels, were analyzed for ammonia and urea excretion. Unfed control groups were also included in the analyzed. Ammonia and urea concentration in the water were determined hourly for six hours after feed. The proportion of ammonia on the total nitrogenous excretion were between 56.45-87.40% in 1.17 gm. live weight, 3-88.35% in 5.25 gm. live weight and 59.61-90.11% in 14.68 gm. live weight. Ammonia excretion of the prawn were significant among different dietary protein contents, water salinities

also significantly their interaction effects ($P < 0.05$). The result showed that the prawn mainly excreted in the form of ammonia. The ammonia excretion increased with dietary protein content and was not consequently with water salinities and the prawn sizes. Urea excretion of the small size prawn were significant among different dietary protein and salinity level. For the large size, there significant effect of water salinity on urea excretion.

Keywords: Ammonia; Urea; Proteins; Diets; Salinity; Shrimps; *Penaeus monodon*

240 Putth Songsangjinda. 1994. **Effect of different levels of ambient ammonia on oxygen consumption of tiger shrimp (*Penaeus monodon*)**. Technical Paper No.23/1994. National Institute of Coastal Aquaculture. Songkhla. 7 p.

The effect of different levels of ambient ammonia on oxygen consumption in tiger shrimp (*Penaeus monodon*) was studied under Static-closed system. The consumption of ambient ammonia ranged 0, 0-1, 1-2, 2-3, 3-4 and 4-3 mgN/l. The result showed that tiger shrimp weight of less than 10 g increased oxygen consumption when ambient ammonia was increased. While tiger shrimp weight of more than 20 g decreased oxygen consumption. This may indicated that > 20 g shrimp tolerance higher level of ambient ammonia that smaller shrimp due to the decrease of oxygen consumption.

Keywords: Oxygen consumption; Oxygen; Ammonia; Shrimps; *Penaeus monodon*

241 Jaruwat Nabhitabhata, Somnuk Kbinrum and Yongyuth Soodmee. 1991. **Oxygen consumption of banana prawn, *Penaeus merguensis* de Man**. Technical Paper No.8/1991. Rayong Coastal Aquaculture Station. Coastal Aquaculture Division. Department of Fisheries. 19 p.

Routine metabolism of *Penaeus merguensis* was determined from oxygen consumption rate of 69 samples in closed-static respirometer at 28 °C and 30 ppt salinity. Relationship of metabolic rate (mgO_2/hr) and body weight (gm) was $R = 0.982W^{0.693}$ and of weight specific metabolic rate (mgO_2/hr) body weight (gm) was $Q = 0.993W^{-0.301}$ metabolic rate of female was significantly higher than of male. Dissolved oxygen critical value of limiting level was 3.7 mg/L and lethal level was at 0.8 mg/L

Keywords: Oxygen; Oxygen consumption; Shrimps; *Penaeus merguensis*

242 Jaruwat Nabhitabhata and Somnuk Kbinrum. 1989. **Effect of salinity and temperature on oxygen consumption of tiger prawn, *Penaeus monodon* Fabricius**. Technical Paper No.24/1989. Rayong Brackishwater Fisheries Station. Brackishwater Fisheries Division. Department of Fisheries. 36 p.

Of the three factors, body weight was the highest influence to routine metabolism or oxygen consumption rate temperature was the second: oxygen consumption rate increased as temperature increased (25-30 °C) at every level of salinities. Temperature effect was significant only at low salinity (10, 20 ppt) salinity was the lowest influence. Oxygen consumption rate increased as salinities decreased (10, 20 ppt) but reversed as salinity increased (30 ppt). Combined effect of temperature and salinities is highest at high temperature, low salinity and increasing body weight.

Keywords: Oxygen; Oxygen consumption; Temperature; Shrimps; *Penaeus monodon*

243 Jaruwat Nabhitabhata and Somnuk Kbinrum. 1989. **Estimation on optimum stocking density of tiger prawn, *Penaeus monodon* Fabricius, in earthen pond on basis of dissolved oxygen budget**. Technical Paper No.7/1989. Rayong Brackishwater Fisheries Station. Brackishwater Fisheries Division. Department of Fisheries. 30 p.

Dynamics of environmental parameters were monitored in *P. monodon* cultured pond through one crop (March-July 1988). The pond was 9.4 rai (15,400 m²) in area and average 1.24 m depth with intensive management. Average DO was 6.81 ± 0.32 mg/L, temperature $30.15 \pm 0.58^\circ\text{C}$, pH 7.53 ± 0.21 and salinity 20.50 ± 4.69 ppt. Net oxygen production was 0.027 ± 0.050 gm/m³ and benthic oxygen uptake was 0.077 ± 0.014 gm/m². Total circulation rate was 3656.99 ± 909.93 m³/hr and 0.080 ± 0.020 m/sec Velocity was enable by 2-15 aerators responded to culture period on basis of DO budget, estimated optimum stocking density at lower or safe level was 27 ind/m² for 30 gm. prawn and 22 ind/m² for 40 gm. prawn. Higher or possible level was 60 and 50 ind/m² for 30 and 40 gm prawn respectively. Optimum stocking density of 20-130 gm prawns were also estimated.

Keywords: Water quality; Dissolve Oxygen; Stocking density; Shrimps; *Penaeus monodon*

244 Panit Sangkasern and Jaruwat Nabhitabhata. 1995. **Oxygen consumption and optimum oxygen content for coastal aquaculture of some species**. Technical Paper No.24/1995. Rayong Coastal

Aquaculture Station. Coastal Aquaculture Division. Department of Fisheries. 23 p.

Oxygen consumption rate of tiger shrimp (*Penaeus monodon*), banana shrimp (*Penaeus merguensis*), sea bass (*Lates calcarifer*) brown-spot grouper (*Epinephelus coioides*) was determined from respirometer of closed-static system. Oxygen consumption rate and weight relationship was in model $R=aW^b$ and $Q=aW^{b-1}$ for weight specific oxygen consumption rate and weight. Regression coefficient of the model was 0.69 in shrimps and 0.72-0.73 in fishes. Metabolism of the four species was oxygen independent pattern. Dissolved oxygen content at critical portion of limiting level, median tolerance level and lethal level was estimated to be 3.8, 2.2 and 0.7 mgL⁻¹ for tiger shrimp; 3.7, 3.7, 1.2 and 0.8 mgL⁻¹ for banana shrimp; 2.4, 1.4 and 0.4 mgL⁻¹ for sea bass and 3.5, 1.9 and 0.4 mgL⁻¹ for grouper respectively.

Keywords: Oxygen; Oxygen Consumption; Shrimps; *Penaeus monodon*; *Penaeus merguensis*; *Lates calcarifer*; *Epinephelus coioides*; Regressions

245 Orapin Jintataporn. 1987. **Oxygen consumption of penaeid shrimps found in extensive shrimp pond in Thailand.** Master Thesis. Kasetsart University. 91 p.

Oxygen consumptions of *Penaeus indicus*, *Metapenaeus ensis* and *M. brevicornis* were studied using flow-through system. Oxygen consumption per individual of every tested species increased with size but oxygen consumption per unit weight decrease when the size of tested shrimp increased. Oxygen consumption rates were 1.56 to 4.87 mgO₂/hr for 1 to 20 g *P. indicus*, 0.78 to 1.62 mgO₂/hr for 1 to 10 g *M. ensis*, and 1.23 to 1.97 mgO₂/hr for 1 to 10 g *M. brevicornis*. Lethal concentrations of dissolved oxygen were also studied in closed system. The death points were between 0.40 to 0.80 mgO₂/hr for 2-24 g *P. indicus*, 0.20 to 0.40 mgO₂/l for 2 to 9 g *M. ensis*, and 0.33 to 0.68 mgO₂/l for 2 to 10 g *M. brevicornis*.

Keywords: Oxygen; Oxygen Consumption; Penaeid; Shrimps; Extensive culture; *Penaeus indicus*; *Metapenaeus*

246 Klaiwan Phaewcham. 1992. **Effect of light intensity and salinity on growth and survival rate of post-larval stage of the tiger prawn, *Penaeus monodon* Fabricius.** Master Thesis. Kasetsart University. 107 p.

Light intensity and water quality especially salinity is among the most important factors for nursing of prawn larvae. Tiger prawn (*Penaeus monodon* Fabricius) is one of major coastal aquatic species. How to gain higher growth as well as survival rate of prawn larvae, however, are the main problems facing tiger-prawn culturists. This study deals with those factors were performed on P₁₅ or postlarvae of prawn to find out best means for improving tiger-prawn culture and it was done in the laboratory of the Faculty of Fisheries Kasetsart University.

Four levels of salinity; 5, 10, 20 and 30 ppt were used on P₁₅ larval stage for the period of 28 days. The results of this study showed that prawn larvae had gained best results at 20 ppt in average weight, average length, growth rate and survival rate as well. Statistical significance between groups reared in 20 ppt salinity and others were occurred.

Five levels of light intensity; 0, 750, 1,000, 1,250 lux and natural light were selected on P₁₅ larval stage reared in 30°C and 20 ppt salinity. This study was also last for 28 days. The results showed that prawn larvae reared in water of 0 lux of light were gained the best results in average weight, average length, growth rate and survival rate. Zero lux of light intensity, however, showed statistically significance on the first three results.

Keywords: Light intensity; Salinity; Hatcheries; Growth; Survival; Postlarvae; Shrimps; *Penaeus monodon*

247 Pornpun Yutharaksanulkul. 1995. **A study on relationship between soil and water redox potential and aquatic animals toxic reducing agents with special cases of Tilapia (*Oreochromis niloticus*) and tiger prawn (*Penaeus monodon* Fabricius) under intensive culture in aquaria.** Master Thesis. Kasetsart University. 189 p.

Results from the experiments in soil-water system indicated significant (P<0.05) and highly significant (P<0.01) correlation between the nitrite in water and redox potential of water at 0, 5 and 20 ppt. Highly significant correlation was also found between sulfide in water and redox potential of water at 20 ppt and between sulfide in water and redox potential of soil at 0 and 35 ppt. Significant difference were also observed between redox potential, Fe²⁺ and Mn²⁺ of water and soil of treatment using acid sulfate soil comparing to other treatments using normal clay and sandy soil. In intensive culture system of Tilapia and tiger prawn, highly significant correlation were found between redox potential of water and soil. The decrease in redox potential of water and soil resulted in higher concentration of nitrite and ammonia in water, in all experimental systems with aeration, except the treatment using CaCO₃ in Tilapia culture

system. In Tilapia culture system with out aeration, the decrease in redox potential of water and soil resulted in the decrease in nitrite and the increase in Fe^{2+} and sulfide causing total mortality of experimental fish within 9 days.

Keywords: Water quality; Soil; Redox potential; Aeration; Intensive culture; Fishes; Nile tilapia; *Oreochromis niloticus*; Shrimps; *Penaeus monodon*

248 Suriya Chankaew. 1997. **Effect of ammonia and salinity on growth, molting periods and calcium in exoskeleton of black tiger shrimp (*Penaeus monodon* Fabricius).** Master Thesis. Kasetsart University. 113 p.

The 90-h LC_{50} of ammonia to *Penaeus monodon* with an average weight of 0.81 ± 0.17 , 1.59 ± 0.24 , 2.46 ± 0.25 and 3.47 ± 0.67 g. in 10, 20 and 30 ppt seawater using the static renewal method were 12.81, 18.69, 24.34 and 25.99 mg/l ammonia-N; 15.27, 20.62, 29.49 and 25.79 mg/l ammonia-N; 19.0, 27.79, 30.43 and 32.74 mg/l ammonia-N respectively. The LC_{50} (Concentration that reduced growth by 50% of the control of ammonia-N (unionized plus ionized as nitrogen) and NH_3 -N (unionized ammonia-N) at 10, 20, 30 ppt for 60 days period were 15.30, 17.35, 16.81 mg/l ammonia-N and 0.53, 0.48 and 0.50 mg/l NH_3 -N respectively. The MATC (maximum acceptable toxicant concentration) for 60 days at 10, 20 and 30 ppt were 3.5, 7 and 3.5 mg/l for ammonia-N and 0.15, 0.29 and 0.26 mg/l NH_3 -N for unionized ammonia. Increasing of ammonia caused reduction in molting period of 1st intermolt to 2nd intermolt. Experiment at 10, 20 and 30 ppt showed that the shortest molting period occurred at 10 ppt. The molting period at 10 ppt. for the control, 3.5, 7 and 14 mg/l ammonia-N were 11.45, 10.23, 9.49 and 9.31 days respectively. At salinity of 10 and 30 ppt. calcium content in shrimp muscle kept in control and expose to 3.5, 7 and 14 mg/l ammonia-N were 1.137, 1.249, 1.635 and 2.246 mg/g and 2.462, 2.548, 2.603 and 2.624 mg/g respectively. Increased ammonia directly raised calcium content in shrimp muscle. However, calcium content in exoskeleton and intermolt exoskeleton were not affected by ammonia but increasing salinity raised calcium content in both of the exoskeleton.

Keywords: Physiology; Ammonia; LC_{50} ; Salinity; Growth; Moulting; Calcium; Shrimp shell; *Penaeus monodon*

249 Piyanut Juruphant. 1996. **Effect of *Alexandrium minutum* and *Alexandrium cohorticula* on mortality of *Oreochromis***

***niloticus* and *Penaeus monodon*.** Master Thesis Chulalongkorn University. 133 p.

Because of mass mortality of shrimp and fish caused by *Alexandrium minutum* bloom in the culture pond, comparative effect of *A. minutum* and *A. cohorticula* on mortality of *Oreochromis niloticus* size 2.81-5.34 cm. in Length and 0.463-2.38 g in weight, and *Penaeus monodon*, size 4.49-5.32 cm. in length and 0.550-0.742 g. in weight were conducted by a static biotesting in the laboratory. Both species of algae were cultured in limited volume until approaching late log phase. Under normal laboratory condition, the doubling time of *A. minutum* and *A. cohorticula* were 2.89 and 2.48 days, respectively. Both algal species were further studied for the effects of their cell concentrations and cell extracts on the mortality of fish and shrimp.

The median lethal concentration at 96 hours (96 h - LC_{50}) of *A. minutum* was 6.59×10^3 cells/ml for *O. niloticus* and 1.09×10^3 cells/ml for *P. monodon*, while the 96 h - LC_{50} of *A. cohorticula* on *O. niloticus* and *P. monodon* were 1.39×10^2 and 4.17×10^2 cells/ml, respectively. The cell extract from *A. minutum* showed more effect on shrimp mortality than fish (33.3%, 3.33%). The result from *A. cohorticula* also indicated the same trend which was 28.57% mortality of shrimp in comparison with 26.67% mortality found in fish. Cell-free medium of *A. minutum* indicated no effect on fish whereas the aliquot from *A. cohorticula* culture affected shrimp mortality more than fish. Histopathology of fish revealed the edema of gill lamellae, posterior kidney nephrocalcinosis and tubular hydropic change. The histopathology of shrimp gills showed the inflammatory gill filaments due to clog of algal cells. The present results indicated that the toxicity of cell both intact cells and extract of *A. minutum* on fish and shrimp is less than those of *A. cohorticula*.

Keywords: Prawns; Shrimps; *Penaeus monodon*; Fish; *Oreochromis niloticus*; *Alexandrium cohorticula*; Culture pond; Toxicity; Mortality; *Alexandrium minutum*

250 Chunchara Thuithuisong. 1998. **Chemical control of red tide phytoplankton (*Chattonella marina* and *Heterosigma akashiwo*) in the black tiger shrimp (*Penaeus monodon*) ponds.** Master Thesis. Kasetsart University. 114 p.

The laboratory culture of red tide organisms, *Chattonella marina* and *Heterosigma akashiwo*, manipulated under the light density of 2,000 luxes, temperature of 28°C and salinity of 30 ppt., indicated that the growth rates of those two phytoplankton were 0.792 and 0.872 divisions/day, respectively. Chemical control (calcium hypochlorite, benzalkonium chloride and hydrogen peroxide) was

used to treat *Chattonella marina* and *Heterosigma akashiwo*. The concentrations of calcium hypochlorite, benzalkonium chloride and hydrogen peroxide completely disintegrated *Chattonella marina* 50% for 24 hours (24-hLC₅₀) were 65.77, 0.29 and 38.51 ppm, respectively. While in the *Heterosigma akashiwo* treatment the concentration of chemicals (24-h LC₅₀) were 34.69, 0.12 and 15.01 ppm, respectively. Acute toxicities (24-h LC₅₀) of calcium hypochlorite, benzalkonium chloride and hydrogen peroxide to the black tiger shrimp size PL-30 in the *Chattonella marina* treatment were 52.26, 0.17 and 42.10 ppm, respectively. In the *Heterosigma akashiwo* treatment, the acute toxicities (24-h LC₅₀) or the chemicals to the black tiger shrimp verified to be 50.78, 0.16 and 65.16 ppm, respectively. The chemical presented the best result in the control of both phytoplanktons during the black tiger shrimp culture was hydrogen peroxide. During the treatment procedure, the water quality expressed little variation.

Keywords: Red tide; Phytoplankton; Plankton; Acute toxicity; Cell culture

251 Suwanna Benjatammanont. 1991. **Effects of environment and carotenoid pigment on blue discoloration of pond-raised tiger prawn, *Penaeus monodon* Fabricius.** Master Thesis. Kasetsart University. 156 p.

Blue discoloration of pond-raised tiger prawn at Tambol Nongshim, Amphur Lamsingh, Chantaburi province and at Tambol Mongkunsing, Amphur Mueng, Trad province, during July-October, 1990, was studied. Throughout the period of cultivation cycle, most of phytoplanktons found were Cyanophyceae, especially the genus *Oscillatoria*. When there was less incidence of blue discoloration, planktons frequently found were diatoms: *Chaetoceros* and *Coscinodiscus*. These two genera of diatom contained high amount of carotenes and xanthophylls, which directly affected blue discoloration. Blue tiger prawn contained lower amount of carotenoids when compared to normal shrimp. Water qualities affecting blue discoloration were salinity and transparency. Low salinity and high transparency caused blue discoloration. Raw feed had indirect effect on blue discoloration. Raw feed contained minerals which was necessary for the growth of planktons. When raw feed was used. The number of planktons increased, thus water transparency was decreased which consequently lessen blue discoloration. Raw feed also contained high quantity of carotenoids, therefore, shrimp fed raw feed obtained higher content of carotenoid which normal shrimps had content of carotenoid more than blue shrimp

protein, moisture, fat and ash contents of blue shrimp were in the range of 15.83- 20.80, 71.22-77.46, 0.06-0.24 and 1.30-1.56 percents respectively and normal shrimp were in the range of 15.19-19.46, 70.95-80.28, 0.06-0.26 and 1.31-1.74 percents respectively. It appears that the proximate composition of both blue and normal shrimp are in the same range SD value found in general shrimp.

Keywords: Pigments; Blue Color Syndrome; Carotenoid; Plankton; Phytoplankton; *Oscillatoria*; *Chaetoceros*; *Coscinodiscus*; Environment; Water quality; Salinity; Transparency; Feed; Feeding; *Penaeus monodon*

252 Chamaiporn Akkanvanitch and Chaloeimwilai Chuensri. 1997. **Observation on ecological factors in limited water exchange shrimp cultured system.** Final Report 1997. Research Project Code T-M 5.40. 37 p.

Field data and water samples were collected from the Chantaburi Marine Farm Company in Changwat Chantaburi, during January-July, 1997, for the study on relationships of water qualities, physical and biological factors in limited water exchanged shrimp cultured system, which controlled pH and dissolved oxygen level. The results from linear correlation between water quality variables (alkalinity, dissolved oxygen, soluble inorganic nitrogen groups such as ammonia, nitrite, nitrate, pH, total ammonia, total phosphorus, orthophosphate and silicate) and physical factors (transparency, salinity, suspended solids and temperature) and biological factors (individual shrimp weight, carotenoid and chlorophyll a, b, c contents) revealed that most of the factors were highly significant correlation among the three groups. Transparency and dissolved oxygen in the early morning were highly negative significant, but feed per day showed highly positive significant differences, while total feeds had proved to be one of the main problems effected the chemical and biological property of water qualities. Hence, the balance management on the production and on the water quality changing in the closed system indicates promising success of sustainable yield.

Keywords: Ecosystems; Closed system; Intensive culture; Water quality; Feed; Ponds; Productivity; *Penaeus monodon*; Chanthaburi

253 Thanom Pimoljinda and Gritsan Nongrat. 2001. **Effect of colour in water from plankton and "Lake Colorant" to growth rate of *Penaeus monodon*.** Technical Paper No.2/2001. Andaman Marine Shrimp Research and Development Center. Department of Fisheries. 9 p.

Rearing the postlarva (fifteen up) of *Penaeus monodon* in sea water mixed with phytoplankton:- *Chlorella* sp. (I), *Tetraselmis* sp. (II), Lake Colorant (III) and control (IV) in concrete tanks, fiberglass tanks and aquariums. In 45 days the result showed that for concrete tanks, the average weight (grams) of shrimp in number I, II, III and IV were 3.93, 2.6, 4.2 and 4.23 respectively which the number II was lowest and significantly ($P < 0.05$) to number III and IV. But the survival rate were 39.3, 33.9, 53.3 and 52.3% respectively and also nonsignificant ($P > 0.05$). In fiberglass tanks, the average weight (grams) of shrimp in number I, II, III and IV were 0.59, 0.57, 0.54 and 0.52 for the survival rate were 67.66, 76.66, 69.00 and 70.25% respectively and both of them were nonsignificant ($P > 0.05$). In aquaria, the average weight (grams) of shrimp in number I, II, III and IV were 1.12, 1.05, 1.27 and 1.05 for the survival rate were 43.75, 41.87, 69.37 and 56.25% respectively and both of them were nonsignificant ($P > 0.05$). The end of experimental, shrimps in *Chlorella* sp. showed dark green colour and healthy, also the same in *Tetraselmis* sp., except the Lake Colorant that body looked lightly green and blue. But the control, shrimps were light colour and weakly. So from this experiment showed that Lake Colorant can use instead of phytoplankton in shrimp pond for first month.

Keywords: Feed; Natural feeds; Plankton; *Chlorella*, *Tetraselmis*; Water; Shrimp colours; Growth; Shrimp performance; Shrimps; Postlarvae; *Penaeus monodon*

254 Voravit Cheevaporn, Vipoosit Manthachitra and Somthawin Jaritkruan. 1991. **Some ecological factors effect on the growth of giant tiger prawn, *Penaeus monodon* Fabricius (Biological Factors)**. Department of Aquatic Science, Faculty of Science, Burapha University. 67 p.

Monitoring study on phytoplankton and zooplankton communities and production of giant tiger prawn, were carried out during 4 January to 12 May 1991. The pond was 3.8 rai (6,080 square meter) in area with intensive management. Results showed that blue-green alga and diatom are the major component of phytoplankton while copepod and decapod larva are of zooplankton. Stocking density of the study was 50-prawns/square meter. After rearing periods, the final size of prawn was 25 grams with yield 1,366 kg/rai. Survival rate and Food Conversion Ratio were 62.4% and 1.474 respectively. The result indicated that rearing is success. From statistical analysis, the results indicated that phytoplankton do not show significant relationship with growth of shrimp. But zooplanktons show significant negative

relationship. To improve efficiency of rearing, density of zooplankton should be considered.

Keywords: Ecosystems; Plankton; Shrimp products; *Penaeus monodon*

255 Tawat Sriveerachai, Tanan Tattanont and Niwes Ruangpanit. 2001. **Effects of stocking density on growth of banana shrimp (*Penaeus merguensis*) cultured for 2 and 3 months in earthen pond**. Technical Paper No.20/2001. Narathiwat Coastal Aquaculture Development Center. Department of Fisheries. 15 p.

To study 3 stocking densities on growth of banana shrimp (*Penaeus merguensis*) P20 cultured for 2 and 3 months in earthen pond for 3 crops. First crop was cultured in 800 m² earthen ponds for 2 replicates, stocking densities of shrimp were 50, 100 and 150 individuals per m² for 2 months. Second crop was done by the same method with the first for 3 months. And the third was cultured in 2,100 m². Earthen ponds for stocking density 50 and 100 individual per m² for 3 months. Every crop was fed with commercial black tiger shrimp pellets. Results showed that the stocking density of 50 individuals per m² showed better growth rate than 100 and 150 individuals per m². The average lengths of shrimp cultured at three stocking density in the first crop for two months were 6.64±0.11, 5.13 ±0.38 and 5.83±1.37 cm, average weights 2.13±0.04, 1.22±0.25 and 1.54±0.79 grams, total ADG 0.036±0.001, 0.020±0.004 and 0.026±0.0013 grams per day, respectively. The average lengths of the second crop cultured for three months were 7.52±0.42, 6.62±0.24 and 6.34±0.75 cm, average weights were 3.50±0.28, 2.35 ±0.07 and 2.35±0.49 grams, total ADG 0.039±0.003, 0.027±0.001 and 0.026±0.003 grams per day, respectively. And the third crop, banana shrimp cultured for 3 months showed the same. At the stocking rate of 50 individuals per m² had the better growth rate than 100 individuals per m². Average lengths were 7.85±0.80 and 6.20±0.50 cm, average weights were 3.53±0.29 and 1.95±0.16 grams, total ADG 0.039±0.003 and 0.022±0.002 grams per day, respectively.

Keywords: Shrimps; Shrimp culture; Growth; Banana shrimp; *Metapenaeus*; *Penaeus merguensis*

256 Thavorn Thamsavate and Tweek Chindamaikul. 1993. **Studies on the survival rate of larvae of *Penaeus monodon* (Fabricius) from the first, second, third, fourth and fifth spawning of eyestalk ablation spawner**. In Proceeding the Seminar on Fisheries 1993 Department of Fisheries. 15–17 September 1993 Inland Fisheries Institute, Bangkok. p. 376-390.

Studies on the survival rate of larvae of *Penaeus monodon* (Fabricius) from the first, second, third, fourth and fifth spawning of eyestalk ablation spawner and natural spawner were as follows; the survival rates of nauplius stage were 91.0, 90.7, 85.2, 76.3, 72.3 and 92.2 percentage respectively. The survival rates of zoea stage were 79.2, 74.2, 62.1, 52.3, 48.3 and 81.3 percentage respectively. The survival rates of mysis stage were 70.4, 65.8, 47.1, 32.1, 0 and 72.1 percentage respectively. The survival rate of post larva 5 were 32.5, 31.3, 21.1, 12.3, 0 and 32.9 percentage respectively. The results revealed that survival rate of nauplius, zoea, mysis and post larva 5 on nursing from the first, second, third, fourth and fifth spawning of eyestalk ablation spawner were different with highly significant but the survival rate on nursing *Penaeus monodon* (Fabricius) from the first spawning of eyestalk ablation spawner were not different from the natural larvae.

Keywords: Eyestalks; Spawning; Survival; Larvae; Shrimps; *Penaeus monodon*

257 Wooti Kuptawatin. 1995. **Survival rate of tiger prawn (*Penaeus monodon* Fabricius) larva in 4 different salinity.** Technical Paper No.31/1995. Kung Krabaen Bay Fisheries. Development Study Centre. Department of Fisheries. 19 p.

Survival rate of tiger prawn larva cultured in four different salinity was significantly different. The survival rate of tiger prawn larva from nauplius to mysis III stage cultured in 30 ppt salinity was highest (60.7 percents). The survival rate of larva cultured in 32 ppt (control) and 25 ppt were 45.3 and 17.2 percents. Larva cultured in 20 ppt salinity were unable to develop into Zoea II stage.

Keywords: Salinity; Hatcheries; Survival; Shrimps; *Penaeus monodon*

258 Prachaub Chaibu. 1995. **The Relationship of salinity and povidone iodine on the death of giant tiger prawn (*Penaeus monodon* Fabricius).** Master Thesis. Mahidol University. 77 p.

Povidone Iodine was disinfectant that widely used in giant tiger prawn larva nursing, high efficiency for kills bacteria and parasites that was cause the disease in larva stage. The objective of this study was for using the povidone iodine to protect and control the disease in larva stage well. To protect the larva died, in the cause of using povidone iodine and it was used the other factors for this studying; the giant tiger prawn larva stage (*Penaeus monodon* Fabricius), salinity, the concentration of povidone iodine. It study for the

relation of the factor that was effect to the larva death and experimentation prawn hatchery of Khungkraen Fishery Development Centre with completely randomized design. The 7 levels of povidone iodine concentration was effect to 4 larva stage death as; zoea 2, mysis 2, post larva 2 and post larva 15 in 24 hours with 3 replication. Four simple linear regression equations that used for calculating the concentration of povidone iodine, that was not the effect on death in each stages which was 0.72, 0.71, 1.06 and 1.56 ppm respectively. Otherwise it studied, for acute toxicity of povidone iodine on giant tiger prawn larva were conducted by using the static bioassay. The 24-hours median lethal concentration (24-hrLC₅₀) of povidone iodine on zoea 2, mysis 2, post larva 2 and post larva 15 were 2.05, 2.24, 3.43 and 6.46 ppm respectively. Water quality in this experiment had studied, too. Two equations of multiple linear regression equation were represent the results between 7 levels of salinity (S) and 8 levels of povidone iodine concentration (P) on the death of post larva 15 for 24 hours in 2 different salinity range. Equation 1 $D1 = 16.666 + 8.570 P - 0.125 S1$, S1 were salinity range about 10-30 ppt, R-square=0.866 Equation 2 $D2 = -31.495 + 8.720 P + 0.583 S2$, S2 were salinity range about 30-40 ppt, R-square=0.923. The povidone iodine concentration which were not harmful to post larva 15 raising by salinity range about 16-35 ppt were 0.16, 0.28, 0.41, 0.55, 0.68, 0.61, 0.94, 1.07, 1.20, 1.33, 1.46, 1.60, 1.73, 1.86, 1.60, 1.53, 1.47, 1.40, 1.33 and 1.27 ppm respectively. The water quality during the studies was also discussed.

Keywords: Chemicals; Povidone iodine; Disinfectants; LC₅₀; Shrimps; *Penaeus monodon*

259 Sanae Pholprasit, Luechai Darunchu and Titima Thongsriphong. 1997. **Ozone adding to *Penaeus monodon* Fabricius culture pond effect on growth and survival.** Thai Fisheries Gazette. 50(3): 203-212.

Experiment on culturing *Penaeus monodon* Fab. Have done in four earthen ponds with area of 800 m² each. Ozone was added in pond 1, 2 and not added in the pond 3, 4. The 15 days old postlarvae were reared at the density of 30 ind/m³ in each pond for 112 days. Difference of growth rate and specific growth rate are non-significant (P>0.05). Average survival rate was 38.75±9.45% and 9.38±1.48% respectively. Average production was 257.63±156.87 kg. and 55.58±3.08 kg. respectively. Difference of survival rate and production are non-significant (P>0.05). The average of water quality in added ozone pond salinity 9.28±0.04 ppt, pH 8.06±0.07, alkalinity 57.27±3.78 mg/l as CaCO₃, nitrite 0.01±0 mg/l, ammonia 0.16±0.04 mg/l, DO 6.98±0.04 mg/l, ozone 0.45±0.17 mg/l and in non added ozone pond

salinity 9.27 ± 0.04 ppt, pH 7.99 ± 0.05 , alkalinity 53.06 ± 3.49 mg/l CaCO_3 , nitrite 0.02 ± 0.01 mg/l, ammonia 0.09 ± 0.04 mg/l, DO 7.08 ± 0.02 mg/l, ozone 0.02 ± 0.01 mg/l.

Keywords: Chemicals; Ozone; Disinfectants; Growth; Survival; Shrimps; *Penaeus monodon*

260 Kanyajit Lopinyosiri. 2000. **Application of ozone for controlling water quality in black tiger shrimp culture.** Master Thesis. Chulalongkorn University. 112 p.

Total Ozone Output (TOO) by Iodometric method (APHA, 1976) and Residual Ozone Concentration (ROC) by Indigo method (APHA, 1976) were used parallelly in this study. TOO values increased continuously with time whereas ROC was much lower than TOO because of rapid evaporation of ozone. The pattern of ROC accumulation was irregular and did not reflect the ozone concentration produced from the machine. In studies with bacteria, it was found that the minimal effective dosage of ozone to inhibit *Vibrio harveyi* growth was 51.23 ppm (TOO). Three log units of *Vibrio* was inhibited after 6 hours of treatment while 2 log units *Bacillus sp.* S11 was suppressed after 48 hr of treatment. Exposure to 97.48 mg/l of TOO or 0.30-0.40 mg/l of ROC initiated loss of balance of prawns, including immobility and destruction of gill lamellar epithelium. Much higher concentration of ozone (424.24 mg/l of TOO or 0.180 mg/l of ROC) was required for reducing total ammonium-nitrogen, BOD and total suspended solids in water. Study on the optimal dosage of ozone treatment for *Penaeus monodon* culture revealed that at 51.23 mg/l total ozone output (TOO) or 0.350 mg/l residual ozone concentration (ROC) was effective in inhibiting 3 log units of *Vibrio harveyi* D331 for 24 hours and could reduced 30% of ammonium-nitrogen concentration. At this dosage, there was no effect neither on prawn nor on intestinal probiotics (*Bacillus* S11). The prawn survival rate was increased statistically ($P \leq 0.05$) when compared with the control and the treatment without probiotic and ozonation.

Keywords: Chemicals; Ozone; Disinfectants; Residues; Histopathology; Probiotics; Survival; Mortality; *Penaeus monodon*

261 Chatchawal Intramontree, Putth Songsangjinda and Lakana La-ongsiriwong. 2001. **Effect of ozone treatment on dissolved nitrogen compounds and planktons in water from tiger shrimp culture.** Technical Paper No.3/2001. Songkhla Marine Shrimp Research and

Development Center. Department of Fisheries. 13 p.

Chemical parameters especially ammonia and nitrite, which are the common toxicants in shrimp grow-out pond, are considered to be the important parameters affecting production of shrimp. Ozone (O_3) has been shown to be efficient and applicable to improve water quality. The objectives of this study are to investigate the effect of ozone treatment on chemical parameters (ammonia, nitrite and nitrate) of water from shrimp pond and evaluate the affect of ozone treatment on the biological parameters (respiration and photosynthetic rates) of planktons. The ozone was produced from atmospheric oxygen by flow passing uv lamp. The flow rate of air was adjusted to be constant at 61/ min. The produced ozone was added to react with the water sample from shrimp pond, cultured *Chlorella sp.*, *Skeletonema costatum* and *Brachionus plicatilis*, at the rate of 9 mgO_3/min . Water samples were collected at the interval of 15, 30, 60, and 120 min, for the analysis of total ammonia, nitrite, nitrate, and total dissolved nitrogen. The respiration rate of plankton was measured for the water samples from shrimp pond, cultured *Chlorella sp.*, *Skeletonema costatum* and *Brachionus plicatilis*. A photosynthetic rate was measured from all water samples except water sample from cultured *Brachionus plicatilis*. Results showed that ozone treatment could improve water qualities by increasing nitrate and reducing ammonia and nitrite. The ammonia and nitrite reduction were 15 and 98%, respectively, after 120 min. for ozone treatment (638 mgO_3/l) indicating the slow rate of ammonia treatment under the experimental condition. The concentration of nitrate was found to significantly correlate ($P < 0.05$) with the reduction of nitrite in water samples. Within 60 min. of treatment, the respiration rate of planktons in water samples from shrimp pond, cultured *Chlorella sp.*, *Skeletonema costatum* and *Brachionus plicatilis* reduced 84, 76, 49, and 98% and photosynthetic rate reduced 70, 26 and 79%, respectively, showing the affect of ozone on the activities of planktons. Results from the present study indicate that, the ozone treatment is able to reduce the toxicants in shrimp pond water. However ozone can depress the photosynthesis and respiration of planktons, resulting the unbalance of pond ecosystem.

Keywords: Water quality; Ozone; Ecosystems; Plankton; Respiration; Shrimp culture; *Penaeus monodon*

262 Nopchanok Tanapongsathorn. 2001. **Ozonation and Bioflocculation in Black Tiger Shrimp (*Penaeus monodon* Fabricius) Pond in Low Salinity Area.** Master Thesis. King Monkut's University of Technology Thonburi. 136 p.

At the present time, the productions of black tiger shrimp increase sharply in Thailand. The pollution loading of intensive farming has been implicated in the deterioration of environmental and yields of harvest shrimps. Main problems of polluted water come from disease, ammonia-N, nitrite-N and other pollution loading such as uneaten feed, feces, chemical substance and organic matters. This paper studied effect of ozonation and chitosan as bioflocculation in low salinity area of shrimp pond. The main properties of ozone are disinfectant and high power oxidizing agent. Chitosan removed various kinds of pollutants such as suspended solid, BOD and COD.

Experiments from JarTest in various pH (7-9), alkalinity (53-104 mg/l as CaCO_3), salinity (4-10 ppt) and initial turbidity (16-102 NTU) by using chitosan solution 1, 5, 10, 20, 40 and 80 ppm showed that the ability and power of flocculant depended on pH, alkalinity, salinity and initial turbidity value. At low and medium pH, low alkalinity, low salinity and high initial turbidity had higher power of flocculant. The optimum dose of chitosan solution was 1 and 10 ppm (reduced turbidity more than 63 percent). For the optimum ozone dose from pilot scale was 0.001023 mg O_3 /l.

Experiments on the low salinity area of 3rai shrimp culture pond size for 120 days with 5 condition (pond using chitosan solution 1 ppm, pond using chitosan solution 10 ppm, pond without chitosan and ozone using, pond using chitosan solution 10 ppm and ozone, pond using only ozone). pH, DO, BOD, COD, alkalinity, turbidity, TSS, ammonia-N and nitrite-N indicated water quality level every week. Water quality was lowest in control pond. Ozone pond had found little ammonia-N and nitrite-N problems. Chitosan pond (Dosage of chitosan solution is 10 ppm) was low turbidity and TSS. Ozone&Chitosan pond was the best quality. Good water quality level in shrimp pond affected positively yield of harvested shrimp. The total weights of harvested shrimps were 2,502, 2,805, 2,302, 3,164 and 2,709 kilograms respectively, but no different survival rate. This experiment confirmed that pond using chitosan solution and ozone improved water quality and yield of harvested shrimps.

Keywords: Ozone; Black tiger shrimp; Shrimp ponds; Bioflocculation; Low salinity

263 Wiboon Ruksaree. 1998. **Growth of *Noctiluca scintillans* and effect of cell concentrations on mortality rate of black tiger shrimp larvae and juvenile sea bass.** Master Thesis. Chulalongkorn University. 96 p.

The isolated natural cell of *Noctiluca scintillans* was cultured in laboratory conditions

which fed on four phytoplankton species: *Dunaliella* sp., *Tetraselmis* sp., *Isochrysis* sp. and *Skeletonema* sp. at light intensity of 3,000 and 6,000 lux and varying salinity of 20, 30 and 40 ppt. The results showed that *N. scintillans* fed on *Tetraselmis* sp., at the salinity of 20 ppt. and light intensity of 6,000 lux was the best specific growth rate of $0.397 \pm 0.021 \text{ day}^{-1}$ with maximum yield of $176 \pm 16 \text{ cells/ml}$. Culture of *N. scintillans* fed on *Isochrysis* sp. and *Skeletonema* sp. had low growth rate and very low cell concentration. The effects of cell concentrations and extracted solution from *N. scintillans* cells as well as dissolved ammonia on mortality rate of black tiger shrimp larvae (*Penaeus monodon*) and juvenile sea bass (*Lates calcarifer*) were carried out. The result revealed that cell density of *N. scintillans* obtained from the natural environment was more toxic than that obtained from laboratory culture with 72-hr LC_{50} value of 8.139 ± 1.221 and $120.7392 \pm 2.714 \text{ cells/ml}$, respectively. The same trend was also observed in juvenile sea bass with 72-hr LC_{50} values of 8.510 ± 0.291 and $278.983 \pm 64.956 \text{ cells/ml}$ for natural cells and cultured cells, respectively. The study on effect of the extracted solutions from natural cells and cultured cells showed almost the same toxicity level on tiger shrimp larvae with 72-hr LC_{50} value of 111.347 ± 4.898 and $142.774 \pm 6.895 \text{ cells/ml}$, respectively and on sea bass with 72-hr LC_{50} value of 100.915 ± 9.026 and $103.345 \pm 8.809 \text{ cells/ml}$, respectively. The depletion of dissolved oxygen was also observed in all experiments that mentioned earlier. Furthermore, the study indicated that black tiger shrimp larvae was more higher tolerance to ammonia toxicity than juvenile sea bass with 72-hr LC_{50} values of 14.322 ± 0.251 and $11.521 \pm 0.415 \text{ mg/l}$, respectively.

Keywords: Water quality; Plankton; *Lates calcarifer*; Mortality; *Penaeus monodon*

264 Yont Musig. 1989. **Effect of acid pH on survival rate and growth rate of *Penaeus monodon* and *Penaeus merguensis*.** Kasetsart University Research Report. 9 p.

Short term effect of acid pH within 96 hours period were tested with three different sizes of *Penaeus merguensis* with average weight of 0.015, 0.52 and 2.20 g and three different size of *Penaeus monodon* with average weight of 0.018, 0.70 and 6.22 g. Both *P. monodon* and *P. merguensis* died 100 percent at pH 3 in every size groups. At pH 4, 0.018 g *P. monodon*, 0.015 g *P. merguensis*, and 0.52 g *P. merguensis* died 100 percent, while 20 percent of 2.20 g *P. merguensis*, 70 percent of 0.73 g *P. monodon* and 80 percent of 6.22 g *P. monodon* survived. No mortality was observed in all three size groups of both species at pH 5 or higher. When long term effect of pH 5 and 6 were tested with

0.018 g *P. merguensis* and 0.021 g *P. monodon*, within 2 months period, all of *P. merguensis* died within 7 days and all of *P. monodon* died within 33 days at pH 5. Both growth rate and survival rate of *P. merguensis* decreased significantly ($P < 0.05$) at pH 6 comparing to control shrimp. Growth rate of *P. monodon* rearing at pH 6 were nonsignificant different ($P > 0.05$) from control shrimp but survival rate of experimental shrimp at pH 6 were significantly lower ($P < 0.05$) than control shrimp.

Keywords: Water quality; pH; Mortality; Growth; Shrimps; *Penaeus monodon*; *Metapenaeus*

265 Jamaree Poongem. 1997. **The Evaluation of the use of formalin and copper sulfate for plankton control in giant tiger prawn (*Penaeus monodon* Fabricius) grow-out ponds.** Master Thesis. Kasetsart University. 124 p.

Results of the study of toxicity of formalin and copper sulfate on *Chaetoceros calcitrans*, *Chlorella* sp., *Oscillatoria* sp. and *Brachionus rotundiformis* indicated that the concentration of formalin of 1.0 ppm did not have any effect on growth rate of all three phytoplankton species and the concentration of formalin of 5.0 ppm did not have any effect on growth rate of *Brachionus rotundiformis* at 48 hours testing period. Concentration of formalin which resulted in 100% mortality of *C. calcitrans*, *Chlorella* sp., *Oscillatoria* sp. and *B. rotundiformis* were 0.1, 0.1, 0.25 and 5.0 ppm. at 48 hours testing period. The concentration of copper sulfate that result in 100% mortality of *C. calcitrans*, *Chlorella* sp., *Oscillatoria* sp. and *B. rotundiformis* at 48 hours testing period were 50.0, 80.0, 40.0 and 50.0 ppm, respectively. 96-hr LC_{50} of formalin for *C. calcitrans*, *Chlorella* sp., *Oscillatoria* sp. and *B. rotundiformis* were 7.5, 7.8, 7.2, 8.2 ppm, respectively. 96-hrs LC_{50} of copper sulfate for *C. calcitrans*, *Chlorella* sp., *Oscillatoria* sp. and *B. rotundiformis* were 1.50, 1.70, 1.45 and 4.70 ppm, respectively. 96-hrs LC_{50} of copper sulfate for PL15 and PL30 of *P. monodon* were 7.2 and 13.0 ppm., respectively. The use of 20 ppm. formalin and copper sulfate at the rate calculated from alkalinity of divided by 100 ppm. were able to control plankton to keep secchi disc visibility above 40 cm. The use of formalin and copper sulfate at these application rate did not have any effect on water quality (alkalinity, hardness, BOD_5 and nitrite) and did not have any effect on survival rate growth rate and production of *P. monodon*.

Keywords: Chemicals; Water quality; Formalin; Copper; Plankton; EC_{50} ; Growth; Shrimps; *Penaeus monodon*

266 Nujaree Janmanee. 2000. **Effect of benzalkonium chloride, copper chelated and formalin on *Oscillatoria* in tiger giant prawn (*Penaeus monodon* Fabricius) grow out ponds.** Master Thesis. Kasetsart University. 124 p.

Optimum conditions for the growth of *Oscillatoria* were studied in laboratory scale. It was found that Conway medium was the most suitable source of media with salinity of 15 ppt. temperature of 35°C, light intensity of 3,000 lux and light/dark cycle of 12:12 hrs with continuous aeration. Effect of benzalkonium chloride and chelated copper at 1, 5, 10, 15 and 20 ppm. and formalin at 1, 15, 20, 45 and 60 ppm. on *Oscillatoria* at lag and log phase with and without aeration was studied. Benzalkonium chloride at 1 and 5 ppm. could effectively reduce *Oscillatoria* (chlorophyll a) in lag phase without aeration and log phase with aeration in which cell wall was destroyed and complete eradication was found within 96 hrs. Higher concentrations of benzalkonium chloride only caused the trichome to be broken down into small pieces. However complete eradication was observed after 7 days of the trial. All concentrations of chelated copper could effectively control the growth of *Oscillatoria* only with aeration condition. Without aeration, chelated copper from 5 and 10 ppm were effective at lag and log phase respectively. Every concentration of formalin could control the growth of *Oscillatoria* within 24-28 hrs only. Chelated copper and formalin caused the settlement of trichome while formalin also caused the pale coloration of the trichome. These three chemicals did not cause any significant changes of water qualities measured in this experiment. Result from this study suggested that benzalkonium chloride was the most effective chemical for the growth control of *Oscillatoria* in laboratory condition.

Keywords: Water quality; Plankton; *Oscillatoria*; Benzalkonium chloride; Copper chelate; Shrimps; *Penaeus monodon*

267 Arunee Jitrakorn. 1995. **Effect of calcium hypochlorite on water quality, giant tiger prawn (*Penaeus monodon*, Fabricius) and some species of phytoplankton and zooplankton.** Master Thesis. Kasetsart University. 112 p.

Effect of calcium hypochlorite on the plankton, the giant tiger prawn and the water quality was studied. Highest concentration of calcium hypochlorite that did not have any effect on growth of *Chaetoceros calcitrans*, *Oscillatoria* sp. and *Chlorella* sp. were 2.0 ppm. and highest concentration of calcium hypochlorite that did not have any effect on growth of *Branchionus plicatilis* was 0.5 ppm, while the concentration of 25, 70, 90 and 20 ppm. of calcium hypochlorite killed 100% of these

respective species. The 96 hrsLC₅₀ of calcium hypochlorite on giant tiger prawn larvae. PL-15 and PL-30, were 6.0 and 6.6 ppm. respectively, when the tests were carried out with neither aeration nor feed, comparing to 96 hrsLC₅₀ value of 6.4 ppm. of calcium hypochlorite on PL-15 when the tests were carried out with either aeration or feed. The use of calcium hypochlorite at the rate of 3 ppm. had no effect on growth rate, survival rate, and production of *P. monodon*. In aquarium test, calcium hypochlorite had no effect on water alkalinity and water hardness, but calcium hypochlorite reduced BOD₅ and nitrite in water and raised up water pH. Concentration of ammonia was also decreased in the experiment without aeration. In pond experiment, calcium hypochlorite also had no effect on water alkalinity and water hardness. BOD₅ of water in pond treated with calcium hypochlorite were lower than control. Calcium hypochlorite at the concentration of 3 ppm. can be used affectively to control phytoplankton.

Keywords: Water quality; Chemicals; Calcium hypochlorite; Plankton; Treatment; Shrimp performance; Shrimps; *Penaeus monodon*

268 Chanin Sangrungruang and Sakorn Makta. 1997. **Effect of chemical treatment for water quality control in closed system on survival of tiger prawn larvae, *Penaeus monodon* Fabricius, nursing with different of feed.** Technical Paper No.12/1997. Kung Krabaen Bay Fisheries Development Study Center, Chantaburi. Coastal Aquaculture Division. Department of Fisheries. 25 p.

Larvae of black tiger shrimp, *Penaeus monodon*, were nursed in closed system. Used seawater was treated by formalin and lime water. Shrimps were reared at density of 100 ind/L from nauplius stage in concrete tank of 9 m³ capacity. Grinded *Artemia* flake and microencapsulated feed was fed to shrimps as different treatment. Survival of shrimps fed with grinded flake was significantly higher in mysis stage, postlarva 1 and postlarva 15. Survival was significantly related to most of water quality parameter excluding nitrite (NO₂⁻). The degree of such relationship for shrimps fed with grinded flake was lower than those fed with microencapsulated feed.

Keywords: Hatcheries; Water quality; Diets; Microencapsulated diets; Chemicals; *Artemia*; Shrimps; *Penaeus monodon*

269 Putth Songsangjinda and Youngyut Predalumpaburt. 1995. **Effect of difference levels of oxytetracyclin on change of nitrogenous compounds, total organic carbon and**

chlorophyll a of intensive tiger shrimp cultured water. Technical Paper No.5/1995. National Institute of Coastal Aquaculture, Songkhla. Department of Fisheries. 8 p.

The study of effect of different levels of oxytetracyclin on change of nitrogenous compounds, total organic carbon and chlorophyll a of intensive tiger shrimp cultured water was conducted in a 110 liter aquarium. Oxytetracyclin (as HCl) was added into tested water at a concentration of 1, 3 and 5 mg/l with 3 replications for each treatment. Water quality changes of oxytetracyclin groups were compared to the control group (no oxytetracyclin) day by day up to seven days. The results showed rapidly decreased of level of oxytetracyclin in all treatments to the non detected levels at the 5th and 7th day of experiment. Only level of total nitrogen and total organic carbon at the 5th day of experiment of the control group were significantly lower than that of 5 mg/l additional oxytetracyclin, while total ammonia, nitrate, nitrite and chlorophyll a showed insignificant differences among treatments. The result from this study indicated that oxytetracyclin at 5 mg/l may affect the decomposition of total nitrogen and total organic carbon in shrimp cultured water.

Keywords: Water quality; Oxytetracycline; Nitrogenous compounds; Intensive culture; Shrimps; *Penaeus monodon*

270 Chalor Limsuwan and Wara Taparhudee. 1997. **Degradation and effect of formalin on planktons and water quality in *Penaeus monodon* Fabricius cultured ponds.** In the 35th Kasetsart University Annual Conference, 3–5 February 1997. p.47-95.

Degradation and effect of formalin on planktons and water quality was studied in intensive ponds cultured black tiger shrimp (*Penaeus monodon*). Formalin at the concentration of 30 ppm was applied into the ponds while all aerators were operated throughout the first 48 hours except during broadcast the feed. At the concentrations of 30 ppm formalin had already degraded within 36 hours. Formalin significant reduced the amount of planktons, dissolved oxygen, pH and total ammonia during 48 hours. Results from this study indicated that upon application of formalin, it is recommended to operate aeration at full speed to ensure dissolved oxygen is sufficient during 48 hours. Lime application is needed to increase pH to normal level during 48 hours. In case of emergency if dissolved oxygen is lower than 3 ppm water exchanges may be required.

Keywords: Water quality; Formalin; Chemical degradation; Plankton; Shrimps; *Penaeus monodon*

271 Supavadee Koydon. 1994. **Efficiency of formalin in reducing ammonia in water and its**

effects on black tiger prawn (*Penaeus monodon* Fabricius) and hybrid catfish. Master Thesis. Kasetsart University. 90 p.

The experiments were done to evaluate the possibility of using formalin to control ammonia in aquaculture ponds. Formalin is more effective in removing ammonia in water with lower salinity. Concentration of formalin to get rid of ammonia within 5 minutes, at concentrations of 0.3, 0.5, 0.8, 1.0, 1.5 and 2.0 mgN/l are 44, 48, 67, 97 and 173 ppm. in freshwater, 42, 52, 76, 102, 123 and 202 ppm in 10 ppt water, 54, 63, 88, 121, 163 and 235 ppm in 20 ppt. water, and 63, 77, 110, 145, 196 and 254 ppm in 30 ppt. water. Acute toxicity test indicated that substance produced from reaction between formalin and ammonia of 2.0, 1.5 and 1.0 mgN/l result in 40, 33.3 and 15 % mortality of 1.56 grams *Penaeus monodon* within 96 hr. and the concentration of this substance at ammonia concentration of 2.0 and 1.5 mgN/l result in 30 and 15 % mortality of 2.05 grams hybrid cat fish. Chronic toxicity of this substance, at concentration of ammonia of 1.0 and 0.8 mgN/l result in lower survival rate and growth rate of hybrid catfish and *Penaeus monodon* respectively.

Keywords: Water quality; Formalin; Low salinity; Toxicity; Growth; Survival; Mortality; Treatment; Catfish; Shrimps; *Penaeus monodon*

272 Nares Suanyuk, N. Songseechun, A. Songpradit, W. Thapuksorn and K. Supamattaya. 2000. **Effect of chlorine dioxide on black tiger shrimp (*Penaeus monodon*) pathogen and water quality.** Songklanakarin J. Sci Technol. 22 (Suppl.): 707-715.

Study of chlorine dioxide was performed in post larvae as well as in juvenile black tiger shrimp (*Penaeus monodon*). The LC₅₀ at 96-h for post larvae and juvenile individuals were 0.455 and 1.891 ppm, respectively. The effect of chlorine dioxide in the eradication of pathogenic bacteria (*Vibrio* sp.) was tested by tube dilution and for shrimp virus using bioassay. The chlorine dioxide at concentration 0.25 ppm was capable of eradicating all four strains of *Vibrio harveyi* and *Vibrio* sp. within one hour while the concentration 0.75 ppm was capable of eradication of white spot virus (systemic ectodermal and mesodermal baculovirus; SEMBV) and yellow head virus (YHV) within two hours. The use of 0-0.15 ppm chlorine dioxide causes no effect on water pH, salinity, alkalinity, dissolved oxygen and growth of phytoplankton (*Skeletonema costatum* and *Chaetoceros calcitrans*).

Keywords: Chemical; LC₅₀; Chlorine; *Vibrio*; Toxicity; SEMBV; YHV; Diatoms; Bacteriocidal activity; Bioassays; Water quality; Shrimps; *Penaeus monodon*

273 in Thai

274 Somkhuan Khaikaw. 2002. **Effect of oil and oil dispersant on black tiger shrimp (*Penaeus monodon* Fabricius).** Master Thesis. Prince of Songkla University. 133 p.

Static bioassays of oil dispersant (OD 4000), diesel oil (water soluble fractions, WSF) and fuel oil (WSF) on juvenile Black Tiger Shrimp (*Penaeus monodon* Fabricius) were conducted for toxicity test. The results indicated 96-h LC₅₀ of OD 4000, diesel oil and fuel oil at 4.97, 47.80 and 40.31 mg/l, respectively. Lethal Threshold Concentration (LTC) of OD 4000, diesel oil and fuel oil were 4.53, 46.99 and 39.53 mg/l, respectively, whereas safety levels of these toxicants were 0.63, 5.88 and 4.91 mg/l, respectively. The effects of growth and histopathology changes on Black Tiger Shrimp, which were continuously exposed to OD 4000, diesel oil and fuel oil at 25, 50 and 75% of LTC for 6 weeks, were also studied. It was found that gill's epithelial were damaged when 50% LTC fuel oil and 50% and 75% OD 4000 were applied. The minimum growth rates together with edema and telangiectasis of the secondary gill's lamellae were observed on Black Tiger Shrimp which were exposed to a 75% concentration of LTC of fuel oil. The effect is due to the damaging of pillar cells that support the gills, subsequently causing the expansion of blood sinusoids. The results of toxicity, effects on growth and histopathological changes can be used as an indicator to estimate toxicity and effects on other marine animals. Moreover, the LTC and the safety levels can be used to consider a criteria for water quality management, control prevention and improvement from oil pollution.

Keywords: Effects; Histopathology; LC₅₀; *Penaeus monodon*

275 Smarn Kuchi. 1995. **The Study on the efficiency of chemicals and bacteria being used in *Penaeus monodon* Fabricius grow-out pond.** Master Thesis. Kasetsart University. 122 p.

Application of hydrated lime at the rate of 160 kg/rai, into shrimp pond with normal bottom soil, before filling water, resulted in higher water pH and lower concentration of ammonia within the first week of culturing period, but did not have any effect on either water quality after one week or growth rate and survival rate of shrimp. The use of phosphate fertilizer at the rate of 0.64 kg/rai once a week

resulted in higher amount of phytoplankton and lower concentration of ammonia within the first 8 days, but did not have any effect on either water quality after that period or survival rate and growth rate of shrimp. Application of zeolite at the rate of 20 kg/rai every 15 days, resulted in the decrease of ammonia concentration in water within the first 8 day, but there was no significant decrease of ammonia concentration after that period. The use of zeolite also had no effect on survival rate and growth rate of shrimp. The use of 2 kinds of commercial bacteria in *P. monodon* culturing system did not have any effect on water quality, growth rate and survival rate of shrimp

Keywords: Water quality; Chemicals; Lime; Fertilizers; Zeolite; Shrimps; *Penaeus monodon*; Bacteria

276 Orawan Ruangdetkom. 1998. **Effect of chlorine and trichlorphon on water treatment for stocking black tiger shrimp (*Penaeus monodon* Fabricius) in intensive culture.** Master Thesis. Kasetsart University. 117 p.

Black tiger shrimp (*Penaeus monodon*), cultured in water treated with calcium hypochlorite at a concentration of 18 mg/l for 166 days, were studied. The production was 637.43 kg/rai and the average weight was 27.08 g. The survival rate was 30.09%, the feed conversion rate (FCR) was 2.14 and the average daily gain 0.16 g. black tiger shrimp, cultured in water treated with trichlorphon at concentration 1 mg/l for 159 days, were also studied. The production was 1022.88 kg/rai and the average weight was 29.44 g. The survival rate was 45.65%, the FCR was 1.95 and the average daily gain 0.17 g. Calcium hypochlorite at 18 mg/l can decrease levels of *Oscillatoria* sp., copepods, rotifers and *Navicula* at approximately 42%, 50%, 65% and 100% respectively during the first hour after application. It can decrease levels of copepod, *Oscillatoria* sp. and rotifer at approximately 92%, 98% and 100% respectively 96 hours after application. Trichlorphon at 1 mg/l does not affect levels of *Oscillatoria* sp. *Navicula* or rotifers. However, it can reduce copepods by 100% during the first hour after application. Calcium hypochlorite at 18 mg/l killed 99% of bacteria within 3-12 hours and 100% of *Vibrio* sp. during the first hour, however the bacteria population increased considerably after 24 hours. Trichlorphon does not kill bacteria. Between the water treated with calcium hypochlorite at 18 mg/l and the water treated with trichlorphon 1 mg/l there was no significant difference. The 7 *Vibrio* species identified each week were *Vibrio alginolyticus*, *V. anguillarum*, *V. fluvialis*, *V. harveyi*, *K. parahaemolyticus*, *V. damsela* and *V. vulnificus*.

The water quality of shrimp ponds treated with calcium hypochlorite at 18 mg/l was also studied. Transparency varied between 36-95 cm, the temperature averaged between 25-31°C, the pH between 7.5-8.6, the dissolved oxygen (DO) between 5.2-8.1 mg/l, the salinity between 12-29 ppt, the alkalinity between 97-181 mg/l, the unionized-ammonia between 0.0099-0.1077 mg/l and the nitrite-nitrogen between 0.0024-0.0155 mg/l. The water quality of shrimp ponds treated with trichlorphon at 1 mg/l was also considered. The transparency varied between 35-79 cm, the temperature between 26-31 °C, the pH between 7.3-8.57, the DO between 5.8-8.3 mg/l, the salinity between 12-29 ppt, the alkalinity between 91.177 mg/l, 90-176 mg/l, the unionized-ammonia between 0.0169-0.1064 mg/l and the nitrite-nitrogen between 0.0021-0.0276 mg/l.

Keywords: Water quality; Chemicals; Chlorine; Water preparation; Intensive culture; Plankton; Shrimps; *Penaeus monodon*

277 Chitchart Chitmon. 1995. **Effect of Chlorine on intensive black tiger shrimp culture in recycle system.** Master Thesis. Kasetsart University. 163 p.

Black tiger shrimp (*Penaeus monodon*) cultured in water treated with calcium hypochlorite at a concentration of 18 ppm and using recycle system for 143 days was studied. The production was 1156 kg/rai and the average weight was 29.22 g survival rate 66.42%, feed conversion rate 1.90, average daily gain 0.2 g for non-treated water groups the production was 182 kg/rai with an average weight of 11.67 g for 85 days and the survival rate 13%, feed conversion rate 4.42 with daily gain of 0.2 g. Calcium hypochlorite at 18 ppm can increase the pH from 7.74 to 8.19 after 24 hours. The total killed bacterial count was greater than 99% within 3-9 hours, and *Vibrio* sp. 100% in 1 hour. Decreased phytoplankton were approximately 50% and 99.6% at 1 and 96 hours after application. However, calcium hypochlorite can not detect after 24 hours. Average total bacterial count and *Vibrio* sp. in treated ponds were lower than the non-treated ponds during this study. Dissolved oxygen, temperature and pH were similar in both groups. The average Chemical Oxygen Demand (COD) in treated and non-treated ponds were 20.90 and 19.92 mg/l respectively. Chlorophyll a in treated ponds and non-treated ponds were 88.79 and 85.15 ppb respectively. Total alkalinity, bicarbonate alkalinity, hardness, dissolved solid, ammonia, nitrite, nitrate, orthophosphate and organic matter in both groups were similar for most of the grow-out period. In non-treated groups however, ammonia levels were higher during the disease outbreak in the pond. Essential minerals in both groups are suitable for shrimp culture but heavy metals could not detected in this study. Water quality

assessed in sedimentation pond, fish pond, aeration pond 1 and 2 such as ammonia, orthophosphate, total alkalinity, chlorophyll a, and dissolved solid generally decreased from first pond to aeration ponds 2. Nitrite, nitrate and COD tend to increase during the culture period.

Keywords: Water quality; Chemicals; Chlorine; Chemical degradation; Recirculating water system; Treatment; Shrimps; *Penaeus monodon*

278 Juadee Pongmaneerat, Sawitri Silakes and Jamaree Rakbangleam. 2001. **Monitoring of Water Quality in Culture Ponds of Black Tiger Shrimp and Water Quality in the Coastal Shrimp Culturing Area in 1997-2000.** Technical Sub-Division, Coastal Aquaculture Division. Department of Fisheries. 87 p.

Monitoring of water quality in culture ponds of black tiger shrimp and water quality in the coastal area of 21 provinces during January to December in 1997-2000. The parameters determined the water quality in culture ponds of black tiger shrimp were transparency, salinity, ammonia, nitrite, DO and BOD. The parameters determined the water quality of coastal area were salinity, temperature, ammonia, nitrite, phosphate, pH, DO and BOD. The water quality in the culture ponds belong to the farmers and that in the coastal areas are presented in this report. The water quality parameters of the year 1997 to 2000 are compared in each province. Therefore, the monitoring of water quality in both culture ponds and coastal areas might be beneficial for shrimp farm management and being as the basic environmental data for coastal management of sustainable shrimp culture.

Keywords: Surveys; Water quality; Shrimp culture; Shrimps; *Penaeus monodon*

279 สมภพ รุ่งสุภา, พิพัฒน์ พัฒนผลไพบูลย์ และ เปี่ยมศักดิ์ เมนะเสวต. 2541. ปริมาณธาตุอาหารและแหล่งกักตุนพืชบริเวณเลี้ยงกุ้งกุลาดำและไม่มีแหล่งกักตุนกุ้งกุลาดำ บริเวณป่าชายเลน ปากแม่น้ำตราดจังหวัดตราด. ใน การสัมมนาระบบนิเวศป่าชายเลนแห่งชาติครั้งที่ 10 “การจัดการและการอนุรักษ์ป่าชายเลน : บทเรียนในรอบ 20 ปี” วันที่ 25 – 28 สิงหาคม 2541. คณะกรรมการทรัพยากรธรรมชาติชายเลนแห่งชาติ สำนักงานคณะกรรมการวิจัยแห่งชาติ. I-4.

Studied site at the River Mouth of Trat River, Trat province the eastern part of Thailand, between dry season (February 1994) and raining season (August 1993 and May 1994). The sampling period covered high and low tide. Average temperature was 27.3-30.9 Celsius, pH 4.4-7.6, salinity 0-31.1 ppt, DO 4.4-7.6 mg/l, conductivity 27.5-48.0

μmho/sq.cm and transparency was 0.5-1.3 meters. Water depth at no shrimp culture area was higher than shrimp culture area. pH and DO was low in rainy season at shrimp culture area. Total ammonia concentration was high only in rainy season at shrimp culture area (0.710 μgat/L). Nitrite, nitrate, phosphate and silicate were higher at shrimp culture area than no shrimp culture area in dry season (0.546±0.942, 1.179±0.942, 0.233±0.226 and 35.180±2.182 μgat/L). Dominant and most frequency phytoplankton genera found both 2 area was *Trichodesmium*, *Chaetoceros*, *Coscinodiscus*, *Gyrosigma*, *Nitzschia*, *Rhizosolenia*, Dinoflagellate cyst and *Codonellopsis*. *Noctiluca scintillans* was also found at no shrimp culture area. *Chaetoceros* was high at no shrimp culture area and *Rhizosolenia*, Dinoflagellate cyst and *Codonellopsis* was high at shrimp culture area.

Keywords: Water quality; Surveys; Nutrients; Plankton

280 Dusit Tunvilai, Kanit Chaiyakam, Yongut Predalumpabutr and Choa Sriwichai. 1994. **Water and soil quality monitoring of shrimp farms in Pattani province.** In Proceeding the Seminar on Fisheries 1994 Department of Fisheries, 19-21 September 1994. National Inland Fisheries Institute. Bang Khen. p. 185-193.

The tiger shrimp farms of three districts in Pattani province were evaluated for water quality monitoring. Twenty-six ponds were examined during January to August 1993. The results indicated water supplies were unpolluted and suitable for shrimp culture. However the maximum of water quality in inlet of some farms was over the natural water criteria with total nitrogen and total phosphorus of 1 mg/l. The water qualities that were suitable for shrimp culture in this study such as salinity, NO₂-N and NH₄-N were 11.4-27.5 ppt, 0.010-0.069 mg/l and 0.075-1.463 mg/l, respectively. But the BOD of some farms was exceed 10 mg/L and chlorophyll a was also high ranging from 61.22-126.2 mg/l. The pollution loading from shrimp farm such as, total nitrogen, orthophosphate, BOD and COD were 0.070-0.357, 0.007-0.022, 0.69-1.75 and 2.49-6.03 kg/rai/day; respectively. The NH₄-N, dissolved inorganic nitrogen, total nitrogen, orthophosphate, total suspended solids, chlorophyll a, BOD and COD were significantly related to culture period and discharge (P<0.01). The quality of sediment after harvest, including pH, hydrogen sulfide, ammonia-nitrogen, nitrite-nitrogen and orthophosphate were range from 7.1-7.8, 4.2-48.7 mg/kg, 19.35-50.10 mg/kg 0.12-0.21 mg/kg 0.44-0.77 mg/kg and 1.24-6.04 mg/kg, respectively.

Keywords: Surveys; Water quality; Soil; Effluents; Shrimp farm; Shrimps; Pattani; *Penaeus monodon*

281 Prachuab Leeruksakiat, Niwat Suteemchaigun and Yanyon Saranrom. 1991. **Study on marine prawn farming and effect of sea water in Kung Krabaen bay.** In Proceedings the Seminar on Fisheries 1991 Department of Fisheries, 16-18 September 1991. National Inland Fisheries Institute. Bang Khen. p. 292-305.

Keywords: Marine prawns; Sea water; Kung Krabaen Bay

282 Sunan Tuaycharoen, Samart Pramkit, Wanloap Kumsupa, Pattanapong Chuaychandee, Sunit Pattapong and Mongkolat Charoenporntip. 1994. **Study on the causative organisms associated with clay scent in the shrimp ponds at Samut Songkhram and Phetchaburi province.** Technical Paper No. 4/1994. Samut Saklon Coastal Aquaculture Center, Coastal Aquaculture Division, Department of Fisheries. 20 p.

The study on the causative organisms associated with clay scent in cultured shrimp at Samut Sakhon, Samut Songkhram and Phetchaburi provinces were conducted between January to August 1992. The results shown that the causative organisms and clay scent have not associated in shrimp in every provinces during the study period. The water parameters were analyzed as follows, salinity ranges 2-22 ppt, pH ranges 7.2-9.4, NH_3 ranges 0.000-0.2985 mg/l, NO_2 ranges 0.0000-0.2032 mg/l, and Si ranges 0.0000-7.3306 mg/l. *Oscillatoria* sp. and *Anabaena* sp. which play the role of mud smell in shrimp meat have not found during the study period.

Keywords: Mud smell; Water quality; Phytoplankton; Shrimps; Samut Songkhram

283 Sooksri Sumpawapol. 1997. **Survey of water and soil quality in canals for marine shrimp culture in Chumphon Province.** Technical paper No. 32/1997. Chumphon Coastal Aquaculture Station. Department of Fisheries. 47 p.

The survey of water and soil quality in canals for marine shrimp culture, Chumphon Province was conducted during January 1996 to August 1997. results showed that the canals can be classified into groups. The first group consisted of canals with high salinity throughout the year and suitable for coastal aquaculture: Khlong Daog 1, Khlong Bang Ruk Thong 1, Khlong Bang man, Khlong Bang Nam Chut, Khlong Song Phi Nong, Khlong Phanang Tat, Khlong Bang Long and Khlong Tha Charakhe. The second group consisted of canals with high salinity and suitable for coastal aquaculture half of the year (January-June): Khlong

Daog 2, Khlong Bang man 3, Khlong Sawi Num 2, Khlong Sawi Thao, Khlong Bang jaroe, Khlong Eled and Khlong Thung Kha. The third group consisted of canals with low salinity throughout the year: Khlong Wisail. Total coliforms bacteria in all the canals were higher than standard level for coastal aquaculture, but water transparency, temperature, pH, dissolved oxygen, BOD, alkalinity, hardness, ammonia, nitrite, nitrate and phosphorus were in normal range. Analysis of soil showed low organic matters and normal pH of all the samples.

Keywords: Water quality; Marine shrimps; Chumphon

284 Komane Booncher. 1999. **The comparison of some soil and water properties between low and high yield ponds of giant tiger shrimp (*Penaeus monodon*): a case study at Tambon Na Saton Amphoe Hua Sai Changwat Nakhon Sri Thammarat.** Master Thesis. Prince of Songkla University. 201 p.

The soil and water samples collected from 12 ponds of intensive Giant Tiger Shrimp (*Penaeus monodon*) farming every 14 days during the 126 days raising period at Amphoe Hua Sai, Nakhon Sri Thammarat Province, in 1997 were chemically and physically analyzed for pH, electrical conductivity (EC), organic matter, total Kjeldahl nitrogen (TKN) and total phosphorus (TP) of the soil samples and for transparency, dissolved oxygen (DO), alkalinity, pH, salinity and total ammonia of the water samples. Production of ponds were categorized into 3 bases according to yield (AY), survival rate (SR) and average daily growth (ADG). Each basis was divided into 3 different pond groups (ie. high medium and low) and correlated with the analysis results. The results revealed that at the beginning of the observation, the groups with high yield, survival rate and average daily growth possessed low organic matter, TKN, EC, total ammonia but high TP. However, TKN and total ammonia of high SR and ADG groups were statistically lower than those of other groups ($P < 0.05$), whereas the rest of the parameters showed no significantly different among the different groups. At the end of the observation, the groups with high AY, SR and ADG had statistically higher amounts of organic matter, TKN, TP and alkalinity than those of other groups ($P < 0.05$), while the reverse was true for EC, salinity, DO and total ammonia except that the dig different for the total ammonia was found only among the ADG groups. Most of the positive correlation among the parameters were found as follows, TKN vs. total ammonia, organic matter vs. TKN, organic matter vs. TP, TKN vs. TP and water salinity vs. EC of soil with correlation coefficient (r^2) of 0.67, 0.92, 0.81, 0.84, and 0.54 respectively, whereas most of the negative

correlation among the parameters were observed in total ammonia vs. water pH, TKN vs. water pH, EC vs. soil pH. TP vs. transparency with the correlation coefficient (r^2) of 0.75, 0.64, 0.51 and 0.56 respectively. Furthermore, the correlation of yield with TKN, TP total ammonia and organic matter are positive with partial correlation coefficient (r^2) of 0.87, 0.025, 0.011 and 0.014 respectively, whilst the negative ones of yield with DO and water pH both have partial correlation coefficient (r^2) of 0.004. The partial correlation coefficient (r^2) of 0.578, 0.185, 0.018 and 0.016 were found between average daily growth with TP, EC, water salinity and TKN respectively. The results of this study suggest that the shrimp farm management for sustainable utilization includes cleaning up shrimp ponds to increase the pond capacity in absorbing waste during raising activity to maintain TKN level lower than 1400 ppm as well as washing the pond with fresh water for reducing soil salinity. Transparency of water should be maintained at level not less than 20 cm and DO measurement should be conducted at the lowest level of ponds. Furthermore, eradicating plankton in waste water prior to drain into natural water body and constructing a central waste water treatment plant are recommended. Limiting the numbers of shrimp farms and designating suitable area for shrimp farming should take into consideration the capacity of ecosystem.

Keywords: Soil; Water quality; Intensive culture; Shrimp products; Shrimp performance; Shrimps; *Penaeus monodon*; Nakhon Sri Thammarat

285 Tanittha Chongpeepien. 1998. **Water and soil quality of low salinity farmed shrimp (*Penaeus monodon*) and the environmental impact assessment in Suphan-buri province.** Technical Paper No. 19/1998. Coastal Aquaculture System Research Group. Coastal Aquaculture Division. Department of Fisheries. 44 p.

The study of 3 crops, with 3 ponds each, of low salinity shrimp ponds (*Penaeus monodon*) in Bangplama, Suphan-buri province during April 1995-August 1996 found no significant statistical differences between pond soil quality of each crop. The classification of the soil was clay, with the average of 58.0-73.7% clay particle. The average value of soil properties were pH 6.7-7.8, organic matter 1.4-5.2% and electrical conductivity 2.03-11.9 mmhos/cm. The organic matter was rather high, pH was low-alkalinity to moderate acidity. The soil can be identified as high saline to low saline soil. The average salinity of ponds soil were 4.7, 4.4 and 5.9 in the 1st, 2nd and the 3rd crop, respectively.

The quality of pond water had the average salinity of 0-9.7 ppt, pH 7.4-8.6, $\text{PO}_4^{3-}\text{-P}$ 0.0001-0.0007 mg/l, $\text{NO}_2\text{-N}$ 0.0044-0.6490 mg/l, $\text{NH}_3\text{-N}$ 0.0402-2.0624 mg/l, DO 3.9-11.1 mg/l, BOD 1.4-18.4 mg/l, depth of water 36.3-122.3 cm., transparency 6.3-62.8 cm. and alkalinity 61.0-107.5 mg/l.

During the 1st and the 2nd crop, high salinity seawater was added into the ponds. At the end of these crops, the remain of salinity in the water was found rather high, at the average of 1.5 and 2.5 ppt, respectively. While the salinity at the end of the 3rd crop in which some freshwater was added was 0 ppt. The remain of salinity in the soil in the 1st, the 2nd and the 3rd crop, after the harvest, was found to have electrical conductivity at the average of 2.62, 8.57 and 3.59 mmho/cm, respectively. BOD at the end of the 1st and the 3rd crop were 13.6 and 16.8 mg/l and total ammonia at the end of the 3rd crop was 2.0624 mg/l. BOD, total ammonia and soil and water salinity, at the end of those crops were higher than their standard values. The drainage of water from the farm will affect the surrounding environment.

By comparing the salinity of soil in the shrimp pond to those in the rice field which was partially affected, and in the irrigation canal which was not affected by the drainage of water from their neighboring shrimp farms. It was found that the salinity of soil in the shrimp pond was highest while those in the rice field was the second and tended to increase. However, there was no impact by the salinity from the shrimp farm to soil and water in the irrigation canal nearby.

Keywords: Black tiger shrimp; Low salinity culture; Water quality; Soil; Environmental impacts

286 Dusit Tunvilai, Kanit Chaiyakam and Pairoj Sirimontaporn. 1994. **Sediment and water qualities around seawater irrigation for marine shrimp culture project in Padonna Wetland, Pattani province.** Technical Paper No. 8/1994. National Institute of Coastal Aquaculture, Songkhla. Department of Fisheries. 52 p.

Water quality in Tha Rua Canal and Ba Ka Mu Do Canal at Nangchik District in Pattani province, were studied during November 1992-September 1993. The result showed that Nitrogen compounds such as: nitrate, nitrite and ammonia-N and phosphorus compound such as: orthophosphate and total-P was usually low concentration, but total-N in average was rather high concentration of 0.9-1.3 mg/l. The salinity was decline in December especially in the terminal of canal (station 1.4) with range of 0.0-0.5 ppt. This report also include the study of depth, transparency, current velocity, dissolved oxygen and suspended solids.

Keywords: Water quality; Sea Water Irrigation for Shrimp Farming Project; Sea water irrigation system; Marine shrimp culture project

287 สิริ ทุกชีวินาศ และ จำลอง อรุณเลิศอารีย์. 2536. ปริมาณและความเข้มข้นของน้ำที่จากแหล่งเลี้ยงกุ้งกุลาดำ บริเวณอ่าวคุ้งกระเบน : แนวทางการประเมินศักยภาพการรองรับของแหล่งน้ำชายฝั่ง. ใน การสัมมนากระบวนวิธีปะชาชนเลนแห่งชาติครั้งที่ 8 “การจัดการทรัพยากรปะชาชนเลนแบบยั่งยืน” วันที่ 25-28 สิงหาคม 2536 ณ โรงแรมวังใต้ จังหวัดสุราษฎร์ธานี. คณะกรรมการทรัพยากรธรรมชาติชายเลนแห่งชาติ สำนักงานคณะกรรมการวิจัยแห่งชาติ. III – 4.

Marine shrimp culture at Kung Krabaen Bay has been done since 1986. The water quality in culture area and the bay have been done since 1986. The water quality in culture area and the bay have been collected since 1989. The results shown that the water parameters in the culture area were higher than in the bay such as water turbidity. The environmental impact study have been already planned and done since the beginning of 1993. And the carrying capacity of the bay have also studied at the same time.

Keywords: Wastewater; Quality; Quantity; Intensive culture; Marine shrimps; Farming; Coast; Kung Krabaen Bay

288 Siri Tookwinas, Permsak Pengmark and Jurdsang Buntae. 1988. **Study on some aquatic environment parameters in marine shrimp culture pond at Nakornsri Thammaraj province.** Technical Paper No.12/1988. Satul Brackishwater Fisheries Station. Department of Fisheries. 30 p.

The investigation result of water and sediment quality from shrimp pond in Nakornsri Thammaraj province during November 1986-March 1987 are as following. The average water quality are visibility 0.15-0.42 m, salinity 15.02-16.66 ppt, pH 7.62-8.15, DO 4.68-7.82 mg/l, ORP (+1.61x100) - (+2.69x100) mv, COD 0.32-0.83 mgO₂/l, Chlorophyll a 0.46-1.10 mg/l and net primary production 0.29-0.48 mg/l/24 hr. The average sediment quality are %organic matter 2.75-6.27, %organic carbon 0.07-0.17, COD 50.00-73.00 mgO₂/l, Potential pH 5.61-6.07 and ORP (-1.20x100)-(-1.80x100) mv.

Keywords: Surveys; Water quality; Soil; Intensive culture; Natural waterways; Shrimps; Nakhon Sri Thammarat

289 Somvipha Yothaphant. 1990. **A study of areas of marine shrimp culture in Khung**

Kraben Bay: problem and recommendations. Master Thesis. Chulalongkorn University. 194 p.

This thesis aims to investigate basic situation of marine shrimp culture, around Khung Kraben Bay, and physical, economic and social problem of marine shrimp culture. In order to suggest guidelines for land development, location improvement, questionnaire and field survey including other information from concerning agencies and surveyed are acquired. It is found that around Khung Kraben Bay Area is the appropriate area for marine-shrimp culture. The expansion and dense culture are commonly found. This leads to the following problems: encroachment fertile mangrove, becoming shallow of water resource, the pulling of sea water from shrimp farm to plant area led to the conflict of social benefit groups. Moreover, the study provides the understanding of other problems in areas which effect land development areas; for example, Public Utilities, low supply of agricultural product, the uncontrol expansion of building around seaside area, etc. this problems have to be solved by some measures. In addition, the appropriate land use planning such as the limitation of shrimp farm, tourism promotion associating with the development of plant areas, and the conservation of natural resource are recommended.

Keywords: Surveys; Shrimp culture; Shrimps; Kung Krabaen Bay

290 in Thai

291 Piya Wanpen. 2000. **Accumulation of some heavy metals in tiger prawn (*Penaeus monodon*) raised around outer part of the Songkhla lake.** Master Thesis. Naresuan University. 125 p.

Tiger prawn (*Penaeus monodon*) raising around outer-part of the Songkhla lake has been largely increased since early 1985, causing a diverse impact on environment. Moreover wastewater released from agro-industries and plants into several canals then to prawns farms may also has large impact on qualities of water, on soil and hence, the quality of the prawns raised nearby. The accumulation of heavy metals in soil and water may occur as well as in the prawns. The contamination of some heavy metals in prawns above toxic threshold may cause industrial collapse. The major aim of this study is to find the amount of some heavy metals which may contaminate in the abdomen and the cephalothorax of tiger prawns, in water and surface soil in the ponds utilized to raise the tiger prawns. The sample prawns, sediment and water were randomly sampled twice at 45 and 90 day old prawns from the 11 small holder ponds around outer-part of the Songkhla lake then heavy metals i.e. cadmium, copper, chromium, iron, manganese,

nickel, lead and zinc were determined in the cephalothorax, abdomen, surface sediment and water. The results showed that all the heavy metals determined were accumulated much higher in the cephalothorax than in the abdomen of the prawns and the amounts of the heavy metals found in the cephalothorax were generally increased with increasing age of the prawns with the exception of nickel. Fortunately, the amounts of all heavy metals studied in the abdomen of the prawns were not exceed the toxic threshold reported by other researchers. It was concluded that in order to prevent intake of phytotoxic elements one should avoid consuming the cephalothorax portions of the prawns. The amount of heavy metals in sediment and water were somewhat lower when compared with the cephalothorax and the abdomen of the prawns.

Keywords: Surveys; Heavy metals; Environmental impacts; Songkhla Lake; Shrimps; *Penaeus monodon*

292 Walaipan Kesthong. 2001. **Metal behavior reduced condition in rearing pond and a quantitative model of metal uptake by tiger prawn *Penaeus monodon*.** Master Thesis. Chulalongkorn University. 56 p.

The study on metal behavior under reduced condition in rearing pond, was conducted in the shrimp grow-out pond at Panthong, Chonburi province. Flux chamber, the new equipment is designed to use to collect the data of porewater, was buried in the pond sediment for 105 days. The result showed that there are uniform relationship between the redox potential and the concentration of iron and manganese. The concentration of these metals will increase with the lowering redox potential. The result showed the shift of manganese's peak to the overlying sediment over the period. This also corresponded to the grow-up of the new sediment. The relationship between zinc and redox potential is not clarified. The quantitative model of metal uptake by tiger prawn, was established with the elemental fractionation. Phosphorus and aluminium were chosen to be the normalizing element for the biological and physical process of metal uptake. The result showed that the fecal ejection is the important process to release the unused metal to the environment. Among these metals, zinc is the most accumulated. Feed uptake was the most important process for the shrimp's metal accumulation metal.

Keywords: Heavy metals; Elemental fractionation; Water quality; Shrimp culture; *Penaeus monodon*

293 Sukit Rattanavinitkul, Sansern Chorcheng, Thavee Rojansarumpakit and Pin Polchai. 1989. **Study on some quality sea water of penaeid shrimp in rearing and nursing tanks.** Technical Paper No. 23/1989. Nakornsrihammarat Coastal Aquaculture Station. Coastal Aquaculture Division. Department of Fisheries. 25 p.

Some water quality of Giant tiger shrimp (*Penaeus monodon*) in rearing tank from nauplii to post larva stage, temperature was 28.1–31.0 °C, pH 7.68–8.10 and salinity 30–34 ppt. For white shrimp (*Penaeus merguensis*), temperature was 27.2–30.6 °C, pH 7.58–8.23 and salinity 30–34 ppt.

From Post larva stage to harvest in nursing tank (20 tons), temperature was 26.7–29.4 °C, pH 7.48–8.07 and salinity 30–33 ppt. In nursery tank (10 tons) temperature was 26.3–29.2 °C, pH 7.49–7.95 and salinity 31.34 ppt.

Keywords: Water quality; Nursing; Penaeid

294 Tanan Tattanont, Visuth Vereakulpiriy, Tawat Sriveerachai, Somboon Laoprasert and Panawan Jirawong. 1994. **Priliminary study on shrimp culture on acid sulphate soil area at Narathiwat.** In Proceeding the Seminar on Fisheries 1994 Department of Fisheries, 19–21 September 1994 DOF Meeting Hall, National Inland Fisheries Institute. Bang Khen. p.77–85.

Three crops of *Penaeus monodon* were cultured in acid sulphate soil area at Narathiwat Coastal Aquaculture Station. In the first crop, 1.5 months larvae were stocked in each pond at 20 larvae/m² and cultured for 80 days. At harvest 32.90 gm. averaged shrimp, 730.8 kg/rai production, FCR of 3.21 and 70.10% survival rate were resulted. Determination of soil qualities showed the pH range of 5.84–5.46, while the concentration of Al³⁺Fe³⁺ and SO₄²⁻ were gradually decreased during the cultured period. The water pH were 7.31–8.51 and the concentration of PO₄-P was increased during the cultured period. In the second crop, PL-20 larvae were stocked at 30 and 45 larvae/m² in pond No.1 and No.2, respectively. After 142 days of culture, 39.00 and 34.95 gm shrimp, 1,535.7 and 2,273.7 kg/rai. 2.13 and 1.93 of FCR and 83.34 and 91.57% survival rate were harvested in pond No.1 and No.2, respectively. During the cultured period, the soil pH were 5.00–6.70 and water pH were 7.07–9.13, while the concentration of PO₄-P were increased gradually during the cultured period and the concentration of NO₂-N and NO₃-N were increased in the last month. In the third crop, PL-18 larvae were stocked at 30 larvae/m² in each pond, but daily water exchange was performed in pond No.1 while twice water exchange weekly was performed in pond No.2. After 161 days of culture, 31.44 and 33.33 gm. shrimp, 1,384.9 and

1,315.4 kg/rai production, 1.54 and 1.51 FCR, and 91.56 and 82.21% survival rate were harvested in pond No.1 and No.2, respectively. During the culture, the soil pH range was 5.20-6.40, the water pH was 7.21-9.01, the salinity was 10-29 ppt, while other parameters of water qualities were normal. It should be concluded that acid sulphate soil area can be used for marine shrimp culture in which the production is as high as in non-acid soil cultured area. However, ones must be reminded that the soil must be left non-removal during pond construction but dikes were constructed by compacted latterite of non-acid soil from nearby area instead and less water drainage could be performed if the water supply is limited.

Keywords: Acid soil; Shrimp culture; Water quality; *Penaeus monodon*; Shrimp products

295 Visuth Verakulpiriya, Tanan Tattanong and Panawan Jirawong. 1993. **A preliminary study on *Penaeus monodon* culture in acid sulfate soil area at Narathiw.** In Proceeding the Seminar on Fisheries 1993 Department of Fisheries, 15-17 September 1993, Inland Inland Fisheries Institute, Bangkok. p.349-375.

A preliminary study on *P. monodon* culture in acid sulfate soil was conducted at Tak-Bai district, Narathiw province. The soil's pH prior to experiment was 3.50. Two ponds size of 37x58x1.8 m³ (1.3 rai) were constructed. Acid sulfate soil was washed out several times by pumping water in and draining out. *P. monodon* average size of 5.33 cm TL; with average weight of 1.15 gm. were stocked with density of 20 inds/m². The water exchange had been done regularly in 80 days culture periods. The result showed shrimp size 28-32 inds/kg with mean individual weight of 33.33 gm. when harvested. The productions were 980 and 920 kg/pond or 753.85 and 707.69 kg/rai. Survival rates were 72.70% and 67.50% with food conversion ratio of 3.16:1 and 3.25:1

Keywords: Acid soil; Shrimp culture; Water quality; Shrimps; *Penaeus monodon*

296 Khorkiat Koolkaew. 1995. **Production of Nursing of *Penaeus monodon* Larvae by Using Three Treated Seawater.** Technical Paper No. 50/1995. Satul Coastal Aquaculture Development Center. Department of Fisheries. 13 p.

Comparison on nursing of black tiger shrimp, *Penaeus monodon* larvae by three different types of treated seawater; sedimented and filtered water (SFW), heated water (HW) and chlorinated water (CW) were conducted in density of 133.3 individuals/liter. The result revealed that no

statistical differences ($P>0.05$) were found on survival rates and production of postlarvae among these treated water. Meanwhile, the periods of morphological development from nauplius IV to postlarva I in SFW, HW and CW were 21.33 hrs., 218.67 hrs. and 225.33 hrs. respectively which these values showed statistically significant difference ($P<0.05$) by Duncan's new multiple range test. Microorganisms in nursing water were probable suggested to be the some factor of morphological development of shrimp larvae.

Keywords: Water quality; Hatchery; Water preparation; *Penaeus monodon*

297 Dusit Tunvilai, Kanit Chaiyakam and Putt Songsangjinda. 1993. **Variation of phosphorus compounds in the intensive shrimp farm system.** Technical Paper No.7/1993. Songkhla Institute of Coastal Aquaculture. Department of Fisheries. 18 p.

Dissolved organic phosphorus (DOP), particulate phosphorus (PP), orthophosphate (DIP) and total phosphorus (TP) were studied in 5 earthen shrimp ponds. Shrimp production was divided into 2 groups as low production group and high production group with average harvest of 590 kg/pond and 1,668 kg/pond, respectively. The average over all crop of DOP, PP and orthophosphate of low production group was average 53%, 44% and 2% of TP and the other group was 56%, 39% and 4% of TP, respectively. TP in pond's preparation period, culture period and after harvesting period in low production group were 1,222, 10,188 and 8,516 g. and the other group were 1,201, 24,755 and 14,206 g., respectively.

Keywords: Water quality; Shrimp products; Intensive culture

298 Suriyan Tunkijjanukij. 1989. **Dynamic of Dissolved Oxygen in Tiger Prawn *Penaeus monodon* Fabricius) Intensive Culture Pond.** Master Thesis. Kasetsart University. 71 p.

Dynamic of dissolved oxygen in *Penaeus monodon* intensive culture pond was studied for a culture period of 4 months (16 weeks) in a farm in Samut Songkram Province. Highest of dissolved oxygen concentration was found at 3.00 p.m. and the lowest concentration was found at 6.00 a.m. In pond No.1 the lowest and the highest concentration of dissolved oxygen were 3.70 and 10.0 mg/l in the 12th week. In pond No.2, the highest concentration of dissolved oxygen was found in the 16th week and the lowest concentration was found in the 6th week. In pond No.2, daily difference of dissolved oxygen concentration were less than in pond No.1. In pond No.1, beginning from 12th week to harvesting period the lowest dissolved oxygen concentration of each

day were closed to or lower than the critical value of dissolved oxygen for normal growth of tiger prawn.

In both ponds, secchi-disc visibility were decreased after the 4th week but chlorophyll a was significantly increased after the 4th week. These trends were markedly observed after 12th week till the harvest. The rate of production and utilization of oxygen by microorganisms in the ponds were also increased from the stocking till harvest in which the highest rate of increase was found between 12th-16th week, which followed the same trend as chlorophyll a.

The BOD₅ values of both ponds were low from stocking date to the 4th week but became higher from the 4th week. The highest values was found in last two weeks before harvesting. No specific trend of the change of COD and mud respiration of both ponds were observed. Considering from the correlation coefficient between secchi-disc visibility and chlorophyll a concentration, the cause of turbidity of water in shrimp culture ponds was phytoplankton, whereas the cause of turbidity of water in the reservoir should be suspended solids. The fluctuation of the amount of phytoplankton significantly affected BOD₅, respiration rate of microorganisms in water, and minimum oxygen concentration in both ponds and were significantly affected maximum oxygen concentration of pond No.2, while in the reservoir it showed only significant effect on minimum oxygen concentration. Significant correlation was also observed between temperature and maximum oxygen concentration in both ponds and between temperature and minimum oxygen concentration in pond No.2. According to the correlation coefficient between dissolved oxygen and various parameters, amount of phytoplankton seem to be the most important factor on the dynamic oxygen in shrimp ponds.

Keywords: Dissolve Oxygen; DO; Black tiger prawn; *Penaeus monodon*; Shrimp ponds; Intensive culture

299 Chumpol Srithong. 1998. **Comparative study of sediment management systems using sediment suspension and periodically removal of sediment in closed culture system of black tiger prawn (*Penaeus monodon* Fabricius).** Master Thesis. Kasetsart University. 162 p.

The study was carried out to evaluate management methods for shrimp pond sediment in intensive closed culture system of *Penaeus monodon* Fabricius. Management methods includes sediment suspension and periodically removal of sediment. Results from the experiment indicated that both management methods are effective in

controlling phytoplankton growth in shrimp ponds. Sediment suspension method is the most effective method to control phytoplankton growth. Periodically removal of sediment resulted in the significant decrease of phosphorus and ammonia concentration in water and the decrease in organic matter, ammonia and sulfide in pond bottom soil. Redox potential of pond bottom soil of this treatment was also significantly higher than those of control ponds. Suspension of sediment resulted in higher accumulation of ammonia in water due to less number of phytoplankton. There was no significant change in the accumulation of ammonia and phosphorus in pond bottom soil in this treatment but less sulfide in pond bottom soil was detected. In this sediment suspension treatment narrow daily fluctuation of pH and dissolved oxygen of pond water were observed. There was no significant different ($P>0.05$) among shrimp production and feed conversion ratio among treatments. The different in soil and water properties were clearly observed during the last part of culturing period.

Keywords: Water quality; Sediment; Closed system; Intensive culture; Environment; Black tiger prawn; *Penaeus monodon*

300 Malinee Smithrithee. 1990. **Marine shrimp culture development approach in Amphoe Muang Samut Sakhon, Changwat Samut Sakhon.** Master Thesis. Kasetsart University. 93 p.

Hundred and six shrimp farms were sampled from 1,100 farms from the shrimp farms in Amphoe Muang Samut Sakhon Changwat Samut Sakhon in this study. The samples covered three types of culture, i.e., extensive, semi-intensive and intensive; in each type of culture the samples were further divided into three groups according to the farm size, namely small (<50 rai), medium (50-100 rai) and large (>100 rai). The results of cost and earning analysis, it was revealed that the intensive farm had the highest production cost followed by semi-intensive and extensive which account for 71,020.46, 54,578.26 and 18,701.18 baht per rai per year respectively. However, in term of the earning per rai, intensive farm gave the highest earning 38,054.54 baht followed by semi-intensive farm 7,580.74 baht and extensive farm got loss for 14,679.18 baht. The analysis on cost and earning of intensive farms accordingly to their it was found that total cost per rai per year of small, medium and large farms were 72,909.01, 68,129.88 and 68,592.88 baht respectively. Yield per rai per year of small, medium and large farms were 525.11, 515.51 and 426.60 kg accordingly. The net profit per rai was 36,173.99 Baht for small farm, 47,085.99 Baht for medium farm and 18,808.12 baht for large farm. However, in terms of return from investment the medium semi-intensive

farm gave the highest profit of 91.18 percent of total cost followed by medium intensive farm, which gave profit 69.11 percent of total cost. From the regression analysis of input and output, the labor cost had high correlation with the production for semi-intensive farm ($R^2=0.276$). For the intensive farm, stocking density and total invested capital affected to the changes of production for 46.6 percent. There was no any input that affected on the production for extensive farm.

Keywords: Surveys; Cost analysis; Shrimp culture; Shrimps; Samut Sakhon

301 Siriwan Khidprasert. 1995. **Absorption of nitrogen compounds from shrimp pond effluence by marine algae.** Master Thesis. Kasetsart University. 90 p.

A study was conducted to investigate the ability of 3 algal types namely *Caulerpa macrophysa*, *Sargassum polycystum* and *Gracilaria salicornia* in decreasing nitrogen compounds in shrimp pond effluence. These algae were soaked in 100 liters of shrimp pond effluence for 72 hours. Four densities of alga which are 0, 1, 5 and 10 g/l were also investigated. The result showed that 10 g/l reduced the concentration of ammonia and nitrate more effectively than 5 and 1 g/l, respectively. However, the use of 1 g/l of algae had a higher absorption rate than 5 and 10 g/l, respectively. Nitrogen compounds accumulated in all kinds of algae tend to increase after soaking them in shrimp pond effluence.

Keywords: Effluents; Treatment; Macroalgae; Nitrogenous compounds; Shrimp culture

302 เกศริน ที่มายุ และ ศิริวรรณ คิตประเสริฐ. 2540. การบำบัดน้ำทิ้งจากการเลี้ยงกุ้งโดยใช้สาหร่ายทะเลสกุลกรากิลารียลดปริมาณสารประกอบไนโตรเจน. ใน รายงานการประชุมสัมมนาทางวิชาการสถาบันเทคโนโลยีราชมงคล ครั้งที่ 14 วันที่ 26-29 มกราคม 2540 ณ โรงแรมพาววิลเลียนและวิทยาเขตภาคใต้ จ. สงขลา. น. 1-10.

A study was conducted to investigate the ability of *Gracilaria fisheri* in decreasing nitrogen compounds (ammonia, nitrate and nitrite) in the shrimp pond effluence. Four densities of alga which were 0 (control), 5, 10 and 15 g/l were investigated. The algae were soaked in shrimp pond effluence for 0, 6, 12, 24, 48 and 72 hours. Ammonia, nitrate and nitrite concentrations in the effluence and total nitrogen content in the alga were determined immediately after the soaking period. Results indicated that 15 g/l of alga reduced the concentration of ammonia, nitrate and nitrite

more effectively than 10 and 5 g/l respectively. Total nitrogen compounds accumulating in the alga tended to increase after soaking in the shrimp pond effluence.

Keywords: Effluents; Nitrogenous compounds; *Gracilaria*; Water quality; Shrimps

303 Rateewan Onrutsamee, Tirapong Tirumgnus, Danai Bavonkaentikun and Rudjarude Shodkaving. 1998. **Wastewater treatment from shrimp farm by biological process.** Research Report. Burapa University. 80 p.

This study was an experiment testing wastewater from a shrimp farm using biological processes. The models consisted of completely mixed tanks and wetlands with *Gracilaria* sp. as submerged plants. The Sequence Batch Systems were divided into 2 sections according to the aeration time and the organic loading. Section 1: The organic loading 72.64 gBOD/m³.d, aeration time 6 hours, the hydraulic retention time in wetlands 24 hours. Section 2: The organic loading 108.96 gBOD/m³.d, aeration time 4 hours, the hydraulic retention time in wetlands 24 hours. The results show that the efficiency of BOD removal was 58.10%, and 49.25% for the organic loading of 72.64 gBOD/m³.d, and 108.96 gBOD/m³.d, respectively. It was also found that with the same organic loadings the efficiency of NH₃-N removal was 57.46%, and 47.84%, the efficiency of NO₃-N removal was 42.24%, and 35.69%, the efficiency of suspended solids was 84.91%, and 73.79%, respectively. In addition, it was found that the efficiency of salinity removal was low.

Keywords: Effluents; Treatment; Biological treatment; Macroalgae; *Gracilaria*; Water quality; Shrimps; *Penaeus monodon*

304 Achareeya Kaewmesri. 2001. **The treatment of wastewater from *Penaeus monodon* farming by the agarophyte, *Gracilaria fisheri*.** (Xia & Abbott) Abbott, Zhang & Xia. Master Thesis. Mahidol University. 122 p.

The objective of this research is to investigate the treatment of wastewater from *Penaeus monodon* pond effluent by *Gracilaria fisheri*. This experiment on a farm was divided into two parts. The first part of the experiment was to determine the changes in wastewater qualities in the experimental pond (1,600 m²) with and without *Gracilaria fisheri*. Samples of wastewater were taken and analyzed every 6 hours for 66 hours and the reduction efficiencies of ammonia-nitrogen, nitrite-nitrogen, nitrate-nitrogen, orthophosphate and BOD were calculated. 1,500 g. of *Gracilaria fisheri* were placed in one set of 3 m² plastic net and 80 sets were fixed in the experimental

pond. The second part of the experiment was to determine the productivity and growth rate of *Gracilaria fisheri* in the experimental pond of wastewater from the *Penaeus monodon* culture every 2 weeks and study the changes in wastewater qualities once a week for 8 weeks. The results showed that the experimental pond with *Gracilaria fisheri* could reduce ammonia-nitrogen, nitrite-nitrogen, nitrate-nitrogen, orthophosphate and BOD at the retention time of 1 day. Furthermore, the reduction efficiencies had increased when the retention time was 2 days. From the 2 experiments using *Gracilaria fisheri* with 2 days retention time, the reduction efficiencies of ammonia-nitrogen, nitrite-nitrogen, nitrate-nitrogen, orthophosphate and BOD were 33.23%, 10.45%, 16.10%, 32.18% and 21.88%, respectively. The treatment of wastewater from the *Penaeus monodon* pond by *Gracilaria fisheri* during the 8 weeks showed that the total weight of *Gracilaria fisheri* had increased from the initial weight of 120.00 kg to 430.99 kg in the last week. The specific growth rate was between 15.81-24.76% and the average reduction efficiencies of ammonia-nitrogen, nitrite-nitrogen, nitrate-nitrogen, orthophosphate and BOD were 45.65%, 23.40%, 11.10%, 17.55% and 24.27%, respectively. The results of this research suggest that *Gracilaria fisheri* should be used to reduce the nutrients in wastewater from *Penaeus monodon* farming.

Keywords: Effluents; Treatment; Biological treatment; Macroalgae; *Gracilaria*; Water quality; Shrimp culture

305 ศิริวรรณ คิตประเสริฐ และ ประพฤติ พรหมสมบูรณ์. 2541. การใช้สาหร่ายทะเลสกุลกราซิลเลียช่วยลดปริมาณออร์โธฟอสเฟตในน้ำทิ้งจากการเลี้ยงกุ้ง. ใน เอกสารการประชุมสัมมนาทางวิชาการสถาบันเทคโนโลยีราชมงคล ครั้งที่ 15 วันที่ 12-14 กุมภาพันธ์ 2541 ณ โรงแรมปางสวนแก้ว และวิทยาเขตภาคพายัพ จังหวัดเชียงใหม่. น. 277 – 282.

A study was conducted to investigate the ability of *Gracilaria fisheri* in decreasing orthophosphate in the shrimp pond effluence. Four densities of alga which were 0 (control), 1, 5 and 10 g/l were soaked in shrimp pond effluence for 7 days. Orthophosphate concentration in the effluence and total phosphorus content in the alga were determined immediately after the soaking period. Results indicated that 10 g/l of alga reduced the concentration of orthophosphate more effectively than 5 and 1 g/l. Total phosphorus accumulation in the alga tended to increase after soaking in the shrimp pond effluence.

Keywords: Effluents; Treatment; Macroalgae; *Gracilaria*; Shrimp culture

306 Thaksina Sawatphong. 1998. **Utilization of seagrass *Halophila ovalis* for the reduction of BOD nitrogen compounds and phosphorus from *Penaeus monodon* pond effluent.** Master Thesis. Mahidol University. 133 p.

The purpose of this study is to investigate the efficiency of seagrass *Halophila ovalis* in reducing BOD, ammonia, nitrite, nitrate and orthophosphate from *Penaeus monodon* pond effluent. Seagrasses were kept under the density of 1.0, 2.0 and 3.0 kg/m², in 250-liter fiberglass tanks which each held 200 liters of shrimp-pond wastewater. The experiment were planned by CRD with 3 replicates and repeated 3 times. It was found that there are statistically significant (p-value<0.05) in the reduction of BOD, ammonia, nitrite, nitrate and orthophosphate in the tanks where the *H. ovalis* is raised compared to the control. Different densities of *H. ovalis* reduce BOD from 56.52-80.20 percent, but there is no significant difference in efficiency among them. It is also found that *H. ovalis* raised at different densities reduce ammonia, nitrite, nitrate and orthophosphate from 64.64-92.05 percent. A seagrass density of 2.0 kg/m² is the most efficient density for reducing the studied compounds and 3.0 and 1.0 kg/m² are second and third in efficiency respectively. The absorption capacity of ammonia, nitrite, nitrate and orthophosphate by the *H. ovalis* seagrass is relatively high at the beginning and gradually decreases towards the end of the process.

Keywords: Effluents; Treatment; Water quality; Sea grass

307 Alisa Chokwiwattanawanit. 2000. **Efficiency of the macroalgae *Caulerpa lentillifera* and *Acanthophora spicifera* for the treatment of nitrogen compound from shrimp pond effluent.** Master Thesis. Chulalongkorn University. 136 p.

Caulerpa lentillifera and *Acanthophora spicifera* are the macroalgae often used for taking up nitrogen waste in shrimp wastewater treatment pond in Thailand. The present study aims to evaluate photosynthesis efficiency and nitrogen uptake in these algae. It was found that *Caulerpa lentillifera* and *Acanthophora spicifera* had light saturation, indicated by oxygen evolution, at approximately 15,000-20,000 lux. On the other hand, ammonium and nitrate uptake kinetic of both algae in laboratory condition (30 ppt, 30°C and 15,000 lux light intensity) were studied using Michaelis-Menten equation. It results showed that *Caulerpa lentillifera* had maximum ammonium uptake rate (V_{max}) and half saturation constant (K_m) of 0.0897 mgNH₄⁺-N/g(fw)/hr and 18.5822 mgNH₄⁺-N/l,

respectively, while *Acanthophora spicifera* had $V_{\max}=0.406 \text{ mgNH}_4^+-\text{N/g(fw)/hr}$ and $K_m=50.9554 \text{ mgNH}_4^+-\text{N/l}$, respectively. For nitrate uptake, *Caulerpa lentillifera* had maximum nitrate uptake rate ($V_{\max}$) of $0.0175 \text{ mgNO}_3^--\text{N/g(fw)/hr}$ with $K_m=40.7094 \text{ mgNO}_3^--\text{N/l}$ while *Acanthophora spicifera* had ($V_{\max}$)= $0.425 \text{ mgNO}_3^--\text{N/g(fw)/hr}$ and $K_m=90.0509 \text{ mgNO}_3^--\text{N/l}$. The results suggested that *Acanthophora spicifera* had the higher nitrogen uptake rate than *Caulerpa lentillifera*. Ammonium was found the primary nitrogen source and high concentration of nitrate was not effect ammonium uptake rate in both algae. In the experiment with the water from shrimp pond, both algae could rapidly reduce ammonium and the treatment with continuous artificial light (15,000 lux) had higher efficiency than natural light (control). The results also indicated that *Acanthophora spicifera* had higher treatment efficiency than *Caulerpa lentillifera* which was related to the kinetics experiments.

Keywords: Macroalgae; Photosynthesis; Light saturation; Nitrogenous compounds; Respiration; Enzyme kinetic; Ammonia; Shrimp culture; *Penaeus monodon*

308 Putth Songsangjinda and Dusit Tunvilai. 1993. **Pollution loading from an intensive tiger shrimp farm.** Technical Paper No.15/1993. National Institute of Coastal Aquaculture. Songkhla, Department of Fisheries. 14 p.

Pollution loading from an intensive tiger shrimp farm size of 496 rais, total 94 ponds which located at Ranot district, Songkhla province, Thailand, was studied during January-July, 1992. Water samples were collected from inflow and outflow canal. Precipitation, seepage, evaporation and inflow volume was observed. The result showed that this farm pumped in seawater in an average rate of 438 tons/rai/day. The average precipitation was 2.3 tons/rai/day. The evaporation was averaged 7.1 tons/rai/day. The seepage was averaged 106.9 tons/rai/day. While an outflow volume was estimated about 326 tons/rai/day. A comparison test on an average of pollution loading were showed a significantly difference ($P<0.05$) between inflow and outflow in the variable of, nitrite-nitrogen (0.002 and 0.005 kg/rai/day), total ammonia-nitrogen (0.030 and 0.095 kg/rai/day), biochemical oxygen demand (1.02 and 1.99 kg/rai/day), chlorophyll a (0.003 and 0.017 kg/rai/day), and total inorganic nitrogen (0.040 and 0.1083 kg/rai/day). The net loading of those variables were 150%, 217%, 95%, 467%, and 171% of inflow loading, respectively. However, the loading of phosphorus compound, chemical oxygen demand, total suspended solid, organic

nitrogen, total nitrogen, and nitrate-nitrogen in an inflow and outflow water were showed a non significantly difference ($P>0.05$). The net loading of these parameters ranged from 12% decreasing-37% increasing of inflow loading. In order to reduce the impacts of disposal water from the intensive tiger shrimp farm to the water receiving areas, we ought to play an attention to the water treatment system which have a high ability to decrease the amount of nitrogen compound especially total ammonia, phytoplankton, and increase the level of dissolved oxygen in the disposal water.

Keywords: Surveys; Effluents; Pollution loading; Environmental impacts; Water quality; Songkhla; Shrimp culture; *Penaeus monodon*

309 Putth Songsangjinda, Siri Tookwinas, Chatchaval Intramontree and Chanin Sangrunruang. 2000. **Impact of shrimp farming effluent on nitrogen budget in Kung Krabaen bay.** Technical Paper No.7/2000. Marine Shrimp Research and Development Center, Songkhla. Department of Fisheries. 21 p.

Kung Krabaen Bay is a small shallow bay, average water depth of 1.5-1.8 m with the total bay area 4000 rai (640 ha). Water exchanges at the mouth size of 600-700 m. The sediment on the bottom of the bay is soft clay. The inner bay locates with mangrove and shrimp farming area. Shrimp farming produce huge amount of effluent creating the environmental impact to the bay. The present study applied the study of nitrogen budget to evaluate the impact from shrimp farm. Water samples were collected from the effluent and bay water at the mount of the bay. The study included the measurements of sedimentation, regeneration and flux at the sediment and water interface as well as the using of secondary data related to the study that reported by several authors. The nitrogen uptake from water column and sediment re-suspension were estimated based on the static model of total nitrogen and ammonia budgets. The results from this study showed that the effluent from shrimp farms contains high concentrations but less mass of nitrogen comparing to the inflow water. The model of total ammonia nitrogen (TAN) contributed to the nitrogen budget in the bay indicates that mangrove is less significant in absorption of nitrogen from shrimp farm (8% of TAN loaded from shrimp farm) due to the main effluent discharging through the canal. About 78.9% of TAN remaining after passed mangrove area were taken up in the water column of the bay, transforming to the particulate organic nitrogen. The outflow of nitrogen contributed by shrimp farm TAN was about 37.6% due to the high exchange rate. Nitrogen regeneration and sedimentation were about 33.8 and 21.8%, respectively. The net nitrogen accumulation

contributed to TAN loaded from shrimp farm was about 14% or 15 kg N/d (nitrogen gas produced by de-nitrification process was included). The high process of organic nitrogen and sediment re-suspension probably suggests the important role of microbial loop on absorption and regeneration of dissolved organic nitrogen in the bay. Thus, the results from the present study suggest the idea that shrimp farm effluent is affected the nitrogen budget and ecosystem in Kung Krabaen Bay by the mean of accelerating the nitrogen uptake in water column and sedimentation to the benthic of the Kung Krabaen Bay.

Keywords: Surveys; Effluents; Water quality; Environmental impacts; Shrimp culture; Nitrogen; Kung Krabaen Bay

310 Dusit Tunvilai, Putth Songsangjinda and Kanit Chaiyakam. 1993. **Pollution loading of effluent from intensive tiger shrimp culture ponds.** Technical Paper No.4/1993. National Institute of Coastal Aquaculture, Songkhla. Department of Fisheries. 16 p.

Pollution loading of effluent from intensive shrimp (*Penaeus monodon*) culture ponds was studied. Shrimp larvae (P17) were stocked in 5 ponds, with an area of 2,846 m²/pond, at various densities of 30, 40, 50, 60 and 70 ind/m², respectively. The results showed the lower harvesting group (pond No.1 and 2) had an average production of 590 kg/pond. Pollution load of effluent from this group were 2.8, 0.05, 0.19, 3.0, 10.8, 0.6, 0.3, 30.5 and 294 kg/pond for a parameter of NH₄-N, NO₃-N, NO₂-N, DIN (dissolved inorganic nitrogen), TN (total nitrogen), TP (total phosphorus), chlorophyll a, BOD and SM (settleable matter), respectively. The other group that had an average production of 1667 kg/pond, and pollution loading were 19.67, 0.20, 0.43, 20.3, 50.2, 1.27, 1.1, 86.87 and 1666 kg/pond for those parameters, respectively.

Keywords: Surveys; Pollution loading; Effluents; Water quality; Shrimp products; *Penaeus monodon*

311 Dusit Tunvilai. 1991. **The Study on pollutant removal rate of *Artemia* in the biological waste water treatment from intensive shrimp farming.** In Proceedings the Seminar on Fisheries 1991 Department of Fisheries, 16-18 September 1991 National Inland Fisheries Institute, Bang Khen. p. 231-242.

The experiment was conducted in 350 liter circular concrete tanks for 23 days. The waste water exchange were designed to supplied food for *Artemia* (1.86 mm in length) with density of 100

ind/l. The criteria of waste water exchange was determined to reduce the pollutant reach at normal level for brackish water ecology (BOD < mg/l). This experiment was comprised 6 replications, to study the polluted removal rate of *Artemia*'s filtrability.

The results showed the BOD removal rate were 0.0348, 0.0410, 0.0651, 0.1100 and 0.0244 mg BOD/ind/day and chlorophyll a removal rate were 0.3414, 1.6894, 1.2076, 1.3080 and 4.8335 µg/ind/day for the sequentially waste water exchange of the 1st, 2nd, 3rd, 4th and 5th, respectively. The highly removal pollutant rate were occurred at adult stage. It might be affect of filter feeding and locomotive development. However, the long term culture made accumulation of dirt and infester and caused high mortality at the end of experiment (20th-23rd day of rearing for 38.44% mortality). The post harvest (by wet weight or live weight average) of *Artemia* was 19.7 grams/tank and average length was 5.81 mm.

Keywords: Pollution loading; Effluents; *Artemia*; Utilization; Treatment; Shrimps

312 Yongyut Predalumpaburt and Nikhom Laongsiriwong, Passakorn Thompolkrang and Thongpetch Sunbuka. 1996. **Impacts of shrimp farms effluent on water qualities in pakpanang river, Nakornsrihammarat.** In Proceedings the Seminar on Fisheries 1996 Department of Fisheries, 18-20 September 1996. National Inland Fisheries Institute, Bang Khen. p.333-336.

Water quality surveys were carried out monthly in Pakpanang river and Huasai canal. The results showed that shrimp farm effluent caused water quality impact in Huasai canal. The impacted areas indicated by average total ammonia of 0.784-0.949 mg/l, average salinity of 13.28-20.82 ppt, average BOD of 5.18-6.22 mg/l, average chlorophyll a of 81.48-86.55 µg-C/l, average kjeldahl nitrogen of 0.964-1.410 mgN/l. Moreover, the *Vibrio* count show average of 2.1x10³-2.2x10³ cfu/ml while the total plate count ranged between 6.5x10⁴-1.0x10⁵ cfu/ml. The impacted Huasai canal received shrimp farm effluent from the shrimp farm areas of 11,642 rai.

Keywords: Effluents; Environmental impacts; Water quality; Shrimp farm; Shrimps; Pak Phanang

313 Yongyut Predalumpaburt and Kanit Chaiyakam. 1994. **Impacts of shrimp farm effluent on receiving water qualities.** Technical Paper No.7/1994. Songkhla National Institute of Coastal Aquaculture. Department of Fisheries. 39 p.

Water quality surveys have been carried out monthly in canals, coastal water, lake along Suratthanee, Nakorn Sri Thammarat, Songkhla and Pattanee provinces in order to monitor negative

impacts of shrimp farm effluent on receiving water qualities. The results show that Dam, Pakpanang and Thasak canals were highly contaminated by total ammonia and BOD as an average of 0.424 and 6.29 mg/l, 0.554 and 3.20 mg/l and 0.380 and 3.13 mg/l, respectively. The other canals showed low degree of organic waste contamination. Water qualities changed seasonally according to monthly rain degree of organic waste contamination. Water qualities changed seasonally according to monthly rainfall, tidal range. In northeast monsoon (during November-January), the degree of waste contamination seem to be minimal. BOD and total ammonia have been found having relationship with shrimp farm areas with correlation coefficient (r^2) of 0.825 and 0.988 for total ammonia and 0.461 for BOD chlorophyll a changes have been controlled by various water qualities averaged 55.0%. Salinity, tidal range, total ammonia and total phosphorus were the most effective parameters influenced chlorophyll a changes. Furthermore, a draft of receiving water quality standard for coastal aquaculture has been proposed in order to manage water quality on sustainable uses.

Keywords: Surveys; Effluents; Environmental impacts; Water quality; Shrimp culture; Surat Thani

314 Chanin Sangrungrung. 1997. **Effect of shrimp pond effluent on soil and sediment qualities in Kung Krabaen bay.** Master Thesis. Kasetsart University. 168 p.

Results of the investigation on the effects of effluent from shrimp farms on soil and sediment in Kung Krabaen Bay indicated that the most affected area was wastewater canal. The degree of effect decreased from wastewater canal to shoreline to 500 meters and 1,000 meters offshore which were indicated by organic matter content of soil which decreased from 6.97 to 2.04 to 0.77 to 0.25 percent. Data of sediment collected throughout one year indicated significant effect of monsoon on quantity of sediment trapped from various stations. Significantly higher amount of sediment 2296.7 g/m²/day, were collected in monsoon season comparing to another period which 414.9 g/m²/day were collected. The decreased in organic content of sediment collected in wastewater canal, shore-line, 500 meters offshore and 1,000 meters offshore indicated that less amount of sediment from shrimp farms were carried out to offshore areas. Large portion of sediment trapped in these areas were the old sediment in the Bay that were stirred up by wind and wave action and a large portion of sediment also came in with water mass from the outer sea. The soil and sediment of water supply canal also had high concentration of organic matter

(4.84 and 4.31%) these canals had also been used as wastewater canal before. At present, some shrimp farms are also release shrimp pond effluent into these canals eventhough it is prohibited.

Keywords: Surveys; Effluents; Environmental impacts; Soil; Water quality; Organic matter; Shrimp culture; Kung Krabaen Bay

315 Siri Tookwinas, Surang Tipyotin, Chart Mongkulnann, Wanrob Kubsupa, Arunee Chindanon and Laddawan Sukcharean. 1991. **Investigation on some bio-physicochemical properties at marine shrimp farm in Samut Songkram province, 1990.** In Proceedings the Seminar on Fisheries 1991 Department of Fisheries, 16-18 September 1991. National Inland Fisheries Institute, Bang Khen. p. 166-175.

The bio-physicochemical properties at marine shrimp farm in Samut songkram province were investigated between March to May 1990. The results have shown that some water properties were very poor. The ammonia-nitrogen content was very high which could be toxic to shrimp. The phytoplankton was more abundance than in natural coastal water and was measured on the range of 10,000 to 100,000 cell/l. The abundance of blue green algae in shrimp pond was very high due to the prevalence to a degree of polluted water in the pond. Among them, the diatom in the genus of *Nitzschia* sp. was found to be more abundance. This would be caused by the high silicate content in the water since diatom could directly use silicate nutrient for metabolism process. *Nitzschia* sp. which attached to shrimp gill filament would have synergistic effect with poor water quality to the respiratory mechanism of the shrimp. The recommendation were given as follows the water storage would have at least 25 percent in volume of culture area. The technical aspects for farm management and feeding would be improved. The appropriate stocking density of shrimp fry should be adjusted.

Keywords: Surveys; Water quality; Shrimp farm; Shrimps; Samut Songkhram

316 สุวัจน์ ธีรสร. 2539. การศึกษาผลกระทบของน้ำทิ้งจากการเลี้ยงกุ้งกุลาดำ ต่อคุณภาพน้ำในบริเวณป่าชายเลน อำเภอลิเกา จังหวัดตรัง. รายงานการวิจัยทุนอุดหนุนการวิจัยประเภททั่วไปประจำปี 2539. สำนักงานคณะกรรมการวิจัยแห่งชาติ. 80 น.

Intensive shrimp culture relies on high stocking densities and inputs of large of high quality feed. The shrimp wastes and uneaten feed are released directly into the water and settle to the bottom of the pond. A large amount of water is discharged during the culture period through water exchange and

harvesting. The high densities of phytoplankton and nutrient-rich water may cause problems when discharged into surrounding ecosystems. Over the year, the coastal areas of Sikoa district, Trang province has been continuously converted for marine shrimp culture, and most of shrimp farms were directly discharged the wastewater into natural water body. There were necessary to study the impact of discharge water from intensive shrimp ponds on water quality of natural receiving water. Empirical information would be helpful to use for the further management to reduce the environmental impacts of wastewater from intensive shrimp farm, and to achieve the sustainable of shrimp culture. The study on impact of wastewater from intensive shrimp pond on estuarine water quality, Sikoa district, Trang province were carried out during February 1997 to January 1998. The area of Maifad canal, Plu-Jud canal, and Chang-Lang canal were selected as study sites. From the investigation, the water quality in Maifad canal, Plu-jud canal, and Chang-Lang canal were found to be in a good condition. Non-impacts of wastewater discharge from intensive shrimp were found in the study site of Maifad canal and Chang-Lang canal, while high ammonia concentration was found in the natural water body of Plu-Jud canal. Higher diversity index and evenness in intensive shrimp pond than those in the reservoir and natural canal were found in the present study. Most of phytoplankton was dominated by *Oscillatoria* sp. Copepod is the dominant species found in each study site.

Keywords: Surveys; Mangroves; Effluents; Environmental impacts; Water quality; Intensive culture; *Penaeus monodon*; Trang

317 Anand Tunsutapanich, Tanan Sanggontanagit, Thongchai Permngarm and Charoen Omanee. 1998. **Study on elimination of pollutants in closed culture system of giant tiger shrimp (*Penaeus monodon*)**. Thai Fisheries Gazette. 51(3): 203-209.

A study on elimination of pollutants in recycled sediment and seawater was done for giant tiger shrimp (*Penaeus monodon*) culture in closed system. Previous used ponds for shrimp culture and the remaining sediment and recycled seawater were treated by using a combination of biological, physical and chemical treatments until get ecological balance in the pond. Then, these ponds were used for reculturing of giant tiger shrimp in closed system. In this study, 3, 2 and 1 earthen ponds of 1, 4 and 5 rai, respectively were used to stock shrimp larvae (Post larvae-15) at the rate of 30,000, 100,000, and 150,000 per rai, respectively. During rearing, there was neither water exchange nor sediment removal, but treated recycled water

was filled up to maintain water level and salinity. Water quality was monitored and maintained by a combination treatment method. The total yield of each pond stocked with 30,000, 100,000 and 150,000 shrimp per rai were 350-550, 1,300-1,500 and 1,960 Kg. per rai, respectively. Consequently, the survival rate was 63, 60 and 60% from 1, 4 and 5 rai earthen pond, respectively. The advantages of this technique were: 1) a decrease in water requirement 2) a decrease in waste produced and 3) a decrease in production cost.

Keywords: Pollutants; Treatment; Shrimps; Closed system; *Penaeus monodon*

318 Luechai Sunitsagul. 2001. **Efficiency of Tilapia (*Oreochromis* sp.) for quality improvement of waste water from black tiger shrimp culture**. Master Thesis. Mahidol University. 117 p.

The purpose of this study is firstly to study the change in quality of wastewater from shrimp ponds used for culturing Tilapia and Red Tilapia. Secondly, to compare the quality of wastewater used for culturing the two species of Tilapia. Thirdly, to study the efficiency of the treatment of wastewater with the species of Tilapia. And finally, to compare the growth rate and survival rate of these two species of Tilapia. After seven days of the study, it was found that both species of Tilapia can reduce the quantities of ammonia, nitrite, BOD, dissolved oxygen in water, chlorophyll a, temperature and pH. However, nitrate, orthophosphate, transparency and alkalinity all increased. The control ponds (which were not used for culturing Tilapia) yielded the same results for changes in levels of dissolved oxygen in water, temperature, pH, nitrate, orthophosphate, transparency and alkalinity. However, the control ponds showed a greater reduction in the quantity of ammonia, nitrite, BOD, Chlorophyll a than those used for culturing Tilapia. The study also found that the growth rate of red Tilapia was greater than that of Tilapia, but the survival rate of Tilapia was greater than that of red Tilapia. The condition of Tilapia was better than that of red Tilapia, but the difference was not statistically significant ($P > 0.05$). The study concludes that the culture of Tilapia is not efficient in the treatment of wastewater, but that the addition of algae along with Tilapia would improve the efficiency of treatment.

Keywords: Effluents; Utilization; Treatment; Water quality; Growth; Survival; Shrimps

319 Kobsak Kedmuean. 2002. **Efficiency of turning central drained tube for reduction of nitrogen in intensive culture of *Penaeus monodon***. Technical Paper No.18/2002. Songkhla Coastal Aquaculture Station. Department of Fisheries. 22 p.

Study on the efficiency of turning central drained tube (TCDT) on the reduction of nitrogen content in the intensive black tiger shrimp culture was carried out in an 2 rai (0.31 ha) earthen pond. The stocking density was 75 PL/m². After 60 days of growing, the TCDT was operated twice daily until harvest at 136 days. The TCDT removed wet sediment about 15.3 ton or 0.2 ton/day from the center of the pond to the sediment storage tank. The efficiency of TDCT in reduction of nitrogen from the intensive shrimp pond was calculated to be 0.28 kgN/day. The harvested shrimps had average body weight of 16.13 g or 62 ind/kg. The survival rate and food conversion rate were 81% and 1.58 respectively.

Keywords: Sludges; Treatment; Nitrogen; Nitrogenous compounds; Turning central drained tube; Intensive culture; Shrimp performance; *Penaeus monodon*

320 สุวัจน์ ธิญรส, ประชีพ ชูพันธ์, J. B. Hambrey และ C. K. Lin. 2542. การใช้หอยนางรม (*Crassostrea belcheri*) เป็นตัวกรองทางชีวภาพในน้ำทิ้งจากการเลี้ยงกุ้งทะเลแบบพัฒนา : ผลของระดับความเข้มข้นของอาหารและความเค็มต่ออัตราการกรอง. ใน การประชุมสัมมนาทางวิชาการสถาบันเทคโนโลยีราชมงคล ครั้งที่ 16 วันที่ 22-24 มกราคม 2542 ณ โรงแรมโซฟิเทลราชาออดิต และวิทยาเขตขอนแก่น จ.ขอนแก่น. น. 417-428.

The aims of this experiment, to examined the effects of food density and water salinity on filtration rate of oyster (*Crassostrea belcheri*) for fundamental data on assessing the suitable use of oyster as an alternative of biofilter in wastewater from an intensive shrimp pond. From the experimentation showed that an average of filtration rate within 24 hours of both size of oysters at different food density were significantly different ($P<0.01$). The filtration rate of oysters were decreased with increasing the food density. The average of filtration rate of oysters when exposed to different water salinity were significantly different ($P<0.01$). The decrease in filtration rate of oyster was correlated with water salinity. The average filtration rate of oyster was high at water salinity range 15-25 ppt for small size and 10-25 ppt for large size.

Keywords: Effluents; Water quality; Treatment; Biological filtration; Oysters; Feed density; Salinity; Shrimp culture

321 Thanitta Thiraksapan. 1994. **The study on using green mussel (*Perna* sp.) to improve waste-water from intensive shrimp pond.** Master Thesis. Mahidol University. 64 p.

The purpose of this thesis was to study the change of water quality drained off marine shrimp culture, before and the treatment by green mussel. This was undertaken from 3.46 rai *Penaeus monodon* intensive culture pond of Charoenpokaphan Co. Ltd., Samutsongkram province, at the rate of one month old shrimps, 34 pieces/ a square metre. The density rate of green mussels in 3 experimental intervals was limited into 4 rates: 1, 3, 5 and 7 kilogrammes per 1 tonne of wastewater, totally 1 controller for replications. It was found that before and after the treatment by green mussels in 3 experimental intervals, the quantity of chlorophyll a, ammonium-nitrogen, orthophosphate, nitrite -nitrogen, dissolved oxygen, total suspended solid, total volatile solid was significant difference ($P<0.05$). Furthermore, it showed average means of temperature, salinity, pH were 26-29°C, 31-33 ppt and 7.970-8.730, respectively. However, the ash residue quantity was no significant difference ($P<0.05$) it was discovered that the density rate at 1 kilogramme of green mussel weight was on appropriate rate for 1 tonne of wastewater treatment. Moreover, the growth rate of green mussels was significant difference ($P=0.001$, 0.001, 0.003). Nevertheless, the survival rate was no significant difference ($P=0.246$, 0.132, 0.300)

Keywords: Effluents; Treatment; Biological treatment; Green mussels; Water quality; Intensive culture; Shrimp culture

322 Krissana Rattana-r-pa. 1997. **Effect of creeper shell (*Cerithium* sp. Bruguiere) in intensive black tiger shrimp (*Penaeus monodon* Fabricius) culture in closed system.** Master Thesis. Kasetsart University. 193 p.

The creeper shell (*Cerithium* sp. Bruguiere) is frequently found in the muddy area and in shrimp ponds. This snail has a high growth rate. A comparison of the effect of creeper shell in intensive black tiger shrimp ponds indicated that within 146 days shrimp production reached 1,238.6 kg/rai with size of 27.35 grams in ponds infested with creeper shell. Survival rate was 58.29 percent and food conversion ratio was 1.90. In control ponds (without creeper shell) within 143 days production reached 1,547.4 kg/rai with size of 27.54 grams survival rate was 73.51 percent and food conversion ratio 1.85. Comparison between ponds infested with creeper shell and the control unit showed that creeper shell ponds had lower production, lower survival rate and higher food conversion ratio. The number of creeper shell after harvesting was 875,733 shell/rai (547.33 shell/m²) with an average weight 358.54 kg/rai. Water quality showed that total alkalinity was significantly different. Average total alkalinity in creeper shell ponds was 99.69 mg/l (54.33 mg/l-165 mg/l) and average total alkalinity in control ponds

was 125.35 mg/l (85 mg/l-184 mg/l). Total alkalinity in the creeper shell ponds lower than in control ponds. Total alkalinity also varied according to creeper shell density. The result of total alkalinity with stocking density 100,300 and 500 shell/m² was 112.6, 95.9 and 95.7 mg/l respectively. Average total alkalinity in control unit was 115.9 mg/l. This study showed that creeper veliger stage and shrimp both need alkalinity to form the shell, so the more creeper shell in a shrimp pond, the slower growth rate of shrimp in intensive shrimp culture alkalinity has an important role in shrimp molting. The growth of creeper shells in ponds can significantly affect the culture conditions in the ponds. The methods to reduce creeper veliger stage are by using BKC 2 ppm, tea seed cake 50-60 ppm or calcium hypochlorite 35 ppm.

Keywords: Effects; Shell; Closed system; Tea seed cake; Chlorine; Treatment; Shrimp performance; Shrimps; Shrimp products; *Penaeus monodon*

323 Sinthi Daensakul, Thavorn Thamsavate, Watthana Rewthong, Sanong Pimput, Sanor Keingrum and Prasert Thongsomboon. 1991. **Experiment on intensive jumbo Tiger Prawn culture with biological control and chemical control in earthen pond.** In Proceedings the Seminar on Fisheries 1991 Department of Fisheries, 18-20 September 1991. National Inland Fisheries Institute, Bang Khen. p. 97-102.

P. monodon were reared from P11 for 157 days in four earthen ponds which have a size 0.5rai and water depth 1.60 meters. The experiments to control water quality by biological and chemical methods were conducted in last 38 days by using 25 kg of Zeolite two times a week in pond No1 which had total Zeolite using 12 times. Green mussel which had average weight 5.26 gm and total weight 105 kg were cultured in pond No. 2-3 each. Pond No. 4 was a control. Water quality in pond No. 1-4 were: transparency 24.5, 27.7, 29.8 and 24.8 cm; pH 7.79, 7.75, 7.73 and 7.80; alkalinity 150, 146, 136, and 134 ppm. and DO 6.6, 8.0, 7.2 and 7.7 mg/l in average. Highest dissolved ammonia 0.198, 0.218, 0.206 and 0.193 ppm respectively. Salinity were 28-33 ppt and water temperature were 29-32°C in the experiments. Ponds which cultured green mussel had more transparency than other ponds. Highest ammonia in every pond was not only so different but also were safety to shrimp. Nitrite and Nitrate were not detected in the experiment. Result of shrimp rearing in pond No. 1-4 were: average weight 29.73, 30.94, 32.44 and 26.65 gm; production 714.6, 1,056.0, 976.9 and 592.7 kg/pond; survival rate 60.09, 86.05, 75.28 and

55.18; food conversion ratio 1:3.265, 1:2.218, 1:2.400 and 1:4.066 respectively; and green mussel were harvested from pond No. 2-3 at average weight 20.41 and 26.67 gm, total weight 382.5 and 355.4 kg, weight increasing 277.3 and 250.2 kg respectively. The experiment showed that stocking green mussels in shrimp ponds was a good technique to control water quality by biological control. We can get not only more shrimp production but also more survival rate and better food conversion rate from these ponds. Marketable size green mussels were harvested more than two time of stocking weight of about 500 kg/rai/month as by product.

Keywords: Water quality; Green mussels; Shrimps; *Penaeus monodon*

324 Tawat Sriveerachai, Tavee Ronjanasarnpkit, Supon Tansuwan and Korkiat Koolkeaw. 1992. **Experiment on *Penaeus monodon* culture by using the wastewater from shrimp hatchery.** Technical Paper No.11/1992. Narathiwas Coastal Aquaculture Station. Coastal Aquaculture Division. Department of Fisheries. 13 p.

The experiment on tiger prawn (*Penaeus monodon*) culture by using the wastewater from shrimp hatchery was done in 3 earthen ponds (10x80x2 m³) with stocking density 20 inds/sqm in 110 days period. The results showed: production were 349.4, 353.9 and 271.1 Kilograms, average weight were 28.57, 26.45 and 24.03 gm, survival rate were 76.4, 83.6 and 71.2% and food conversion rate were 1.26, 1.32 and 1.47, respectively.

Keywords: Effluents; Utilization; Hatcheries; Shrimp culture; Shrimp performance

325 Dumrong Lohalaksnadech. 1997. **Experiment on the use of different aeration methods for the management of water quality and pond bottom soil in closed culture system of *Penaeus monodon* Fabricius.** Master Thesis. Kasetsart University. 130 p.

The use of aeration system to suspend the sediment and to move the sediment to accumulate in certain areas of pond bottom resulted in higher turbidity of pond water which resulted in lower amount of phytoplankton and chlorophyll a comparing to control ponds. Lower amount of phytoplankton in ponds using these two systems of aeration resulted in less diurnal fluctuation of pH and dissolved oxygen, less accumulation of organic matter, and higher redox potential of pond bottom soil. In sediment suspension system, higher turbidity of water, less diurnal fluctuation of water pH and dissolved oxygen, were observed comparing to that

use aeration to move the sediment to accumulate in certain areas. There was non-significant difference ($P < 0.05$) among survival rate, growth rate and feed conversion ratio of all treatments. Considering from water and soil quality data from this experiment, sediment suspension system was considered to be most effective in pond water and pond soil management.

Keywords: Water quality; Aeration; Closed system; Shrimps; *Penaeus monodon*

326 Yongyuth Preedalumpabutt, Permsak Perngmark, Putth Songsangjinda, Supayork Suwanmanee and Wicharn Chusuwan. 1989. **Water quality dynamic in intensive tiger shrimp ponds.** Technical Paper No.10/1989. Songkhla National Institute of Aquaculture. Department of Fisheries. 20 p.

The water qualities in intensive tiger shrimp pond with different shrimp density (23, 24, 30 inds/sqm) were investigated every two weeks. Water samples were collected and analyzed in several parameters. The result shows that average ammonia (NH_3), nitrite (NO_2^-) and nitrate (NO_3^-) are nonsignificantly different while orthophosphate (PO_4^{3-}) are different significantly. After five weeks, dissolved oxygen (DO) is lower than optimum level (4 mg/l) in the morning and increase to a supersaturated point in the afternoon. BOD ranges between 0.2-10.5 mg/l salinity ranges between 11-24 ppt, pH ranges between 6.3-8.9 and transparency ranges between 18-63 cm. The authors also propose some method to improve the water quality management effectively in shrimp pond.

Keywords: Surveys; Water quality

327 Putth Songsangjinda and Dusit Tunvilai. 1991. **Distribution and variation of dissolved oxygen in intensive shrimp culture pond.** Technical Paper No.1/1991 Songkhla National Institute of Coastal Aquaculture. Department of Fisheries. 13 p.

This study was conducted in a 5 rai intensive shrimp culture pond. Rate of stocking was 35 $\text{PL}_{18}/\text{m}^2$. It was found that average dissolved oxygen of surface and bottom water in the 2nd week were 5.7 and 5.4 mg/l at dawn, and 7.6 and 11.7 mg/l in the afternoon. In the 14th week, the dissolved oxygen were changed to 2.9 and 3.1 mg/l at dawn, and 11.5 and 5.7 mg/l in the afternoon. When compared, average dissolved oxygen at dawn of water in an area of 0-22 m far from pond bank was higher than those of the water in an area of 22-44 and 45-50 m. Fluctuation of the dissolved oxygen within 24 hr. period of week 6, 8 and 10 were shown a rising

time in the morning, and up to peak of 8.30-10.0 mg/l during 03.00-06.00 pm. After 06.00 pm, dissolved oxygen was declined at the rate of 0.31-0.53 mg/l to the lowest level of 2.8-3.8 mg/l at a dawn of the following day.

Keywords: Water quality; Oxygen; Shrimps; Intensive culture

328 Patcharida Hemman. 2000. **Study on the variations of water and soil qualities, phytoplankton in black tiger shrimp (*Penaeus monodon* Fabricius) pond in freshwater area at Ratchaburi province.** Master Thesis. Kasetsart University. 131 p.

The study on the variations of water and soil qualities, phytoplankton in black tiger shrimp ponds in Ratchaburi province was conducted from June to October 1997. The results shown that pH, salinity and BOD in the three culture ponds were significantly different from those in water supply canal ($P < 0.05$). BOD and pH were increased, while salinity was decreased along with the progress of the culture period. The average water salinity was approximately 4.9 ± 0.4 ppt at last week of the culture period. As for the soil quality study, it was found that pH and electrical conductivity of soil within the culture ponds were greater than those in water supply canal and were significantly different ($P < 0.05$), while soil quality among culture ponds in terms of pH and electrical conductivity was not significantly different ($P > 0.05$). The phytoplankton found in culture ponds and water supply canal was of 5 phyla or 58 genera. They comprise of 16 genera of phylum Cyanophyta, 22 genera of phylum Chlorophyta, 15 genera of phylum Bacillariophyta, 1 genus of phylum Chrysophyta and 4 genera of phylum Pyrrophyta. Average number of phytoplankton throughout the culture period was 2.27×10^5 cell/L. The most abundant genus was *Oscillatoria* which was found about 16.98 percent of total number of phytoplankton, while the least abundant genus was *Micractinium* which was found about 0.003 percent of total number of phytoplankton. A relationship between water quality and number of phytoplankton was also studied. It was found that number of phytoplankton has a reversed relationship with salinity, transparency, BOD and phosphate, while it has a direct relationship with pH, dissolve oxygen, $\text{NO}_2\text{-N}$, $\text{NH}_3\text{-N}$ and alkalinity.

Keywords: Low salinity culture; Water quality; Soil; Plankton; Shrimps; *Penaeus monodon*

329 Sabaithip Amornjaruchit, Patcharida Hemman, Siri Tookwinas and Rangsichai Tabkaew. 2000. **Study on the variations of water and soil qualities in black tiger shrimp (*Penaeus monodon* Fabricius)**

pond in freshwater area at Ratchaburi province. Technical Paper No.10/2000. Marine Shrimp Research and Development Institute. Department of Fisheries. 63 p.

The study on the variation of water and soil quality in black tiger shrimp ponds in Ratchaburi province was conducted from June to October 1997. The results shown that pH, salinity and BOD in the three culture ponds were significantly different from those in water supply canal ($P < 0.05$). BOD and pH were increased, while salinity was decreased along with the progress of the culture period. The average water salinity was approximately 4.9 ± 0.4 ppt at last week of the culture period. As for the soil quality study, it was found that pH and electrical conductivity of soil within the culture ponds were greater than those in water supply canal and were significantly different ($P < 0.05$), while soil quality among culture ponds in terms of pH and electrical conductivity was not significantly different ($P > 0.05$).

Keywords: Low salinity culture; Water quality; Soil; Plankton; Shrimps; *Penaeus monodon*

330 Palawut Noikleang. 1996. **Study on water quality in tiger shrimp (*Penaeus monodon*) ponds in the eastern part of Thailand.** Master Thesis. Kasetsart University. 73 p.

The culture of tiger shrimp (*Penaeus monodon*) in Thailand has been faced with a destructive problem, that is the high mortality rate before a catch for sale. Viral and bacterial diseases favoured by accumulated biowaste and toxic substances in raising ponds seem to be a major cause. The objective of this thesis was to study on water quality in tiger shrimp ponds in the eastern provinces of Thailand, they are Prachinburi, Chachoengsao, Chonburi, Rayong and Chanthaburi. Its results will be applied to the solution of water quality and others environmental problems in shrimp ponds for the sake of sustainable shrimp farming. This study was investigated during February 1997 to January 1998. Shrimp culture data showed the following results: stocking density 30-80 ind/m², culture period 60-140 days and survival rate between 37-76%. Water quality in tiger shrimp ponds data showed the following results: water temperature 25.6-35.5°C, pH 6.9-9.6, electrical conductivity 2.5-59.0 mmho/cm, salinity 1.0-35.4 ppt, transparency 20-95 cm, alkalinity 36-218 mg/L, hardness 400-5,300 mg/L, DO 3.8-14.0 mg/L, BOD 2.0-12.0 mg/L, ammonia (NH₃) 0.007-3.22 mg/L, nitrite (NO₂) 0.00-0.33 mg/L, nitrate (NO₃) 0.002-0.56 mg/L and phosphate (PO₄³⁻) 0.01-8.67 mg/L. Almost all the shrimp ponds' water quality data were good. But only one pond had fairly high

contamination of ammonia, which caused low survival rate, and the other one had high phosphate.

Keywords: Water quality; Shrimp culture; Shrimps; *Penaeus monodon*

331 Putth Songsangjinda. 1994. **Linear correlation of water quality and growout data of the tiger shrimp intensive culture in Ranot district, Songkhla.** Technical Paper No.10/1994. National Institute of Coastal Aquaculture, Songkhla. Department of Fisheries. 11 p.

The study of linear correlation between water quality variables (DO, pH, transparency, nitrite, total ammonia, BOD and chlorophyll a content) and growout data (stocking density, growout period, size, survival, harvested density and harvested standing crop) was conducted in total 52 tiger shrimp intensive culture ponds during August 1990-November 1992 in Ranot district, Songkhla province. The result showed stocking density was the first variable degraded water quality. Worst water quality, especially total ammonia, nitrite, BOD, and transparency, then, correlated negatively to growout period, and correlated positively to harvested density and harvested standing crop. High concentrations of total ammonia, nitrite and day-time DO concentration, and also low level of transparency showed high correlation to the survival of tiger shrimp during 20-60% of growout period. The result also showed the negative feedback of worst water quality, especially total ammonia, nitrite and transparency, at the final of growout period which decreased harvested size. The result from this study indicated that the farmer who designed to stock the shrimp more higher density ought to face water quality problems which troublesome shrimp grow out.

Keywords: Water quality; Production; Intensive culture; Shrimp products; Shrimps; *Penaeus monodon*

332 Suthee Kurkate. 2000. **Accumulation and distribution of ions from seawater in tiger shrimp pond in freshwater zone: A case study on amphoe Bansrang changwat Prachin Buri.** Master Thesis. Kasetsart University. 150 p.

The study on accumulation and distribution of ions from sea water in soil profile of tiger shrimp pond in fresh water zone was conducted at Amphoe Bansrang, Changwat Prachin Buri. Results of the study revealed that, in both new and old ponds, the average pH of soil inside the pond, at the pond's dike and at the nearby rice field had become highest at the pre-harvested period where of the old ponds were relatively higher than of the new ponds. The distribution of soil pH from shrimp pond to out side

area was low but it had a tendency to distribute along the soil's depth. The electrical conductivity of soil in both new and old shrimp ponds at the three locations was relative high in the pre-culture period and became highest in the pre-harvested period. Distribution of ions from the new ponds to outside soil profile was observed to be more than of the old ponds while the old ponds accumulated more ions than in the new ponds. Distribution of ions along the soil depth was low in both new and old ponds. For average sodium adsorption ratio, they were relatively high in the pre-culture period and became lower in the pre-harvested period. Also, their values were found to decrease with soil's depth. The average sodium adsorption ratio at the pond's dike and at the nearby rice field were low in the pre-culture period and became higher in the pre-harvested period. Mainly, the overall average sodium adsorption ratio of the new ponds were higher than of the old ponds indicating their more accumulation of sea water ions. For the accumulation and distribution of ions from sea water in tiger shrimp ponds cultured with diluted concentrated salt-bed water and brackish water, the soil pH in new and old ponds of both cultured systems were relatively steady in all culture period. The electrical conductivity in shrimp ponds of the both cultured systems were also not different and had less distributed to the out side area. Results on the study of sodium adsorption ratio also indicated that there were no significant accumulation of salt in shrimp pond during the culture period but the ponds that used brackish water had a tendency to accumulate more salt than in the ponds that used diluted concentrated salt-bed water. In contrast, distribution of salt from the ponds using diluted concentrated salt-bed water to outside area was observed to be more than from the ponds that used brackish in shrimp culture.

Keywords: Water quality; Soil; Low salinity culture; Ions; Conductivity; Shrimp ponds; Shrimps; *Penaeus monodon*; Ponds

333 ธงชัย นิตริรัฐสุวรรณ. 2542. ความสัมพันธ์ของคุณภาพน้ำกับแพลงก์ตอนในบ่อเลี้ยงกุ้งกุลาดำ ต.บางสัก อ. กันตัง จ. ตรัง. ใน การประชุมสัมมนาทางวิชาการสถาบันเทคโนโลยีราชมงคล ครั้งที่ 16 วันที่ 22-24 มกราคม 2542 ณ โรงแรมโซฟิเทลราชาออคิต และวิทยาเขตขอนแก่น จ.ขอนแก่น. น. 408 – 416.

This paper reports on the relationship between water quality and plankton in Shrimp culture ponds, Bang Sak Subdistrict, Kantang District, Trang Province. Data was collected from the Bang-Sak service center, Leo Fishery company Ltd., from the April 10th-5th September 1998. Salinity decreases during the last few months of the

collection period. Alkalinity related to the stage of culturing (culture day) and it was also found to have a relationship with salinity. The level of ammonium shown to have a relationship with the culture day only. Specifically, the stage of culturing increased results increase the concentration of blue green algae, green algae and diatoms. Increases in salinity cause an increase the intensity of zooplankton and *Zoothamnium*, while such increases were found to cause decreases in the number of blue green algae, diatom and plankton scum. An increase in pH value corresponded with an increase in blue green algae but a decrease in the number of dinoflagellate and plankton scum. Increasing ammonium was found to correspond with high concentrations of dinoflagellate, zooplankton and *Zoothamnium*. The results from this investigation indicate that the shrimp farmers should check and monitor water quality and attempt to control plankton concentrations in order to reduce the problems created by poor water quality.

Keywords: Water quality; Plankton; *Zoothamnium*; Shrimps; *Penaeus monodon*; Trang

334 Kanit Chaiyakam, Putth Songsangjinda and Dusit Tunvilai. 1992. **Water quality and production of 2 management systems of tiger shrimp culture in Songkhla province.** Technical Paper No.11/1992. Songkhla National Institute of Coastal Aquaculture, Department of Fisheries. 14 p.

Water quality and production of 2 management systems of tiger shrimp, system 1 (private) and system 2 (company) were investigated during August 1990 to April 1992 at Ranot district, Songkhla province. Water samples of 2 sampling sites (central and outflow) of a pond were taken from 38 ponds of system 1 and 22 ponds of system 2 every 2 weeks at the level of 15 cm. above pond bottom. The results shown Least Square Mean of an average water quality overall crop for transparency (33.2 cm), nitrite-nitrogen (0.013 mg/l), nitrate-nitrogen (0.033 mg/l), total ammonia-nitrogen (0.612 mg/l), BOD (7.1 mg/l), total suspended solid (213.9 mg/l), chlorophyll a (140.1 mg/l), and COD (39.04 mg/l) were significantly difference ($P < 0.05$) from those of the system 2 (40.8 cm, 0.003 mg/l, 0.016 mg/l, 0.106 mg/l, 5.4 mg/l, 184.4 mg/l, 75.7 μ g/l and 27.58 mg/l respectively). Salinity and water temperature of the 2 management systems were also had a significant difference, but varied in the optimal level for growth. The water quality parameters, DO, pH, depth, orthophosphate and silicate between these 2 shrimp management systems, shown no significantly difference ($P > 0.05$). Shrimp culture data shown the significant difference in Least Square Mean between 2 systems for pond are (2.61 and 6 rai), stocking density (75.5 and 30.1 ind/m²), culture period (123 and 151 days), total feed (6,662 and 8,800 kg/crop),

number per kg (40 and 30 ind/kg), production per unit area (1,410 and 673 kg/rai), and average weight (25.68 and 35.16 g). Total shrimp stocked, total harvested, FCR and survival didn't shown the significantly difference ($P>0.05$). Although the Management system 1 had poor water quality and produced more waste products due to the high stocking density, the management system 1 obtained a high production per unit area when compared to the management system 2 with lower stocking density and better water quality.

Keywords: Water quality; Shrimp culture; Intensive culture; Culture management; Shrimps; *Penaeus monodon*; Songkhla

335 Itchika Phromthong, Ekapol Aumnuch, Nittharatana Paphavasit, Ajcharaporn Piumsomboon, Krongkaew Suampun, Natthanij Sunsawad and Pranee Watthanaworasakun. 2001. **Water quality and plankton composition in traditional shrimp ponds at Ban Klong Kone, Samut Songkram province.** In Symposium on Aquatic Resources and Environment: Integrated Management and Utilization December 6-8, 2001. p.81-87.

Water quality and plankton community surveys in traditional shrimp ponds at Samut Songkram Province were carried out weekly from 8 January 2001 to 24 February 2001 during the culture period. Water samples were collected for further analyses major nutrients and chlorophyll a biomass. Phytoplankton and zooplankton samplings were conducted by filtering with 20 and 103 micrometer net, respectively. Environmental parameters were also investigated. Average temperature was 27.06 Celsius, salinity 17.03-21.15 ppt., DO 2.49-6.08 mg/l and pH 7.83-8.18. The average concentration of major nutrients such as ammonia, nitrite, nitrate, phosphate and silicate were 0.042-0.093, 0.027-0.051, 0.071-0.463, 0.160-0.236 and 3.037-7.146 mg/l, respectively. Biomass of total phytoplankton in form of average chlorophyll a concentration was 8.877-23.618 ug/l. Diatom genera *Nitzschia* was the dominant microphytoplankton and nauplius of crustacean and copepod were that water quality in these traditional shrimp ponds were within the Thailand National Water Quality Classification for aquaculture purpose. The traditional shrimp culture is possible in these areas.

Keywords: Water quality; Traditional culture; Plankton; Shrimps; Samut Songkhram

336 Varin Tanasomwang, Pornthip Uangsukanjanakun, Thaweechai Supaiwan and Walai Kleechaya. 2000. **Water quality during**

treatment for marine shrimp hatchery. Technical Paper No.22/2000. Samutsakhon Coastal Aquaculture Development Center. Department of Fisheries. 14 p.

Water quality in marine shrimp breeding system was examined starting from coastal water running through supply canal in Samutsakhon Coastal Aquaculture Development Center until the water being treated ready for use. The canal water was turbid with sediment suspension by which the transparency ranged from 10 to 35 cm. (water depth 20-35 cm). The other parameters like salinity varied in the range 13-31 ppt, alkalinity 98-205 mg/l, pH 7.86-8.92, total ammonia 0.010-1.031 mg/l, nitrite 0.022-0.328 mg/l, nitrate 0.0174-0.394 mg/l, dissolved oxygen 2.87-7.39 mg/l, BOD 1.6-11.5 mg/l, total bacteria and *Vibrio* counts 1.5×10^3 - 8.9×10^4 CFU/ml and 1.4×10^2 - 3.9×10^4 CFU/ml, respectively. Stocking of the canal water in earthen ponds (14 and 1.5 rais) has raised the salinity while the total ammonia, nitrite, BOD and total bacteria have reduced. The average of these parameters were different significantly ($P<0.05$) from those of canal water. The treatment of water from the earthen pond with 30 ppm. of calcium hypochlorite ($\text{Ca}(\text{OCl})_2$) in concrete ponds twice by changing pond made the water more transparent. Such chemical could suppress the number of bacteria especially *Vibrio* contamination in the water for a short period not exceeding 76 h. Thereafter, the total bacteria and *Vibrio* counts approached also the same as those in water before being treated. The sensitivity test of 5 species of *Vibrio* against $\text{Ca}(\text{OCl})_2$ *in vitro* was also carried out. The minimal inhibitory concentration of $\text{Ca}(\text{OCl})_2$ against all the *Vibrio* species tested was 6.3 ppm. at $\frac{1}{2}$ h. and 3.1 ppm. at 24 h.

Keywords: Water quality; Shrimps; Banana shrimp; Hatcheries; Calcium hypochlorite; *Vibrio*; *Penaeus monodon*; *Metapenaeus*; *Penaeus merguensis*

337 Jaruwat Nabhitabhata and Somnuk Kbinrum. 1987. **Comparative oxygen consumption of normal and eye-stalk ablated tiger prawn, *Penaeus monodon* Fabricius.** Technical Paper No.13/1987. Rayong Brackishwater Fisheries Station. Department of Fisheries. 51 p.

Static-closed system respirometer was used in this study for tiger prawn, *Penaeus monodon*, at routine stage of activity. Metabolic rate-weight model for normal prawns was $R=1.22w^{0.69}$ and $F=0.76w^{0.76}$ for eye-stalk ablated ones, when R was oxygen consumption rate in mgO_2/hr and W was wet body weight in grams. Higher metabolic rate was in normal females than eye-stalk ablated ones. There was no significant difference between sex in eye-stalk ablated group although normal females of over 20 gm. were with higher rate than male. Both sex of

normal and females (except males) of eye-stalk ablated group were not significantly difference on diurnal metabolic rate. Weight-specific metabolism models were $Q=1.21w^{-0.31}$ for normal and $Q=0.77w^{-0.24}$ for eye-stalk ablated group. When Q was weight-specific metabolic rate in mgO_2/hr Limiting level of *Penaeus monodon* was estimated to be above $3.8 \text{ mgO}_2/\text{L}$ where metabolism pattern was oxygen-independent. Lethal level was estimated to be at about $0.7 \text{ mgO}_2/\text{L}$. Condition of the study was $23.4\text{-}30.0^\circ \text{C}$ and $30\text{-}33$ ppt salinity.

Keywords: Shrimps; Oxygen; Oxygen consumption; Respirometer; Eyestalks; *Penaeus monodon*

338 Chutima Khomvilai and Siri Tookwinas. 2002. **Water quality monitoring in low salinity shrimp culture at upper Bangpakong Dam.** Technical Paper No.2/2002. Marine Shrimp Culture Research and Development Institute. Department of Fisheries. 114 p.

Study on water quality monitoring in low salinity shrimp culture at upper Bangpakong Dam was investigated at 4 farms from April 2000 to August 2001. The result shown that water quality was good for shrimp growth. Natural water salinity was fluctuated depending on the season. Water quality was classified in class 4 of surface water resources standard. In Bangpakong area, the high densed seawater was diluted to 8 ppt for culturing shrimp. Salinity in pond gradually decreased over culture period. *Oscillatoria* sp. was found high abundantly in phytoplankton and the dominated zooplankton was *Moina* sp. Major benthic species in shrimp pond was *Chironomus* sp. found densely during pond preparing time. Gastropoda was dominated in the natural water. Water monitoring in this area indicated that it is appropriate for shrimp culture.

Keywords: Low salinity; Water quality; Shrimp culture; Shrimps; *Penaeus monodon*; Bang Pakong Dam

339 Charan Wongwiwatanawute, Pirach Jiayaratana and Kukiart Chomanee. 2002. **Heavy metal determination in the water in the tiger prawn (*P. monodon*) culture area, Chachoengsao province.** Technical Paper No.7/2002. Chachoengsao Coastal Aquaculture Development Center. Department of Fisheries. 12 p.

Study on some heavy metals content (iron, manganese, copper, zinc and cadmium) in the water in tiger prawn (*P. monodon*) farm areas in Chachoengsao province was conducted during June, 1999 to March, 2000. Manganese, copper, zinc and

cadmium were in the criteria limit of water qualities for consumption, aquatic animals conservation, fishery and swimming, established by the Office of National Environmental Board so that had no effected to farmer's tiger prawns. Concentration of total iron was still high and total copper was drastically increased. Manganese, zinc and cadmium were still low concentration. And the average heavy metals content in the water in rainy season were higher than dry season.

Keywords: Water quality; Heavy metals; Shrimp culture; Chachoengsao

340 กรรณิการ์ กาญจนชาติรี และ วุฒิชัย เจนการ. 2541. การวิเคราะห์น้ำจากฟาร์มกุ้งกุลาดำ ก่อนปล่อยลงสู่สิ่งแวดล้อม ในจังหวัดภูเก็ต วิทยาลัยชุมชนภูเก็ต. มหาวิทยาลัยสงขลานครินทร์ วิทยาเขตภูเก็ต. 20 น.

The comparison of saltwater analysis before and after being used in the ponds used for raising tiger prawns from 9 villages in Phuket: Mai Khao, Tepkrasatri, Pa-clok, Srisuntorn, Koh-kaew, Rassada, Talad-yai, Vichit and Chalong: showed that the amount of oxygen in water after being used was higher than before being used and also higher than the standard water used for aquaculture which should contain oxygen at least 4 ppm. This was resulted from the fact that an oxygen increasing machine was always used while the prawns were raised. On part of the amount of ammonia, it was found that there was no significant difference between water before and after being used. Besides, its amount was lower than the standard which was set at 0.4 ppm. Only water in Rassada contained higher ammonia than the standard, which were 0.43 ppm in water before being used and 0.57 ppm after being used. This was the effect of wastewater from a fish meal factory which was sometimes released to natural water resources. For other variations like the value of pH and temperature, they were not higher than the standard. The value of pH was 7.0-8.5 while its temperature was 33°C . However the amount of nitrite in the water mentioned above was higher than the standard which was fixed at 0.004 ppm. Water in Srisuntorn and Koh-kaew for example contained nitrite at 0.005 ppm and 0.007 ppm, respectively. The study indicated that natural water resources had some variations of which the amount was higher than the standard for aquaculture and it affected the growth of aquatic animals and others. Worse than that it was also found that about 52.9% of mud got rid from the ponds was kept in mud paddles while 3.9% was directly released to natural water resources. Though it looked such a small rate, it certainly affected the quality of natural water.

Keywords: Surveys; Effluents; Environmental impacts; Water quality; Treatment; Zeolite; Bacteria; Shrimp culture; *Penaeus monodon*; Phuket

341 Naporn Kitimasak. 1998. **Comparative study of water quality between closed recirculating water systems with biodrum and submerge biofilter for aquaculture.** Master Thesis. Chulalongkorn University. 91 p.

A Study was conducted to compare the efficiency between the biodrum and the submerged biofilter used in the closed recirculating seawater system to culture the black tiger shrimp (*Penaeus monodon*) and seabass (*Lates calcarifer*) for 3 months. The recirculating system consisted of a circular rearing tank (7 diameter) with the operating capacity of 38 m³ (1m depth) and a rectangular shaped concrete treatment tank with accommodated biofilter. Used seawater from rearing tank was treated in a separated biofilter tank. During operation, turn-over rate of the system was 4 times daily. During the culture of black tiger shrimp, both biofilters were able to regulated water quality parameters namely total ammonia, nitrite and nitrate to be within the normal ranges. Due to the low biomass of shrimp in this trial, it was unable compare the efficiency between two biofilters. The survival and growth rate of shrimp was 6.25%, 7.03% and 0.056 g/day, 0.051 g/day for biodrum and the submerged biofilter treatments, respectively. During the culture of sea bass, both biofilters were able to regulated water quality parameters namely total ammonia, nitrite and nitrate to be within the normal ranges. However, during total ammonia and nitrite of the submerge biofilter system were significantly higher ($P < 0.05$) than those of the biodrum biofilter system. The survival and growth rate of seabass was 58.42%, 57.00% and 1.273 g/day, 1.228 g/day for biodrum and the submerged biofilter treatments, respectively.

Keywords: Water quality; Biological filtration; Biodrum; Closed recirculating system; *Penaeus monodon*; *Lates calcarifer*; Polyculture

342 Gunlada Bunluewong. 2001. **Iron removal from water in closed system of *Penaeus monodon* Fabricius culture by oxidation and coagulation.** Master Thesis. Chulalongkorn University. 115 p.

The method of removing dissolved iron from water in *Penaeus monodon* Fabricius culture is oxidation and coagulation by using 4 oxidizing agents: potassium permanganate, hydrogen peroxide, calcium hypochlorite and air as well as 2

coagulants: aluminum sulfate and polyaluminum chloride. After the oxidation, sodium hydroxide and calcium hydroxide are used to adjust the pH of the water in the range of 6 to 9 to produce the precipitate of iron. Iron can be oxidized rapidly by potassium permanganate, hydrogen peroxide and calcium hypochlorite, but in air oxidation, it require the enough time for the completely oxidation reaction. The removal of iron when use sodium hydroxide give a better result than of calcium hydroxide. In the case of using calcium hydroxide with aluminum sulfate, the settlement of precipitate is faster than use of sodium hydroxide with aluminum sulfate. The conditions used for removing of dissolved iron from water in *Penaeus monodon* Fabricius culture are as follows: hydrogen peroxide as a oxidizing agent, pH 8 adjusted by calcium hydroxide and aluminum sulfate as a coagulant. A resulted water is produced suitable pH and alkalinity and containing a iron concentration less than 0.3 mg/l to meet the acceptable limit.

Keywords: Water quality; Iron; Closed system; Shrimps; *Penaeus monodon*; Coagulation

343 Somchai Wangvibondkid, Adcharee Rungdat and Sungchai Chochoed. 1996. **Studies on water quality and plankton in pond-tiger prawn (*Penaeus monodon*).** Annual Report 1996. Department of Fisheries Sciences, Agricultural Tehnology, King Mongkut's Institue of Technology. 23 p.

Studies on water quality and plankton in freshwater and brackishwater pond-tiger prawn have been investigated. For water quality, water was measured every 2 weeks from 10 ponds for temperature, pH, salinity, dissolved oxygen, total alkalinity, total ammonia-nitrogen, nitrite-nitrogen and orthophosphate. Species of plankton were identified each pond every 2 weeks. In freshwater pond-tiger prawn salinity was decreased to 10 ppt. after 4 weeks of culture. During the cultural period, the results showed that water quality in freshwater and brackishwater pond-tiger prawn temperature, pH, total ammonia-nitrogen, nitrite-nitrogen and orthophosphate were similar excluding salinity 0-5, 32-35 ppt; disssolved oxygen 3.6-14, 7.6-8.7 ppm; total alkalinity 52-144, 98-198 ppm. in freshwater and brackishwater pond-tiger prawn, respectively. It was found that there were several species of plankton in freshwater which the dominant species were *Oscillatoria* sp. and *Merismopidia* sp. in every pond. However, there were only 2-4 species of plankton in brackishwater which the dominant species were *Trichodesmium* sp., *Peridinium* sp., *Gymnodinium* sp., *Melosira* sp. and *Chaetoceros* sp., From these results there were marked trends that growth and mortality rates of tiger prawn were affected by some dominant species in brackishwater pond-tiger prawn.

Keywords: Surveys; Water quality; Plankton; Low salinity culture; Shrimp culture; Shrimps; *Penaeus monodon*

344 Siri Tookvinas, Kwanrutai Tanomkiat and Chanin Sangrungrung. 1999. **The efficiency of bio-filter for seawater improvement in an intensive marine shrimp pond.** Technical Paper No.1/1999. Kung Krabaen Bay Fisheries Development Study Center, Chantaburi. Department of Fisheries. 11 p.

The result from the experiment on the efficiency of bio-filter for seawater improvement in an intensive marine shrimp pond, it was found that several water quality parameters were decrease into under the water quality standard for coastal aquaculture such as BOD₂₀ was decreased from 7.05 to 1.67 mg/l. TN was decreased from 4.212 to 2.7332 mg/l. Chlorophyll a was decreased from 58.40 to 14.96 mg/l. Suspended solid was decreased from 68.48 to 11.84 mg/l. And total bacteria was decreased from 2.0×10^4 to 1.1×10^4 CFU/ml. The efficiency of water treatment ranged from 24.8 to 84.8%. This bio-filter instrument can be constructed on the dike of one shrimp pond which would be suitable and convenience to small scale shrimp farmers.

Keywords: Water quality; Treatment; Biological filtration; Shrimps; *Penaeus monodon*

345 Putth Songsangjinda. 1994. **Effect of water quality change on phytoplankton community in grow out ponds of two management systems of intensive tiger shrimp culture.** Technical Paper No.9/1994. Songkhla National Institute of Coastal Aquaculture. Department of Fisheries. 14 p.

The study of effect of water quality change on phytoplankton community in grow out ponds of two management systems of intensive tiger shrimp culture (system 1:private and system 2:company) was conducted in Ranot, Songkhla province. Multivariate technique was use to analyse both biotic and abiotic data. There were 11 genera of phytoplankton (*Polycystis*, *Lyngbya*, *Oscillatoria*, *Trichodesmium*, *Chlorella*, *Spirogyra*, *Coscinodiscus*, *Asterionella*, *Nitzschia* and *Gymnodinium*) that dominated to the total 45 genera found in grow out ponds of both systems. *Trichodesmium* was the most abundance genera occupied more than 80% of total density. The concentration of total ammonia-nitrogen in water of system 1 grow out ponds were higher than in system 2. The main change in phytoplankton of system 1 was the qualitative change of *Trichodesmium* density. While system 2 was showed the quantitative change of phytoplankton

genera such as *Chlorella*, *Spirogyra*, *Asterionella* and *Nitzschia* before the end of culture period. The result indicated that total ammonia-nitrogen may play an important role to the change of phytoplankton community in tiger shrimp grow out pond.

Keywords: Water quality; Plankton; Culture management; Intensive culture; Shrimps

346 Putth Songsangjinda and Kanit Chaiyakam. 1994. **Application of pond water quality data for the management of tiger shrimp intensive cultured:case study of Ranot district, Songkhla province.** Technical Paper No.17/1994. Songkhla National Institute of Coastal Aquaculture. Department of Fisheries. 16 p.

Study of an application of pond water quality data for the management of tiger shrimp intensive culture was conducted using data from 52 ponds studied during 1990-1992 in Ranot district, Songkhla province. The objective of this study is to establish the best Multiple Linear Regression Model to explain the variation of shrimp production. Water quality data was grouped by growout period into 5 groups as follow: 0-20%, 20-40%, 40-60%, 60-80% and 80-100% of growout period. Water quality variables of all groups used in the model were dissolved oxygen (mg/l), pH, transparency (cm), nitrite (mg/l), total ammonia (mg/l), biochemical oxygen demand (mg/l) and chlorophyll a content ($\mu\text{g/l}$). Growout variables used in the model were stocking density (indv/sqm), weight (g), survival (%) and harvested standing crop (kg/sqm). The result showed that weight and survival were the most importance factors to determine shrimp production. Multiple Linear Regression Model of dependent variables weight, survival and growout period was established using water quality variables in each growout period, survival and harvested standing crop as independence variable. R-square were 0.89, 0.95 and 0.78 at the level of $P=0.011$, 0.001 and 0.039 for model of weight, survival and growout period respectively. The result of this study was obtained several guide lines of water quality in each growout period for the predicted production of 500-1000, 1000-1500, 1500-2000 and over 2000 kg/rai when post larvae of shrimp were stocked at the density of 30-120 indv/sqm.

Keywords: Water quality; Shrimp culture; Regression analysis; Shrimps; *Penaeus monodon*; Songkhla

347 Putth Songsangjinda, Yongyut Predalumpaburt, Supayuak Suwanmanee and Wichan Chusuwan. 1990. **Note on some soil qualities in intensive tiger shrimp ponds.** Technical Paper No.12/1990. Songkhla National Institute of Coastal Aquaculture. Department of Fisheries. 15 p.

Some soil quality analysis was done in 4 ponds with the stocking density of 23 and 30 tails/m² during April-August 1989. The result showed the difference of an accumulated feed between 2 stocking densities after 1 month. As a culture period go on, soil sulfide, COD, and Kjeldahl-nitrogen of the 2 stocking density ponds were ranged between 2-167, 1024-17521 and 301-1391 ppm respectively, and had no significantly difference ($P>0.05$). However, available phosphorus was higher at the stocking density of 30 tails/m² than that in the other one.

Keywords: Soil; Shrimp ponds; Stocking density; Shrimps

348 Apirak Masa. 1997. **Relationship of feeding rate and water quality in black tiger shrimp ponds.** Master Thesis. Kasetsart University. 106 p.

Results from the study of the relationship of feeding rate and water quality intensive *Penaeus monodon* Fabricius ponds indicated that there was no correlation between accumulated feed and ammonia concentration, accumulated feed and nitrite concentration, accumulated feed and water pH measured in the afternoon. Accumulated feed were significantly correlated with carbon dioxide, water pH measured in the morning, secchi disc visibility ($P<0.01$) and nitrite concentration ($P<0.05$). R^2 values of accumulated feed and secchi disc visibility, and accumulated feed and water pH measured in the morning were 0.4120 and 0.8131, respectively. Calculation of appropriate accumulated feed, shrimp production and stocking density were made using the relationship between accumulated feed (X) and secchi disc visibility (Y) which indication the amount of phytoplankton, from the equation $Y=115.2-8.3749 \ln x$. At the secchi disc value between 30-40 centimeters, survival rate of 70 percent and feed conversion ratio of 1.8, appropriate feeding rate per crop should be between 1288-4251 Kg/rai and stocking density should be between 21-70 shrimp/m². This will result in shrimp production between 716-2362 Kg/rai.

Keywords: Feeding; Water quality; Shrimps; *Penaeus monodon*; Black tiger shrimp; Ponds

349 Sukit Rattanavinitkul, Sansern Chorcheng and Poonsin Parnichsuke. 1994. **Culture of the black tiger shrimp, *Penaeus monodon* by treated water.** Technical Paper No.22/1994. Nakorn Sri Thammarat Coastal Aquaculture Station. Department of Fisheries. 14 p.

Culture of the black tiger shrimp, *P. monodon* was obtain from 5 rai pond at Pak-Nakorn District,

Nakorn Sri Thammarat Province. The pond was stocked of 500,000 post larvae (P₁₇) (62.50 individuals/m²). The rearing period of 107 days and the shrimp were fed daily formulated pellets. After harvesting the results as follows: the total production was 7,300 kg or 1,460 kg/rai. The survival rate was 84.68% while the average total weight and number of shrimp/kg were 17.24 gm. and 58 indiv/kg. The food conversion ratio was 1.42.

Keywords: Water; Chemicals; Chlorine; Shrimp culture; Shrimps; *Penaeus monodon*; Black tiger shrimps

350 Witaya Woonchoom. 2000. **Water and soil quality changes in intensive tiger shrimp ponds in freshwater area in Nakhon Pathom province.** Master Thesis. Kasetsart University. 104 p.

Variation in water quality and the accumulation of phosphorus and nitrogen in pond bottom soil of low salinity tiger shrimp culture system in Kamphangsaeen district Nakhon Pathom province were studied during May to October 1998. Water quality changes could be categorized into 3 groups according to the culture period. Those significantly increased with culture period included dissolved oxygen, pH, alkalinity, total suspended solids, chlorophyll a, BOD, total nitrogen, and total phosphorus. Those significantly decreased with culture period included transparency, temperature, salinity, total dissolved solids, hardness, nitrate nitrogen, and orthophosphate. And those insignificantly increased with culture period included ammonia nitrogen and nitrite nitrogen. Increased value of some water quality parameters resulted mainly from high stocking density, small volume of water exchange and phytoplankton bloom. While, the dilution from freshwater added to culture ponds and phytoplankton bloom reduced value of some parameters. The increment of ammonia and the decreasing to lower appropriate level of transparency indicated that water qualities were not suitable for the culture. Water quality, namely, pH, total dissolved solids, and BOD were higher than the standard of water discharged into irrigation canal and its joined canal in irrigation area. Total phosphorus was also higher than the value recommended to prevent the degradation of water resource. Therefore, discharging of wastewater from the pond can deteriorate the environment. Both phosphorus and nitrogen in pond bottom soil after harvesting were obviously higher than that of at the beginning of the culture cycle. Moreover, phosphorus in pond bottom soil at the beginning of the culture cycle in the elder ponds was higher than that of new ponds. This indicated that phosphorus was accumulated in pond bottom soil. Therefore, shrimp culture pond must be managed property both during pond preparation and during a culture cycle.

Keywords: Low salinity culture; Water quality; Soil; Shrimps; Freshwater area; *Penaeus monodon*

351 Wara Taparhudee 1991. **Study on the relationship between planktons and water quality in *Penaeus monodon* Fabricius culture.** Master Thesis. Kasetsart University. 145 p.

Planktons in tiger prawn (*Penaeus monodon* Fabricius) ponds at Shrimp Culture Training Center of Bangkok Aquaculture Company in Samutsongkhram Province were studied during November 1989 to January 1990 of the grow-out period. Fifty-Three genera and five groups of plankton had been observed. There were thirty-one genera and three groups of phytoplankton and twenty-two genera and two groups of zooplankton. The predominant groups of phytoplanktons were diatoms such as *Coscinodiscus*, *Nitzschia*, pennate diatom, *Pleurosigma*, *Gyrosigma*, blue green algae *Oscillatoria* and some unidentified dinoflagellate. Zooplankton were protozoa *Tintinnopsis* and arthropoda nauplius and cirripede larvae. The amount of plankton was related to temperature, dissolved oxygen, transparency and silicate. Phytoplanktons were correlated to zooplankton while the water color in ponds were correlated to the photosynthetic pigment in dominant species of plankton. Water qualities in culture ponds during the grow-out period were as follows: temperature $28.05 \pm 1.29^{\circ}\text{C}$; pH 8.62 ± 0.16 ; salinity 27.97 ± 3.69 ppt; transparency 41.09 ± 12.68 cm.; dissolved oxygen 7.95 ± 1.01 ppm; ammonia 0.0519 ± 0.0525 m; nitrite 0.0024 ± 0.0033 ppm; nitrate 0.0854 ± 0.0456 ppm; phosphate 0.056 ± 0.1603 ppm and silicate 0.2787 ± 0.3378 ppm. Disease problems during one and a half month of grow-out period may caused by the diatom bloom. The dominant species were *Coscinodiscus* and *Nitzschia* that caused irritation and blockade of shrimp's gill. The mortalities of these shrimps were also associated with the increasing of nitrite in culture ponds during less water exchange of early weeks and cold season. These results suggested that physical and chemical factors in culture ponds cause stress in shrimp and susceptible to pathogens.

Keywords: Water quality; Plankton; Shrimps; *Penaeus monodon*

352 Fairda Malem. 1993. **The study of BOD loading and some parameters of water and soil quality from intensive marine shrimp farm with varying stocking rates.** Master Thesis. Mahidol University. 234 p.

Water quality, soil quality, plankton and water drainage from 20 intensive shrimp ponds, 4 inlet canals and 1 outlet canal were studied at Kung

Krabea Bay Royal Development Study Centre, Tambol Klongkhud, Amphur Thamai Chantaburi Province in March-August 1991. Shrimp ponds were divided into 2 groups, stocking rate less than 60 pl/m^2 (group 1) and 60 pl/m^2 (group 2). The results of water and soil quality in the two groups of shrimp ponds showed the significant ($P < 0.05$) difference salinity, temperature, nitrite nitrogen, ammonia-nitrogen, orthophosphate, dissolved oxygen, BOD and transparency. But the others, namely pH, silicate, soil-pH and organic matter were not significantly different ($P < 0.05$). Seventynine species of phytoplanktons were found, which consisted of 19 species of phylum Chlorophyta, 44 species of phylum Chrysophyta, and 16 species of phylum Cyanophyta. Sixty-nine species of zooplankton were found, which consisted of 1 species of phylum Annelida, 2 species of phylum Arthropoda, 2 species of phylum Coelenterata, 1 species of phylum Echinodermata, 3 species of phylum Mollusca, 52 species of phylum Protozoa and 8 species of Phylum Trocheiminthes. *Trichodesmium* sp. of phytoplankton and Naked Dinoflagellated of zooplankton were dominant species. Average of quantity of monthly discharge waste water and monthly BOD loading of group 2 were more than the loading of group 1. Average quantity of discharge wastewater were 10,323.0 (group 1) and 14,311.8 (group 2) ton/rai/crop. Average quantity of BOD loading were 87.1 (group 1) and 140.5 (group 2) kg/rai/crop. BOD loading was significantly related to stocking rate and the average BOD loading of waste water from 1 rai of shrimp pond was equal to BOD loading of domestic waste water of 17 persons. The BOD got the significant relation to salinity (sal), nitrite-nitrogen (NO_2), dissolved oxygen (DO), silicate (SiO_3), transparency (tran), as $\text{BOD}^{20}_5 = 16.47 + 0.330 \text{ DO} + 2.59 \text{ SiO}_3 - 0.18 \text{ sal} - 4.64 \text{ NO}_2 - 0.09 \text{ tran}$ and the BOD^{20}_5 also directly varied with feeding rate ($P < 0.05$).

Keywords: Water quality; Soil; Plankton; Intensive culture; Shrimps; *Penaeus monodon*

353 Dusit Tunvilai, Putth Songsangjinda and Kanit Chaiyakam. 1993. **Variation of sediment quality and quantity in intensive tiger shrimp culture ponds.** Technical Paper No.5/1993. National Institute of Coastal Aquaculture. Songkhla. Department of Fisheries. 20 p.

The quality and quantity of sediment in 5 intensive shrimp ponds and a reservoir were studied. The earthen shrimp ponds were $2846.5 \text{ m}^2/\text{pond}$ and P17 shrimp larvae were stocked with different densities of 30, 40, 50, 60 and 70 ind/m^2 in pond No.1 to 5, respectively. The samplings were done once a week within 16 weeks of culture period. The results showed the average amount of sediment in shrimp pond No.1 to 5 were 42.9, 113.5, 108.5, 80.7 and

179.1 m³, respectively (by dry weight of 57.0, 151.0, 144.3, 107.4 and 238.2 tons, respectively). Sediment rate and sediment quality of pH, organic matter, NH₄⁺-N, NO₂⁻-N, NO₃⁻-N, Kjeldahl-N orthophosphate, TP and H₂S were analysed with regression analysis and results showed sediment rate, NH₄⁺-N, TP and H₂S were related with culture period (P<0.05).

Keywords: Soil; Sludges; Shrimp products; Intensive culture; Shrimps; *Penaeus monodon*

354 Porn-uma Krainara. 2000. **Change of organic matter and some chemical properties in pond bottom soil of *Penaeus monodon* Fabricius treated by crushing method.** Master Thesis. Kasetsart University. 73 p.

Comparison of the change of organic matter and some chemical properties in pond bottom soil of *P. monodon* treated by crushing method shown no differences in organic matter content, pH level and available phosphorus content (P>0.05). In the experimental pond, the available phosphorus content was found to be highly significant difference (P<0.01). The amount of total nitrogen, nitrite nitrogen and nitrate nitrogen appeared increase after crushing while the ammonium nitrogen content decreased. The redox potential also was found to increased with the crushing periods. Among the three methods used for bottom soil treatment in the model, there were differences in pH level and in the amount of organic matter, total nitrogen, nitrite nitrogen, nitrite nitrogen and available phosphorus. The redox potential in both treated and non-treated bottom sediment by crushing method increased between day 7 to day 15. However, highly significance in redox potential was found in the soil treated by crushing method and filled with water compared to other methods. The ammonium nitrogen content was high on day 15 in all methods.

Keywords: Soil; Ponds; Treatment; Crushing method; Organic matter; Nitrogenous compounds; Shrimps; *Penaeus monodon*

355 Suvanit Chainark. 1997. **The change in properties of pond bottom soil of *Penaeus monodon* Fabricius in the inner gulf of Thailand.** Master Thesis. Kasetsart University. 172 p.

The studies on the change in properties of bottom soil of shrimp (*Penaeus monodon*) ponds in the inner gulf of Thailand were conducted by comparing with old soil that is not affected by shrimp culture activity. The study was done in different age groups of shrimp pond either still

culturing shrimp (5, 6 and 7 years old) or being abandoned (stop using for 3, 5 and 6 years) due to mass mortality problems. Result of this study indicated significant (P<0.05) change in some soil properties comparing to the old soils. In shrimp ponds that still culturing shrimp, the accumulation of calcium was found in every age groups of culturing ponds. Accumulation of phosphorus was also found in 5 years old ponds and significantly increased in soil BOD₅ was found in 7 years old ponds. The seven year old pond had lower ammonium-nitrogen content in bottom soil than the old soil. In ponds that were abandoned, significantly higher BOD₅ values of pond bottom soil were found comparing to the old soil in all age groups. Bottom soil of ponds that were left empty for 5 and 6 years had significantly higher amount of ammonium-nitrogen, organic matter, iron, manganese and copper than those of the old soil. The accumulation of zinc and potassium were found in bottom soil of ponds which were left empty for 6 years.

Keywords: Soil; Shrimp ponds; Ponds; Gulf of Thailand

356 Uscharee Ruangdej. 1993. **Effect of acid soils on water quality and giant tiger prawn *Penaeus monodon* Fabricius.** Master Thesis. Kasetsart University. 126 p.

The experiment was done to study the effect of acid sulfate soil on water quality and *Penaeus monodon* Fabricius. The result from the experiment indicated that under the condition that acid sulfate soil can lower down pH of water to the range of 1.6 to 3.2 in aerated and non-aerated condition. In non-aerated condition dissolved oxygen was significantly decreased. Ammonia and iron increased significantly in both aerated and non-aerated condition but nitrate and nitrite decreased. When acid water resulting from acid sulfate soil were adjusted to pH 5, 6 and 7 and use for culturing post larvae 30 of *P. monodon*, all experimental shrimp died at 6 and 15 days at pH 5 and 6 respectively. At pH 7 the survival rate was 13.33% at 56 days, When lime was added to acid sulfate soil to adjust soil pH to 5 and saltwater were added, there was not any effect on survival rate and growth rate of experimental shrimp.

Keywords: Acid soil; Water quality; Shrimp performance; Shrimps; *Penaeus monodon*

357 Payung Patarakutchai. 1989. **Soil properties and lime requirement of soils in shrimp farm and mangrove areas of changwat Trat.** Master Thesis. Kasetsart University. 73 p.

Soil properties and lime requirement of soils in shrimp farms and mangrove areas of changwat Trat

were studied. Most of the soils in the shrimp farm areas are sandy loam and sandy clay loam composing of 18.0-93.0 percent sand, 3.0-51.0 percent silt and 2.0-48.0 percent clay. pH of the soils are between 2.6-7.8, organic matter range from 0.10 to 20.66 percent and lime requirement of the soils are between 184.59-2,960.60 kg/rai. The texture of soils in the mangrove areas of changwat Trat, from surface to 2.0 m. depth level, are classified as sandy loam and sandy clay loam which composing of 17.0-84.3 percent sand, 6.9-75.0 percent silt and 4.4-60.0 percent clay. pH range from 2.5 to 7.4, percentages of organic matter are between 2.10-13.8 percent and lime requirement of soils are between 134.53-8,085.37 kg/rai.

Keywords: Soil; Lime; Shrimps; Mangroves

358 in Thai

359 สมบูรณ์ ประสงค์จันทร์, ประวิทย์ โตวัฒนะ และ นิภา พนาพิทักษ์กุล. 2545. การฟื้นฟูปุ๋ยดินจากบ่อเลี้ยงกุ้งกุลาดำโดยการล้างด้วยน้ำกรองและการใช้ปุ๋ยขี้หมู. ใน การประชุมทางวิชาการด้านเกษตร ทฤษฎีการและสิ่งแวดล้อม งานเกษตรภาคใต้ ครั้งที่ 10 วันที่ 10-11 สิงหาคม 2545 ณ คณะทรัพยากรธรรมชาติ มหาวิทยาลัยสงขลานครินทร์. น. 46-97.

Two proposed methods for reclaiming the abandoned shrimp pond soils from the central and southern parts of the country for cultivation were investigated. The first method was used 300 gram soil samples, adding the calculated amount of gypsum and leaching the soils with deionized water 3 times (1 liter per time). The second method followed the same procedure as the first one except that the calculated amount of gypsum was divided into three equal amount and then applied to the soil prior to leach with deionized water each time for the total of 3 leaching times. The study result showed that the pH and electrical conductivity (EC) of the supernatant from leaching the abandoned shrimp pond soils from the central part the country between the first and second methods are not statistically different, whereas the same result was also observed in the soil from the southern part except that there was statistically lower EC of the supernatant in the first method than the second one. Thus, the application of gypsum to the soil 3 times rather than one time has no effect on reducing the EC of the abandoned shrimp pond soils.

Keywords: Soil; Shrimp ponds; Ponds

360 Chanin Sangrungruang, Sangtien Archimangkul and Borisut Dumrak. 2001. **Quality**

of organic matter in bottom soil of black tiger shrimp ponds. Technical Paper No.6/2001. Kung Krabaen Bay Fisheries Development, Chanthaburi. Department of Fisheries. 21 p.

The study of organic matter in the bottom soil of black tiger shrimp (*Penaeus monodon*) ponds from 31 farms, 51 ponds in Nayaiaam, Thamai and Laemsing district, Chantaburi Province were conducted during Jun 1996-Feb 1997. The results showed that organic matter and some chemical parameters of bottom soil taken from the ponds between changing and no changing soil surface were significantly difference ($P < 0.05$). The values of BOD^{20}_5 , organic matter, organic carbon, total nitrogen and pH of the changing soil surface ponds were 0.404 mg/g soil, 1.64%, 0.98%, 0.048% and 6.16 respectively where as in the ponds which no changing soil surface were 0.894 mg/g soil, 4.37%, 2.56%, 0.085%, and 6.04 respectively. However, the available phosphorus values of both types of pond were 85.3 and 82.5 mg/kg which have no significant difference ($P > 0.05$). When analysis the data by culture methods (closed and opened system), the results showed that BOD^{20}_5 , organic matter and organic carbon of the opened system ponds were 0.531 mg/g soil, 2.49%, and 1.45% while the closed system ponds were 0.675 mg/g soil, 3.12% and 2.84% respectively. It was revealed that the qualities of bottom soil in the ponds of both systems were not significantly difference ($P > 0.05$) in those parameters. But the available phosphorus, total nitrogen and pH observed from those systems were significantly difference ($P < 0.05$) which in the opened system were 79.2 mg/kg, 0.039% and 6.83; in the closed system were 85.2 mg/kg, 0.074% and 6.19 respectively. There were cleared that the organic contents observed in changing soil surface ponds were significantly lower than no changing soil surface ponds. But there were no different of different of the organic contents between the opened and closed system ponds. Even though the organic matters were accumulated in the closed system ponds higher than in opened system ponds.

Keywords: Soil; Organic matter; Shrimp ponds; Shrimps; Ponds

361 Chanin Sangrungruang and Borisut Dumrak. 1998. **Impact of shrimp (*Penaeus monodon* Fabricius) pond effluent to soil qualities at Kung Krabaen Bay.** Technical Paper No.12/1998. Kung Krabaen Bay Fisheries Development, Chanthaburi. Coastal Aquaculture Division. Department of Fisheries. 34 p.

Soil qualities in Kung Krabaen Bay was carried out during May-December 1994. The samples were taken in level 0-20 cm. depth, 23 points around the

bay area. The results indicated that soil qualities in supply canal and drain out canal were accumulated the most nutrients area with average organic matter of 4.84, 6.97%; total nitrogen of 0.224, 0.161%; available phosphorus 84.26, 82.62 mg/kg and BOD₅ 3.25, 3.72 mg/g soil. The degree of effect decreased from drain out canal and supply canal to shore-line to 500 meters and 1,000 meters offshore which were indicated by organic matter content of soil which decreased from 2.04 to 0.77 to 0.25 percent respectively.

Keywords: Environmental impacts; Effluents; Soil; Shrimp ponds; Kung Krabaen Bay; *Penaeus monodon*; Shrimps; Ponds

362 Somluck Nongnuch. 2000. **Study on heavy metals in tiger shrimp (*Penaeus monodon*) ponds in the eastern part of Thailand.** Master Thesis. Kasetsart University. 95 p.

The culture of tiger shrimp (*Penaeus monodon*) in Thailand has been faced with a destructive problem, that is the high mortality rate before harvesting. This might cause by viral and bacterial diseases favoured by accumulated biowaste and toxic substances in raising ponds, resulting in tiger shrimps' weakness. This research objective was to study types and quantity of heavy metals in shrimp ponds in the eastern provinces of Thailand, these include; Prachinburi, Chonburi, Chachoengsao, Rayong and Chanthaburi. The result will be applied to solution of water quality and other environmental problems in shrimp ponds for the sake of sustainable shrimp culture. Water samples and shrimp samples were taken from different shrimp ponds in the above mentioned provinces during the period of February 1997 to January 1998. The samples were collected on the basis of 11-180 days of raising. Collected samples were analyzed for five heavy metals, they were lead, zinc, cadmium, copper and mercury by Atomic Absorption Spectrophotometry. Among the five metals, zinc appeared to be the highest concentration in all samples followed with copper, lead and cadmium respectively; 0.02-0.81, 0.001-0.407, 0.001-0.153 and 0.001-0.007 mg/l and mercury was not detectable (less than 0.001 mg/l) in all water samples. Those four heavy metals found contaminated in shrimp samples were also in the same trend, which were 7.0-21.5, 0.59-3.046, 0.021-0.43 and 0.004-0.08 mg/kg dryweight, respectively and mercury was also not detectable (less than 0.001 mg/kg dryweight) in all shrimp samples.

Keywords: Heavy metals; Surveys; Shrimp ponds; *Penaeus monodon*; Ponds

363 Niwooti Whangchai. 1991. **Accumulation and degradation of organic matter in bottom soil of tiger prawn (*Penaeus monodon* Fabricius) intensive culture ponds.** Master Thesis. Kasetsart University. 99 p.

Organic matter content in bottom soil of tiger prawn intensive culture ponds were determined for a period of 4 months. Organic matter content in bottom soil of the ponds constructed in mangrove area was in very high level comparing to the bottom soil of ponds outside mangrove area which organic matter content of the soil was in medium level. Organic matter content at the surface of the bottom of ponds constructed in mangrove area was 5.05-6.01% comparing to 1.76-2.05% of the ponds outside mangrove area. Soil samples were taken at three different depths (surface, 10 cm and 20 cm). The highest organic matter content was found at 20 cm. depth and the lowest organic matter content was found at the surface. Significant correlation was also observed between organic matter and soil pH ($r = -0.9429, -0.8874$), organic matter and clay content ($r = 0.8122, 0.8626$) and organic matter and percentage of water exchange ($r = -0.3663, -0.8177$). Decreasing rate of organic matter content of ponds bottom soil outside mangrove area in three different depths (surface, 10 cm and 20 cm) in a period of 4 months were 2.99, 10.06 and 8.75%/month comparing to 2.61, 6.64 and 3.36%/month of the ponds constructed in mangrove area. The highest decreasing rate occurred at 10 cm. depth of both areas and the lowest decreasing rate of both areas occurred at the surface. Degradation rate of organic matter of ponds outside mangrove area bottom soil during 30 days period of drying the depth of surface, 10 cm. depth and 20 cm. depth was 9.31, 9.28 and 2.77%/10 days, respectively, comparing to 9.58, 9.00 and 9.15%/10 days of degradation rate of organic matter of the ponds constructed in mangrove area. The decreasing rate of organic matter of surface soil and the soil at 10 cm. depth of both area were not significant different. The lowest degradation rate of organic matter of the soil outside mangrove area was observed at 20 cm. depth.

Keywords: Soil; Organic matter; Shrimp ponds; Intensive culture; *Penaeus monodon*; Shrimps; Ponds

364 Lakana La-ongsiriwong, Putth Songsangjinda and Chatchaval Intramontree. 2001. **Efficiency of different methods for treating sediment from marine shrimp pond in the experimental tray.** Technical Paper No.1/2001. Marine Shrimp Research and Development Center, Songkhla. Department of Fisheries. 12 p.

Pond bottom in the place where sediment and organic wastes accumulate through out the shrimp

growing period. The effective pond's bottom mangement reduces the growing problems in next crop cycle and prolongs the aging period of the pond. Moisture and microorganisms are the factors acceleration the degradation processes of the organic matter in the sediment. This experiment is aimed to compare the efficiency of sediment treation with 3 different methods; expose to the sun (ES), moisture control (MC) and adding the effective microorganisms (EM). Sediment from shrimp pond located in Songkhla Coastal Aquaculture Station was used in this experiment. The sediment was filled in the plastic trays with the size of 29x45x15 cm³ and 5 cm. thick. The 3x3 complete randomized designed (CRD) was used to study the efficiency of the methods ES, MC (pouring the 30 ppt. artificial seawater; distilled water+NaCl, on the sediment) and EM (7 ml. of effective microorganisms+3 days fermentation with molasses+artificial seawater 1 l.). Sediment samples were collected every week for the 2 months experiment. The samples were analyzed for ignition loss (IL), ammonia, nitrite, nitrate, sediment oxygen demand (SOD), chemical oxygen demand (COD), sulfide, organic carbon and total nitrogen. The statistic was tested for the treating efficiency calculated for the 1 and 2 months of experimental period. Results from the study showed that within 1 month of treating period, the MC and EM could reduce nitrite, organic carbon and total nitrogen about 65 and 38%, 12 and 21%, and 23 and 33%, respectively. Whereas, the ES could not significantly ($P<0.05$) reduce nitrite, organic carbon and total nitrogen in the sediment. Sulfide reduced 38% within 1 month by the EM. The results of 2 months treating period showed that MC, EM and ES significantly ($P<0.05$) reduced the level of ammonia in sediment by 75, 56 and 34%, respectively. The ES reduced 16% IL showing a significant difference ($P<0.05$) from MC and EM. The ES has limited efficiency in treation sediment from shrimp pond. The MC and EM methods are able to enhance the efficiency of reducing the organic wastes. However, considering the management and cost, the MC is probably the effective method for the preparation of pond bottom in marine shrimp culture. The optimum period of pond preparation to improve the sediment qualities in shrimp pond is recommended to be 1-2 months

Keywords: Sludges; Treatment; Ponds; Shrimp culture

365 Sathit Boonnom. 2002. **Effect of low salinity farming of *Penaeus monodon* (Fabricius) on soil properties.** Master Thesis. Kasetsart University. 150 p.

Results from the study of low salinity farming of *Penaeus monodon* (Fabricius) on the properties of pond bottom soils and soils in the surrounding areas indicated that in most shrimp farming areas including Amphur Kamphaengsean of Nakhon Pathom province, Amphur Bangphae of Rachaburi province, Amphur Bansang of Prachinburi province, and Amphur Ongkarak of Nakhonnayok province soil salinity were increase down to the layer of 10 cm depth considering from the increasing trends of soil electrical conductivity 1:5 (EC 1:5), exchangeable sodium and exchangeable calcium in upper soil layers. Average values of EC 1:5 and exchangeable sodium of 0-5 cm soil were significantly higher ($P<0.01$) than those of soils in deeper layers. Significantly higher concentrations of exchangeable calcium were also observed in soil layers of 0-5 and 5-10 cm comparing to deeper layers ($P<0.01$) in pond bottom soils in Amphur Ongkarak and Amphur Bansang. At Amphur Bangnampreaw of Chachoengsao province, the increase in salinity of pond bottom soils were observed down to the depth of 15 cm. Average values of soil EC 1:5, exchangeable sodium and sodium absorption ratio (SAR) of pond bottom soils at the layers of 0-5, 5-10, and 10-15 cm were significantly higher ($P<0.01$) than soil in deeper levels. Non significant difference of these soil properties were observed at different levels of reference soils taking from nearby vicinity. When soil samples were taken from surrounding areas of shrimp ponds at the depth of 0-30 cm. to study horizontal distribution of soil salinity, increasing trends of soil EC 1:5 and exchangeable sodium indicated horizontal distribution of soil salinity occurred at the distance of 1-2 meters in shrimp farming areas in Amphur Bansang of Prachinburi province, Amphur Bangphae of Rachaburi province, and Ampure Bangkok of Chachoengsao province. No horizontal distribution of soil salinity were found in shrimp farming areas in Amphur Kamphaengsean of Nakhon Pathom province, and Amphur Ongkarak of Nakhonnayok province.

Keywords: Low salinity culture; Environmental impacts; Conductivity; *Penaeus monodon*; Shrimps

366 Nikhom La-Ongsiriwong, Youngyut Predalumpabutt and Thongpetch Sunbuka. 1999. **Sediment quality in intensive tiger shrimp culture vicinities, Surat Thani province.** Technical Paper No.6/1999. National Institute of Coastal Aquaculture, Songkhla. Department of Fisheries. 11 p.

Sediment quality in Ram Canal, Tha Thong Canal and Ban Don Bay surrounded by many intensive tiger shrimp ponds was carried out from January 1992 to September 1994. The results showed the concentration of total ammonia was significant difference ($P<0.05$) by the mean of 34.4 ± 45.5

mgN/kg dry soil, 22.4±25.2 mgN/kg dry soil and 10.6±8.9 mgN/kg dry soil in Ram Canal, Tha Thong Canal and Ban Don Bay, respectively. Although the concentration of nitrite, nitrate, total kjeldhal nitrogen and hydrogensulfide was not significant difference ($P>0.05$), its concentration in Ram Canal and Tha Thong Canal was highly different from those of Ban Don Bay. This indicates intensive tiger shrimp culture has important role in supplying nitrogen and hydrogensulfide to the bottom sediment. Furthermore, monthly variation of sediment qualities in those areas were rather clear especially the monthly variation of nitrogen forms in Ram Canal and Tha Thong Canal which reach peak in July or August.

Keywords: Environmental impacts; Intensive culture; Sediment; Shrimps; Surat Thani

367 Sugitra Svangsub. 1999. **Effect of black tiger shrimp farming in freshwater cultural areas on paddy soil properties: case study Ongkharak district Nakhonnayok province.** Master Thesis. Mahidol University. 200 p.

The purpose of this research was to study the effect of black tiger shrimp farming in freshwater cultural areas on chemical and physical soil properties of paddy areas. Properties of soil from paddy areas which were not close to shrimp farming operations (reference soil) and soil from paddy areas which were located near shrimp ponds (neighboring soils) were compared. Soil samples were collected at depths of 0-30, 30-50 and 50-100 centimeters. Reference soils were collected from 2 paddy areas. Neighboring soils were collected from paddy areas near shrimp ponds which had been cultured for 1, 2 and 3 years, with samples collected at 2 ponds of each age interval. Samples were collected at distances of 0, 50, 100, 150 and 200 meters from the shrimp ponds. Results of study indicate that some chemical properties of neighboring soils had been changed significantly ($P<0.05$). In particular, electrical conductivity, sodium adsorption ratio and sodium content tended to increase with longer shrimp pond use period and decrease with greater distance from shrimp pond. The electrical conductivity showed a high value of more than 2 dS/m after 1 year of shrimp farming. Sodium adsorption ratio showed a ratio more than 13 after 2 years of shrimp farming while sodium level increased in every shrimp farming period interval. These soil property changes indicate a trend of increasing salinity in neighboring soils. Calcium level was found to be lower in neighboring soils than in reference soils but magnesium level of neighboring soils was found to be higher at some sites and lower at others than that of reference soils. Others soil properties such

as soil reaction, organic matter, total nitrogen, available phosphorus, available potassium and soil texture were the same for neighboring soils and reference soils.

Keywords: Environmental impacts; Low salinity culture; Soil; Rice fields

368 Chatree Wirasith. 2000. **Change of some bacteria in pond soil of giant tiger prawn (*Penaeus monodon* Fabricius) treated by crushing method.** Master Thesis. Kasetsart University. 67 p.

Three experiments were carried out to determine the effect of crushing method on change of *Vibrio*, *Bacillus* and Biological Oxygen Demand (BOD) level in pond bottom soil of giant tiger prawn after harvest. Bottom soil from a new pond and old pond was used for the study. In the first experiment, significant reduction of *Vibrio* was observed in both ponds treated by crushing method. However, significant reductions of *Bacillus* and BOD level were detected only in the new pond. Because the deposition of organic matters were higher in the old pond. In the second experiment, significant reductions of *Vibrio* and *Bacillus* were observed in Bottom soil obtained from the same ponds treated by crushing method in five replications of experimental containers. The BOD level was found to increase in all replications due to the presence of blue-green algae during the experiment. In the third experiment, bottom soil from the old pond was treated as follows; dried soil without crushing, dried and crushed soil. No significant reductions of *Bacillus* and the BOD level were observed in all three treatments.

Keywords: Bacteria; Bottom soil treatment; Giant tiger prawn; Crushing method

369 Koolvara Sangrungruang. 1991. **The study on the variation of bacterial quantity in the shrimp pond (*Penaeus monodon*).** Technical Paper No. 14/1991. Khung Kraben Bay Royal, Development Centre Project. Department of Fisheries. 49 p.

From this studied case found that Total Plate Count (TPC) varied range 3.33×10^3 - 3.19×10^6 CFU/ml, *Vibrios* Count (VC) varied range 0.65×10^2 - 1.22×10^4 CFU/ml and indicated that TPC more than 10^4 CFU/ml, VC more than 10^3 CFU/ml caused disease syndrome in shrimp but related with water quality and dense epicomensal organisms so. Stocking more than 40/m² pond's TPC and VC are higher than 30/m² pond's.

In pond that during operated, less used disinfectant and antibiotic had related between TPC and VC with water exchange, but in treated pond had not.

Epicomensal organisms such as *Zootanmium* sp., *Epistylis* sp., *Euphelota* sp., Filamentous bacteria

and Filament algae that fouled on the body surface, appendages and gill related with water exchange too.

External disease syndrome: black erosive tail; antennal scale, swimmeret and uropod edema. Internal: melanized and red pellets in gill and gill necrosis. Chroma: coming to surface, crowding to the edge of pond and death.

Pond's transparency be related with plankton dense and water circulation. When total ammonia value range 0.030-0.297 mg/l were often disease syndrome. Another than total ammonia have been related with shrimp age in stocking more than 40/m²

Identified bacteria which isolated from sick shrimp: *Vibrio harveyi*, *V. alginolyticus*, *Vibrio* spp. and *Pseudomonas* sp. Bacteria in pond: *V. cholerae*, *V. parahaemolyticus*, *V. vulnificus*, *V. harveyi*, *V. fluvialis*, *V. anguillarum*, *V. tubiashii*, *V. splendidus*, *Plesiomonas* sp., *Aeromonas caviae* and unidentified bacteria.

Keywords: Shrimp ponds; Bacteria; Quantity

370 Kannika Atirat. 2000. **Utilization of bacteria and zeolite for reduction of ammonia and nitrite in black tiger prawn (*Penaeus monodon* Fabricius) culture.** Master Thesis. Kasetsart University. 88 p.

On the utilization of bacteria and zeolite for reduction of ammonia and nitrite in black tiger prawn (*Penaeus monodon* Fabricius) culture, the experimental planning was completely randomized design which divided into 4 treatments with 3 replication of each. They were control (T1), *Bacillus* spp. (T2), *Bacillus* spp. and Modified Zeolite (T3), *Bacillus* spp. and Nitrifying bacterium (T4). The size of culture pond were 3 cubicmeter and raising with the density of 66 baby prawns/cubicmeter. Data were collected on the basis of 18 weeks.

From the experiments shown that when dissolved oxygen level increased more than 5 mg/L and pH between 7.5-8.5, *Bacillus* spp. were exhibited on the increasing of ammonia, which result in a higher concentration than standard level (0.1 mg/L). Application of mix items between *Bacillus* spp. and Nitrifying bacterium of Modified Zeolite showed higher acceleration in changing ammonia into nitrite only after the third week of rearing, while the trend of increasing nitrite concentration start at 8 weeks, in the control group. Low nitrite concentration level in water did not interfere to the growth of black tiger prawn. Trend of increasing nitrate concentration increased at 11 weeks after rearing and nitrate were decreased after eleven weeks. Application of *Bacillus* spp. and Nitrifying bacterium in black tiger prawn culture

showed good effective in decreasing ammonia and nitrite especially at low dissolved oxygen and low pH level. Frequently water drainage and organic waste removal from the culture pond is still be a good method for decreasing ammonia and nitrite in intensive black tiger prawn culture.

Keywords: Utilization; Bacteria; Zeolite; Ammonia; Nitrite; Black tiger prawn

371 Jiraporn Kasornchandra, Sitdhi Boonyaratpalin, Ussanee Aekpanithanpong and Sataporn Direekbutsarakom. 1992. **Isolation of *Streptomyces* Producing off-Flavor in Pond-Cultured Tiger Shrimp (*Penaeus monodon*).** In Proceedings the Seminar on Fisheries 1992 Department of Fisheries, 6-18 September 1992 DOF Meeting Hall National Inland Fisheries Institute, Bang Khen. p.268-271.

Streptomyces sp. was isolated from the collected bottom soil of the off-flavor pond-cultured tiger prawn (*Penaeus monodon*). Colony on chitin media showed the concentric type morphology. This fungus-like microorganism consisted of 2 types of mycelium, substrate mycelium and aerial mycelium. The arthrospores form a spiral-shaped with 10-12 turns. The conditions suitable for growth of *Streptomyces* sp. isolated were as follows: temperature 25-35°C, pH 4-9, salinity 0-20 ppt. It has ability to degrade chitin which is abundant in shrimp ponds. The experimental shrimp gave a weak muddy flavor after feeding shrimp with the arthrospores mixed to the commercial pelleted feed. Therefore, *Streptomyces* sp. is considered to be one of the factors producing the off-flavor in tiger shrimp.

Keywords: Isolation; Streptomyces; Off-flavor; Shrimp ponds; *Penaeus monodon*; Black tiger prawn

372 Pensri Boontamchuy and Sapon Onkong. 1997. **Quantity of total bacteria and total *Vibrio* in intensive black tiger shrimp, *Penaeus monodon* ponds and natural canals in Satul province.** Technical Paper No. 36/1997. Satul Coastal Aquaculture Development Center. Department of Fisheries. 19 p.

Total bacteria and total *Vibrio* were studied in intensive shrimp ponds and natural canals during January-June, 1996 in Satul province. It was found out that the quantity of total bacteria in shrimp ponds and in natural canals were 1.28×10^5 - 3.39×10^9 CFU/ml and 1.85×10^4 - 4.71×10^8 CFU/ml respectively. The quantity of total *Vibrio* in shrimp ponds and in natural canals were 1.09×10^2 - 1.37×10^5 CFU/ml and 10 - 7.8×10^4 CFU/ml respectively. Statistical analysis showed that the average quantity of total bacterial in shrimp ponds and in natural canals were non-significant difference ($P > 0.05$). The quantity of total *Vibrio* in Klong Yara

and Klong Thungrin were also non-significant difference from the shrimp ponds ($P>0.05$), but significant difference ($P<0.05$) was found at Klong Mung, Klong Senten and Klong Phrao.

Keywords: Bacteria; *Vibrio*; Black tiger shrimp; Intensive culture; Shrimp ponds; Satun

373 Suttinee Limthammahisorn, Kom Silapajarn and Ratchadaporn Aeumsamang. 2001. **Number of ammonia oxidizing bacteria in black tiger shrimp pond in Prachuap Khirikhan province.** Technical Paper No. 22/2001. Prachuab Khiri Khan Coastal Aquaculture Development Center. Department of Fisheries. 28 p.

Soil samples from 16 Black tiger shrimp ponds were taken for ammonia oxidizing bacteria enumeration during October 1998-January 2001. Eight of the ponds used low salinity cultured system and the rest were traditional normal salinity cultured system. The result showed that initial ammonia oxidizing bacterial number were $42,623.75 \pm 72,563.49$ cfu/g soil (wet weight) in low salinity system compared to $602,875 \pm 825,703$ cfu/g soil in normal system. However, there is no statistical difference between these two culture systems.

Keywords: Ammonia; Bacteria; Black tiger shrimp; Shrimp ponds; Prachuab Khiri Khan

374 Kiriratnikom S., Ruangsri J., Wanadet M., Songpradit A., Suanyuk N., Thapuksorn W. and Supamattaya K. 2000. **The abiotic factors influencing the growth of luminescent bacteria, *Vibrio harveyi* in seawater.** Songklanakarin J.Sci.Technol. 22(suppl.): 697-706.

A study was performed on the influence of abiotic factors, i.e. water, pH, temperature, salinity, organic matter, ammonia, nitrite, nitrate, phosphate and dissolved oxygen on the growth luminescent bacteria, *Vibrio harveyi* in seawater. High levels of organic matter, salinity range 10-60 ppt, water temperature range 25-32 °C, water pH 5-9, as well as dissolved oxygen range 0.5-7.8 mg/l enhanced the bacterial growth, while low salinity (5 ppt) high water pH (9.5) showed slow growth and acidic water (pH 3) is no growth. Different levels of ammonia, nitrite and nitrate had no effects. On the contrary, higher levels of phosphates negatively affected the bacterial growth. Suggestions are provided for the quantitative control of bacterial growth in the black tiger shrimp farm environment.

Keywords: Environmental factors; *Vibrio harveyi*; Luminescent bacteria

375 Chanin Sangrungruand and Sakorn Makta. 1997. **Effect of Microorganism for Water Quality Control in Closed System on Survival of Tiger Prawn Larvae, *Peneaus monodon* Fabricius, Nursing with Different Kinds of Feed.** Technical Paper No. 13/1997. Kung Krabaen Bay Fisheries Development Study Center, Chantaburi Coastal Aquaculture Division Department of Fisheries. 27 p.

Larvae of black tiger shrimp, *Peneaus monodon*, were nursed in closed system by using Effective Microorganism, (EM), for water quality control. Shrimps were reared at density of 100 ind./L from nauplius stage in concrete tank of 9 m³ capacity. Grinded *Artemia* flake and microencapsulated feed was fed to shrimps as different treatment. Survival of shrimp was nonsignificant in mysis stage, postlarva 1 and postlarva 15. Survival was significant related to most of water quality parameter and Total bacterial count excluding nitrite (NO₂⁻). The degree of such relationship for shrimp fed with grinded flake was lower than those fed with microencapsulated feed.

Keywords: Microorganisms; Water quality; Closed system; Larvae; *Penaeus monodon*; Nursing

376 Premasuda Saman. 1995. **Microorganisms for wastewater treatment of marine shrimp culture.** Master Thesis. Chulalongkorn University. 101 p.

Isolation of effective microorganisms that could degrade organic compounds from sediment and sea water of shrimp farms from Songkla, Nakornsrithammarat, Chachoengsao Province was investigated. Five strains were selected and designated as following : S25, the protein hydrolysing strain; S22 and P3, protein and starch hydrolysing strains and finally P1 and P4, protein, starch and lipid hydrolysing strains. Their enzymatic activities were assayed when their growth reached late exponential phase. P4 was the highest protease producing strain (115 U/ml) following with P1 (85 U/ml), P3 (84 U/ml), S22 (80 U/ml) and S25 (78 U/ml). When activity of amylase was assayed, it was found that P1 produced the highest amylase activity at 5 U/ml, then P4 at 4.77 U/ml, S22 at 3.41 U/ml and P3 at 3.33 U/ml, consecutively. Whereas lipase activity (0.45 U/ml) of P4 was higher than that of P1 (0.166 U/ml). All isolated strains were gram positive, rod shape and spore formation bacteria. They could survive in low water activity and in salinity range of 10-100 ppt. Interestingly, S25 strain could tolerate to high salinity up to 100 ppt. Biochemical test was performed and it was found that P1, P3, P4, S22 and S25 were *Bacillus subtilis*, *B. megaterium*, *B. firmus*, *B. lentus*, *B. marinus*, respectively. Co-culture among these species showed no inhibition to individual growth. Efficiency test of organic substance degradation illustrated that when comparing only any

individual strain to co-culture up to 5 strains, five strains with a ratio of 1:1:1:1:1 gave the best performance of organic substance reduction in sea water mixed with shrimp feed at concentrations 0.5%, 1%, 2%, and 3% (W/V) with the percentage of 97%, 88%, 88% and 84% in 7 days. These results indicated that bacteria isolated from this study could be monitored as a biological control for wastewater treatment of the shrimp farm.

Keywords: Microorganisms; Wastewater; Shrimp culture

377 Aroon Tanyanan. 2001. **Supplementation of *Bacillus* S11 in black tiger shrimp *Penaeus monodon* culture at field trial level.** Master Thesis. Chulalongkorn University. 123 p.

Black tiger shrimp, *Penaeus monodon*, cultivation at field trial in earthen pond, a size of 1,000 m² were supplemented with *Bacillus* S11 probiont and commercial feed, to find out its influence on shrimp growth and survival. Live weights of probiotic shrimp were significantly higher ($P < 0.05$) than those of the control group, but non significantly different results among the same group was observed. These results corresponded with the live weights and survival of shrimp after 100 days of culture in duplicated trials in net cages, a size of 2 m², located in the same pond. Challenge test on shrimp after cultivation for certain time with *Vibrio harveyi* strain 1526 for 8 days revealed that cumulative mortality of shrimp fed *Bacillus* S11 was lower in control group non significantly but mortality in probiotic treatment was gradually delayed.

Keywords: Probiotics; *Penaeus monodon*

378 Chantasing Duangbansao. 2001. **Use of bacteria for water quality and organic compound in sediment management in closed system of *Penaeus monodon* Fabricius culture.** Master Thesis. Chulalongkorn University. 150 p.

Bacillus S11, *B. subtilis* and *B. firmus* can grow well in practical media consisting of wheat flour and fish meal as 1:1% (wt/v). *Bacillus* S11 can be mixed well at a ratio of 10% in shrimp feed and used for the following experiments. Two experiments were conducted for bacteria used in water recondition and probiotic. The first one was carried out in a 130 L container, shrimp at average size of 5.96 ± 1.45 gram were stocked in each unit. The experiment was a completely randomized design, included control (no bacteria treated) and treatment units (provided with probiotic and water recondition bacteria at a concentration of 10^3 CFU ml⁻¹) with 3 replications. Both systems had no water

change during 30 days of experiment. The result indicated that water quality in both systems was not significantly different, but shrimp fed *Bacillus* S11 gave better survival than the control one. In the second experiment, black tiger shrimp, *Penaeus monodon* Fabricius, postlarvae 25 were cultured in earthen pond, the size of 900 m² at a density of 33 shrimps/m² in closed water system. *Bacillus* S11-probiotic feed and added *Bacillus* spp. into the pond for $\sim 10^3$ CFU ml⁻¹ were conducted as a tested group through this experiment. After 100-day of culturing, the significant difference ($P < 0.05$) of shrimp growth from the tested group more than that of the control was observed. As well as shrimp yield from the tested group was higher. Water quality and organic compound in sediment monitoring every 2 weeks; for example, BOD, total ammonia, nitrite, nitrate, orthophosphate and organic compound in sediment from tested group were lower than those of the control significantly ($P < 0.05$).

Keywords: Water quality; *Penaeus monodon*; Probiotics; *Bacillus*

379 Sirichome Luang-on.. 1993. **Microorganisms which can degrade some organic compound in tiger prawn farms.** Research Report. Department of Microbiology, Faculty of Science, Burapha University. 65 p.

The protein, lipid, starch and cellulose degrading microorganisms were investigated in water and sediment samples collected from tiger prawn farms in Chantaburi and Chachoengsao Province. It was found that most of the protein-degrading microorganisms isolated on skim milk agar were bacteria of genus *Bacillus*, *Aeromonas* and *Pseudomonas*. The lipid degrading microorganisms isolated on spirit blue agar and tween agar were bacteria mostly of genus *Pseudomonas* and *Aeromonas*. In addition, starch-degrading microorganisms isolated on starch agar were bacteria of genus *Pseudomonas* and *Bacillus*. However, no cellulose-degrading microorganisms could be isolated from any samples. Furthermore, only protein-degrading bacteria were found in ready-to-use microbial cells used for the degradation of organic matter in tiger prawn farms. They belong to genus *Bacillus*, *Micrococcus* and *Pseudomonas*. The selection of protein-degrading bacteria isolated from the tiger prawn farms samples and from ready-to-use products samples were Coryneforms, *Pseudomonas*, *Aeromonas* and *Micrococcus* respectively. High degradative activity of lipid were found in *Aeromonas* and *Pseudomonas* cultured on spirit blue agar and Coryneforms, *Pseudomonas* and *Aeromonas* cultured on tween agar, while starch degradation was found to be strong both in *Pseudomonas* and *Bacillus*.

Keywords : Microorganisms; Organic compounds; Shrimp farm

380 ศุภชัย ประพัศตร และ ลีลา เรืองแป้น. 2540. แบคทีเรียฟลอราในดินบ่อเลี้ยงกุ้งกุลาดำ. ใน รายงานการประชุมสัมมนาทางวิชาการสถาบันเทคโนโลยีราชมงคล ครั้งที่ 14 วันที่ 26–29 มกราคม 2546 ณ โรงแรมพาววิลเลียนและวิทยาเขตภาคใต้ จ. สงขลา. น. 133–144.

With the increase in the number of shrimp farms, various disease have been encountered and considerable losses have frequently occurred. In most of the cases, *Vibrio* bacteria were incriminated as the pathogen due to their routine isolation from infected shrimp. However, little is known about bacterial constituents in the pond which may influence shrimp health. This investigation attempts to provide the normal flora of *Vibrio* and total bacteria living in the sediment of cultured black tiger shrimp, *Penaeus monodon*, ponds.

During June to November 1994, the sediment of three shrimp ponds located in Chanthaburi province were regularly obtained from the period of rearing at 0, 1, 2, 3, 4 months and immediately post harvest. Standard plate count (APHA, 1980) using TCBS and marine agar 2216 were performed with three replications, to determine *Vibrio* and total bacterial count. The samples were incubated at 30 °C for 24 hours before examination and identification.

Results from plate count technique showed that average number of *Vibrio* on TCBS were 3.3×10^2 , 4.1×10^3 , 2.9×10^4 , 6.0×10^4 and 2.3×10^5 whereas the average number of total bacteria were 8.2×10^7 , 1.3×10^8 , 2.3×10^8 , 1.6×10^9 , 1.2×10^9 and 2.7×10^7 CFU/g, respectively from the sediment obtained during 0, 1, 2, 3, 4 months of rearing and immediately post harvest. Based on 40 biochemical characteristic tests, eight species of *Vibrio* were identified from total of 262 isolated, they were *V. harveyi*, *V. alginolyticus*, *V. parahaemolyticus*, *V. vulnificus*, *V. fluvialis* type I., *V. anguillarum*, *V. damsela* and *V. cholerae*. Other bacteria that were also constituents in the sediment include *Escherichia coli*, *Salmonella* spp., *Pseudomonas* spp., *Bacillus* spp. and others. This investigation revealed that the number of *Vibrio* in shrimp pond sediments increases by the rearing time, and the highest level of bacteria were found after 3–4 months in culture.

Keywords: Bacteria; Sediment; Black tiger shrimp; Shrimp ponds

381 Chalit Noradee. 1992. **Effect of bacteria on decomposition of organic matter during cultivation of black tiger prawn, *Penaeus monodon* Fabricius in cement tank with clay soil**

bottom. Master Thesis. Kasetsart University . 185 p.

Feed residues and prawn excretion due to large amount of feed as well as high density of prawns had caused problems to water quality of pond, and will finally affect to prawn industry. In order to solve these problems, uses bacteria; *Bacillus subtilis*, was, then, introduced to control water quality.

In every two weeks, *B. subtilis* were introduced into cement tanks filled with clay soil on the bottom the number of bacteria used for this purpose was at the rate 1 kg/rai. Experiments were performed at Faculty of Fisheries, Kasetsart University.

At the end of the twelve weeks experiments, the results of this study showed that at density of 30 and 40 individuals of prawn per square meter; with and without bacteria, the average length as well as average weight of the cultured prawns were not significantly different. The prawn survival rate, however, were highly significantly different. The results of water analyses within cement tanks where 30 and 40 individual of prawn per square meter were reared showed that either with and without *B. subtilis*, concentrations of ammonia and nitrate salts were highly significantly different. Biological oxygen demand of the same experiment was significantly different, while the nitrite one showed the opposite result.

Keywords: Bacteria; Organic matter; Black tiger prawn; *Penaeus monodon*; Cement tank; Soil

382 Tanittha Chongpeepien. 1999. **Relationship between bacteria flora and water quality in low salinity black tiger shrimp ponds (*Penaeus monodon*)**. Technical Paper No. 1/1999. Coastal Aquaculture System Research Group. Coastal Aquaculture Division. Department of Fisheries. 29 p.

Bacteriological investigation in low salinity black tiger shrimp farm (*Penaeus monodon*) was done during April 1995–July 1996. Water samples of 3 crops, with 3 ponds each, were collected bimonthly from a farm in Suphan-buri province, for bacterial counts and for water quality analysis of temperature, salinity, depth of water, transparency, pH, phosphate, nitrite, total ammonia, DO, BOD and alkalinity. The results of 164 water samples showed that the number of Total bacteria, Aeromonads and Vibrios were 9.7×10^2 – 1.65×10^5 CFU/ml, 0 to 2.16×10^4 CFU/ml and 0 to 5.47×10^3 CFU/ml, respectively. The average number of Aeromonads found in every crop was higher than the average of Vibrios found in the same respective crop. The total average number of Aeromonads and those of Vibrios accounted for 9.6 and 3.9% of the total bacteria counts, respectively.

At the 95% confidence level, total bacteria showed highly positive correlation with the period of cultures and BOD, on the other hand, it showed

negative correlation with water transparency. The number of Vibrios showed highly positive correlation with phosphate and water salinity. The number of Aeromonads was not significant correlated with water quality. Since it showed significant correlation with BOD only in the 3rd crop and correlation with water transparency when analyzed with the whole 3 crops.

Keywords: Black tiger shrimp; Bacteria; Water quality; Low salinity culture

383 Suphol Phantumaophas. 1999. **Studies on the use of *Chlorella* sp., *Chaetoceros calcitrans* and yellow colony of *Vibrio* sp. to control *Vibrio harveyi* in larval rearing system of *Penaeus monodon* Fabricius.** Master Thesis. Kasetsart University. 62 p.

The study was conducted to investigate the possibility of using *Chlorella* sp., *Chaetoceros calcitrans* and yellow colony of *Vibrio* (*Vibrio alginolyticus*) to control *Vibrio harveyi* in shrimp hatchery. Results of this study indicated that only the addition of *V. alginolyticus* plus 5 ppm sugar can limit the growth of *V. harveyi*. Significantly ($P < 0.05$) higher survival rate, 46.00 percent by average, of post-larva 5 of *Penaeus monodon* Fabricius were observed in treatment with no application of *V. harveyi* and treatment with the application of *V. harveyi* plus *V. alginolyticus* plus 5 ppm sugar comparing to treatment with the application of *V. harveyi* with an average survival rate of 27.25 percent.

Keywords: *Chlorella*; *Chaetoceros*; Yellow colony; *Vibrio*; *Penaeus monodon*; Nursing

384 Pulsak Payapmek. 2000. **Effect of *Chlorella* sp. and *Oscillatoria* sp. on *Vibrio harveyi* 1526 in giant tiger prawn *Penaeus monodon* Fabricius culture.** Master Thesis. Chulalongkorn University. 95 p.

Present study indicated the interactive effect between *Chlorella* sp. and *Oscillatoria* sp. to inhibited the growth of *Vibrio harveyi* 1526 designed using CRD involved factorial containing 4 concentrations of *Chlorella* sp. (0, 10^5 , 10^6 and 10^7 cells/ml) and 4 concentrations of *Oscillatoria* sp. (0, 10^3 , 10^4 and 10^5 cells/ml). After inoculated with *V. harveyi* 1526 for 120 hour, *Oscillatoria* sp. at concentrations 10^3 , 10^4 and 10^5 cells/ml showed significant effect on *V. harveyi* 1526 reductions. *Chlorella* sp. at concentrations 0, 10^5 and 10^6 cells/ml associated with *Oscillatoria* sp. concentrations 10^3 , 10^4 and 10^5 cells/ml negatively affected survival of *V. harveyi* 1526 than the absence of *Oscillatoria* sp. in mixed culture. A

similar growth inhibition of *V. harveyi* 1526 was observed for *Chlorella* sp. 10^7 cells/ml without *Oscillatoria* sp. associations. When performing for the challenge test by bathing shrimp with *V. harveyi* 1526 for 8 days, results showed a non-interactive effect between *Chlorella* and *Oscillatoria* inhibiting growth of *V. harveyi* 1526 and shrimp survival. Although the reduction of *V. harveyi* 1526 populations exposed to various density of *Chlorella* sp. and *Oscillatoria* sp. mixed culture, the high *V. harveyi* sustained in the culture also caused high shrimp mortality. The toxicity of high ammonia and nitrite nitrogen concentration from overfeeding also other caused of luminescent disease.

Keywords: *Chlorella*; *Oscillatoria*; *Vibrio harveyi*; *Penaeus monodon*

385 Pornchai Rungsri. 2002. **Application of microbial compound in black tiger prawn (*Penaeus monodon* Fabricius) culture and efficiency on inhibition of *Vibrio* spp.** Master Thesis. Kasetsart University. 88 p.

Application of microbial compound as brown powder consisting of three species of *Bacillus* : *Bacillus subtilis*, *B. cereus* and *B. licheniformis* with total number of cells at 1.116×10^{11} CFU/g was studied. Efficiency on inhibiting the growth of *Vibrio parahaemolyticus* and *V. harveyi* was investigated. Inhibition of *V. parahaemolyticus* was found at early stage when 5, 50, 500 and 5,000 ppm of microbial compound was applied but only at high concentration would be effective at later stage. On the contrary, *V. harveyi* could be effectively inhibited by every concentration of microbial compound throughout the experimental period

The effects of microbial compound on ammonia content was studied in experimental scale. Concentration at 0, 0.1, 0.5, 1.0, 5.0, 10.0 and 20.0 ppm of microbial compound did not cause any significant different on the ammonia level after 7 days of the trial. No improvements on water qualities, survival rate and health of *Penaeus monodon* postlarva were found during the transportation in which same concentrations of microbial compound were added in the plastic bags for 48 hours. Effects of microbial compounds at 0.25, 0.50 and 0.75 ppm on culture condition was studied in closed system *P. monodon* culture. After four months of culture in cement tanks, microbial compound did improve the culture condition especially at the later stage of the trial. Total ammonia nitrogen of all treated tanks were significantly lower than the control during the last 6 weeks and nitrite from 11th to 15th week. At the end of the four month trial, biological oxygen demand were significantly different ($p < 0.05$) in which the lowest was found in 0.75 ppm treated tank.

However, all parameters on growth and survival rate of control and treated tanks were not significantly different ($p > 0.05$).

Keywords: Microbial Compound; *Bacillus*; *Vibrio*; Shrimp culture; Black tiger prawn

386 Suwat Tanyaros and Pracheep Choopunth. 2001. **The efficiency of oyster *Crassostrea belcheri* (Sowerby) feeding on phytoplankton commonly found in intensive shrimp pond.** In Symposium on Aquatic Resources and Environment: Integrated Management and Utilization, 6-8 December 2001. p. II, 1-8.

Four trials were conducted to examine the performance of oysters *C. belcheri* feeding on phytoplankton commonly developed in intensive shrimp ponds. The pond water consisted mainly of the dominant species. Those were *Oscillatoria* sp. (short fragment), *Protoperdinium* sp. and *Oscillatoria* sp. (short fragment), *Oocystis* sp., and *Oscillatoria* sp. (long fragment) for trial 1, 2, 3 and 4, respectively. The oysters fed on shrimp pond water with different dominated species of phytoplankton were found to vary in the filtration rates, assimilation efficiency and the biodeposition rates. The algal composition of the selected shrimp pond differed greatly from the stomach contents. A smaller size of phytoplankton was always found in the stomachs of oyster than in the selected shrimp ponds, while larger size was the predominant component in the matter ejected as pseudofaeces.

Keywords: Water quality; Treatment; Biological filtration; Oysters; Feeding; Phytoplankton; Shrimp ponds; Intensive culture

387-388 in Thai

389 Supaporn Saeoung. 1996. **Treatment of wastewater from intensive culture of black tiger prawn (*Penaeus monodon*) by phytoplankton.** Master Thesis. Prince of Songkla University. 99 p.

Physio-chemical parameters of water from intensive-culture black tiger prawn ponds and wastewater pond were analysed for one crop (4 months). The average of water salinity, pH, transparency and dissolved oxygen of water and wastewater were 26 and 22 ppt, 8.05 and 7.75, 35.5 and 23.75 cm., 1.4 and 0.75 mg.l⁻¹, respectively and the color of water is relatively green. Phytoplankton of 39 genera involving 6 divisions was recorded. Seven algal genera, i.e. green algae (*Chlorella*), golden-brown algae (*Chroomonas*), blue-green algae (*Phormidium*), diatoms (*Skeletonema*, *Chaetoceros*, *Pleurosigma* and *Navicula*) were isolated. Four genera were selected

to determine their growth rate by culturing in Walne medium at light intensity of 4700 and 6300 lux. *Chlorella* and *Chroomonas* required high light intensity (6300 lux) whereas *Skeletonema* and *Chaetoceros* gave better growth in lower light intensity (4700 lux). *Chroomonas* exhibited the highest specific growth rate of 0.16 per hour among selected genera cultured for 6 days in wastewater samples from ponds of black tiger prawn culture. Nutrients requirement and optimum concentrations of nutrient added in wastewater for growth of *Chroomonas* were investigated. Urea was found to be a better nitrogen source for growth than sodium nitrate, ammonium nitrate and potassium nitrate. The optimum concentration of urea on *Chroomonas* growth was 30 mg.l⁻¹, whereas the addition of phosphorus was unable to promote algal growth. Wastewater from intensive-culture black tiger prawn (added and not added 30 mg.l⁻¹ urea) was treated by *Chroomonas*. *Chroomonas* can use all of nitrite, nitrate and ammonia within one day and three days for orthophosphate. Total nitrogen and COD were reduced by 20.82–40.27 % and 36.14–43.66% respectively within 4 days. The toxicity of *Chroomonas* was primarily tested using black tiger prawn larvae (postlarvae 25). It was found that there was no difference compared to the control (no *Chroomonas*).

Keywords: Biological treatment; Wastewater; Application; Phytoplankton; Water quality

390 Duangjai Korppibun. 1990. **Effectiveness of shrimp shell to flocculate colloid in surface water.** Master Thesis. Kasetsart University. 181 p.

This study was conducted to investigate the effectiveness of shrimp shells in removing colloidal matter in water through coagulation and flocculation process. The Jar test experiments were applied to the water sample taken from Klong Prapa in front of the Bangkok Water Treatment Plant. There were 2 kinds of shrimp shell used, i.e. the shell from Giant Tiger (*Penaeus monodon* Fabricius) and miscellaneous shrimps (shell of dried shrimp). The shrimp shells were dissolved in acetic acid to obtain amino polysaccharides in solution which performed coagulating agent and some were removed protein by alkali extraction.

Using the shrimp shell solution as coagulant, it was found that 0.5–0.8 g/l of shrimp shell (dried shell) solution getting from Giant tiger of dried shrimps gave 85–97% of turbidity removal when the pH of tested water was 6.0–9.0. The use of different segments of Giant Tiger shell (without protein extraction and with protein extraction) i.e. abdomen and tail did not show significantly different results.

The study of shrimp solutions as coagulant aid shows that using 10 mg/l alum and 0.05 g/l shrimp

shell solution (both kinds of shrimp) resulted in 97.7% turbidity removal when the pH of water was 8.

From this study, it was noticed that Giant Tiger shell (protein extraction) solution and the shrimp shell solution with alum were so effective in removing the turbidity as well as other interfering substances in water that the quality of flocculated water met the standard of drinking water (WHO, 1984). However using the shrimp shell solution alone in flocculation, would slightly increase the BOD₅ in water. Eventhough the shrimp shell (without protein extraction) solution reduced turbidity of water, the flocculated water quality was not acceptable to WHO's standard of drinking water.

Keywords: Shrimp shell; Surface water; Colloid

391-392 in Thai

393 Siri Tookwinas and Chanin Sangrungruang. 1998. **Study on Bio-filtering treatment for improving the water quality in and intensive marine shrimp pond.** Thai Fisheries Gazette 51(6): 535-540.

The Bio-filtering bacterial treatment process was set to improve the water quality in an intensive marine shrimp farm in Thamai, Chanthaburi, Eastern Thailand. The aerobic bacterial process can decrease the concentration of ammonia-nitrogen and biochemical oxygen demand (BOD₅²⁰) down to the acceptable level for safety to aquatic organism with the residence time of 7 hrs. The anaerobic bacterial process for converting nitrate to nitrogen gas is needed for further study.

Keywords: Shrimp ponds; Intensive culture; Biological treatment; Water quality; Marine shrimps

394 Kwanrearn Sripirom. 1991. **Effects of steroid hormones on ovarian development and moulting in giant tiger prawn (*Penaeus monodon* Fabricius).** Master Thesis. Chulalongkorn University. 86 p.

The study on the effects of progesterone and β -estradiol 17 on ovarian development of *Penaeus monodon* was carried out by injection technique. A comparative study of 7, 14 and 21 days durations was undertaken by injection progesterone of β -estradiol 17 at the doses of 0.01, 0.1, 0.2 and 0.4 μ g-hormone/g body weight. Solvent without hormone injection (Sham) dose of 0.1 μ l-solvent/g body weight and non treated prawn (control) were used for controls. The result showed that all treatments with hormone injection had a positive

response on ovarian development. Gonad index of the groups injected by the double dose hormones seemed to be higher than the controls and the shams. However, there was no statistical significance among those hormonal treatments, sham and control, and between sources of hormones on ovarian development.

Moulting duration cycle of *Penaeus monodon* averaged body weight 35 g was approximately 18 days. Moulting stage B (3 days after moulting), stage C (6 days after moulting) and stage D₁' (10 days after moulting) were designed for hormones, 2-deoxyecdysone (sigma) and pure β -ecdysone (extracted from *Vitex glabrata*) treatment. Concentration of 0.01, 0.1, 0.2 and 0.4 μ g-hormone/g body weight were singly injected into abdominal muscular tissues. Moulting duration of stage B, stage C and stage D' in the hormone treated group decreased approximately 5.5 days, 4.9 days and 4.2 days comparing the control. While moulting duration of sham group on stage B, stage C and stage D₁' were decreased 1 day, 2 days and 2 days comparing to the control. There was no statistical significance between sources of moulting hormones on moulting duration cycle.

Keywords: Steroid hormones; Moulting; Giant tiger prawn; Progesterone

395 Sommai Chiayvareesajja and Reungchai Tansakul. 1988. **Culture of banana prawn (*Penaeus merguensis*) and tilapia (*Oreochromis niloticus*) by using aquatic weed mixture pellet.** Songklanakarin J. Sci. Technol. 10: 84-91.

A study on the culture of banana prawn and tilapia in plywood tanks containing 0.43 m³ of 20 ppt sea water by using aquatic weed mixture pellet was conducted. An aquatic weed mixture pellet composed of dry weed *Ceratophyllum demersum*, rice bran and fish meal in a ratio of 4:3:1. There were 5 treatments i.e. prawn culture, fish culture and polyculture of prawn and fish in ratios of 1:1, 1:2 and 1:4. After a 9 week trial period, it was found that the tilapia in all treatments were grew well. A poor growth rate and survival rate of prawns obtained from the prawns in the polyculture system. A better growth performance of prawn was obtained from the prawn in the monoculture system. These results suggest it may be feasible to use aquatic weed as prawn feed.

Keywords: Banana prawn

396 Siri Tookwinas, Fairda Malem and Putth Songsangjinda. 2003. **Quality and quantity of discharged water from intensive marine shrimp farms at Kung Krabaen bay, Chanthaburi province, Eastern Thailand.** In Proceedings the Seminar on Fisheries 1994 Department of Fisheries,

19-21 September 1994 DOF Meeting Hall National Inland Fisheries Institute, Bang Khen. p. 136-141.

The study of 20 shrimp ponds in Kung Krabaen Bay during the first crop of 1992 showed that the average water drainage was 16,697.5 tons/pond. The average water salinity was 35.03 ppt, the average BOD was 8.47 mg/l (range: 0.30-21.20 mg/l), the average NO₂-N was 0.02 mg/l the average NH₃-N was 0.19 mg/l, the average soil organic matter was 7.23%, BOD₅²⁰=16.47+0.33 DO+2.59 SiO₂-0.18 Salinity-4.64 NO₂-0.09 Visibility ($r^2=0.56$). BOD₅²⁰ concentration was also directly varied with the feeding rate ($r^2=0.40$). The average shrimp production from 20 intensive cultured ponds was 4,118 kg/ha/crop.

Keywords: Surveys; Water quality; Intensive culture; Shrimp farms; Shrimps; Kung Krabaen Bay

397 Patcharida Hemman, Siri Tookwinas and Rangasichai Tabkaew. 2000. **Study on the variations of phytoplankton in black tiger shrimp (*Penaeus monodon* Fabricius) pond in freshwater area at Ratchaburi province.** Technical Paper No.11/2000. Marine Shrimp Research and Development Institute. Department of Fisheries. 41 p.

The study on the variation of phytoplankton in black tiger shrimp pond, the phytoplankton found in culture ponds and water supply canal were of 5 phyla of 58 genera. They comprise of 16 genera of phylum Cyanophyta, 22 genera of phylum Chlorophyta, 15 genera of phylum Bacillariophyta, 1 genus of phylum Chrysophyta and 4 genera of phylum Pyrrophyta. The most abundant genus was *Oscillatoria* which was found about 16.98 percent of total number of phytoplankton, while the least abundant genus was *Micractinium* which was found about 0.003 percent of total number of phytoplankton. Relationships between water quality and number of phytoplankton was also studied. It was found that number of phytoplankton has a reversed relationship with salinity, transparency, BOD and phosphate, while it has a direct relationship with pH, dissolve oxygen, NO₂-N, NH₃-N and alkalinity.

Keywords: Shrimps; Phytoplankton; Plankton; Freshwater area; Water quality; *Penaeus monodon*

398 Ong-ard Lawhavinit, Chantana Nithima thachoke and Phusit Prathanpipat. 1992. **Studies a Suitable Bacterium for the Quantitative Determination of Oxolinic Acid in the Muscle of Black Tiger Shrimp, *Penaeus monodon*.** In the

30th Kasetsart University Annual Conference, 29 January -1 February 1992. p. 503-510.

An suitable bacterium for the quantitative determination of oxolinic acid in the muscle of the Black Tiger shrimp, *Penaeus monodon* by the microassay method was studied. The 4 strains of bacteria were *Aeromonas hydrophila*, *Bacillus subtilis* BGA, *Escherichia coli* and *Klebsiella pneumoniae*. The results showed that, *Aeromonas hydrophila* was the most suitable bacterium for use in this test because it was the one bacterial species that could determine the lowest concentration of oxolinic acid (0.05 ppm) The mean percentage of the recovery rate was 31.08±3.80.

Keywords: Prawns; Shrimps; Black tiger shrimp; *Penaeus monodon*; Bacteria; Oxolinic acid; Quantitative; Determination; Microassay method; *Aeromonas hydrophila*; *Bacillus subtilis*; *Escherichia coli*; *Klebsiella pneumoniae*

399 Terd Tessprateep, Kriengsag Saitanu, Lila Ruangpan, Tadashi Aoki and Makoto Endo. 1990. **Histopathology of *Vibrio alginolyticus* Infection in *Penaeus monodon*.** The Thai Journal of Veterinary Medicine. 20(4): 537-550.

Vibrio alginolyticus infection of *Penaeus monodon* was examined histopathologically. Hemocyte responses to the bacteria comprised hemocyte aggregation with necrotic core, infiltration of free hemocytes, and hemocyte encapsulation. However, there was no melanization in association with the hemocyte encapsulation. The pronounced parenchymal lesions occurred in the gill, antennal gland, lymphoid organ, and hepatopancreas. In the most serious cases, the sick prawns exhibited septicemia and decreased in numbers of free hemocytes.

Keywords: Prawns; Shrimps; *Penaeus monodon*; Bacteria; *Vibrio alginolyticus*; Histopathology; Hemocytes; Parenchymatous lesions; Melanization

400 Suwanna Benjatammamont, Pikul Jiravanichpisal, Pornlerd Chanratchakool, Chalor Limsuwan. 1991. **Studies on Minimal Inhibition Concentration (MIC) and Minimal Bactericidal Concentration (MBC) of oxytetracycline against some isolated bacteria from diseased tiger shrimp.** In the 29th Kasetsart University Annual Conference, 4-7 February 1991. p. 479-485.

Minimal inhibition concentration (MIC) and minimal bactericidal concentration (MBC) of oxytetracycline against isolated bacteria from diseased giant tiger shrimp at 2 areas, Samutsakorn, Samutsongkhram Province (Central Thailand) and

Chantaburi, Rayong Province (Eastern Thailand) were carried out. The results showed that each species of isolated bacteria has different in both MIC and MBC value. Almost bacteria from central Thailand province showed higher MIC and MBC value than the bacterial from eastern Thailand province. *Vibrio vulnificus* which believed to be the causative organism of black splint disease has the same MIC and MBC value, 50 ppm as well as in *V. cholerae*.

Keywords: Prawns; Shrimps; Tiger shrimp; Diseases; *Penaeus monodon*; *Vibrio vulnificus*; Minimal Inhibitory Concentration; MIC; Bacteria; Minimal Bactericidal Concentration; MBC; Oxytetracycline

401 Jirasak Tangtrongpiros, Weena Koeypudsa, Aranya Ponpornpisit and Naratip Mounsang. 1991. **Microsporiosis in black tiger prawn (*Penaeus monodon*)**. In Proceedings of the 18th Annual Veterinary Conference, 4-6 November 1991. p. 191-198.

In July 1991, the Veterinary Medical Aquatic Animal Research Centre (VMARC) received 2-month-old milky shrimps (Cotton shrimp or roe shrimp) from private frozen sea food product plant. The numerous microsporidian spores were found in these affected shrimps after the examination by fresh impression smear, stained with 0.5 percent malachite green, wright-geimsa stain and H&E stain under the light microscope with the magnification of 40 and 100.

Keywords: Prawns; Shrimps; *Penaeus monodon*; Black tiger prawn; Microsporiosis; Cotton; Microsporidian; Bacteria; Diseases

402 Jirasak Tangtrongpiros, Nantarika Issarasak na Ayuthaya, Somsak Panukchoklap, Nakares Tanongsakmontri and Rabin Rattanapanee. 1992. **A Study of Black Splint disease in *Penaeus monodon* by inducing *Vibrio vulnificus* in 1, 2, 3 and 4 month old shrimps**. Journal of Aquatic Animal Diseases 13(1): 31-44.

The study of Black Splint Disease in *Penaeus monodon* by inducing *Vibrio vulnificus* which was isolated from the diseased shrimps, into 1, 2, 3 and 4 month old shrimps. Each trial was done by injecting a single dose of 1.0×10^3 cells intramuscularly on the left side of shrimp between the 3rd and 4th abdominal segment. The experiment was done by having double duplication and on control group. The specimens were collected from each group every three days. For histopathological and microbiological study. The result showed that the 1 and 2 month old shrimps had only moderate

lesion of cellulitis in the muscle while the 3 and 4 old shrimps had severe lesion of cellulitis, inflammatory nodule, granulomatous nodule and granulomatous streak. All of the shrimps in group C had only slight lesion of cellulitis.

Keywords: Prawns; Shrimps; *Penaeus monodon*; Black splint disease; *Vibrio vulnificus*; Cellulitis; Inflammation; Granulomatous streak; Bacteria

403 Sataporn Suwannaruk, Supatra Srichirat and Jirasak Tangtrongpiros. 1992. **Acute toxicity of methyl parathion on *Penaeus monodon* Fabricius**. The Thai Journal of Veterinary Medicine 22(4): 189-201

Seven groups of *Penaeus monodon* were exposed to methyl parathion at the concentration of 1 to 90 mcg/litre (ppb) and the LC₅₀ at 96 hours interval was found to be 54 ppb. Clinical signs and mortality rates of intoxicated prawns were dose dependent. Cholinesterase activities in haemolymph of treated prawns were not correlated with the toxicity, whereas the cholinesterase enzyme activities in nerve and muscle decreased with increasing doses of methyl parathion. The histopathological examination revealed muscle necrosis, F-cell cytoplasm vacuolation, hyperemia and hepatopancreatic cell necrosis in the treated group with 1-50 ppb. of methyl parathion. No pathological change was found in the groups exposed to 75-90 ppb. Concentration of methyl parathion and duration of exposure to insecticide were also discussed to be the main factors. All of the results suggested that the strong inhibition of cholinesterase in muscle and nervous tissues of *Penaeus monodon* is a good indicator for organophosphate insecticide intoxication.

Keywords: Prawns; Shrimps; Black tiger shrimp; Toxicity; Acute toxicity; Methyl parathion; *Penaeus monodon*; Enzymes; Cholinesterase; Drugs; Drug residues; Chemicals

404 Amornchai Somjetlertcharoen, Supanee Chinabut and Chalor Limsuwan. 1993. **Oxolinic acid residues from *Penaeus monodon* Fabricius in intensive culture pond**. In the 31st Kasetsart University Annual Conference, 3-6 February 1993. p. 460-472.

Residues of OXA were studied in shrimp under farm conditions after oral administration with OXA at 2.5 gm/kg feed for 7 days. The result demonstrated that OXA persisted in hepatopancreas and muscle of shrimp fed with pellets mixed on farm with OXA for 14 and 10 days respectively; and for 22 and 18 days respectively in shrimp fed with factory-produced medicated feed. Sensitivity of this experiment for

detection of OXA residues in shrimp tissue was limited at concentrations of 0.1 ppm.

Keywords: Prawns; Shrimps; Black tiger shrimp; *Penaeus monodon*; Oxolinic acid; Residues; Ponds; Drug residues; Drugs

405 Pornlerd Chanratchakool, Chalor Limsuwan, Supranee Chinabut. 1993. **A Study of oxytetracycline pre-treatment and injection of *Vibrio parahaemolyticus* into *Penaeus monodon* Fabricius.** In the 31st Kasetsart University Annual Conference, 3-6 February 1993. p. 441-450.

Two experiments were conducted to examine the mortality and histopathological changes associated with prophylactic use of oxytetracycline (OTC) followed by injection of *Vibrio parahaemolyticus* into *Penaeus monodon* Fabricius. Each experiment consisted of three groups of shrimp: a) saline injected controls b) untreated shrimp injected with bacteria and c) pre-treated shrimp injected with bacteria. The prophylactic treatment was administered for 7 days prior to injection, on pellets containing 5 g. OTC/kg of feed. The bacteria used were from an OTC sensitive isolate, recovered from clinically diseased shrimp. In the first experiment the OTC pre-treated shrimp were found to have lower mortalities following the injection with bacteria. In the second experiment the shrimp were sampled for 35 days after injection. Histological examination revealed that the pre-treated shrimp produced a less marked cellular response and healed more rapidly when injected with bacteria.

Keywords: Prawns; Shrimps; *Penaeus monodon*; Oxytetracycline; Feed; *Vibrio parahaemolyticus*; Treatment; Histopathology; Bacteria

406 Wanna Ruttanagosrikit and Yont Musig. 1993. **Toxicity of nitrite on *Penaeus merguensis* larva.** In the 31st Kasetsart University Annual Conference, 3-6 February 1993. p. 409-413.

Acute toxicity of nitrite on *Penaeus merguensis* larva were studied using static bioassay. The result of this study indicated that nitrite is more toxic to shrimp larva in nauplius stage than to other stages, 24 hr LC₅₀ of nitrite were 6.1, 29.0, 12.8, 125.0, 67.0, 58.0 and 50.4 mg-N/l for nauplius, protozoa, mysis, postlarva 7, postlarva 12, postlarva 16 and postlarva 25, respectively. Toxicity of nitrite on postlarva stage of *P. merguensis* decreased with increasing stage of postlarva. Toxicity of nitrite on postlarva stage increased with the increase of exposure period. 96 hr LC₅₀ of were 6.1, 6.0, 5.6 and 4.8 mg-N/l for

postlarva 7, postlarva 12, postlarva 16 and postlarva 25, respectively.

Keywords: Shrimps; Prawns; *Penaeus merguensis*; Toxicity; Nitrite; Aquatic animals; Chemicals

407 Supawadee Pumpuang, Pornlerd Chanratchakool and Chalor Limsuwan. 1992. **Leaching of oxytetracycline from medicated feed and its retention in *Penaeus monodon* Fabricius.** In the 30th Kasetsart University Annual Conference, 29 January-1 February 1992. p. 511-517.

Oxytetracycline (OTC) medicated feed at the rate of 5 g/kg feed prepared by using 3 percent cooked starch as binder could decreased leaching rate of the drug from the pellets and proved to be more efficient than using fish oil or distilled water. The highest active-OTC was detected during 2 hours post treatment at approximately 15 percent. Leaching rate was promoted by aeration. The maximum drug levels in muscle and hepatopancreas (0.97 and 1.38 ppm. respectively) was obtained in shrimp fed with 5 gram OTC-medicated feed prepared by using cooked starch for 7 days, but showed non-significant different between the others groups.

Keywords: Prawns; Shrimps; Black tiger shrimp; *Penaeus monodon*; Medicated feed; Oxytetracycline; Drug residues; Drugs; Residues

408 Piyawat Wasayanggure, Mnus Tangon, Anawin Pitiwan, Anong Bintvihok, Wara Panichkriangkrai, Jirasak Tangtrongpiros and Arunya Ponpornpisit. 1997. **Effect of aflatoxin B1 on black tiger shrimp (*Penaeus monodon*) Hemocytes.** Clinical Conference. Faculty of Veterinary Science. Chulalongkorn University. 15 p.

Nine hundred and sixty black tiger shrimps were divided into four groups. Each group consisted of 4 tanks containing 60 shrimp in each tank. Group 1 was used as a control, groups 2, 3 and 4 were fed aflatoxin mixed feed at the concentration of 5, 10 and 20 ppb (μg aflatoxin B1/kg feed), respectively. Mortality and growth rates were observed during the experiment. Hemolymph samples were collected at days 8 and 10 after feeding. Total hemocyte counts showed no statistics difference ($P > 0.05$) between samples collected at days 8 and 10 of the same experimental groups. However, the average total hemocyte counts and granulocyte counts of aflatoxin-exposed shrimp 10 and 20 ppb. were significantly higher than the control group ($P < 0.05$). The growth rate of the aflatoxin-exposed shrimp was lower than the control group while the mortality rate was higher.

Keywords: Shrimps; Prawns; *Penaeus monodon*; Hemocytes; Aflatoxin B1; Black tiger shrimp

409 Chalor Limsuwan, Gray Nash, W. Rerkamnuaychoke, Anutra Arkarajamon and Boosirm Withyacheumnarnkul. 1993. **Pathology of Yellowhead Diseases in Black Tiger Shrimp (*Penaeus monodon* Fabricius)**. In the 31st Kasetsart University Annual Conference, 3-6 February 1993. p. 424-432.

Yellowhead disease has been reported from black tiger shrimp since 1990 in the central region and the eastern region and since early 1992 in the southern region. This is the most serious disease in black tiger shrimp because 100% mortality can occur within 2-5 days. Diseased shrimp were generally pale in color, with yellow, swollen cephalothorax, also with pale or yellowish gills. Histological examination revealed extensive necrosis of hemocytes in the hemal sinuses, and lumen of the lymphoid (Oka) organ, hemal sinuses of the gills and the hepatopancreas. Ultrastructurally, aggregation of free viral particles were commonly found in the cytoplasm of infected hemocytes, gill lamellars and lymphoid organ. Preventive measures are also discussed.

Keywords: Shrimps; Black tiger shrimp; Pathology; Yellow-head Disease; Yellow Head Virus; *Penaeus monodon*; Prawns; Viruses; Hemocytes; Gill lamella; Monodon baculovirus; MBV

410 Jirasak Tangtrongpiros, Nantarika Chansue and Weena Koepudsa. 1998. **Determination of oxolinic acid and oxytetracycline residues in giant freshwater prawn (*Macrobrachium rosenbergii*), banana prawn (*Penaeus merguensis*) and giant black tiger prawn (*P. monodon*)**. In Proceedings of the 24th Annual Conference of the Thai Veterinary Medical Association (TVMA) and the 4th Conference of the Veterinary Practitioner Association of Thailand to commemorate the auspices of the Golden Jubilee to the TVMA, 5-7 August 1998. p. 133-140.

Determination of oxolinic acid and oxytetracycline residues in shrimp muscle were studied from August 1996 to January 1997. The samples were randomly purchased from Klongtoei market in Bangkok Metropolitan. High Performance Liquid Chromatography (HPLC) was used to detect residues. The result from this study indicated that oxytetracycline residue level found in Giant freshwater prawn was ranged from 0.223 to 1.407 mg/kg. In Banana prawn was ranged from 0 to 0.225 mg/kg and in Giant black tiger prawn the level was ranged from 0.256 to 1.242 mg/kg. Oxolinic acid residue was found only in Giant freshwater prawn in January 1997. The oxolinic

acid residue concentration was 0.241 mg/kg in shrimp muscle.

Keywords: Prawns; Shrimps; Black tiger shrimp; *Macrobrachium rosenbergii*; Banana prawn; *Penaeus merguensis*; Giant black tiger prawn; *Penaeus monodon*; Oxytetracycline; Oxolinic acid; Tetracycline; Norfloxacin; Drugs; Drug residues; Residues; Antibiotics.

411 Boonchit Sriarm, Sompong Nuchkong, Sunpetch Angkititrakul and Jirasak Tangtrongpiroj. 1988. **The use of oxytetracycline, ampicillin, chloramphenicol, erythromycin, and trimethoprim & sulfadiazine for disease prevention in larva of *Penaeus monodon***. Clinical Conference. Faculty of Veterinary Science. Chulalongkorn University. 11 p.

Two experimental trials were done on 5 antibiotics for prevention of disease in larva of *Penaeus monodon* from Nauplius, Zoea, Mysis until Post Larva stage. Erythromycin, Chloramphenicol, Trimethoprim & Sulfadiazine Ampicillin and Oxytetracycline were used in different concentration of 5, 10, 15, 20 and 25 ppm. respectively. The survival rates of the larva were determined. Erythromycin has the highest efficiency in disease prevention with 55% and 26.33% survival rates in both trials. Trimethoprim & Sulfadiazine has the minimal survival rate of 4.33% in the first trial while Oxytetracycline showed the minimal survival rate of 17.67% in the second trial. All condition in the experiment were control for suitability of *Penaeus monodon* larviculture.

Keywords: Prawns; Shrimps; *Penaeus monodon*; Antibiotics; Oxytetracycline; Ampicillin; Chloramphenicol; Erythromycin; Trimethoprim; Sulfadiazine

412 in Thai

413 Jirasak Tangtrongpiros and Weena Koepudsa. 1989. **The use of flumequine for treatment of bacterial infection in banana tiger prawn (*Penaeus monodon*) and seabass (*Lates calcarifer*)**. The Thai Journal of Veterinary Medicine 19(4): 181-191.

The efficacy of flumequine (Imequyl, Rhone Merieux Company) was studied both *in vitro* and *in vivo*. The MIC was 0.5 µg/ml to 17 strains of *A. hydrophila* and 23 strains of *V. anguillarum* isolated from affected fishes and shrimps in Thailand. Sodium chloride (NaCl) has no effect on flumequine in inhibiting the growth of these bacterias. The mortality of shrimp (*P. monodon*) and seabass (*L. calcarifer*) was reduced at the dosage of 5 ppm, 10 ppm and 20 ppm when flumequine was administered every day or

every 2 day. This drug should be one of the drug of choice in treatment of bacterial infection in aquatic animals.

Keywords: Prawns; Shrimps; *Penaeus monodon*; Seabass; *Lates calcarifer*; Flumequine; Fishes; Aquatic animals; *Aeromonas hydrophila*; *Vibrio anguillarum*; Bacteria

414 Somsak Panukchoklap, Nakares Tanongsakmontri, Rabin Rattanapanee, Jirasak Tangtrongpiros and Nantarika Issarasak. 1989. **A study of Black Splint disease in *Penaeus monodon* by inducing *Vibrio vulnificus* in 1, 2, 3 and 4 month old shrimps.** Clinical Conference, Faculty of Veterinary Science. Chulalongkorn University 13 p.

The study of black splint disease in *Penaeus monodon* by inducing *Vibrio vulnificus* which was isolated from the diseased shrimps, into 1, 2, 3 and 4 month old shrimps. Each trial was done by injecting a single dose of 1.0×10^6 power 3 cells intramuscularly on the left side of shrimp between the 3rd and 4th abdominal segment. The experiment was done by having double duplication and one control group. The specimens were collected from each group every three days. For histopathological and microbiological study. The result showed that the 1 and 2 month old shrimps had only moderate lesion of cellulitis in the muscle while the 3 and 4 month old shrimps had severe lesion of cellulitis, inflammator nodule, granulomatous nodule and granulomatous streak. All of the shrimps in group C had only slight lesion of cellulitis.

Keywords: Prawns; Shrimps; Black splint disease; *Penaeus monodon*; *Vibrio vulnificus*; Diseases; Bacteria; Cellulitis

415 Ussanee Ekpanithanpong, Vinai Krachaiwong and Sitdhi Boonyaratpalin. 1995. **Residues of oxytetracycline in black tiger prawn (*P. monodon*) and sediments from shrimp farms in Songkhla province.** Technical Paper No. 6/1995. National Institute of Coastal Aquaculture, Songkhla. Department of Fisheries. 8 p.

Oxytetracycline residues were detected from black tiger prawn (*Penaeus monodon*) and sediments from 3 sizes of shrimp farm in Songkhla province during November 1991 to August 1992. Sensitive bioassay was used for oxytetracycline testing. Samples were periodically collected at the interval of the culture period from 30-59 days, 60-89 days, 90-119 days and after 120 days respectively. The results showed that in big-size farm (> 15 ponds) oxytetracycline residues were

detected from 5-27 percents of samples from muscle and hepatopancreas. There was no oxytetracycline residues detected from muscle after 120 culture days. In medium-size farm (3-5 ponds), oxytetracycline residues were detected from hepatopancreas only 12 percents of samples at the interval of culture period from 60-119 days, whereas small-size farm, oxytetracycline residues were detected from 7-56 percents of samples both from muscle and hepatopancreas during 30-119 days and after 120 culture days. Furthermore, oxytetracycline were also detected from sediments collected from shrimp farms ranging 20-32 percents from big-size farm, 22-33 percents from medium-size farm and 17-87 percents from small-size farm.

Keywords: Shrimps; White Spot Syndrome Virus; Prawns; *Penaeus monodon*; Polymerase Chain Reaction; SEMBV; PCR; White Spot Disease; Viruses; Nudibaculovirinae; Songkhla

416 Jiraporn Kasornchandra, Sitdhi Boonyaratpalin and T. Itami. 1997. **Detection of White Spot Syndrome in cultured Penaeid shrimps in Asia: microscopic observation and polymerase chain reaction.** Technical Paper No. 8/1997. National Institute of Coastal Aquaculture, Songkhla. Department of Fisheries. 16 p.

The serious disease outbreak caused by a new virus has occurred among cultured penaeid shrimps in Asian countries since 1993. Typical signs were white spots or patches on the inside surface of the shell and carapace and/or reddish coloration of the body. Histopathological changes observed among diseased shrimps collected from various countries exhibited widespread cellular degeneration and severe nuclear hypertrophy in cells of most tissues derived from ectodermal and mesodermal origin. Similar rod-shaped to elliptical virus particles surrounded by typical trilaminar envelope were found in nucleus of those infected cells with various sizes of 70-120 nm. by 240-340 nm. This virus was tentatively confirmed to be a member of genus Non Occluded Baculovirus (NOB) of the subfamily Nudibaculovirinae of Baculovirus. A portion of the sequences of specific DNA fragment of the Thai's isolate was used as a primer and compared to the other isolated collected from various countries. Results indicated that the causative agent of the white spot syndrome of cultured penaeid shrimps occurring in Asian countries were in fact closely related.

Keywords: Shrimps; Prawns; White Spot Syndrome Virus; *Penaeus monodon*; Polymerase Chain Reaction; SEMBV; PCR; White spot Disease; Viruses; Nudibaculovirinae; Asia

417 Lila Ruangpan, Sataporn Direkbusarakom, Yaowanit Danayadol and Yubonrat Srikaew. 1997. **Efficiency of commercial drugs for control diseases in black tiger shrimp on the growth inhibition of luminous and *Vibrio* bacteria**. Technical Paper No. 19/1997. Nation Institute of Coastal Aquaculture, Songkhla. Department of Fisheries. 10 p.

Fifteen commercial drugs for control bacterial diseases of cultured *Penaeus monodon* were studied form their effectiveness on growth inhibition of 90 luminous and 30 *Vibrio* bacterial strains. Based on the minimal inhibitory concentration method the MIC of the studied drugs against luminous and *Vibrio* bacterial ranging from 0.2->100 and 0.8-100 µg/ml respectively. The inhibitory concentration of those agent against 50% of studied strains were observed from 6.3-100 and 12.5-50 µg/ml and LC90 were 50->100 and 25-100 µg/ml respectively. Percent of drug resistant strains of luminous and *Vibrio* spp. were found between 32-85% and 29-90%, respectively. The concentration recommended on each drug's labelling can inhibit respective of 9-36% and 0-20% of total tested bacteria. The results revealed that most the commercial drugs have low effectiveness on growth inhibition of the bacterial pathogens isolated from the diseased black tiger shrimp.

Keywords: Prawns; Shrimps; Black tiger shrimp; *Penaeus monodon*; Drugs; Minimal Inhibitory Concentration; *Vibrio*; Bacteria; Oxolinic acid; Tetracycline; Oxytetracycline; Chlortetracycline; Fluoro quinolone; Norfloxacin; Pefloxacin

418 Sataporn Direkbusarakom and Usanee Ekepanithanpong. 1992. **Study on *Vibrio parahaemolyticus* isolated from the Red Disease in tiger prawn (*Penaeus monodon*)**. Technical Paper No. 2/1992. National Institute of Coastal Aquaculture, Songkhla. Department of Fisheries. 9 p.

Vibrio parahaemolyticus was isolated from muscle, hepatopancrease and lymphoid organ of disease shrimp in cultured pond at Pagpanang District, Nakornsrithammaraj Province during August to September 1991. The pathogenicity studied in juvenile shrimp showed that 100% mortality occurred within 24 hr. after injection with bacteria at the concentration of 10^6 - 10^8 cell/cc. Moreover; the bacteria could be isolated from hepatopancrease and lymphoid organ after injection 30 min. This bacteria is sensitive to Chloramphenicol, Gentamycin, Nalidixic acid and Nitrofurantoin.

Keywords: Prawns; Shrimps; *Penaeus monodon*; Tiger prawn; Bacteria; Red Disease; *Vibrio parahaemolyticus*; Chloramphenicol; Gentamycin; Nalidixic acid; Nitrofurantoin; Nakhon Sri Thammarat

419 Juadee Pongmaneerat, Jamaree Rakbangleam, Sawitri Silakes, Komkhai Lawanyawut and Patcharin Niumhom. 2001. **Detection of white spot syndrome virus in post larvae and pond-cultured black tiger shrimp (*Penaeus monodon*) in year 2000**. Technical Sub-division Coastal Aquaculture Division. Department of Fisheries. 22 p.

The detection of white spot syndrome virus (WSSV) in post larvae and pond-cultured adults of black tiger shrimp (*Penaeus monodon*) from hatcheries and culturing areas was demonstrated in 23 provinces during January to December 2000 by polymerase chain reaction. The pond-cultured adults shrimp showed the visible sign or suspicion of white spot syndrome were carried out for detection of WSSV. The results showed that 655 samples of shrimp, from the total detection number of 18,687 samples, were infected with WSSV. This WSSV infection number was found to be 3.51% of the total detection sample from 23 provinces in the year round. The biggest infection number of WSSV were observed in the shrimp samples from Samutsongkram, Samutsarkorn and Chantaburi at 9.26%, 8.24 and 7.09%. For post larvae shrimp, the WSSV infection were detected in 369 samples of shrimp, from total detection number of 17,427 samples, as 2.12%. The WSSV infection in the adult shrimp from the pond culture were detected in 255 samples of shrimp, from total detection number which showed visible sign of white spot syndrome of 1,144 samples, as 22.29%. The infection of WSSV in the post larvae shrimp and in the adult shrimp from pond-culturing sample within 12 months varied from 0.3-4.87% and 6.68-39.7%. In addition, the highest number of infection were detected in December for post larvae and August for adult shrimp.

Keywords: Prawns; Shrimps; Black tiger shrimp; *Penaeus monodon*; White Spot Syndrome Virus; Postlarvae; WSSV; PCR; Polymerase Chain Reaction; Samut Songkhram; Samut Sakon; Chanthaburi; Viruses

420 Montira Thavornyutikarn and Jiraporn Thongnun. 2000. **Determination of antibiotic residues in soil and black tiger shrimp muscle from culture ponds in Chachoengsao province from 1993 to 1996**. Technical Paper No. 32/2000. Chachoengsao Coastal Aquaculture Development Center. Department of Fisheries. 9 p.

Determination of antibiotic residues in soil and black tiger shrimp muscles by using microbiological assay method was conducted during October 1993 to September 1996. Soil and shrimp (with 3 months old up) were sampling from shrimp ponds in Chachoengsao province. It found that, during October 1993 to September 1994, antibiotic residue in soil was detected in 1 out of 31 samples or accounting for 3.2% of the total sample examined and in shrimps were 11 out of 72 samples or contributing 15.3% of the total sample determined. During October 1994 to September 1995 and during October 1995 to September 1996, antibiotic residue in shrimp were 5 samples from 89 samples (5.6%) and 12 samples from total 221 samples (5.4%) respectively. Trend of using drugs for prevention and curing diseases in shrimp, especially for those more than 3 months of culture period, was declined in year by year. From observation, trend of using oxytetracycline was changed to the other antibiotics such as oxolinic acid sulfa or sulfatrimethoprim.

Keywords: Prawns; Shrimps; Black tiger shrimp; *Penaeus monodon*; Antibiotic residues; Residues; Drugs; Drug residues; Culture ponds; Chachoengsao; Microbiological assay

421 Sukit Rattanavinitkul, Sansern Chorcheng, Thavee Rojanasarpakrit and Pitoon Chopsaart. 1998. **Experiment on solving the problem of P2 – P15 larval stage of Penaeid-shrimp cause by disease in the nursery tank.** Technical Paper No. 13/1988. Nakorn Sri Thammarat Brackishwater Fisheries Station. Department of Fisheries. 8 p.

Oxytetracycline and Chloramphenicol at the concentration of 2.68-7 ppm were treated in the nursery tanks of P2-P15 Penaeid-shrimp larvae, with 10-15 ppm. Formalin to prevent and cure the pathogenic infection of Penaeid-shrimp larvae especially luminous bacteria, *Vibrio* sp.

Keywords: Shrimps; Prawns; Aquatic animals; Penaeid; *Penaeus monodon*; *Penaeus merguensis*; Oxytetracycline; Chloramphenicol; Formalin; Luminescent bacteria; *Vibrio*; Diseases

422 Jiraporn Kesonchun, Sitthi Boonyarattapalin and Kitchakan Supamat. 1994. **Electron microscopic observation on the replication of yellow head baculovirus in lymphoid organ of *Penaeus monodon*.** Technical Paper No. 2/1994. National Institute of Coastal Aquaculture, Songkhla. Department of Fisheries. 10 p.

The replication process of the yellow-head baculovirus (YBV) infected the black tiger prawn,

Penaeus monodon, was studied in the lymphoid organ. Ultrastructural observations at various time sequences suggested that viral replication primarily initiated in nucleus and assembly occurred in the cytoplasm. After 32 hours postinjection, the cytoplasmic replication took place and became majority site for viral replication. Shrimp detected between 48 to 56 hours postinjection were moribund due to the massive cytoplasmic necrosis of those infected cells caused by viral infection.

Keywords: Shrimps; Yellow Head Baculovirus; YBV; *Penaeus monodon*; Lymphoid organs; Black tiger prawn; Yellow Head Disease; Electron Microscopy; Prawns; Viruses

423 Montira Thavornytikarn. 2000. **Using microbiological assay and HPLC method for determination of oxytetracycline residues in shrimp (*Penaeus monodon*) by variation of feed concentrations.** Technical Paper No. 33/2000. Chachoengsao Coastal Aquaculture Development Center. Department of Fisheries. 23 p.

Oxytetracycline (OTC) residues in tissues of ca. 3-month old shrimp (*Penaeus monodon*) were examined by using of microbiological assay and High Performance Liquid Chromatography (HPLC) method. 0, 3, 5 and 10 grams of OTC were blended in 1 kilogram of pelletized meal as a control and 3 treatments. The treated and untreated meal separately fed to experimented shrimps for 7 consecutive days, followed by normal feeding for another 23 days. Examinations were carried out daily on minced shrimp (Homogenized tissues) over a period of 30 days (from day 1 to day 30) for all 3 treatments and control.

Microbiological clear zones were observed in day 2 for every treatment. Treatments at 3, 5 and 10 grams per kilogram, yielded positive results up to day 7, 8 and 9 (or 0, 1 and 2 days after treated period). Compared to the assay, OTC residues were detected by HPLC method from day 1 on in all treatments. The detectable concentrations ranged from 0.020-0.759, 0.11-1.109 and 0.011-2.495 parts per million and these detectable effects were prolonged up to day 13, 14 and 15 for 3, 5 and 10 grams per kilogram OTC treatments, respectively.

In this experimental detectable limit for Microbiological assay was 0.6 microgram per gram (tissues), whilst HPLC method revealed lower threshold and better sensitivity at 0.01 part per million.

Keywords: Prawns; Shrimps; Black tiger shrimp; *Penaeus monodon*; Microbiological assay; HPLC; Oxytetracycline; Residues; Feed; Variation; Drugs; Drug residues

424 Darunee Sae-oui, Anant Tansutapanit and Lila Ruangpan. 1987. *Vibrio harveyi* a causative agent of white shrimp nauplii, *Penaeus merguensis*. Technical Paper No. 6/1987. Coastal Aquaculture Research Sub-Division, Brackishwater Fisheries Division. Department of Fisheries. 11 p.

Luminous bacteria which bloomed in white shrimp, *Penaeus merguensis*, nursing pond while a mortality of the shrimp nauplii occurred 70-100% was isolated and identified by characterization tests as *Vibrio harveyi*. By additional method for pathogenicity test, it was found that the white shrimp nauplii had the most sensitivity to 10^8 CFU/ml *V.harveyi* whereas mysis and post larva were less sensitive respectively. *V. harveyi* was sensitive to chloramphenicol and novobiocin but insensitive to streptomycin. This is the first record of luminous bacterial disease in shrimp nauplii.

Keywords: Prawns; Shrimps; *Penaeus merguensis*; *Vibrio harveyi*; Chloramphenicol; Novobiocin; Streptomycin; Bacteria

425 in Thai

426 Jiraporn Kasornchandra, Sitdhi Boonyaratpalin and J.L. Fryer. 1997. **Primer production used in polymerase chain reaction for diagnosis of Red Disease with White Patches in *Penaeus monodon***. Technical Paper No. 14/1997. National Institute of Coastal Aquaculture, Songkhla. Department of Fisheries. 11 p.

An outbreak of red disease with white patches causing serious mortality in cultured *Penaeus monodon* has been reported since 1994. A sensitive, accurate and reliable diagnostic technique is urgently need, therefore Polymerase Chain Reaction (PCR) is considerably. In this study, we designed primer from a DNA fragment of SEMBV (Tr-3). Nucleic acid was extracted from the purified virus and digested with *Bam* HI restriction endonuclease. The DNA fragment was then inserted into the plasmid pUC 18 vector. Competent *Escherichia coli* JM109 were used for transformation. A clone with plasmid containing inserted of about 1.1 kb was sequenced. A set of oligonucleotide primer was designed and constructed from that of sequences. Specificity of the primer was tested with purified SEMBV (Tr-3) and some shrimp viruses including uninfected shrimp tissues. A single band of amplification product of 520 bp was detected only from SEMBV after analysing in 1% agarose gel electrophoresis, therefore the specificity of this primer was confirmed. PCR method using a set of our primer

described here may contribute to an early and accurate diagnosis for SEMBV infection.

Keywords: Shrimps; White Spot Syndrome Virus; Black tiger shrimp; Polymerase Chain Reaction; PCR; *Penaeus monodon*; DNA; Red disease; White Spot Disease; Prawns; Viruses

427 Varin Tanasomwang and Thaweechai Supaiwan. 1997. **Efficacy of formalin, benzalkonium chloride and povidone iodine in inhibiting *Vibrio* isolated from larval black tiger shrimp (*Penaeus monodon*), rearing water and *Artemia salina***. Technical Paper No. 18/1997. Samutsakhon Coastal Aquaculture Development Center. Department of Fisheries. 17 p.

Thirty five strains of *Vibrio* isolated from larval black tiger shrimp, rearing water and *Artemia salina* including *V. alginolyticus*(5), *V. parahaemolyticus*(7), *V. fluvialis*(7), *V. harveyi*(5) and *Vibrio* spp.(11) were tested for their sensitivity to 3 chemicals in sea water at different time interval. Besides, the susceptibility of *V. alginolyticus*, *V. parahaemolyticus* and *V. harveyi* 5 strains each to the 3 chemicals in 3% NaCl was tested. The concentrations of formalin inhibiting all strains of *Vibrio* in sea water at ½ h were from 200 to >400 ppm. These decreased when time intervals increased. At 24 h, the concentration for *V. alginolyticus* ranged from 50 to 100 ppm, *V. parahaemolyticus* at 50 ppm, *V. fluvialis*, *V. harveyi* and *Vibrio* spp. from 25 to 50 ppm. The toxicity of formalin to *Vibrio* in 3% saline was in the same level or a little higher as compared that to the same species in sea water.

Efficacy of benzalkonium chloride in killing *Vibrio* in sea water at 1/2 h ranged from 12.5 to 100 ppm. Increasing of time, the concentration for some species reduced but some did not change. At 12 and 24 h, those for *V. alginolyticus* and *V. harveyi* ranged from 50 to 100 ppm, *V. parahaemolyticus* at 50 ppm, *V. fluvialis* from 6.3 to 50 ppm and *Vibrio* spp. from 12.5 to 50 ppm. Efficacy of the chemical in suppressing *Vibrio* in 3% NaCl was 2-4 times higher than that in sea water.

The inhibitory concentrations of povidone iodine against *Vibrio* in sea water 1/2 h were in the range of 12.5-100 ppm. The concentrations inhibiting some strains of each species decreased when time interval increased. At 12 and 24 h, those for *V. alginolyticus* ranged from 50 to 100 ppm. and the 4 remaining species from 12.5 to 25 ppm. The toxicity of the chemical to *Vibrio* in 3% NaCl was 2-30 times higher than to the same species in sea water.

Keywords: Prawns; Shrimps; *Penaeus monodon*; Black tiger shrimp; Formalin; Benzalkonium chloride; Povidone iodine; *Vibrio*; *Artemia salina*; Chemicals

428 Nopadon Kakhai, Kanchit Petjamrat and Nopporn Kamtonglang. 1989. **The effective of some antibiotics and chemicals on shrimp larvae diseases.** Technical Paper No. 15/1989. Rayong Brackishwater Fisheries Station. Department of Fisheries. 8 p.

The effective of antibiotics and chemicals used for treatment or prevention on shrimp larvae disease were observed. It was found that Treflan-R 0.01-0.05 ppm together with oxytetracycline or chloramphenicol 3-5 ppm is effective to fungus disease. While filamentous bacteria is sensitive to oxytetracycline or chloramphenicol 3-5 ppm. together with formalin 10-15 ppm. for larvae PL₄-PL₇ at 12-16 hrs. treatment or 20-25 ppm long bath for larvae over PL₈. Formalin at the same concentration as prior mentioned also shows good result for treatment of *Zoothamnium*. On the other hand, there is neither antibiotic nor chemical shows constant effect to luminescence bacteria.

Keywords: Prawns; Shrimps; *Penaeus monodon*; Antibiotics; Chemicals; Diseases; Oxytetracycline; Chloramphenicol; Formalin; *Zoothamnium*; *Lagenidium*; Trifluralin; *Vibrio harveyi*

429 Sitdhi Boonyaratpalin, Wanatda Comvet, Phut Songsangjinda, Jenjit Kongkamnerad and Vinai Krajaywong. 1989. **Disease of tiger shrimp (*Penaeus monodon*) reared in circular concrete tank.** Technical Paper No. 4/1989. National Institute of Coastal Aquaculture, Songkhla. Department of Fisheries. 17 P

Disease of tiger shrimp *Penaeus monodon* reared at the stocking density of 100, 150 and 200 tails/m² in three 120 tons circular concrete ponds were investigated for 4 months. Tiger shrimp were randomly sampling periodically for a total number of 372 tails. *Vibrio* sp. was found in shrimp with rotten appendage and black spot on their body. Other symptoms also found were black gill, and abnormality of body color, which caused by filamentous bacteria, *Zoothamnium* sp., *Epistylis* sp. and *Acineta* sp. The water sample from three ponds were examined for total bacteria count and *Vibrio* sp. count. The results showed that the amount of total bacteria count in three ponds were 8.3×10^3 , 2.1×10^5 , 3×10^3 - 3.5×10^5 and 9×10^3 - 4.1×10^5 cells/ml and the average were 8.94×10^4 , 1.4×10^5 and 9.03×10^4 cells/ml respectively. Whereas, the number of *Vibrio* sp. were 4×10^1 - 6.8×10^3 , 6×10^2 - 5.3×10^3 and 2.6×10^2 - 5.4×10^3 cells/ml and the average were 1.83×10^3 , 2.23×10^3 and 2.56×10^3 cells/ml respectively.

Keywords: Shrimps; Prawns; Aquatic animal; Tiger shrimp; *Penaeus monodon*; *Vibrio*;

Zoothamnium; *Epistylis*; *Acineta*; Bacteria; Diseases

430 Mali Boonyaratpalin, Kidchakan Supanmattaya, Duangchan Suprasert and Chusak Borisuth. 2000. **The immune system in black tiger shrimp *Penaeus monodon* Fabricius: IX. Effects of aflatoxin B on growth performance, blood components, immune function and histopathological changes in black tiger shrimp (*Penaeus monodon* Fabricius).** Songklanakarin J. Sci. Technol. (Suppl.): 641-652.

Black tiger shrimp (*Penaeus monodon*) was given feed containing six levels of maize aflatoxin B₁ i.e. 17, 37, 74, 126 and 220 ppb, there were no statistically significant differences regarding growth, feed intake or FCR during an 8-week period of experiment. The total hemocyte counts, phenoloxidase activity as well SGOT, SGPT in plasma showed increasing trends with increasing concentrations of aflatoxin B₁, although without difference from the control. There were no statistically significant differences in the levels of cholesterol and alkaline phosphatase among the treatment.

At 0, 17 and 37 ppb of aflatoxin B₁ concentration, no histological changes were observed in hepatopancreatic tissues while at the concentrations of 74, 126 and 220 ppb, atrophic changes of hepatopancreatic tubules and hyperplasia of intertubular tissue and partial necrosis of tubular epithelium were clearly observed. The severity of histological changes correlated with the concentrations of aflatoxin B₁ the shrimps received.

Aflatoxin B₁ at 37 ppb, caused no histological changes in hepatopancreatic tissues, which are an important indication normally recognized prior to the effect on growth performance. There was no residual aflatoxin B₁ remaining in the shrimps given 0-220 ppb aflatoxin B₁ and, therefore, there is least possibility that the aflatoxin B₁ would be passed on to the consumers. Aflatoxin B₁ at 37 ppb, caused no histological changes were observed in hepatopancreatic tissues while at the concentrations of 74, 126 and 220 ppb, atrophic changes of hepatopancreatic tubules and hyperplasia of intertubular tissue and partial necrosis of tubular epithelium were clearly observed. The severity of histological changes correlated with the concentrations of aflatoxin B₁ the shrimps received.

Among thirty four feed samples collected from shrimp feed manufacturers and forty four sample from shrimp farms, there was only one sample from that contained 48 ppb aflatoxin B₁. This suggests that aflatoxin B₁ contamination in the shrimp feeds occur either during the transportation or the storage and it can be prevented.

Keywords: Prawns; Shrimps; Immune; Black tiger shrimp; *Penaeus monodon*; Aflatoxin B₁

431 Molrudee Sitthipun, Aran Hanpongkittikul, and Kidchakan Supamattaya. 2000. **Immunostimulant and vaccination in black tiger shrimp, *Penaeus monodon* Fabricius: I. extraction of beta-glucan from yeast and application in black tiger shrimp (*Penaeus monodon* Fabricius).** Songklanakarin J. Sci. Technol., 22 (Suppl.): 653-662.

Saccharomyces cerevisiae TISTR 5088 cultivated at room temperature in shaker (200 rpm) for 36 hours in YEPD medium had 9.0 g/l cell homogenization and extraction the yield from the cell wall was 13.65% of cell dry weight. The beta-glucan was extracted from the cell wall by 2 method : (1) extraction with 50 mM phosphate buffer (pH 8.0 at 90 °C) provide crude beta-glucan 20.0 % of cell wall with total sugar 129.0 mg/g and (2) extraction with 0.75 M sodium hydroxide at 75 °C provided crude beta-glucan 30.0% of cell wall with total sugar 82.2 mg/g. Purification of the 0.02 g/ml beta-glucan by Sephadex showed that samples had the same R_f as the standard beta-glucan.

Four test diets were formulated 8.4 g of yeast cell wall/1 kg feed, crude beta-glucan 1.70g/1kg feed, 1.0 g of pure beta-glucan /1kg feed and control feed. The shrimp fed with pure beta-glucan diet showed the highest number of total haemocyte could feed of $9.90 \pm 1.52 \times 10^4$ cell/ml and exhibited better clearance ability after injection with *Vibrio harveyi* as well as higher disease resistance against *V. harveyi* (90.0%) when compare to shrimp fed with other test diet.

Keywords: Prawns; Shrimps; Black tiger shrimp; *Penaeus monodon*; Vaccination; Immunity; Beta-glucan; Yeasts; *Saccharomyces cerevisiae*; Bacteria; *Vibrio harveyi*

432 Kidchakan Supamattaya, Jareeporn Ruangsri, Suprada Kiriratnikom and Naraid Suanyuk. 2000. **The immune system in black tiger shrimp, *Penaeus monodon* Fabricius : V. Effect of water temperature, DO and pH on immunophysiological functions in black tiger shrimp (*Penaeus monodon* Fabricius).** Songklanakarin J. Sci. Technol. 22 (Suppl): 605-613.

Effects of some environmental factor on blood parameters change and the immune system in black tiger shrimp (*Penaeus monodon*) were investigated. The results showed that total haemocyte and phenoloxidase activating system were not effected at pH 6.0 However, clearance ability, and phagocytic activity when compared with normal dissolved oxygen value 5-5.8 ppm. The reduction of the above parameters was also found

in shrimp kept at 25 °C in comparison with control group at 30 °C.

Keywords: Prawns; Shrimps; Black tiger shrimp; *Penaeus monodon*; Immune; DO; pH; Water; Temperature; Hemocytes

433 D. F. Fegan, T.W. Flegel, ศิริพร ศรีอุไรรัตนนา และ มนัสชัย ไวยครุฑ. 1990. การศึกษาโมโนดอนแบคูลัสไวรัสในภาคใต้ของไทย. Thai Fisheries Gazette. 43(5): 371-378.

The occurrence, development and histopathology of Monodon Baculovirus (MBV) in larvae, post-larvae and broodstock of *Penaeus monodon* was studied over a period of one year in southern Thailand. In histological samples of captured male and female broodstock obtained from the Andaman Sea, the incidence of individuals with MBV occlusion bodies (OB's) was approximately 5.7 percent during the period. Absence of MBV virions in electron micrographs of oocytes of MBV infected females, mature eggs and nauplii indicated that the virus may not be transovarially. Together these facts indicate that elimination of MBV from hatcheries by screening of quarantined wild broodstock would be feasible. In the hatchery, baculovirus OB's began to be clearly identifiable in the hepatopancreas of larvae at the third zoeal stage. During all subsequent larval and post-larval (PL) developmental stages, there was a high incidence of infected individuals, some with extremely large number of OB's. The average incidence of PL positive for OB's in histological specimens approached 100% during the period of the study in a survey that included eight commercial PL producers on both the Gulf of Thailand and the Andaman Sea. However, the incidence of OB positive animals gradually fell as the shrimp grew older and OB's were often undetectable in healthy juveniles derived from infected PL within approximately two weeks of stocking in grow out ponds. In some instances, It was possible to follow groups of PL from the nursery stage through to harvest of market size shrimp. Average survival data for such shrimp followed in a large number of ponds over a period of one year indicated that MBV was well tolerated by *Penaeus monodon* if other rearing conditions were optimal. However, in the event of environmental or other stress, the incidence of animals showing large number of MBV particles increased dramatically.

Keywords: Prawns; Shrimps; *Penaeus monodon*; Monodon baculovirus; MBV; Histopathology; Blood; Diseases; Aflatoxicosis

434 Pysarn Sittikornkoon, Virawan Sitthidarakul, Sunti Rurnmaneeptyoon and Permsuck Menasavat. 1993. **Immunocytochemical localization of**

neuropeptides in the eyestalk of giant tiger prawn, *Penaeus monodon*. Faculty of Science. Srinakharinwirot University. 39 p.

Antisera made against 8 neuropeptides were used to determine the distribution of those peptide like immunoreactive substances in the eyestalk of the giant tiger prawn *Penaeus monodon*, the positive results were obtained from 4 antisera against alpha PDH, beta PDH, FMRFamide and CCK. These antibodies recognize neuronal cell bodies and their processes in several regions including sinus gland. Three antisera made against insulin glucagon and somatostatin gave negative results however, another antiserum made against LHRH shows strong immunoreactivity in only one neuron but staining is not specific for LHRH since the pretreatment of the antiserum with LHRH-BSA was not able to eliminate the staining in this neuron. All CCK immunoreactive neurons are colocalized with PDH like substances and about half of PDH immunoreactive neurons are colocalized with FMRFamide like substances and only few neurons were found to have PDH, FMRFamide and CCK-like substances together. This observation demonstrates a large extensive peptidergic system in the crustacean eyestalk. The morphology of this peptidergic system suggest that one part is neurohormonal and the other part neurotransmitter like or neuromodulatory.

Keywords: Prawns; Shrimps; Giant tiger prawn; *Penaeus monodon*; Neuropeptides; Eyestalks; Antisera; Glucagon; Insulin; Somatostatin; Immunocytochemistry; Immunology

435 Kidchakan Supamattaya and Sitdhi Boonyaratpalin. 1995. **The study of immunity and possibility of vaccination against bacterial and viral disease in black tiger prawn (*Penaeus monodon*).** Faculty of Natural Resources, Prince of Songkla University. 17 p.

Shrimp hemocyte separation and culture techniques were performed as well as phagocytic activity of hemocyte (*in vitro*) was studied. Techniques were used in this study gave the good result for culture and survival of separated hemocyte. Phagocytic activity of normal shrimp is ranging between 41.75-59.21%. Vaccinated shrimp exhibited higher in phagocytic activity of hemocyte but showed no effect on disease resistance. Salinity changes of water gave a little effect on hemocyte count and phagocytic activity of hemocyte.

Keywords: Prawns; Shrimps; *Penaeus monodon*; Black tiger prawn; Immunity; Vaccination; Diseases; Hemocytes; *Vibrio*

436 Sawang Waiprib. 1989. **Diseases of pond-raised tiger prawn, *Penaeus monodon* Fabricius.** Master Thesis. Kasetsart University. 100 p.

Diseases of cultured tiger prawn (*Penaeus monodon*) was studied in 3, 3.69, 5 and 6 raised earthen ponds during 17-18 weeks of rearing period at Amphor Thamai, Changwat Chantaburi. Shrimp samples were used for examination of gross lesion and histopathological studies each week. Water quality was also analyzed during the sampling period. Spotted disease was observed during 3-7 weeks period of rearing. External lesion was the pale-spotted or band on the body. Histopathologically, heart muscles and hepatopancreas were necrotized. *Vibrio* sp. was isolated from hepatopancreas of diseased shrimp. This bacterium was sensitive to oxytetracycline and chloramphenicol. Diseased shrimp did not die unless during poor water quality. Blue disease was observed during 5-7 weeks period. Sky blue body coloration was the main characteristic of this disease otherwise shrimp is normal. Cause of this abnormal coloration is unknown and blue shrimps behave normal. Brown gill disease was found after 5 weeks of rearing during diatom bloom. Brown gill was developed from melanization after bacterial infection and diatom was also found in the gill tissue. Chronic condition of bacterial disease cause black spot on the carapace, body and appendages. This disease may not cause mortality. Tail rod disease was observed after 11 weeks of rearing Swelling of uropod was first appeared and then eroded of tail accompanied by black edge after melanization of bacterial infection observed in chronic condition. No septicemic condition occurred for tail rod disease. Primary cause of this disease is not clear but tail rod was more prominent during diatom bloom and disease shrimp may not die.

Keywords: Shrimps; Prawns; Aquatic animal; Tiger prawn; *Penaeus monodon*; Chantaburi; Diseases; Hepatopancreas; *Vibrio*; Oxytetracycline; Diatoms; Chloramphenicol

437 Kreeson Packthongsuk. 2002. **Production of monoclonal antibody for detection of yellow head virus in black tiger shrimp (*Penaeus monodon*).** Master Thesis. Kasetsart University. 160 p.

Hybridoma cells which secreted monoclonal antibody specific to Yellow head virus (YHV) were produced by cell fusion between myeloma cells (P3-X63-Ag8.653) and spleen cells of Balb/C mice

immunized with purified YHV. Screening test for YHV specific monoclonal antibody production was determined by indirect ELISA test using microwell plate coated with purified YHV and non-infected shrimp haemolymph extract. One hybridoma clone designated 7-2D3-1-B10-2-D11 produced highly specific monoclonal antibody to YHV and has no cross reaction with non-infected shrimp haemolymph extract or white spot syndrome virus antigen. Western blot analysis indicated that the antibody reacted with a protein of YHV which has molecular weight of 22 kDa. Isotype of the monoclonal antibody was IgM with kappa light chain. ELISA titer of the monoclonal antibody supernatant fluid was 1:512 and titer of ascitic fluid was 1:640,000. Application of the monoclonal antibody for detection of YHV was determined by dot-ELISA and indirect ELISA test. Both assays have sensitivity to detect purified YHV at 9.4 ng level. Detection of YHV in 40 YHV-infected shrimps and 20 non-infected shrimps using monoclonal antibody showed 100% correction. This monoclonal antibody might be useful for development of detection techniques for YHV infection in shrimp.

Keywords: Shrimps; Monoclonal antibody; Yellow head disease; YHV; *Penaeus monodon*; Black tiger shrimp; ELISA; Prawns; Viruses

438 Phontep Ploodpai. 1994. **Study on viability of yellow-head baculovirus in sea water and histopathology and haemocyte changes of black tiger shrimp *Penaeus monodon* (Fabricius) infected by yellow-head baculovirus.** Master Thesis. Kasetsart University. 93 p.

Yellow-head Baculovirus (YBV) can survive in sea water more than 12 hours but less than 24 hours. From this study YBV can survive in all different salinities at 10, 20 and 30 ppt. respectively. Histopathological and haemocytic changes in Yellow-head disease of black tiger shrimp were investigated through a series of laboratory infectivity experiments and examination of diseased shrimp from grow-out pond. Histologically, there was typically extensive necrosis with prominent nuclear pyknosis and karyorrhexis, and basophilic cytoplasmic inclusions in numerous tissues of mesodermal and ectodermal origin, including the lymphoid organ, haematopoietic tissue, haemocytes, connective tissue, heart, the walls of stomach and gill. The histopathological study of the diseased shrimp from the grow-out pond yielded results similar to those described in experimental shrimp with some additional observations of haemocytic aggregation, encapsulation and nodule formation, probably associated with secondary bacterial infection.

Haemolymph examined using Wright-Giemsa staining revealed characteristic haemocytic nuclear pyknosis, karyorrhexis and basophilic cytoplasmic inclusions as early as 24-42 hours post-injection in still clinically normal shrimp.

Keywords: Shrimps; Yellow-head baculovirus; Yellow Head Disease; *Penaeus monodon*; Histopathology; Hemocytes; Black tiger shrimp; YBV; Prawns; Viruses; Sea water

439 Amornrat Angajchariya. 2001. **Production of monoclonal antibody to white spot virus for detection of viral antigen in black tiger shrimp (*Penaeus monodon*).** Master Thesis. Kasetsart University. 107 p.

Monoclonal antibodies were produced against white spot virus (WSV) by cell fusion between myeloma cells (P3-X63-Ag 8.653) and spleen cells of Balb/C mice immunized with purified WSV. After screening test by indirect ELISA which used 25% sodium caseinate as blocking agent, 2 hybridoma clones (3C6G3 and 3F4B8) which secreted monoclonal antibodies to WSV were selected for studied. Both monoclonal antibodies were IgM isotype with kappa light chain. By Western blot analysis, monoclonal antibody from 3C6G3 clone reacted with WSV protein which have molecular weight 18 and 28 KD while monoclonal antibody from 3F4B8 clone reacted with WSV protein which have molecular weight 18 KD. Monoclonal antibody from 3C6G3 clone can be used for detection of WSV in black tiger shrimp by indirect ELISA test. This monoclonal antibody give clear cut different of ELISA OD at 492 nm between normal shrimp tissue and purified WSV samples. It have no cross reaction with yellow head virus (YHV). Sensitivity of indirect ELISA for WSV detection was 2 µg/ml. Monoclonal antibody from 3C6G3 clone to WSV can be used for detection of WSV by dot ELISA test which have no cross reaction with YHV and normal shrimp tissue. The suitable blocking agent for dot ELISA test is TBS-T containing 0.5% casein. Sensitivity of dot ELISA for detection of WSV was 1.56 µg/ml.

Keywords: Shrimps; Black tiger shrimp; *Penaeus monodon*; White Spot Disease; Monoclonal antibody; Viral antigen; Prawns; Viruses

440 Nudtha Visitvithayagorn. 2000. **Efficacy of lactoperoxidase for control *Vibrio* spp. in black tiger shrimp (*Penaeus monodon* Fabricius).** Master Thesis. Kasetsart University. 85 p.

Efficiency of Lactoperoxidase enzyme system (LP system) for control *Vibrio* spp. in black tiger shrimp was evaluated. Minimal Inhibitory Concentration (MIC) and Minimal Bactericidal Concentration (MBC) against 5 vibrios bacteria were

between 2,000-4,000 ppm. and 4,000- 8,000 ppm. Respectively. Lactoperoxidase system could reduced vibrios bacteria numbers from 10^4 - 10^5 CFU/ml to non-detectable within 1 hour. The efficiency of LP system depended largely on the bacteria strains, dosage and duration as followed. LP system at the concentration of 2,000, 4,000 and 10,000 ppm. could reduced *V. harveyi* number within 45, 15 and less than 15 minutes, *V. parahaemolyticus* within 30, 15 and less than 15 minutes, *V. alginolyticus* within 30, 15 and 15 minutes, *V. vulnificus* within 45, 15 and 15 minutes. For *V. damsela*, LP system at 2,000 ppm. can not inhibited the growth within 1 hour but at 4,000 and 10,000 ppm. could reduced the number to non-detectable within 15 and less than 15 minutes. However, when the shrimp pellet was added into the test medium prior to add the enzyme, the efficiency was reduced. LP system at concentration of 2,000 and 4,000 ppm. could only reduced *V. harveyi* number from 10^5 CFU/ml to 10^3 CFU/ml within 15-60 minutes but could reduced the number to non-detectable level within 15 minutes at 10,000 ppm. If the enzyme was mixed with the pellet at 0.5%, 1% and 2% of pellet before added into the test medium, the enzyme could not reduced the bacteria number. However, when increasing the enzyme concentration up to 10 and 20% of pellet, LP system could reduced *V. harveyi* from 5.6×10^5 to 4.5×10^2 CFU/ml at 15 minutes and non-detectable level less than 15 minutes. The results from the studies on vibrios number in digestive tract of shrimp after fed with enzyme coated pellet at 0.5% 1%, 2%, 10% and 20% for 3 days revealed that enzyme could not reduced the number of the bacteria. *Vibrio harveyi* challenge test was performed to compare the survival rate of shrimp after treated with enzyme coated feed at 1, 2 and 5% for 3 days before challenged. There was no significantly different between the survival rate in all groups. The reduction in enzyme system efficiency may be due to high pH in the water and the shrimp did not obtain the effective dosage since the enzyme dissolve in the water before being fed.

Keywords: Prawns; Shrimps; Black tiger shrimp; *Penaeus monodon*; *Vibrio*; Lactoperoxidase; Control; Bacteria; Enzymes; Minimal Inhibitory Concentration; MIC; Minimal Bactericidal Concentration; MBC; *Vibrio harveyi*; *Vibrio alginolyticus*; *Vibrio vulnificus*

441 Suppachai Prapadsorn. 1995. **Bacterial flora in the sediment of black tiger shrimp pond with the emphasis in *Vibrio* spp. and their resistance to antimicrobial agents.** Master Thesis. Kasetsart University. 74 p.

Vibrio and total bacteria in the sediment of black tiger shrimp pond in Chantaburi province were regularly examined through the periods of pond preparation, rearing at 1, 2, 3, 4 months, and post harvest. The results from plate count technique showed that the number of *Vibrio* on TCBS were 3.3×10^2 , 4.1×10^3 , 2.9×10^4 , 3.6×10^4 , 6.0×10^4 and 2.3×10^5 CFU/g while the total count observed on Marine agar were 8.2×10^7 , 1.3×10^8 , 2.3×10^8 , 1.6×10^9 , 1.2×10^9 and 2.7×10^7 CFU/g, respectively. Eight species of *Vibrio* bacteria were identified from the total of 135 strains including *Vibrio harveyi*, *V. vulnificus*, *V. parahaemolyticus*, *V. fluvialis* type I, *V. cholerae*, *V. alginolyticus*, *V. anguillarum* and *V. damsela*. The other bacteria found in the sediment were *Escherichia coli*, *Pseudomonas* spp., *Bacillus* spp. and *Salmonella* spp. Based on the Japan Society of Chemotherapy (1981) method of the minimal inhibitory concentration (MIC) of oxolinic acid (OA), ofloxacin (NFLX), oxytetracycline (OTC), chloramphenicol (CP) and kanamycin (KM) against 135 strains of *Vibrio* spp. were evaluated. The results indicated that MICs value of OA, NFLX, OTC, CP and KM ranged respectively from 0.0125- >100, 0.0125->100, 0.025-> 100, 0.1-> 100 and 1.6-> 100 µg/ml. The minimal concentration of OA, NFLX, OTC, CP and KM that can inhibit 50 and 90 percentage of bacterial strains were observed at 1.2 and 37.5, 9.45 and 75, 12.5 and 100, 0.1 and > 37.5 and both > 100 µg/ml respectively. *Vibrio* strain carrying R-plasmids encoded with resistance to OTC were detected in 2 of 40 resistance strains, whereas only one out of 20 resistance strains encoded for resistance to CP.

Keywords: Prawns; Shrimps; Bacteria; *Penaeus monodon*; Black tiger shrimp; Sediment; Emphasis; *Vibrio*; Resistance; Antiinfective agents; *Escherichia coli*; *Bacillus*; *Pseudomonas*; *Salmonella*; *Vibrio harveyi*; Minimal inhibitory Concentration; MIC; Oxolinic acid; Ofloxacin; Oxytetracycline

442 Thanathip Lamkom. 1994. **Efficacy of oxolinic acid against Vibriosis infection in black tiger shrimp (*Penaeus monodon* Fabricius).** Master Thesis. Kasetsart University. 100 p.

Efficacy of oxolinic acid against *Vibrio alginolyticus* infection in black tiger shrimp (*Penaeus monodon*) was studied. Biochemical characteristics of *V. alginolyticus* isolated from diseased shrimp was studied. This species could utilize arabinose, sucrose, saccharose and produced lysine and ornithine decarboxylase enzyme. Yellow colony on TCBS agar and growth in media 10 percent with NaCl were observed. Shrimps (averaging 10 gm.) were fed with medicated pellet feed (2.5 g. per kg. of feed) for three days before intramuscular injection with *V. alginolyticus* at a dosage of LD₅₀ level (5.1×10^6 cells)

and survival rate was observed for seven days. Shrimp fed with medicated feed had higher survival rate (73.33%) than control (34.67 %). Histopathological changes in shrimp injected intramuscularly with this bacteria was studied. At 3 hours post injection, the saline injected controls showed the least damaged tissue. The non-pre medicated feed group showed more extensive damaged tissue with small nodules formation than shrimp fed with medicated feed. Seven days post injection, an affected area in the control group was nearly healed whereas large damaged area with dense haemocytes were found in bacterial injected shrimp. The damaged site in non-treated shrimp was larger than in pre-treated one and healed slower.

Keywords: Prawns; Shrimps; Black tiger shrimp; *Penaeus monodon*; Oxolinic acid; Vibriosis; *Vibrio alginolyticus*; Lysine; Ornithine decarboxylase; TCBS; Feed; Histopathology; Bacteria

443 Praphon Raksincharoensak. 1992. **Residues and effects on growth and diseases of oxytetracycline in *Penaeus monodon* Fabricius.** Master Thesis. Kasetsart University. 96 p.

The study on the residue and the effect of oxytetracycline (OTC) on growth and diseases in black tiger shrimp *Penaeus monodon* Fabricius was conducted. The experiment was divided into three parts :1) The study on the residue of OTC in tiger shrimps that were fed with pelleted feed mixed with different concentration of OTC for 7 and 14 days. The amount and retention time of OTC residues in the shrimp's muscle were related to the concentration and the length of drug receiving period. The higher concentration and the longer period the shrimps received OTC, the higher amount and longer retention time of OTC residue were detected. There was no difference between the coated and uncoated medicated feed. 2) The effect of OTC on growth was studied in three sizes of tiger shrimp, post larvae 5, 30 and 2 months stage. OTC-treated post larvae 5 had better growth rate than the controls, however, there was no difference in the post larvae 30. In 2 month stages, OTC-treated shrimp had slower growth rate than the untreated one. OTC had no effect on the survival rate in all sizes of experimental shrimps. 3) The study on the effect of OTC on vibriosis indicated that the higher concentration of OTC tiger shrimp were fed, the better survival rate against *Vibrio parahaemolyticus* they had.

Keywords: Prawns; Shrimps; Black tiger shrimp; *Penaeus monodon*; Diseases; Drug residues; Oxytetracycline; Drugs; *Vibrio parahaemolyticus*

444 Monchan Maketon and Kamonporn Masawhang. 2000. **Potential of some beneficial bacterias in colonizing *Vibrio harveyi* A luminous bacteria causing disease in shrimp.** In the 38th Kasetsart University Annual Conference, 1-4 February 2000. p. 259-268.

Vibrio harveyi, one of the luminous bacteria causing disease in tiger prawn (*Panaeus monodon*) has been studied for the colonization possibility with 8 different types of known beneficial bacterias. There are *Bacillus subtilis* AM-01, *Bacillus licheniformis* AM-04, *Bacillus* sp. AM-14, *Bacillus* sp. AM-3065, *Nitrosomonas* sp. AM-11, *Nitrosomonas* sp. AM-12, *Thiobacillus* sp. FW-01 and *Thiobacillus* sp. SW-01. After 72 hours of competition and colonization activities on the Nutrient Agar media, 3 species showed good potential, they were *B. subtilis* AM-01, *B. licheniformis* AM-04, and *Nitrosomonas* sp. AM-11. However, *B. licheniformis* AM-04 and *Nitrosomonas* sp. AM-11 showed superior colonization effect to *B. subtilis* AM-01. But the Transmission Electron Microscopic studied found that the morphology of *V. harveyi* colonized by *B. subtilis* AM-01 had changed permanently which opposed to slightly changed of *V. harveyi* colonized by either *B. licheniformis* AM-04 or *Nitrosomonas* sp. AM-11.

Keywords: Prawns; Shrimps; *Penaeus monodon*; Giant tiger shrimp; Bacteria; *Vibrio harveyi*; *Bacillus*; *Bacillus licheniformis*; *Nitrosomonas*; *Nitrobacter*; *Thiobacillus*

445 Suda Tandavanitj and Chantana Kaowtapee. 1997. **Survey and determination of oxytetracycline in preharvest tiger shrimp in Phuket province by high-performance liquid chromatography and microbiological assay method.** Technical Paper No. 25/1997. Phuket Coastal Aquaculture Development Center. Department of Fisheries. 17 p.

Microbiological assay method and high-performance liquid chromatographic (HPLC) method were done for oxytetracycline residue determination in preharvest tiger shrimp in Phuket province. For microbiological screening method was done for the samples in 1995 (Feb-Dec) and 1996 (Jan-Dec), the assay strain are *Micrococcus luteus* ATCC 9341 *Bacillus subtilis* ATCC 6633 and *Bacillus mycoides* ATCC 11778. The results showed that 0.88% of 340 samples and 1.05% of 382 samples were found positive with oxytetracycline in shrimp muscle in 1995 and 1996, respectively. And 387 samples from February 1996 to January 1997 were examined for quantitative by HPLC. Oxytetracycline was separated on a Nova-Pak C18 150x3.9 mm elect. Column and UV detector with wavelength at 355 nm and acetonitrile : 0.01 M oxalic acid TEA pH 4.5 (17.83)

as a mobile phase. The results indicated that 48.06% of samples were found positive with oxytetracycline. The amount of oxytetracycline residue were about 0.001-0.05 ug/g and >0.1 ug/g in 36.95%, 5.94% and 5.16% of samples, respectively. The observation of antibiotics using showed that oxytetracycline, oxolinic acid and sulfa drug were generally used, which were applied to 58.70% of samples in 1995 and 65.45% of samples in 1996 during the culture period. However, the antibiotics using from >90 days of rearing were only about 3.83%, and 1.83% of samples in 1995 and 1996, respectively.

Keywords: Prawns; Shrimps; Black tiger shrimp; *Penaeus monodon*; Microbiological assay; HPLC; High Performance Liquid Chromatography; Oxytetracycline; Phuket; Drugs; Drug residues; Residues

446 Sapon Onkong. 2002. **Feed medicated with oxytetracycline and its residues in cultured black tiger shrimp (*Penaeus monodon* Fabricius).** Master Thesis. Prince of Songkla University. 95 p.

Feed medicated with the antibiotics, oxytetracycline (OTC) is commonly administered for the treatment of systemic bacterial infections in aquaculture in black tiger shrimp (*Penaeus monodon*) culture. Use of antibiotics for such purpose needs careful evaluation in order to determine the effect and efficiency of drug usage and safety of consumers. This experiment was conducted to study 1) the leaching and lose of OTC from pelleted shrimp feed, 2) the acceptance of OTC-medicated feed by black tiger shrimp, 3) the residues of OTC in black tiger shrimp cultured in cement tanks and earthen ponds and 4) the residues of OTC in seawater and sediments of earthen shrimp ponds. Commercial pelleted shrimp feed No. 4 and 5 which are normally used for 7.0-12.0 and 12.0-20.0 g shrimp were used in the study. Medication was by coating the pelleted feed with an OTC solution at the rate of 5 g/kg of feed and then spraying the feed with fish oil. The concentrations of OTC in feed, shrimp, seawater and sediment were analyzed using HPLC.

After submerging feed No. 4 and 5 at salinities of 0, 15, 30 and 40 ppt. for durations of 30, 60, 120 and 180 min, leaching of OTC from feed varied with salinities and duration of soaking. Both feeds had the least leaching at 30 min in 0 ppt. water and the highest leaching at 180 min. in 40 ppt. seawater. Leaching of OTC from feed No. 4 was 2 times greater and faster than No. 5. The No. 5 feed had less surface area/volume and density than feed No. 4. The leaching ranged from 40-95% and 20-50% for feed No. 4 and 5, respectively. The main

loss of OTC was from the process of mixing the drug onto the feed. Losses amounted to more than 35 and 60% of initial concentrations of OTC (5,000 ppm) for feed No. 4 and 5, respectively. The study on feed acceptance by 3 month old black tiger shrimp (average weight of 17.54 ± 0.04 g/shrimp) to OTC-medicated feed resulted in an average feed intake (g/day/shrimp) of 0.40 ± 0.010 for shrimp fed with OTC-medicated feed and 0.45 ± 0.008 for shrimp fed normal feed. Feed intake of shrimp fed with OTC-medicated feed was 7.74% lower ($P \leq 0.05$) than those fed with normal feed, but feed intake of both groups of shrimp was 60% of the amount of feed given. However, the average daily growth rate of shrimp fed with OTC-medicated feed was not difference ($P \geq 0.05$) from that of shrimp fed regular feed. This lack of difference probably was due to the short period (7 days) of the experiment.

The OTC concentrations in the hepatopacreas of the shrimp from earthen ponds and cement tanks during the medication period were 2-3 times higher than those in the other tissues in both culturing conditions. The highest average concentrations in this tissue were 34.238 ± 4.370 and 37.746 ± 3.008 ppm. in shrimp reared in earthen ponds and cement tanks, respectively. The lowest concentrations of OTC (ppm) were in total body mass and integument of the shrimp from earthen ponds (10.562 ± 2.431) and cement tanks (9.920 ± 0.058). The OTC concentrations in all tissues rapidly decreased after the medication period to less than detection limit at 15 and 18 days for shrimps kept in earthen ponds and cement tanks, respectively. The fastest elimination of OTC residues occurred in the hepatopancreas of the shrimp from both culturing conditions. The statistical analysis of half-life ($t_{1/2}$) of OTC of different tissues in the same culturing condition showed that there was no significant difference ($P \geq 0.05$) among tissues. However, the half-life of OTC in integument, hepatopancreas and total body mass between the two different culturing conditions was significantly different ($P \leq 0.05$). The concentration of seawater and sediment in shrimp ponds during medication gradually increased, especially in the sediment with the peak concentrations of 0.585 ± 0.127 and 2.156 ± 0.388 ppm, respectively. After medication, OTC concentrations were not detected in seawater at day 10 when the OTC concentrations in sediment were still high (1.098 ± 0.098 ppm.) The average half-life of OTC in seawater and sediment was 1.93 ± 0.59 and 13.57 ± 1.88 days, respectively. The results indicate that OTC may be very persistent in the sediment and that the disappearance of OTC is faster in seawater than in sediment ($P \leq 0.05$).

The results of this study suggest that the efficacy of OTC in black tiger shrimp culture will depend upon the methods of drug administration, water salinity and duration of feed in the water. More

importantly, drug residues both in the shrimp and surrounding environment due to improper drug usage could be detrimental to consumer health.

Keywords: Prawns; Shrimps; Black tiger shrimp; *Penaeus monodon*; Oxytetracycline; Feed; Residues; Antibiotics

447 Doungkamol Jarearnkul, Supat Buranawat and Supol Chantakod. 1994. **Efficacy of immune stimulate products for prevention of bacterial infection in black tiger shrimp, *Penaeus monodon*.** Clinical Conference. Faculty of Veterinary Science. Chulalongkorn University. 15 p.

The efficacy of immune stimulant products for prevention of bacterial infection, *V. parahaemolyticus*, was evaluated in Black Tiger shrimp. The experiment was done by divided the shrimp into 4 groups. Basal diet was used in the control group, Protein, Casein and Casein plus L-ascorbate-2 Sulphate added to the basal diet were used in second, third and fourth groups respectively. The rates of growth and percentage of chemotaxis in each group were measured and found to not significantly different among all groups ($P>0.05$). The survival rates of shrimp fed with the second diet group was not significantly different from the control group ($P>0.05$). While the survival rates of those fed with the third and fourth were not significantly different ($P>0.05$) but the survival rates of both groups were significantly higher than control group ($P<0.05$).

Keywords: Prawns; Shrimps; Black tiger shrimp; *Penaeus monodon*; Immune; Bacteria; Vibriosis; Immunity; *Vibrio parahaemolyticus*; Proteins

448 Rabin Rattanaphani, Jirasak Tangtrongpiros, Nantirika Issarasak na Ayuthaya. 1992. **Histopathology and pathogenesis of Monodon Baculovirus (MBV) in *Penaeus monodon*.** J. Aqua. Ani. Dis. 13(2) : 27- 41

MBV disease is described histologically in the cultured shrimp. The outbreak of the disease was observed in late juvenile up to adult *P. monodon*. Multiple spherical eosinophilic intranuclear occlusion bodies were demonstrated in both fresh and fixed hepatopancreatic epithelial cells. Secondary bacterial infection with *Vibrio* spp. causes severe hepatopancreatitis. The course of the disease is subacute to chronic with high mortality rate of the affected population.

Keywords: Prawns; Shrimps; *Penaeus monodon*; Monodon baculovirus; Diseases; Pathogenesis;

Histopathology; *Vibrio*; Occlusion body; Hepatopancreatitis

449 Bundid Leelyana, Tatchai Sangkool and Jirasak Tangtrongpiros. 1990. **The use of neomycin and lincomycin+spectinomycin for prevention of bacterial infection in *Penaeus monodon*.** Clinical Conference. Faculty of Veterinary Science. Chulalongkorn University. 20 p.

Neomycin and Lincomycin + spectinomycin were used for preventive bacterial infection in postlarva 25 *Penaeus monodon*. The shrimps were divided into 2 groups after 24 hours expose to these drugs. The first group was challenge with 5.74×10^8 cfu/ml of *Vibrio anguillarum* and the second group was challenge with 3.50×10^8 cfu/ml of the same bacterias. Survival Rate (S.R.) of the both groups in the Lincomycin + spectinomycin treatment at 5 ppm was 90.32% and 79.80%, at 10 ppm was 86.90% (in the second group). The S.R. of Neomycin treatment at 5 ppm was 90.43% and 72.73%, at 10 ppm was 92.22% and 73.40% whereas the controlled group was 67.77% and 52.08% consequently. The S.R. of treatment and controlled groups were significant difference ($P>0.01$) but there was no significant different between the 5 and 10 ppm of the treatment groups ($P<0.05$)

Keywords: Prawns; Shrimps; *Penaeus monodon*; Bacterial Infection; Neomycin; Lincomycin; Spectinomycin; Antibiotics; Drugs; Bacteria

450 Arunya Ponpornpisit, Naratip Moungsang and Nawakhanit Sachanonta. 1989. **The effects of sulfadiazine-trimethoprim and sulfatroxazole-trimethoprim in larval stages of giant tiger prawn (*Penaeus monodon*) and 4 kinds of planktons in 24 hours.** Clinical Conference, Faculty of Veterinary Science, Chulalongkorn University. 40 p.

The studies on the effects from using 2 combinations of Sulfonamides and trimethoprim in ratio of 5:1; Aditoprim^R (sulfadiazine-trimethoprim 12.5%) and Leotrox^R (sulfatroxazole-trimethoprim 24%). These drugs were used in larval and postlarval stages of Giant tiger prawn from Nauplii to post larvae 20 in concentrations of 0-100 ppm. The mortality rate were checked at 24 hours. The drugs were also used in Zooplankton; *Artemia* sp., and 3 kinds of Phytoplanktons; *Chaetoceros* sp., *Skeletonema* sp. and *Tetraselmis* sp., in concentrations of 0.0-10.0 ppm then the percentage of death of Zooplankton and the amount of Phytoplanktons were checked at 3, 6, 12, and 24 hours by random sampling. The Nauplius and Zoea have no resistance to these drugs. In 24 hours, the highest concentrations that the Mysis and post larvae could survive was 30 ppm in Aditoprim^R, and 100

ppm in Leotrox^R. The distinguishable effects of the drugs on planktons were recognized when the time was longer than 6 hours.

Keywords: Prawns; Shrimps; Giant tiger prawn; *Penaeus monodon*; Drugs; Sulfadiazine; Trimethoprim; Sulfatroxazole; Plankton; *Artemia*; *Chaetoceros*; *Skeletonema*; *Tetraselmis*; Aditoprim, Leotrox

451 Kriengsak Thamthiwat, Prasert Lormwongvidhaya, Saksiri Thangprakob and Jirasak Tangtrongpiros 1991. **The efficacy of Toltrazuril (Baycox)^R in treatment of Zoothamniasis in black tiger prawn (*Penaeus monodon*) by oral administration.** Clinical Conference. Faculty of Veterinary Science. Chulalongkorn University. 17 p.

The efficacy of toltrazuril was tested to the zoothamnium affected shrimp by oral administration. The drug was mixed to the shrimp feed at the dosage of 25, 50, 75, 100, 200 ppm for 7 days. The number of *Zoothamnium* spp. was examined in day 3, 5, 7 and 14 after the last administration. The results showed that the parasites were most decreased at the 100 ppm concentration. The residue of toltrazuril was also analysed.

Keywords: Prawns; Shrimps; Black tiger prawn; *Penaeus monodon*; Drugs; Toltrazuril; Baycox; *Zoothamnium*

452 Arton Puneam, Udomsak Suksuteepasu, Jirasak Tangtrongpiroj and Natarika Issarasak. 1990. **The Efficacy of Toltrazuril (Baycox)^R in treatment of *Dactylogyrus* spp. in angel fish, carp and *Zoothamnium* spp. in black tiger prawn.** Clinical Conference. Faculty of Veterinary Science. Chulalongkorn University. 6 p.

The efficacy of toltrazuril (Baycox) was studied in treatment of *Dactylogyriasis* in angel fish, carp and *Zoothamniasis* in black tiger prawn. The result showed that 10 and 20 ppm in 5 hours in angel fish and 30 ppm in carp. In shrimp the active stage of parasite changed to inactive stage at the dosage of 40 ppm in 7 hours and 50 ppm in 6 hours. This drug should be the drug of choice in treatment of external parasite in aquatic animal.

Keywords: Prawns; Shrimps; *Pterophyllum scalase*; Carp; Fishes; *Cyprinus capio*; *Zoothamnium*; Black tiger prawn; *Penaeus monodon*; Toltrazuril; Baycox; Drugs

453 Staporn Direkbudsaracham, Angkana Herunsalee, Sitdhi Boonyaratpalin, Yaowanit

Danayadol and Ussanee Ekpanithanpong. 1993. **The virucidal activity of *Clinacanthus nutans* (Lindau) extracts against yellow head baculovirus on tiger prawn (*Penaeus monodon*).** Technical Paper No. 8/2536. National Institute of Coastal Aquaculture. Songkhla. 7 p.

The leaves of *Clinacanthus nutans* Lindau claimed in Thai traditional medicine to have antiviral activities as extracted by ethanol boiling under soxhlet. The extract was tested for inhibitory activity against the Yellow head baculovirus (YBV) by mixing the virus at concentration 1:10000 to a known dilution of the extracts the extracts in Lobster haemolymph medium (LHM) for 2 hr. at 25 °C before injection. Virocidal effect was investigated by the observation of the mortality rate on the injection tiger prawn (*Penaeus monodon*). The result showed that extracts of *Clinacanthus nutans* leaves could inhibit YBV and the minimum concentration which inhibited YBV of the extract was 1 ng/ml. While the LD₅₀ of the extract on post larvae 15 was 2468±7.8 ppm. Moreover, the extract was also induced phagocytosis activity in tiger prawn.

Keywords: Prawns; Shrimps; Tiger prawn; *Penaeus monodon*; *Clinacanthus nutans*; Lindau; Yellow Head Baculovirus; Probiotics

454 Varin Tanasomwang and Thaweechai Supaiwan. 1997. ***Alteromonas* producing antibiotic inhibiting *Vibrio* isolated from black tiger shrimp hatchery.** Technical Paper No. 37/1997. Samutsakhon Coastal Aquaculture Development Center. Department of Fisheries. 17 p.

Fourty five strains of marine bacteria (N01-N45) were isolated as antibiotic producers from larval black tiger shrimp (*Penaeus monodon*), brine shrimp (*Artemia salina*) and seawater by using swarming bacteria as indicators. These marine bacteria were examined for their abilities in inhibiting 50 strains (V01-V50) of various species of *Vibrio* isolated from the similar sources. As a result, 27 to 45 strains of such marine bacteria inhibited *Vibrio* from 32 to 94% of the strains tested. All of the 27 strains were Gram-negative aerobes, short rods 1.0 - 1.5 x 2.0 - 2.5 µm in size and motile by means of single polar flagellum. None fermented glucose and all required a seawater base for growth. The guanine and cytosine content of DNA was 42.4-45.3 % mol. Based on these taxonomic characteristics, they were identified as *Alteromonas* spp. Mixed culture between *Alteromonas* N06 and each strain of *V. alginolyticus* V07, *V. parahaemolyticus* V13 and *V. harveyi* V22 in Marine Broth 2216 was carried out to observe their interaction. Whether *Alteromonas* N06 being cultivated on Marine Agar 2216 for 2, 3 or 4 days before assaying for its inhibitory activity against

Vibrio, the bacterial number of each organism in mixed culture at 1, 2, 3 or 4 days was a little lesser than of each strain in mono-culture at the same period. The interaction between each strain of *Alteromonas* N01, N18 and N29 and each species of *Vibrio* being cultured in Yeast Extract Broth for 3, 4 and 5 days was also assayed. Mixed culture at 4 days duration, slight inhibitory activity of *Alteromonas* N06 against *Vibrio* was noticed by which the number of *Alteromonas* N06 was almost the same while that of *V. alginolyticus* V07 decreased more than 50, *V. parahaemolyticus* V13 about 125 and *V. harveyi* V22 12.5 times as compared to each strain in mono-culture.

Keywords: Prawns; Shrimps; Black tiger shrimp; Hatcheries; *Alteromonas*; Antibiotics; *Vibrio*; *Penaeus monodon*; *Artemia salina*

455 Kitchakarn Supamattaya, Witthiporn Phromkunthong, Chutima Tantikitti and Rudolf Hoffmann. 2000. **The immune system in black tiger shrimp, *Penaeus monodon* Fabricius: II. Cells and tissues involved then removal of foreign particles in black tiger shrimp (*Penaeus monodon* Fabricius).** Songklanakarin J. Sci. Technol. 22 (suppl.): 581-588.

Saccharomyces cerevisiae were used as the foreign particles for tissue and cell examination and monitoring of the cellular defense system in black tiger shrimp (*Penaeus monodon* Fabricius) using the total hemocyte count (THC) and histological techniques. From the experiment, the THC rapidly decreased within 1 hour post injection, from $3.36 \pm 1.85 \times 10^4$ cell/mm³ in control to $2.12 \pm 1.96 \times 10^4$ cell/mm³ in treatment trial. Histological study showed that the hemocytes and fixed phagocyte in the gill tissue, lymphoid organ, heart tissue, hepatopancreas and connective tissue were sensitive to the foreign particles, but could be detected very slightly in muscle and nervous tissue. The mechanism of defense with yeast particles being attacked by a single hemocyte or fixed phagocyte, followed by an increasing number of cells aggregated to form a nodule and capsule respectively, and finally undergoing melanization and removal from the body. The fine structure and the differential of hemocytes and fixed phagocytes are discussed in this paper.

Keywords: Prawns; Shrimps; Black tiger shrimp; *Penaeus monodon*; Immune; Hemocytes; Cells; Yeasts

456 Kitchakarn Supamattaya and Sitthi Boonyaratpalin. 1996. **The study of histopathology and cytopathological changes in black tiger shrimp (*Penaeus monodon*) caused**

by yellow-head virus and red color and white spot disease virus. Songklanakarin J. Sci. Technol. 18(1): 17-33.

Yellow-head virus and red color and white spot disease virus infection in black tiger shrimp (*Penaeus monodon*) were studied. The virulence of these viruses is similar to that estimated under laboratory conditions. Infection by these viruses in *P. monodon* caused a decrease in hemocytes count. Histopathological changes of yellow-head infection included necrosis and degeneration of cell and organs, especially the gills, lymphoid organ, hemopoietic tissues and connective tissues, whereas red color and white spot virus infection caused hypertrophic nuclei of those organs. Electron microscopical evidence indicated that most yellow-head virus are replicated in the cytoplasm of the cell, while red color and white spot disease virus is apparent mainly in the nucleus. Decreased hemocytes after by infection of these viruses was due to infected hemocytes being engulfed by normal hemocyte which then become infected themselves. This cycle reduced the hemocytes in circulating blood.

Keywords: Prawns; Shrimps; Black tiger shrimp; *Penaeus monodon*; Histopathology; Yellow Head Virus; Red Color and White Spot Disease Virus; Electron Microscopy; Cytopathology; Viruses

457 Kidchakan Supamattaya, Jareeporn Ruangsri, Suprada Kiriratnikom and Narin Songsrichan. 2000. **The immune system in black tiger shrimp, *Penaeus monodon*, Fabricius : IV. Normal immuno-physiological values in black tiger shrimp, *Penaeus monodon*, Fabricius.** Songklanakarin J. Sci. Technol 22 (Suppl.): 597-603.

A comparative study was carried out to determine the variations of blood parameters, i.e. total hemocyte count, plasma protein, blood sugar, plasma pH ion, plasma osmolality, plasma, phenoloxidase and phagocytic activity of hemocytes in cultured as well as in laboratory maintained shrimps. It was noted that the blood parameters varied over wide ranges. When comparing between the individuals from the farm and the laboratory environment, the total hemocyte counts were $6.49 \pm 2.33 \times 10^4$ and $3.07 \pm 1.91 \times 10^4$ cell/mm³ while phenoloxidase activity were 335.18 ± 106.29 and 217.84 ± 161.99 unit/min/mg protein, respectively. It indicates that variation in both blood parameters is influenced by culture environment particularly the temperature in the laboratory which may fluctuate widely as compared to the farm environment. Other blood parameters did not show significant differences between the two shrimp groups, i.e. plasma pH was 7.43 ± 0.15 and 7.78 ± 0.08 for the farm cultured and laboratory -maintained individuals. The blood sugar

for the laboratory-maintained individuals had an average of 53.87 ± 54.84 mg% which was higher than that of the farm which had 32.91 ± 27.95 mg%. The serum protein showed on difference between the two shrimp groups, i.e. 11.85 ± 5.17 and 11.43 ± 3.81 g%. The osmolarity of plasma in cultured individuals was 778.49 ± 60.80 mOsmole/kg while the concentrations of Na^+ , K^+ , Cl^- and albumin from plasma in the cultured individuals were 314.52 ± 28.96 , 9.61 ± 1.20 , 347.20 ± 45.54 mOsmole/ kg and 1.51 ± 0.35 g %, respectively.

Keywords: Prawns; Shrimps; Black Tiger Shrimp; *Penaeus monodon*; Immune; Phenoloxidase Activity

458 Varin Tanasomwang, Thaweechai Spaiwan and Somprasong Kanthom. 1994. **Bacterial flora of black tiger shrimp larvae**. Technical Paper No. 11/1994. Samutsakhon Coastal Aquaculture Development Center. Coastal Aquaculture Division. Department of Fisheries. 44 p.

Investigation on the aerobic bacterial flora of black tiger shrimp (*Penaeus monodon*) larvae from the nauplius V-VI to post larva II stages were made in relation to the microflora of rearing waters and feeds. Samples were drawn from 2 nursing ponds. Pond1 was kept untreated and served as control, while pond 2 was subjected to the chloramphenicol, oxytetracycline and formalin treatments normally used by shrimp nursery operators. External and internal bacterial counts on untreated larvae from pond 1 ranged from 10^2 to 10^4 and 10 to 10^4 CFU/individual respectively on Zobell's 2216e agar and from 10^0 to 10^3 and 10^0 to 10^2 CFU/individual respectively, on TCBS agar. The external and internal shrimp flora at nauplius V-VI to zoea III stages consisted primarily of *Pseudomonas* with *Vibrio* and/or *Moraxella*, *Acinetobacter*, *Cytophaga*/ *Flavobacterium* on occasions. The transformation of the shrimp larvae to mysis II was associated with a sharp increase in mortality. From this stage on, *Vibrio* appeared to be predominant. Analogous bacterial counts on shrimp from the treated pond were in the same range or lower than those for pond 1. The mortality was also observed at the mysis II stage but lower probably because proliferation of *Vibrio* was suppressed by the drugs. The bacterial counts on Zobell's agar for rearing water of the two ponds ranged from 10^4 to 10^5 CFU/ml, and for feeds including *Chaetoceros*, frozen brine shrimp (*Artemia salina*) and artificial feed were in the level of 10^4 , 10^6 and 10^3 CFU/ml or g, respectively. The flora of rearing water comprised mainly *Pseudomonas* and *Vibrio*. While *Pseudomonas* predominated in *Chaetoceros* and *Vibrio* in frozen

brine shrimp, Gram-positive bacteria in addition to *Moraxella* were prevalent in artificial feed. These indicate that frozen brine shrimp was the main source of *Vibrio*, the predominant type of bacteria associating with the mortalities of both treated and untreated shrimp stocks.

Keywords: Prawns; Shrimps; *Penaeus monodon*; Black tiger shrimp; Microflora; Feed; Bacteria; *Pseudomonas*; *Vibrio*

459 Jiraporn Kasornchandra and Sitdhi Boonyaratpalin. 1995. **Development of monoclonal antibodies for specific detection of the yellow-head disease in *Penaeus monodon***. Technical Paper No. 15/1995. National Institute of Coastal Aquaculture, Songkhla. Department of Fisheries. 14 p.

Monoclonal antibodies (Mabs) directed against the yellow-head baculovirus (YBV) the pathogen of the yellow-head disease of cultured *Penaeus monodon* were produced. Four Mabs (M1-M4) were developed and had the isotype of immunoglobulin (Ig)M. The Mabs were highly specific to purified YBV in Western blot and dot immuno-binding assays. Testing of fresh clinical specimens in indirect ELISA indicated that not only MAb specifically bind the YBV in the infected shrimp but bind nonspecifically to substances containing in crude shrimp extracts. This nonspecific binding interfere the interpretation of the results.

Keywords: Shrimps; *Penaeus monodon*; Monoclonal antibody; Yellow Head Disease; ELISA; YHV; Yellow head Virus; Black tiger shrimp; Prawns; Viruses

460 Subongkot Kamnertmanee. 1997. **Efficacy of norfloxacin nicotinate against Vibriosis infection in black tiger shrimp (*Penaeus monodon* Fabricius)**. Master Thesis. Kasetsart University. 113 p.

Physiological and biochemical characteristics of *Vibrio harveyi* isolated from diseased shrimp were studied. This species could utilize glucose, saccharose and mannitol. It produced lysine decarboxylase, cytochrom oxidase and β -galactosidase enzyme. Green colony on TCBS agar and growth in media with NaCl 1-6 % were observed. Efficacy of norfloxacin nicotinate was evaluated for control of vibriosis infection in black tiger shrimp. *In vitro* sensitivity test, minimal inhibitory concentrations of norfloxacin nicotinate against 38 isolates ranged between 0.0625-4.0 ppm. and minimal bactericidal concentrations studies indicated efficacy at 0.125-4.0 ppm. Shrimps (averaging 10 g) were fed with medicated pellets (5 g norfloxacin nicotinate/kg of feed) for three days before

intramuscular injection with *V.harveyi* at a dosage of LD₅₀ level (3.14×10^7 cells/ml). Accumulated mortality were studied for seven days post infection, the pre-treated group had a higher survival rate (77.33%) than control (41.33%). A significant ($P \leq 0.01$) reduction in mortality was observed. Histopathological changes in shrimp injected intramuscularly with this bacteria revealed that at 6 hours post injection, in bacterial injected group showed encapsulation and a small nodules around the damaged area. The saline injected controls showed the least damaged tissue. After 7 days, an affected area with dense haemocytes found in bacterial injected shrimp. The damage site in non-treated shrimp was larger than in pre-treated shrimp and healed slower.

Keywords: Prawns; Shrimps; Drugs; Norfloxacin; Vibriosis; Black tiger shrimp; *Penaeus monodon*; *Vibrio harveyi*; Histopathology; Bacteria

461 Panarat Phadee. 1997. **Application of benzalkonium chloride, glutaraldehyde and their mixture to control *Vibrio* spp. and their toxicities in *Penaeus monodon* Fabricius larvae.** Master Thesis. Kasetsart University. 115 p.

Study on the suitable ratio between benzalkonium chloride and glutaraldehyde for disinfection property revealed the ratio of 2:0.5 which resulted in additive effect. Minimal inhibitory concentration (MIC) of benzalkonium chloride, glutaraldehyde and their mixture in *Vibrio alginolyticus*, *V. cholerae*, *V. harveyi* and *V. parahaemolyticus* at 5.5×10^5 CFU/ml were at the range of 16-64, 8-32 and 8-32 ppm respectively. Minimal bactericidal concentration (MBC) tested in Mueller Hinton Broth were 32-128, 16-64 and 8-32 ppm respectively but when tested in 1% NaCl, these values were 2-8, 2 and 1-2 ppm respectively. It was also found that *V. alginolyticus* was the most sensitive to these chemicals while *V. cholerae* was the most resistant one. Benzalkonium chloride was most effective at pH9; 5 and 6 for glutaraldehyde and 7 for the mixture. All three chemicals were most effective at salinity of 5 ppt. And would be less effective when the salinity increased (10, 20, 30 and 40 ppt). Acute toxicity test on *Penaeus monodon* postlarva 15 by static bioassay indicated the LC₅₀ at 24 hr of benzalkonium chloride, glutaraldehyde and their mixture to be 3.15, 2.85 and 1.70 ppm. with slope function of 3.35 (2.39-4.69) 3.75 (2.51-5.61) and 2.61 (1.94-3.51) respectively. These three chemicals did not affect pH, temperature and dissolved oxygen but did cause slight increase on alkalinity, hardness and total ammonia nitrogen.

Keywords: Prawns; Shrimps; *Penaeus monodon*; Benzalkonium chloride; Glutaraldehyde; *Vibrio*; *Vibrio alginolyticus*; *Vibrio cholerae*; *Vibrio harveyi*; *Vibrio parahaemolyticus*; Minimal Inhibitory Concentration; Minimal Bactericidal Concentration; Mueller Hinton Broth; Chemicals; Toxicity; Acute toxicity

462 Somprasong Kanthom. 1996. **Toxicity of formalin on the mortality rate of white shrimp (*P. merguensis*) larvae.** Technical Paper No. 5/1996. Chumpon Coastal Aquaculture Station. Department of Fisheries. 15 p.

The parasite which cause the high mortality of shrimp larvae in hatcheries is Protozoa. Formalin is a popular chemical have been used for eradicate them. It is very toxic to shrimp larvae if formalin was applied with unsuitable concentration. Therefore, the study of toxicity of formalin on the mortality of shrimp larvae is necessary and the results of this study are the following; Zoea 1-2, formalin 20, 30, 40 and 50 ppm. Some of shrimp died suddenly and mortality rate values are 66.67, 66.67, 66.67, 100% at 30 minutes, respectively.

Zoea3 - Mysis1,	12 hr.	LC ₅₀ =	25.61 ppm
Safety concentration		=	2.56 ppm
Mysis 1-2,	24 hr.	LC ₅₀ =	29.67 ppm
Safety concentration		=	2.97 ppm
Mysis 2-3	24 hr.	LC ₅₀ =	32.11 ppm
Safety concentration		=	3.21 ppm
Mysis 3-Post larva 1,	24 hr.	LC ₅₀ =	32.15 ppm
Safety concentration		=	3.22 ppm
Post larva 2-3,	24 hr.	LC ₅₀ =	37.07 ppm
Safety concentration		=	3.70 ppm
Post larva 4-5,	24 hr.	LC ₅₀ =	39.35 ppm
Safety concentration		=	3.94 ppm
Post larva 5-6,	24 hr.	LC ₅₀ =	49.90 ppm
Safety concentration		=	4.99 ppm

Keywords: Prawns; Shrimps; White shrimp; Toxicity; Formalin; Mortality; *Penaeus merguensis*; Drug residues; Drugs

463 Pitchaya Chainark, Kanyanee Nawat and Nongluk Samranrat. 2000. **Monitoring of oxytetracycline residues in black tiger shrimp pond soil in Phangnga province.** Technical Paper No. 46/2000. Phangnga Coastal Aquaculture Development Center. Department of Fisheries. 10 p.

The residues of oxytetracycline in old soil and bottom soil of black tiger shrimp (*Penaeus monodon*) ponds at different age groups of 160 shrimp ponds either still culturing shrimp 1-2, 3-4, 5-6 and more than 7 years old in Phangnga province were studied. The result showed that, the amount of ponds those indicated the residue of oxytetracycline in old soil and bottom soil at still culturing shrimp 1-2, 3-4 and

5-6 years old were not significant ($P>0.05$). The amount of ponds those can be detected the residues of oxytetracycline in old soil at still culturing shrimp 1-2, 3-4 and 5-6 years old were 16, 21 and 16 ponds and in bottom soil were 21, 13 and 11 ponds, respectively. For more than 7 years old amount of ponds those indicated the residue of oxytetracycline in old soil and bottom soil were significant ($P<0.05$) and amount of pond those can be detected the residues of oxytetracycline in old soil and bottom soil were 7 and 18 ponds.

Keywords: Prawns; Shrimps; Black tiger shrimp; *Penaeus monodon*; Residues; Oxytetracycline; Phang-nga; Drugs; Drug residues

464 Kanokphan Srimanobhas. 1997. **Comparative study of Enzyme Linked Immunosorbent Assay (ELISA) and conventional culture procedure for detection of *Salmonella* in frozen shrimps.** Master Thesis. Silpakorn University. 80 p.

The comparative studies of sensitivity and reliability of bead immunocapture system, ELISA test system and conventional culture procedure to detect *Salmonella weltevreden* indicated that there was no significant difference ($P<0.05$) among the three methods. It was found that the bead immunocapture was more sensitive than the others. This is because the bead immunocapture could detect at least 1-10 cfu while the ELISA and conventional culture procedure could detect at least 100 cfu of the organism. The sensitivity and reliability of the bead immunocapture system and the conventional culture procedure to detect *Salmonella enteritidis*, *S. kentucky*, *S. paratyphi B*, *S. senftenberg* and *S. weltevreden* in artificially inoculated frozen shrimps also showed that there was no significant difference ($P<0.05$) with similar sensitivity. Both methods could detect at least 1 cfu per gram of the frozen shrimp. The survival period of *Salmonella* spp. in positive frozen fisheries products (40 samples) kept at -18°C , was found in range 1 to 7 months. Among these 40 positive frozen samples, 5 samples were detected for surviving *Salmonella* using the conventional method and 11 samples were found positive using the bead immunocapture. However, when the VITEK GNI card was used to further identified the organism in these samples, 6 of 11 samples were not *Salmonella*. The exiting of *Salmonella* antigen in 25 positive samples kept in M broth at -18°C for 1, 2 and 4 weeks were found at 96, 96 and 84 percent respectively, of which there was no significant difference ($P<0.05$). The comparative studies of growth efficiency of enrichment media between tetrathionate broth base with brilliant green and selenite cystine broth for *Salmonella* inoculated in frozen shrimps from 89

samples indicated non significant difference ($P<0.05$) with the efficiency of 93 and 80 percentage of growth respectively.

Keywords: Prawns; Shrimps; Frozen shrimps; *Salmonella*; Bacteria; ELISA; Enzyme Linked Immunosorbent Assay; Conventional culture

465 Chokchai Luangthuvapranit. 1995. **Toxicity of ammonia to giant tiger prawn (*Penaeus monodon* Fabricius).** Research Report. Faculty of Science and Technology. Prince of Songkla University. Patani Campus. 40 p.

The toxicity of unionized ammonia to giant tiger prawn (*Penaeus monodon* Fabricius) with the length of 2.0 ± 0.6 cm. and the weight of 0.07 ± 0.08 gm. were studied at 29°C , pH 8.0 and 29 ppt. of salinity. LC₅₀ at 24-h, 48-h, 72-h and 96-h were 1.7330, 1.4353, 1.3774 and 1.3351 ppm., respectively and the threshold toxicity was 1.3254 ppm. The safe concentrations predicted by Laboratory Fish Production Index (LFPI) ranged from 0.0268 to 0.0670 ppm.

Keywords: Prawns; Shrimps; Giant Tiger Prawn; *Penaeus monodon*; Toxicity; Ammonia; Chemicals; Static bioassay; Acute Toxicity

466 Chokchai Luangthuvapranit. 1994. **Toxicity of mercury and lead to giant tiger prawn (*Penaeus monodon* Fabricius).** Research Report. Faculty of Science and Technology. Prince of Songkla University. Pattani Campus. 51 p.

The toxicity of mercury and lead to giant tiger prawn (*Penaeus monodon* Fabricius) which were 20 ± 0.6 cm. in length and 0.05 ± 0.05 gm. in weight at $28-29^{\circ}\text{C}$ were measured in term of 24-h, 48-h, 72-h and 96-h LC₅₀. LC₅₀ at 24-h, 48-h, 72-h and 96-h of mercury were as follows: 0.2148, 0.1637, 0.1495 and 0.1299 ppm. LC₅₀ at 24-h, 48-h, 72-h and 96-h of lead were as follows: 176.2223, 132.9130, 106.8046 and 99.5230 ppm. The threshold toxicity of mercury and lead were 0.1184 ppm and 96.8838 ppm. respectively. The safe concentrations of mercury and lead predicted by Laboratory Fish Production Index (LFPI) ranged from 0.0026 to 0.0064 ppm. and 1.9917 to 4.9794 ppm. respectively.

Keywords: Prawns; Shrimps; Giant tiger prawn; *Penaeus monodon*; Toxicity; Mercury; Lead; Static bioassay; Chemicals

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468 Chokchai Luangthuvapranit. 1995. **Toxicity of copper and zinc to giant tiger prawns (*Penaeus monodon* Fabricius).** Research Report. Faculty of

Science and Technology. Prince of Songkla University. Pattani Campus. 52 p.

The toxicity of copper and zinc to giant tiger prawn (*Penaeus monodon* Fabricius) which were 1.9 ± 0.6 cm. in length and 0.05 ± 0.07 gm. in weight at 28-29° C were measured in term of 24-h, 48-h, 72-h and 96-h LC_{50} , LC_{50} at 24-h, 48-h, 72-h and 96-h of copper were as follows : 7.3028, 4.8591, 3.0387 and 2.1581 ppm. LC_{50} at 24-h, 48-h, 72-h and 96-h of zinc were as follows : 8.9925, 4.2915, 3.5189 and 2.5279 ppm. The threshold toxicity of copper and zinc were 1.6574 ppm and 2.1876 ppm., respectively. The safe concentrations of copper and zinc predicted by Laboratory Fish Production Index (LFPI) ranged from 0.0443 to 0.1106 ppm and 0.0527 to 0.1317 ppm, respectively.

Keywords: Prawns; Shrimps; Giant tiger prawn; *Penaeus monodon*; Copper; Zinc; Toxicity; Static bioassay; Chemicals

469 Suree Wisetsombat. 2001. **Comparison of neuropeptide profiles from the eyestalk of *Penaeus monodon* using High Performance Liquid Chromatography and Matrix Assisted Laser Desorption Ionization Mass Spectrometry.** Master Thesis. Chulalongkorn University. 104 p.

Isolation of the PP-like substances (PPLs) in *Penaeus monodon* was performed using 7,500 eyestalks extracted in methanol-acetic acid-water (90 : 1 : 9). The extract was partially purified using C18 cartridge and was further purified by 5 to 6 steps of RP-HPLC using C18, C8 and Cyano column with 3 solvent systems; acetonitrile/trifluoroacetic acid, acetonitrile/heptafluorobutyric acid and acetonitrile/triethylamine and the detection of PPLs in the fractions during each step of purification was by Dot-enzyme linked immunosorbent assay (Dot-ELISA) using polyclonal antiserum raised against human pancreatic polypeptide C-terminal hexapeptide (PP6). Four isoforms of PPLs (PPL1, PPL2, PPL3 and PPL4) obtained from fraction 19, 23, 24, 26 and 27 of the first RP-HPLC step and having molecular weight of 801.5, 1137.1, 1050.0 and 1165.9 dalton, respectively, determined by Matrix assisted laser desorption ionization time-of flight mass spectrometry (MALDI-TOF MS). From the molecular weight of these isoforms, it revealed that these peptides should not consisted of more than nine amino acid residues which were similar to that of PYF found in the brain of squid, *Loligo vulgaris*. However the different molecular weight that obtained are expected to be different amino acid in

peptide chain from brain squid PYF and PP-like peptides from other animals.

Keywords: Prawns; Shrimps; *Penaeus monodon*; Pancreatic polypeptide; Eyestalks; Neuropeptides; HPLC; High Performance Liquid Chromatography; Hormones

470 Chirawan Chouychoo. 2001. **Detection of injured *Salmonella* spp. in frozen giant tiger shrimp: *Penaeus monodon* Fabricius.** Master Thesis. Chulalongkorn University. 102 p.

The effect of freezing on the survival of *Salmonella* spp. was studied by freezing the sample for giant tiger shrimp added with *Salmonella* at 0.47, 0.79, 1.5 and 45 cm/hr. It was found that the detectable number of survival cells was lowest (0.21%) but highest in the number of injured cells (78.34%) when the samples were frozen at freezing rate of 45 cm/hr. The same affects show in the freezing of *Salmonella* suspension, the percentage of the survival was 0.15% and the injured cell was 81.09% of the survival. The *Salmonella* suspension was stored at -10, -20 and -75 °C for 12 week, and found that the storage at -10°C caused the decreasing of survival of *Salmonella*, healthy *Salmonella* and injured *Salmonella* faster than storage at the lower temperature. At -10 °C, the reduction of total *Salmonella*, healthy *Salmonella* and injured *Salmonella* cells were at the rate of 2.51, 2.34 and 2.56 weeks/log cfu, respectively. The *Salmonella* that added to the shrimp samples when stored with shrimp at -10, -20 and -75 °C for 12 weeks was found that at -10 °C the reduction of total *Salmonella*, healthy *Salmonella* and injured *Salmonella* was fastest, at the rate of 3.04, 3.10 and 2.94 weeks/log cfu, respectively. The suitable pre-enrichment for recovery the injured cell of *S. derby* was Tryptic soy broth supplemented with sodium pyruvate, yeast extract. This medium increased the healthy cells up to 88% from 40% of Tryptic soy broth without yeast extract and sodium pyruvate, within 3 h at 42 °C respectively.

Keywords: Prawns; Giant tiger shrimp; *Penaeus monodon*; Bacteria; Survival; Injuries; *Salmonella*

471 in Thai

472 K. Sripirom, Somkiat Piyatiratitivorakul and Piamsak Menasveta. 1991. **Effects of steroid hormones on moulting of giant tiger prawn (*Penaeus monodon* Fabricius).** In Proceeding the Third Technical Conference on Living Aquatic Resources, Chulalongkorn University, 17-18 January 1991. p. 411-419.

Moulting duration cycle of *Penaeus monodon* averaged body weight 35 g. was approximately 18 days. Moulting stage B (3 days after moulting), stage C (6 days after moulting) and stage D1" (10 days after moulting) were designed for hormones, 2-deoxyecdysone (SIGMA) and pure beta-ecdysone (extracted from *Vitex glabrata*) treatment. Concentrations of 0.01, 0.2 and 0.4 µg-hormones/g body weight were singly injected into abdominal muscular tissues. Moulting duration of stage B,C and D1" in the hormonal treated group decreased approximately 5.5, 4.9 and 4.2 days respectively. While the sham group (0.00 µg-hormones/g injection), moulting duration on stage B, C and D1" decreased 1, 2 and 2 days respectively. There was no statistically significant difference between sources and/or concentrations of hormones on moulting duration cycle.

Keywords: Prawns; Shrimps; *Penaeus monodon*; Giant tiger prawn; Steroid hormones; Moulting; Hormones

473 Pornsilp Pholpunthin, Phorcham Aranyakanonda, Piamsak Menasveta, Nudol Moree and Sompop Rungsupa. 1987. **Effect of beta-ecdysterone on the moulting process of marine shrimps.** In Proceeding of the Second Seminar on Living Aquatic Resources, Chulalongkorn University, 17-18 December 1987. p. 39-44.

Effect of beta-ecdysterone on the molting process of tiger prawn (*Penaeus monodon* Fabricius) and white banana prawn (*Penaeus merguensis* de Man) were studied. It was found that the doses which could successfully induce moulting in *P. monodon* and *P. merguensis* were 0.1 and 0.3 µg/gm. body weight, respectively.

Keywords: Prawns; Shrimps; Black tiger shrimp; Ecdysterone; Moulting; Marine shrimps; *Penaeus monodon*; White banana prawn; *Penaeus merguensis*; Hormones

474 Sumolya Kanchanapangka, Karuna Sattayanas and Piamsak Menasveta. 1987. **Effect of diflubenzuron on the molt cycle of banana prawn larvae (*Penaeus merguensis* de Man).** In Proceeding of the Second Seminar on Living Aquatic Resources, Chulalongkorn University, 17-18 December 1987. p. 240-260.

A preliminary study revealed that the molt of the P₁₀-P₁₅ banana (*Penaeus merguensis* de Man) was 2 to 5 days and the high percentage of the duration of the molt cycle fell on 2 and 3 days. This finding was used in the subsequent experiment to find out the lowest diflubenzuron

concentration that killed the banana prawn larvae. It has long been suggested that diflubenzuron interfered with chitin synthesis thus hindered the cuticle deposition in insects and arthropods (Christiansen *et al.* 1978, 1984 and Costlow 1979). The mean number of dead prawn of the 0.5 ppb diflubenzuron treatment group was significantly greater than the control groups (sea water and acetone). Further investigations suggested that the cause of death of the diflubenzuron prawn was due to effect of diflubenzuron on the molt cycle of the prawn larvae. The mean number of dead larvae on the fourth day (those that died might have a 3 days molt cycle) of this experiment was significantly greater than those died on the second and sixth day of the experiment. Some prawn larvae died during molt period with twisted posture and had old cuticles partly attached to their bodies and carapaces. This finding suggested that the prawns might die because of being unable to ecdyse. Many of the prawn larvae died in postmolt period with bended bodies which may signify the abnormally weak new cuticular structure that may occur due to the exposure of diflubenzuron. It would be interesting to further investigate the effect of diflubenzuron on the cuticular structure during the molt cycle of the banana prawn larvae.

Keywords: Diflubenzuron; Molt; Banana prawn; Larvae

475 Weerawan Sithigorngul, Phaisarn Sithigorngul and Piamsak Menasveta. 1992. **Cross-reactivity of eyestalk extracts and gonad inhibition between *Macrobrachium rosenbergii* and *Penaeus monodon*.** J. Sci Res. Chula. Univ 17 (1) : 3-13

The cross-reactivity of gonad inhibiting hormones (GIH) between the giant freshwater prawn, *Macrobrachium rosenbergii*, and the tiger prawn, *Penaeus monodon*, was investigated in two sets of experiments. Firstly, eyestalk extracts taken from *M. rosenbergii* and from *P. monodon* (1 eyestalk/prawn) were injected into an eyestalkless female *M. rosenbergii* on the fourth day after spawnig for 6 days at 12 hr intervals. The ovarian index (OI=ovarian weight x 100/body weight) was determined on the tenth day. The eyestalk extract taken from *P. monodon* seems to be less effective than the eyestalk extract taken from *M. rosenbergii* on inhibition of ovarian development.

Secondly, the reciprocal experiment was done in eyestalkless *P. monodon* in a similar fashion, except that the amount of each extract used for injection was 1 eyestalk/prawn for the extract taken from *P. monodon* and 5 eyestalks/prawn for the extract taken from *M. rosenbergii*, and the injection period was 5 days. Ovarian development of eyestalkless female *P. monodon* was not significantly inhibited by the injection of eyestalk extract taken from *M.*

rosenbergii but it was inhibited by injection of the equivalent specific eyestalk extract.

This evidence indicates that the GIH from both species does not seem to be identical, since cross-specific treatment of the GIH was less effective compared to the equivalent specific treatment. This was true even though the proportion of extract to body weight in cross-specific treatments was greater than that in the equivalent specific treatments

Keywords: Prawns; Shrimps; *Penaeus monodon*; Eyestalk extracts; Gonads; *Macrobrachium rosenbergii*; Tiger prawn; Hormones

476 Parin Wongsawang. 2002. **Banana prawn gonad inhibiting hormone (GIH)**. Master Thesis. Prince of Songkla University. 109 p.

Cloning of Gonad inhibiting hormone of Banana prawn by using a probe prepared from cDNA of the eyestalks. The probe consisting 245 bp shows the identity to CHH/MIH/GIH about 47/51/48 % respectively. The probe used to screen in 2 cDNA library, however, GIH gene was not detected. Anti-vitellin prepared for use in GIH biological assay was immunized by vitellin. The vitellin purified from ovary of the prawn by Superose 12 HR 10/30 has the MW of 325 ± 7.4 KDa and consists of 6 subunits with the MW of 101 ± 4.1 , 88 ± 3.5 , 79 ± 1.6 , 61 ± 1.9 , 55 ± 4.8 , 47 ± 0.9 KDa. The anti-vitellin has sensitivity to detect vitellin in the range of 62.5-500 ng/ml by ELISA method and has specificity to the vitellin by western blotting. Eyestalk extract separated by μ Bondapak-phenyl column was analysed for biological activity of GIH by using the produced anti-vitellin. The result shows that peak 3 contains GSH activity while peak 5 and 6 have GIH activity.

Keywords: Prawns; Shrimps; Banana prawn; Gonad Inhibiting Hormone; GIH; Cloning; DNA; Eyestalks; Hormones

477 Pitchaya Chinauparvat, Kanyanee Nawat and Visit Kwandee. 1999. **Oxolinic acid residues monitoring in black tiger shrimp (*Penaeus monodon* Fabricius) before harvesting in Phangnga province by HPLC**. Technical Paper No. 9/1999. Phangnga Coastal Aquaculture Development Center. Department of Fisheries. 12 p.

Monitor of residual antibacterial Oxolinic acid in Black Tiger Shrimp (*Penaeus monodon*) of 194 shrimp farms in Phangnga province was carried out during October 1997-September 1998. Three hundred and sixty samples (360 ponds) were tested

residual Oxolinic acid and using Oxolinic acid in shrimp farms of 194 farmers were interviewed. The result showed that the No. Oxolinic acid residues in shrimps were 27 samples (7.5 % of total shrimp inspection) and maximum residual was found in April. The effected of stocking density in each during month period and the during month period to residual Oxolinic acid in shrimps were studied. The finding indicated that the No. Oxolinic acid residues in shrimp at 3 stocking density and each during month period were high significant difference ($P < 0.01$). Residual Oxolinic acid of shrimps were 4, 9 and 14 samples at 30-60, 61-90 and more than 91 PL/m² respectively. And then 6, 3, 10 and 8 samples in October-December, January-March, April-June and July-September, respectively. The results of using Oxolinic acid showed that farmers used Oxolinic acid for 41 farms (21.3% of total sample farm) and mainly used in April – June.

Keywords: Prawns; Shrimps; Black tiger shrimp; *Penaeus monodon*; Phang-nga; Oxolinic acid; Residues; Monitors; HPLC; Drugs residues; High Performance Liquid Chromatography; Antiinfective agents

478 Yainub Waelaeh, Sombat Rukpratanporn, Siwaporn Longyant, Parin Chaivisuthongkura, Weerawan Sithigorngul, Piamsak Menasveta and Paisarn Sithigorngul. 2002. **Natural and experimental infections of yellow head virus (YHV) in Atyid and Palaemonid shrimp**. In the 28th Congress on Science and Technology of Thailand, 24-26 October 2002. p. 505.

Immunohistochemical method utilizing monoclonal antibody specific to putative enveloped protein of yellow head virus (YHV) was used to detect the natural infection of YHV in atyid shrimp; *Caridina* sp., and palaemonid shrimps; *Palaemon styliferus*, *P. serrifer*, *Macrobrachium rosenbergii*, *M. lanchesteri*, and *M. sintangense*, collected from freshwater and brackish water areas nearby the *Penaeus monodon* farms in Samutprakarn and Chonburi provinces, Thailand. No YHV immunoreactivity was observed in all species of natural collected shrimps and experimentally infected shrimps fed with muscle tissues of YHV-infected *P. monodon* for three days. However, in shrimps injected with YHV for three days, mild infection was found with high proportion in *P. styliferus* (9/10) and *M. sintangense* (8/12) and very low proportion in *M. lanchesteri* (4/22) but not in *M. rosenbergii* (0/20). The YHV injection could not be performed in *P. serrifer* and *Caridina* sp. due to the size limitation. The immunoreactivities revealed by MAb specific to 135 kD protein was absent or displayed very weak signal compared to the immunoreactivities revealed by antibody specific to 67 and 22 kD proteins. The

lower level of expression in the putative 135 kD enveloped protein may be related to a low virulence of YHV infection in these species.

Keywords: Prawns; Shrimps; *Penaeus monodon*; YHV; Immunohistochemistry; Yellow Head Virus; Monoclonal antibody; *Macrobrachium rosenbergii*; Viruses

479 Kanjana Payooaha. 1992. **Study on the residue of oxolinic acid in *Penaeus monodon* Fabricius.** Master Thesis. Kasetsart University. 135 p.

Residues of oxolinic acid in *Penaeus monodon* weighing 10-12 gm. were examined after force-feeding at levels of 10, 20 and 30 mg/kg body weight respectively. Seven days after the feeding experiment, residues of oxolinic acid in hepatopancreas, haemolymph and muscle varied depending on the dose given. The maximum level was detected in the hepatopancreas. However, over a long period the concentration of oxolinic acid in the three tissues decreased gradually and were not significantly different. The residence time of oxolinic acid in hepatopancreas, haemolymph and muscle after force-feeding with the dose of 10 mg/kg were 27 days, 10 days and 7 days respectively.

Levels of oxolinic acid were measured after an oral dose of 20 mg/kg body weight was given as medicated feed for 7 days and 10 days. The concentration of oxolinic acid residues in all three tissues examined for both experiments were not significantly different. The residence time of oxolinic acid in the hepatopancreas after 10 and 7 days of feeding with medicated pellets was 38 days and 33 days respectively; in the muscle this was 17 days and 20 days respectively; and in the haemolymph was 5 days for both experiments.

Keywords: Prawns; Shrimps; *Penaeus monodon*; Residues; Oxolinic acid; Feeding; Drugs

480 Jirasak Tangtrongpiros, Somkiat Piyatratorakul, Rabin Rattanaphanee, Nikom Chaisiri, Vara Panichkriengkrai, Sumolya Kanchanapangka, Supatra Srichairat, Nantarika Chansue, Achara Tawatsin, Weena Koeypudsa, Panumas Ruantongdee and Sompop Rungsupa. 1997. **Effects of methyl parathion on shellfish culture important to the economy of Thailand** In Shrimp Biotechnology in Thailand (BIOTEC Publication 2/2540). p. 219-224

The acute effect of methyl parathion (MPT) was studied by static exposure of juvenile *Penaeus monodon* to concentrations of 0, 1, 2 and 3 ppb for 96 hours. The hemolymph, hepatopancreas, nerve

tract, muscle and gills were collected for biochemical, enzymatic, histopathological, immunological, microbiological and ultrastructural studies. The amount of serum protein appeared to vary with MPT concentration. At least 15 bands of protein were observed, and two of these were of high molecular weight. The acetylcholinesterase activity in muscle and nerve tissues was significantly inhibited by MPT. Inflammatory responses in gill, muscle and hepatopancreatic tissue were observed in MPT exposed shrimp. We also found that the SGOT and creatinine levels were significantly different for the test and control groups. Chemotactic and phagocytic activity of haemocytes showed significant reduction after exposure to high MPT concentrations. Phagocytic activity was not observed in ultrastructural examinations but hepatopancreatic cells were altered in an MPT dose related manner. The results from our studies suggest that water should be monitored for insecticides before it is pumped into shrimp aquaculture units.

Keywords: Prawns; Shrimps; *Penaeus monodon*; Methyl Parathion; Shellfish; Chemicals

481 Tirasak Pasharawipas, T.W. Flegel, Siriporn Sriurairatana and D.J. Morrison. 1997. **Latent yellow-head infections in *Penaeus monodon* and implications regarding disease resistance or tolerance.** In Shrimp Biotechnology in Thailand (BIOTEC Publication 2/2540). p. 45-53.

Yellow-head virus (YHV) was first reported from southern Thailand in early 1992 where it occurred as an epizootic of acute infections in rearing ponds of the black tiger prawn, *Penaeus monodon*. During this epizootic, mortalities were rapid and severe, resulting in total crop losses for many farmers within 3 to 5 days after the appearance of shrimp with gross signs of infection. Since 1992, losses due to acute YHV infections have continued to occur. However, in addition to acute infections, a number of ponds with latent infections have been confirmed. From these ponds, reasonable to excellent harvests (3.5 to more than 7 tons per ha) have been obtained, in spite of the presence of YHV infected shrimp in the pond from one to three months before harvest (as diagnosed by gross signs, normal histology and transmission electron microscopy). In only one year, it is unlikely that simultaneous resistance could develop in the multiple-source post larvae used to stock these chronically infected ponds, or that a new viral strain could have developed. An alternate explanation for the occurrence of these chronic infections may be that *Penaeus monodon* can develop tolerance if exposed to YHV in early larval development when hemocytes are undergoing a process of self recognition. Such tolerance (ie, lack of a defense response) may reduce mortality and may

constitute a general defense strategy which could allow for the rapid development of resistance to new viruses. This tolerance hypothesis is used to resolve disparities in results from previous reports regarding the pathogenicity of monodon baculovirus (MBV). If the hypothesis is correct, used of inactivated viruses (called tolerines rather than vaccines). At the self-recognition interval could possibly reduce the economic loss resulting from subsequent disease exposure.

Keywords: Prawns; Shrimps; *Penaeus monodon*; Black tiger prawn; YHV, Yellow head virus; Tolerance; Viruses

482 Timothy W. Flegel, Siriporn Sriurairatana, Chainarong Wongteerasupaya, Vichai Boonsaeng, Sakol Panyim and Boonsirm Withyachumnarnkul. 1997. **Progress in characterization and control of yellow-head virus of *Penaeus monodon***. In Shrimp Biotechnology in Thailand (BIOTEC Publication 2/2540). p. 71-78.

Yellow-head virus was first reported in Thailand in 1992 when it caused pond side losses of approximately 30 million US dollars. This review of the virus includes results of unpublished work by a Thai national task-force on yellow-head. Viral extracts in water remain infective in excess of 72 hours. Infections can also be spread by ingestion of infected animals and planktonic carrier shrimp (*Palaemon styliferus*) fed with tissue from infected tiger prawns. Similar tests indicated that bird feces were not infectious. There is strong indication that infections are initiated either by fresh feed inputs or by contaminated inlet water drawn soon after discharge from a nearby infected pond. Incubation time is 7 to 10 days. Strategies for limiting spread of the virus include strict hygiene procedures, disinfection of ponds and inlet canals, use of only dry commercial feeds, and fine screening of inlet water to eliminate carrier shrimp. When infected ponds are discharged, neighbors are discouraged from exchanging water for at least three days. There are reports of protection by medicinal plants and of resistance in some animals. Incidence of the virus in captured broodstock is estimated at less than 4%. Two rapid histological methods have been devised to help in diagnosis of the disease in time for an emergency harvest decision. Virus infections are systemic, and rod-shaped, enveloped virions are assembled in the cytoplasm of cells of ectodermal and mesodermal origin. Purified virus particles from hemolymph preparations had a distinctive fringe by negative staining, and nucleic acid extracts from these preparations gave single-stranded RNA. Nucleic acid content, cytoplasmic assembly, and morphology by negative staining indicate that the virus may belong to the family

Rhabdoviridae, rather than the Baculoviridae, as suggested in previous reports.

Keywords: Prawns; Shrimps; *Penaeus monodon*; Characterization; Yellow Head Virus; Baculoviridae; Viruses; YHV

483 Gray Nash, Anutra Arkarajamon and Boonsirm Withyachumnarnkul. 1997. **Histological and Rapid Haemocytic diagnosis of yellow-head disease in *Penaeus monodon***. In Shrimp Biotechnology in Thailand (BIOTEC Publication 2/2540). p. 93-102.

The morphological and haemocytic changes in yellow-head disease (YHD) of *Penaeus monodon* were investigated through a series of laboratory infectivity experiments, haemolymph light microscopic examination, including a blind study, histopathology, and examination of cases from shrimp farm disease outbreaks. Histologically, the pathognomonic changes of YHD consisted of extensive necrosis of numerous tissues of mesodermal and ectodermal origin, including the lymphoid organ, haemocytes, haematopoietic tissue, connective tissues, heart, striated muscle, epidermis, and gills, with focal changes in the nervous tissues. Wright-Giemsa-stained haemolymph preparations from YHD-infected shrimp examined with the light microscope revealed characteristic haemocytic nuclear pyknosis, karyorrhexis, and basophilic cytoplasmic inclusions as early as 45 to 54 h post-injection in still clinically normal shrimp, and in moribund shrimp from 65 to 96 h post-injection, practically all the haemocytes displayed the aforesaid abnormal changes. Thus, microscopic examination of Wright-Giemsa-stained haemolymph was determined to be a useful method for the rapid presumptive diagnosis of YHD.

Keywords: Prawns; Shrimps; Black tiger shrimp; *Penaeus monodon*; Yellow-head disease; Hemocytes; Viruses

484 Sataporn Direkbusarakom, Angkana Herunsalee, Sittthi Boonyaratpalin, Yaowanit Danayadol and Usanee Aekpanithanpong. 1997. **Effect of *Phyllanthus* spp. against yellow-head baculovirus infection in black tiger shrimp, *Penaeus monodon***. In Shrimp Biotechnology in Thailand (BIOTEC Publication 2/1997). p. 85-92.

Five species of the herb *Phyllanthus*; *P. amarus*, *P. debilis*, *P. pulcher*, *P. reticulatus*, and *P. urinaria* were tested for their ability to inactivate yellow-head baculovirus (YBV), a virulent pathogen of black tiger shrimp, *Penaeus monodon*. Extraction was done by ethanol using a soxhlet apparatus. The virucidal activities of these extracts were tested by mixing the virus with plant extracts followed by incubation and

injection into healthy black tiger shrimp. Antivirucidal activity was assessed by observation of the mortality rates of the injected shrimp. The toxicity of the plant extracts was also tested against shrimp. The extracts of *P. amarus* and *P. urinaria* inhibited YBV. The minimum inhibitory concentrations for *P. amarus* and *P. urinaria* were 0.1 and 1 mg/mL, respectively while the LD₅₀ of the extract to postlarvae 15 were 2471±6.3 mg/mL and 2564±5.8 mg/mL, respectively. The extracts also enhanced phagocytic activity in black tiger shrimp.

Keywords: Prawns; Shrimps; Black tiger shrimp; *Penaeus monodon*; *Phyllanthus*; YBV; Yellow head baculovirus; Viruses

485 Chainarong Wongteerasupaya, Joan E. Vickers, Siriporn Sriurairatana, Gary L. Nash, Anutara Akarajamorn, Vichai Boonsaeng, Sakol Panyim, Anchalee Tassanakajon, Boonsirm Withyachumnarnkul and T.W. Flegel. 1995. **A non-occluded, systemic baculovirus that occurs in cells of ectodermal and mesodermal origin and causes high mortality in the black tiger prawn *Penaeus monodon*.** Diseases of Aquatic Organisms. 21: 69-77.

In the course of experimental infection of *Penaeus monodon* with yellow-head virus (YHV) for virus isolation and purification, 1 batch of prawns yielded hemolymph fractions dominated by a previously undescribed non-occluded baculovirus rather than YHV. Injection of test shrimp with a semi purified preparation of this virus gave rapid mortality, and examination with the transmission electron microscope revealed a dual infection where cells containing the new virus dominated, but some cells containing YHV could also be seen. The tissues infected by the 2 viruses were similar. However, in contrast to YHV, the new virus was assembled completely in the nucleus and in the absence of occluding protein (polyhedrin). By normal histology, the most characteristic feature of infection was eosinophilic Cowdry A-type inclusions in hypertrophied nuclei with marginated chromatin, especially in epithelial cells of the stomach. These intranuclear inclusions became lightly basophilic in late stages of infection. In the epithelial cells of the gills, ultrastructural pathology included nuclear hypertrophy and cytoplasmic disintegration leading to large voids at lysed cell sites. By negative staining, competely assembled, enveloped virions were ellipsoid to obovate with a distinctive multifibrillar appendage and they measured 276×121 nm (excluding the appendage). Enveloped and unenveloped nucleocapsids were significantly different in size indicating possible shortening and thickening of the viral core and

nucleocapsid during viral assembly. Isolation and purification of the nucleic acid from the new virus yielded double-stranded DNA of approximately 168 kilo base pairs. This DNA did not cross-hybridize with DNA fragments isolated from YHV infected shrimp or from monodon baculovirus (MBV). The features placed this virus in the family Baculoviridae, subfamily Nudibaculovirinae as PmNOBII, but for convenience we have named it informally as Systemic Ectodermal and Mesodermal Baculovirus (SEMBV).

Keywords: Prawns; Shrimps; *Penaeus monodon*; Black tiger prawn; Mortality; Nudibaculovirinae; SEMBV; *Baculovirus*; Viruses; Cells; Systemic Ectodermal and Mesodermal Baculovirus

486 Chaiyuth Chantanachookin, Sitdhi Boonyaratpalin, Jiraporn Kasornchandra, Sataporn Direkbusarakom, Usanee Ekpanithanpong, Kidchakan Supamataya, Siriporn Sriurairatana and T.W. Flegel. 1993. **Histology and ultrastructure reveal a new granulosis like virus in *Penaeus monodon* affected by yellow-head disease.** Disease of Aquatic Organisms. 17 : 145-157.

A recently reported disease syndrome of *Penaeus monodon* in Thailand is called 'yellow-head' or 'hua leung' in Thai. It is usually characterized by lighth yellow coloration of the dorsal cephalothorax area generally pale or bleached apperarance of affected prawns. The yellow color in the cephalothorax region results from the underlying yellow hepatopancreas showing through the translucent carapace in moribund shrimp. In histological preparations of moribund yellow-head specimens for the light microscope no consistent bacterial, fungal or parasitic agents could be found. The lymphoid organs of yellow-head specimens showed extensive abnormalities. These included obviously necrotic cells and vacuolated cells with hypertrophied nuclei. Also evident were vary densely basophilic, globose cytoplasmic inclusions located adjacent to some of the hypertrophied nuclei. Similar basophilic inclusions were found in interstitial hepatopancreatic tissue, in connective tissue underlying the mid gut, in cardiac tissue, in gill tissue and in hematopoetic tissue. Transmission electron micrographs revealed *the presence of presence* of previously undescribed rod-shaped, enveloped virions in the cytoplasm adjacent to the nuclei of cells from various tissues. Free virions were also present in intercellular spaces. The virions were similar to those of the insect granulosis viruses (Baculoviridae) in terms of cytoplasmic location, size, morphology and development. However, they were not occluded by granulin.

Keywords: Prawns; Shrimps; *Penaeus monodon*; Ultrastructure; Granulosis viruses; YBV; Yellow-head disease; *Baculovirus*; Viruses

487 Chainarong Woongteerasupaya, Sriwan Wongwisansri, Vichai Boonsaeng, Sakol Panyim, Pusit Pratanpipat, Gary L. Nash, Boonsirm Withyachumnarnkul and T.W. Flegel. 1996. **DNA fragment of *Penaeus monodon* baculovirus PmNOBII gives positive in situ hybridization with white-spot viral infections in six *Penaeid* shrimp.** *Aquaculture*. 143: 23-32.

PmNOBII was first described from experimentally infected shrimp, but contemporary reports showed that white-spot virus infections in several penaeid shrimp species exhibited similar gross signs and histopathology. Using laboratory infected specimens of *Penaeus monodon*, DNA of the non-occluded baculovirus PmNOBII was extracted and digested with BamHI and EcoRI. Resulting DNA fragments were ligated with Bluescribe vector using T4 ligase and competent cells of *Escherichia coli* JM 107 were transformed. Two recombinant clones that gave negative hybridization with *P. monodon* DNA but positive hybridization with PmNOBII DNA were selected. Inserted DNA fragment of 0.9 kbp and 4.2 kbp were obtained from these clones after plasmid digestion with BamHI and EcoRI. These fragments were subsequently labeled with digoxigenin for visualization and tested using the in situ DNA hybridization technique with tissues from PmNOBII infected and non-infected laboratory shrimp. For viral infected nuclei identified by H and E staining in parallel samples the 4.2 kbp fragment gave a stronger DNA hybridization signal than did the 0.9 kbp fragment. The 4.2 kbp fragment was then used for in situ DNA hybridization test with commercially or experimentally cultivated shrimp specimens showing gross signs and histopathology characteristic of white-spot virus infection. Field signs of the disease included general reddish coloration white-spot virus infection. Field signs of the disease included general reddish coloration, white granules of 1-2 mm. under the cuticle and rapid mortality. Normal histology (H and E) revealed Cowdry-A type nuclear inclusions that developed to produce basophilic hypertrophied nuclei typical of PmNOBII, and transmission electron microscopy revealed characteristic rod shaped virions. All these specimens gave positive hybridization results, and included cultivated shrimp specimens of *Penaeus chinensis*, *P. indicus*, *P. japonicus*, *P. merguensis*, *P. monodon* and *P. vannamei* obtained from various countries in Asia between August 1993 and January 1995. The data indicate that PmNOBII, or closely related variants,

are currently responsible for a widespread epizootic in the Asian shrimp farming industry.

Keywords: Prawns; Shrimps; Black tiger shrimp; *Penaeus monodon*; Baculovirus; DNA; *Escherichia coli*; Viruses; Hybridization

488 Jiraporn Kasornchandra, Sittthi Boonyaratpalin and Kidchakan Supamattaya. 1995. **Electron microscopic observations on the replication of yellow-head baculovirus in the lymphoid organ of *Penaeus monodon*.** *Disease in Asian Aquaculture II : Proceedings of the Second Symposium on Diseases in Asian Aquaculture*, 25-29 October 1993, Phuket, Thailand. p.99-105.

The replication process of the yellow-head baculovirus (YBV) was studied in the lymphoid organ of the black tiger shrimp, *Penaeus monodon*. Ultrastructural observations at various time sequences suggested that viral replication occurred in the nucleus and was followed by assembly in the cytoplasm. At 32 h postinjection, cytoplasmic replication took place and the cytoplasm became the major site for viral replication. Among the single enveloped virions in the cytoplasm, two nucleocapsids per enveloped were observed.

Keywords: Prawns; Shrimps; *Penaeus monodon*; Electron Microscopy; Replication; YHV; Yellow-Head Baculovirus; Lymphoid organs; Viruses

489 Yukinori Takahashi, Toshiaki Itami, Masakazu Kondo, Minoru Maeda, Reiko Fuji, Susumu Tomonaga, Kidchakan Supamattaya and Sittthi Boonyaratpalin. 1994. **Electron microscopic evidence of bacilliform virus infection in kuruma shrimp (*Penaeus japonicus*).** *Fish Pathology* 29 (2): 121 – 125.

Beginning in the spring of 1993, a serious mortality among cultured kuruma shrimp, *Penaeus japonicus* occurred in Japan. The typical sign of this disease was white spots on the inside surface of the carapace. Challenge tests demonstrated that the causative agent was highly virulent. This was demonstrated by injection of a filtrated homogenate of the lymphoid organ obtained from diseased shrimp. A non-occluded bacilliform virus was found by electron microscopy in the lymphoid organ of both naturally and experimentally infected shrimps. The virion was bacilliform and surrounded by a virion envelope (a lipid bilayer membrane). The dimension of the virion was 83 nm. in diameter and 275 nm. in length. From these results, the bacilliform virus is considered to be the causative agent of the disease.

Keywords: Prawns; Shrimps; *Penaeus japonicus*; Kuruma shrimp; Bacilliform virus; Electron Microscopy; Viruses

490 Sitdhi Boonyaratpalin, Kidchakan Supamattaya, Jiraporn Kasornchandra, Sataporn Direkbusaracom, Ussanee Aekpanithanpong and Chaiyuth Chantana chooklin. 1993. **Non-occluded baculo-like virus, the causative agent of yellow head disease in the black tiger shrimp (*Penaeus monodon*)**. Gyoby Kenkyu 28 (3): 103–109.

A new non-occluded baculo-like virus was detected from black tiger shrimp (*Penaeus monodon*) with yellow head disease in the southern part of Thailand. Virus particles observed in necrotic tissues of gills and lymphoid organ were bacilliform in shape, ranging from 150–200 nm. in length and 40–50 nm. in diameter, and were enveloped singly a trilaminar unit membrane. From the experimental infection trials it was assumed that this virus was the most virulent among the viruses which have been known in the black tiger shrimp, to date. Pathogenicity and some characters of the virus as well as pathological changes caused by this virus were described.

Keywords: Prawns; Shrimps; Black tiger shrimp; *Penaeus monodon*; Non-Occluded Baculo-like Virus; Yellow Head Disease; Viruses

491 Supansa Yodmuang, Apinunt Udomkit, Burachai Sonthayanon and Sakol Panyim. 2002. **Molecular cloning and expression of a putative molt-inhibiting hormone of *Penaeus monodon***. In the 4th Symposium on Marine Shrimp, 18–19 November 2002, Rayong Resort, Rayong. National Center for Genetic Engineering and Biotechnology. p. 42–52.

Growth in Crustacean occurs only when the exoskeleton is removed by a physiological process called molting. Molting is triggered by ecdysteroids that are synthesized and secreted from Y-organ. The synthesis of ecdysteroid is negatively regulated by molt-inhibiting hormone (MIH), a member belonging to the CHH/MIH/GIH peptide family of eyestalk neuropeptides produced by X-organ sinus gland complex (XOSG). In this study, a cDNA encoding the mature region of MIH of the black tiger prawn, *Penaeus monodon*, was obtained by amplification of first stranded cDNA from eyestalk using gene specific primers. This cDNA contained a 231 bp open reading frame encoding a 77 residues of putative mature MIH (Pem MIH) that shows comparable degree of identity (94%) with the active MIH of *P. japonicus*. Pem-MIH cDNA was inserted downstream of α -factor secretion signal of pPICZ α A *Pichia pastoris*

expression vector under the control of AOX1 promoter. The putative recombinant Pem-MIH, of expected size about 8.5 kDa, was expressed and secreted to culture medium approximately 5 mg/l after induced with 3% (v/v) methanol for 3 days.

Keywords: Prawns; Shrimps; *Penaeus monodon*; Molt Inhibiting Hormone; MIH; Hormones; Cloning

492 Sirirat Rengpipat, A. Tanyanan, Somkiat Piyatiratitivorakul and Piamsak Menasveta. 2001. **Use of a probiotic bacterium (*Bacillus S11*) for *Penaeus monodon* culture in net cages**. In the 3rd National Symposium on Marine Shrimp. Chulalongkorn University. p. 90–102.

Bacillus S11(BS11), a bacterial probiont, was used as feed supplement for black tiger shrimp culture in net cages located in the same earthen pond. An outdoor, earthen pond the area of 500 m² with one water system was used. Twelve net cages (Experiment I) and six net cages (Experiment II) were parallelly set in the pond. Eighty shrimp in one cage (~2 m²) was arranged, after 100 days of culture probiont shrimp mean weights (25.4±2.5g and 22.0±1.2g in Experiments I and II) were significantly greater ($p<0.05$) than control shrimp mean weights (18.6±0.8g and 18.3±0.6 g in Experiments I and II, respectively). Shrimp survival after 100 days was significantly greater ($p<0.05$) in the probiotic (76.7±6.2% in Experiment I and 80.8±5.0% in Experiment II) compared with the control (65.0±11.5% in Experiment I and 62.5±7.5% in Experiment II). There were no obvious effects of BS11 on water quality in the pond during culturing shrimp in either Experiments I or II. During the 8-day challenge test collected shrimp of control groups from both experiments totally died on Day-6 whereas probiotic groups were still alive ~4.5% and ~9.3% in Experiment I and II, respectively. BS11 were always detected in shrimp intestines, water samples, and sediments of probiotic treatments.

Keywords: Prawns; Shrimps; Bacteria; Probiotics; *Penaeus monodon*; Black tiger shrimp; *Bacillus*; Net cages

493 T.W. Flegel, Tirasak Pasnarawipas, Linda Nielsen, Vitaya Thamavit and Suraphol Kongtim. 2001. **Effect of Hepatopancreatic Parvovirus (HPV), Monodon Baculovirus (MBV) and multiple viral infections on cultivated shrimp in Thailand**. In the 3rd National Symposium on Marine Shrimp. p. 48–63

Histological examinations were carried out on 400 cultivated black tiger (*Penaeus monodon*) from 12 commercial rearing ponds from three different areas in Thailand over a period of 3 years. The

shrimp were collected at or near harvest time as two arbitrary size groups of 10-20 each from each pond. Aside from size difference, they showed no gross signs of disease and were normally active. Examination revealed that infections of hepatopancreatic parvovirus (HPV) or monodon baculovirus (MBV) were relatively frequent. Although both viruses caused pathognomonic histopathological lesions that occurred exclusively in the hepatopancreas or nearby midgut, no severe shrimp mortality had occurred in any of the grow out ponds examined, even though some lesions were severe. Instead, severity of infection was negatively correlated with shrimp size, suggesting that the infections had caused retarded growth or stunting. Since HPV-infected shrimp groups tended to give a mean length not exceeding approximately 6.5 cm, differences in size between uninfected shrimp groups and those infected with HPV became apparent early in the cultivation cycle. By contrast, shrimp groups infected with MBV were not readily distinguishable from uninfected groups until the mean size of the uninfected groups reached 10 cm. or more. At 9 cm. or less, differences in size were not significantly different unless groups with large numbers were compared. Thus, HPV infection was correlated with more severe stunting than MBV. In addition to histological examination, polymerase chain reaction (PCR) assays for HPV and two other viruses (white spot syndrome virus or WSSV and infectious hypodermal and hematopoietic necrosis virus or IHHNV), were carried out on one large sample of 240 shrimp from 6 ponds where visible lesions were apparent for MBV only. Surprisingly, 94% of the specimens gave a positive test for at least one of the 4 viruses. HPV alone or in combination was detected in 148 (62%) of the specimens and IHHNV in 139 (59%), in spite of the fact that there was no histological indication of their presence. Out of 80 triple infections 63 (79%) included HPV and IHHNV as 2 of the 3 viruses detected. In spite of the fact that they are both parvoviruses, southern blot hybridization showed that the PCR products from HPV and IHHNV were distinctive and did not cross hybridize. Clearly, the prevalence of viral pathogens was very high, in spite of the absence of disease and the results showed that shrimp have a high tolerance to viral pathogens. Normally the viruses in these shrimp would have gone unnoticed, since normal shrimp are rarely examined for viruses.

Keywords: Prawns; Shrimps; Black tiger shrimp; *Penaeus monodon*; Viruses; Hepatopancreatic parvovirus; HPV; MBV; Monodon baculovirus; IHHNV; WSSV; White Spot Syndrome Virus

494 Nipavan Bussarawit. 1994. **Toxicity testing of oil dispersant on *Penaeus monodon***. Phuket Mar. Biol. Cent. Res. Bull. 59 : 83-89.

Toxic effects of the oil dispersants Corexit 9527 and BP 110-X were studied in Thailand. Static acute bioassay with standard reference toxicant (DSS), was carried out on tiger prawn (*Penaeus monodon*) at post larval stage (28-30 days old). Oxygen level (3 ppm), pH, and temperature were maintained as constant as possible throughout the tests. Probit analysis was applied to determine the 24, 48 and 96 hrs LC 50 at 95% confidence limit. Corexit 9527 was more toxic, and led to delayed moulting as compared to BP 110-X.

Keywords: Prawns; Shrimps; *Penaeus monodon*; Oil dispersant corexit; Toxicity; Tiger prawn

495 Kidchakan Supamattaya, Jareeporn Raungsri, Suprada Kiriratnikom and Naraid Suanyuk. 2000. **The immune system in black tiger shrimp, *Penaeus monodon* Fabricius: VI. Effect of diseases on immuno-physiological function and blood components in black tiger shrimp (*Penaeus monodon* Fabricius)**. Songklanakarin J. Sci. Technol. 22 (Suppl.): 615-621.

Blood parameters and immune function in black tiger shrimp infected with luminescent bacteria (*Vibrio harveyi*), white spot virus (SEMBV) and yellow-head virus (YHV) were studied. It was found that the infected shrimp showed reductions in the immune parameters including total hemocytes, phenoloxidase activity and phagocytic activity. The results also showed that viral infection had a greater effect on the immune system than did bacterial infection.

Keywords: Immune, Black tiger shrimp, *Penaeus monodon*, Infectious disease

496 Sapon Onkong, Juliwan Thinthara and Pensri Boontamchuy. 1997. **Effects on growth and muscular tissue residues of oxolinic acid in black tiger shrimp (*Penaeus monodon*)**. Technical Paper. No. 35/1997. Satul Coastal Aquaculture Development Center. Department of Fisheries. 12 p.

Growth and oxolinic acid (OA) residues in muscular tissue of 2 months old Black Tiger Shrimp *Penaeus monodon* at initial weight of 7.26 ± 0.27 - 7.82 ± 0.31 g were studied. Three groups (treatment) of shrimps were divided and fed with non-medicated feed and OA-medicated feed containing 1.0 and 3.0 g/kg of feed for 7 days. And then, the shrimp were fed on non-medicated feed from day 8 to through the experiment. The results showed that the average weight of non-medicated (control groups) shrimps are

Growth and oxolinic acid (OA) residues in muscular tissue of 2 months old Black Tiger Shrimp *Penaeus monodon* at initial weigh of 7.26 ± 0.27 - 7.82 ± 0.31 g were studied. Three groups (treatment) of shrimps were divided and fed with non-medicated feed and OA-medicated feed containing 1.0 and 3.0 g/kg of feed for 7 days. And then, the shrimp were fed on non-medicated feed from day 8 to through the experiment. The results showed that the average weight of non-medicated (control groups) shrimps are increased at 3.50 ± 0.26 g while those fed on OA 1.0 and 3.0 g/kg of feed were increased at 3.20 ± 0.20 and 2.98 ± 0.31 g respectively. The average daily growth rate of shrimps fed with non-medicated, OA 1.0 and 3.0 g/kg of feed were 0.125 ± 0.02 , 0.117 ± 0.01 and 0.106 ± 0.01 g/day, respectively. They were no significant difference ($p \geq 0.05$) on growth of shrimps within 3 groups. No OA residues in muscular tissue was detected prior to medication and in the control groups (non-medication) throughout the experiment, whereas those fed on OA medicated feed (1.0 and 3.0 g/kg of feed) were OA detected both during and after medication. The average maximum level of residues in muscular tissue of shrimps fed with 1.0 and 3.0 g OA/kg of feed were 1.372 ± 0.107 and 3.315 ± 0.360 ppm. at the 5th and 6th day of the medication, respectively, and the drug was totally withdrawn from the muscular tissue of the shrimps at 7 and 10 days after the medication was stopped, respectively.

Keywords: Prawns; Shrimps; Black tiger shrimp; Growth; Residues; Oxolinic acid; *Penaeus monodon*; Muscular Tissue Residues; Drugs; Drug Residues

497 T.W. Flegel, Siriporn Sriurairatana, D.J. Morrison and Napaa Waiyakrutha. 1997. *Penaeus monodon* captured broodstock surveyed for yellow-head virus and other pathogens by electron microscopy. In Shrimp Biotechnology in Thailand (BIOTEC Publication 2/2540). p. 37 – 43.

Lymphoid organs (LO's) were collected from 41 male and female captured broodstock shrimp (*P. monodon*) from the Andaman Sea between March 1993 and May 1994, in lots of 5 to ten animals each. Upon examination by transmission electron microscopy two of the LO specimens were too degenerated for analysis. Of the remaining 39 specimens, only 10% (4/39) had lymphoid organs without some degree of cellular pathology. Thus, 90% (35/39) of the readable specimens examined showed abnormal lymphoid organ tissue. If the two degenerated samples are included, the occurrence is still 90% (37/41). The most prevalent

abnormality in the readable specimens (87% or 34/39) was the presence of spheroids. Of the specimens with spheroids, 18% (6/34) showed cytoplasm that contained 45 nm unenveloped virus-like particles of unknown significance (15% of the total readable specimens). In addition, 23% (9/39) showed the presence of paracrystalline arrays of 24 nm particles resembling those of infectious hypodermal and hematopoietic necrosis virus (IHHNV), one showed bacteria (3%) and one showed microsporidians (3%). None of the 39 readable specimens were positive for the presence of yellow-head virus (YHV) particles. However, an earlier study of 5 specimens completed in 1992 showed that 1 of 5 was positive for YHV in the lymphoid organ. Together, the two data sets indicate that the mean incidence of asymptomatic, captured broodstock carriers of YHV from the Andaman Sea is $2.9 \pm 7.6\%$.

Keywords: Prawns; Shrimps; *Penaeus monodon*; YHV; Yellow head virus; Pathogens; Electron Microscopy; Lymphoid organs; Viruses

498 Sumana Kongsom. 1992. **Study of Monodon Baculovirus (MBV) and bacterial infection in black tiger shrimp, *Penaeus monodon* (Fabricius).** Master Thesis. Kasetsart University. 124 p.

The effect of monodon baculovirus (MBV) and bacterial infection on juvenile tiger shrimp, *Penaeus monodon* (Fabricius) was studied for 8 weeks. *Vibrio*, *Aeromonas* and *Pleisiomonas* were isolated from the hepatopancreas of shrimp samples. *Vibrio* and *Pleisiomonas* were sensitive to chloramphenicol, sulfamethoxazole/ trimethoprim and nalidixic acid while *Aeromonas* was sensitive to polymyxin B and nalidixic acid. Histopathological studies showed destruction of epithelial cells, edema, inflammation and focal melanization of the gills lamellae, and also demonstrated the presence of *Zoothamnium* on the gills. Heart samples showed slight hemocytic infiltration (10%) and necrosis (13%). The lymphoid organ had undergone moderate hyperplasia. Hemocytic infiltration was observed in the lumen and the interstitial cells. Basophilic inclusion bodies were found in areas with vacuolative necrosis. Change in the hepatopancreas consisted of hemocytic infiltration and encapsulations. MBV infection was also present in this organ. Occlusion bodies in the hypertrophic nucleus of the hepatopancreatocytes were found in 53% of the sample and MBV infection at early stages was found in 40% of the sample. Hepatopancreatocytes were necrotized and sloughed. Ultrastructural features included numerous cylindrical virions and spherical occlusion bodies in the cell nucleus, and a high concentration of free ribosomes in the cytoplasm.

Keywords: Shrimps; Black tiger shrimp; *Penaeus monodon*; Monodon baculovirus; MBV; Bacteria; *Vibrio*; *Aeromonas*; *Pleisiomonas*; Prawns; Viruses; Antiinfective agents; Chloramphenicol; Sulfamethoxazole; Trimethoprim; Nalidixic acid

499 Punya Jinapariwataporn, Charoon Chugeatiwattana, Thanuth Mepan, Jirasak Tangtrongpiros and Nantarika Isarasak Na Ayutaya. 1989. **Virulence study of *Vibrio anguillarum* isolated from infected shrimp in post larval stage of *Penaeus monodon*.** Clinical Conference 1989. Faculty of Veterinary Science Chulalongkorn University. 13 p.

Bathing method was performed for virulence test of *Vibrio anguillarum* which isolated from affected shrimp. Twenty - fifth larva stage *Penaeus monodon* was induced by using *Vibrio anguillarum* at concentration of 1.27×10^{14} C.F.U./ ml. The result revealed the concentration of 1.27×10^{14} C.F.U./ ml. Provoked 100% mortality in 24 hours. There was not mortality in the other groups during the experimental period.

Keywords: Prawns; Shrimps; *Penaeus monodon*; *Vibrio anguillarum*; Bacteria

500 Suwannakiet Sawengkoon, Preecha Sapkitjakarn and Wichai Luangkrajang. 1990. **Study on the incidence of MBV disease in *Penaeus monodon* broodstocks.** Clinical Conference. Faculty of Veterinary Science. Chulalongkorn University. 12 p.

Seventy *Penaeus monodon* broodstocks (7 male and 63 females) were examined by light microscope for the inclusion bodies of MBV in the nucleus of hepatopancreatocyte and intestinal cells. The techniques of fresh squash smear of hepatopancreas with shorr's stain and histopathological section of hepatopancreas and intestine with hematoxylin and eosin (H&E) stain were used. We found 2 samples positive for shorr's stain technique (10%) and 7 samples for H&E stain technique (2.86%). Inclusion body was not found in cells or lumens of intestine (30 samples).

Keywords: Prawns; Shrimps; *Penaeus monodon*; MBV; Aquatic animal; Viruses; Monodon baculovirus

501 Pratum Wichitking, Sarush Kongdechkasemsuk, Wichian Somjai, Jirasak Tangtrongpiros, Nantarika Isarasak Na Ayutaya. 1990. **The study of LC₅₀ of some insecticides and herbicide to Postlarva stage of *Penaeus monodon*.** Clinical Conference. Faculty of

Veterinary Science. Chulalongkorn University. 20 p.

Postlarva stage of *Penaeus monodon* was used to expose to four groups of insecticides and one group of herbicide by static assay. The LC₅₀ for 72 hours was 8, 0.56, 1, 0.0125, 3.45 ppb for Daitaphos^A (Dichlorvos^B), Alamon^A (Heptachlor^B), Sevin^A (Carbaryl^B), Ambush^A (Permethrin^B), Gramoxone^A (Paraquat^B) respectively. This result showed that Ambush^A (Permethrin^B) was more toxic than the other groups.

Keywords: Prawns; Shrimps; *Penaeus monodon*; Aquatic animal; Chemicals

502 Sedthakiat Krajangwongs, Supot Watanapongchati, Tanapong Intaratanu, Jirasak Tangtrongpiros and Nantarika Issarasak Na Ayudhaya. 1990. **The study of bacteria in hepatopancreas and hemolymph of *Penaeus monodon* broodstocks.** Clinical Conference. Faculty of Veterinary Science. Chulalongkorn University. 15 p.

Hepatopancreas and hemolymph of one hundred and nineteen broodstocks were examined for bacterial microflora. The specimens were inoculated to TSA 1%NaCl and TCBS. API 20 E was used to identify the characteristics of this bacteria. *Vibrio* was isolated from these animals particularly *Vibrio alginolyticus*, *Vibrio parahaemolyticus*, *Vibrio cholerae*, *Vibrio vulnificus*.

Keywords: Prawns; Shrimps; *Penaeus monodon*; Bacteria; Aquatic animal; Hepatopancreas, Haemolymph; *Vibrio parahaemolyticus*; *Vibrio cholerae*; *Vibrio vulnificus*

503 Kanuangnit Limjirakhajorn. 1988. **Effects of oxytetracycline and salinity on ammonia excretion and tissue residue of black tiger shrimp *Penaeus monodon*.** Master Thesis. Chulalongkorn University. 105 p.

Effects of oxytetracycline and salinity on ammonia excretion and tissue residue of black tiger shrimp *Penaeus monodon* (10-13g; 2-2.5 months) were studied using factorial design with 3 levels of salinity (10, 20 and 30 ppt) and 4 levels of oxytetracycline added in artificial diet (0, 1, 5 and 10 g/1kg diet). Experiment were carried out in triplicates. The samples were randomly collected to determine ammonia excretion every 72 hours (3, 6, 9 and 12 days after fed). For tissue residue determination, the samples were randomly collected at 1, 7, 14 and 16 days after fed. The studies

revealed that the effect of salinity was pronounced. There were interaction between salinity and dosage and between salinity and duration that oxytetracycline has been administered, on ammonia excretion. At salinity 10 ppt dose 1 and 10 g/1 kg diet, ammonia excretion was lower than in the shrimps fed with doses 0 and 5 g/1 kg diet. No effects of dose found on ammonia excretion at salinity 20 and 30 ppt. Tissue residue depended mainly on dosage. The residue were highest at doses 10 g/1 kg diet and lower at smaller dosage, respectively.

Keywords: Prawns; Shrimps; Black tiger shrimp; *Penaeus monodon*; Salinity; Ammonia; Aquatic animal; Oxytetracycline; Residues; Drugs; Drug residues

504 Wara Taparhudee and Phutchapol Suvanachai. 1998. **Comparison study using aerial photographs and satellite imagery for determining shrimp farm extent and distribution in Nakhon Pathom province.** Research report. Kasetsart University Research and Development Institute. 23 p.

Aquaculture activities without an appropriate planning and monitoring can result in environment degradation and social conflicts. However, such activities concerning the sustainable use of limited resources can enable the farmers to support their livings. Therefore, maps presenting the extent and distribution aquaculture areas are urgently required for an effective management of aquaculture activities and nearby agricultural activities such as paddy field. This study was carried out for the purpose of mapping aquaculture areas and of making comparison between aerial photographs and satellite imagery for the appropriateness in such a mapping. The results have shown that there are several aquaculture activities such as fishes (e.g. tilapia), and prawns (e.g. Giant freshwater prawn and King tiger prawn) in the study area. The aerial photographs and satellite imagery have obviously shown the spatial pattern of aquaculture areas. In addition, the image analysis techniques that are image masking can measure such an area. The types of aquaculture activities, however, can not be classified for remotely sensed data. This is because the farming techniques for each activities are various and uncertain. Furthermore, satellite imagery is an appropriate tool for mapping and monitoring aquaculture areas. The findings from this study have indicated that satellite remote sensing provides an effective mapping and monitoring tool which enables a resource management to be more effective.

Keywords: Satellite imagery; Shrimp farm

505 Siwaporn Longyant. 2000. **Production of specific monoclonal antibodies to vitellin and vitellogenin for assessing gonad inhibiting hormone levels in the giant tiger prawn *Penaeus monodon* Fabricius.** Master Thesis. Chulalongkorn University. 126 p.

Monoclonal antibodies (MAbs) specific to subunits of yolk proteins, vitellin (in ovary) and vitellogenin (in haemolymph), of the giant tiger prawn *Penaeus monodon* were generated using ovarian extract from gravid ovaries either native or denatured forms as immunogens. These antibodies were used for molecular characterization of vitellin and vitellogenin in this prawn species. Vitellin in ovary first appears as 74 and 200 kD proteins. During maturation processes the 200 kD protein is cleaved to generate 104 and 83 kD protein, then the 104 kD is further cleaved into 58 and 45 kD proteins while the modification of the 74 kD protein was not observed. In haemolymph, vitellogenin appears as 200, 104, 83 and 74 kD proteins, whereas the 58 and 45 kD proteins were not detected. Indirect immunoperoxidase competitive ELISA using monoclonal antibodies specific to vitellin and vitellogenin was applied for determination of vitellogenin levels in haemolymph in order to establish the relationship of vitellogenin fluctuations in the haemolymph during ovarian development. During ovarian development of prawns induced by bilateral eye-ablation, the correlation between haemolymph vitellogenin and gonado-somatic index (or ovarian index = OI) was not clearly demonstrated, due to the high variation of ovarian index and haemolymph vitellogenin levels at each stage of ovarian development among individual prawn. However, the relationship between haemolymph vitellogenin levels and stage of ovarian development are highly correlated especially when individual prawn was used throughout the process of ovarian development. The vitellogenin levels in haemolymph was undetectable during resting stage, then sharply elevated when ovary began to develop and remained at high levels during developing to ripe stages, and fallen down to low levels before spawning and spent stages. The results from injection of eyestalk extract into prawn with developing ovary induced by bilateral eye-ablation revealed that haemolymph vitellogenin levels elevated sharply within 2 hr, reached the maximal levels and remained unchanged during 4-10 hr. and slightly declined at 24 hr. These responses were directly proportional to the injected amount of the eyestalk extract. The elevation of haemolymph vitellogenin levels after the injection of eyestalk extract may be the result of desorption of vitellin from the oocyte during the degeneration induced by

gonad inhibiting hormone (GIH) which is similar to that occur in intact prawns after they were reared in captivity. Therefore, it is possible to determine the GIH activity by determining the alteration of vitellogenin levels during 4-10 hr. after the application of the tested samples.

Keywords: Monoclonal antibody; Vitellogenin; Shrimps; Prawns; Giant tiger prawn; *Penaeus monodon*; Aquatic animal; Hormones

506 Sombat Rukpratanporn. 1999. **Immunoenhancement in black tiger shrimp *Penaeus monodon* by *Bacillus* strain S11.** Master Thesis. Chulalongkorn University. 112 p.

Effect of probiotic *Bacillus* strain S11 on the growth and immunoenhancement either by cellular or humoral defenses in *Penaeus monodon* were shown after feeding black tiger shrimp in closed-recirculating pond for 90 days. Shrimp weight and their survival in postlarvae shrimp but not in juvenile ones were significantly higher ($P < 0.05$) than those of control group. *Bacillus* strain S11 could also efficiently activate and increase the engulfment of foreign particles (phagocytosis) as shown by the significant increase of % phagocytosis, phagocytic index and phenoloxidase at the level of $P < 0.05$. When performing for the challenge test by *Vibrio harveyi* strain 1526 for 10 days, accumulation of mortality (45.7%) was lower in shrimp fed probiotic supplement as compared to a control one (64.5%). Furthermore % phagocytosis, phagocytic index and average number of the beads ingested per cell of probiotic treated shrimp were significantly higher ($P < 0.05$). The effect from the challenge test by *Vibrio harveyi* strain 1526 on immune activation in both probiotic and control groups was observed and found that their total hemocytes decreased but % phagocytosis, phagocytic index and antibacterial activity increased significantly ($P < 0.05$).

Keywords: Prawns; Shrimps; *Penaeus monodon*; Probiotics; Feed; *Bacillus*; Black tiger shrimp; Phagocytosis; Phenoloxidase; *Vibrio harveyi*; Immune

507 in Thai

508 Potchanee Hunsonti. 1998. **Identification of genetic marker by RAPD to differentiate normal and viral disease tolerance black tiger prawn *Penaeus monodon*.** Master Thesis. Chulalongkorn University. 128 p.

Genetic differentiation between normal and white spot viral tolerance shrimps was examined using Randomly Amplified Polymorphic DNA analysis (RAPD). Forty-two RAPD primers were screened and 26 primers which gave resolvable and reproducible RAPD patterns were selected. Two primers, OPA-04 and OPB-20, of 26 selected arbitrary primers showed different DNA band which found only in normal shrimps but not in viral tolerance shrimps. For OPA-04 primer, DNA band with size about 800 bp was found in all normal samples. Amplification using OPB-20 showed a DNA band with size about 1,250 bp which existed only in 12 of 19 normal shrimp (63.2%). Amplification of other geographically separated *P. monodon* using OPA-04 primer, showed only a faint band of 800 bp in samples from Satun-Trang collected later in 1997 but not in other normal groups. This fragment was further analyzed by cloning and sequencing. The 800 bp fragment was cloned and transformed into *E. coli* DH5alpha clone no. 28 containing the desired 800 bp fragment was isolated and partially sequenced by the ABI-PRISM automated sequencer. Four hundred and sixty nine bases (58.6%) were sequenced and then aligned to other genes in the genbank using BLAST program. The sequence comparisons, nucleotides and amino acids, showed no similarity to any known genes or proteins. To test specificity of this fragment using PCR technique, the specific primers were designed from nucleotides of the 800 bp fragment and PCR amplification yielded a 173 bp product. The presence of a 173 bp fragment was found 80% and 15% in normal samples and Satun samples (collected in 1997), respectively. In viral tolerance samples and other normal groups did not showed this PCR product.

Keywords: Prawns; Shrimps; *Penaeus monodon*; Black tiger shrimp; Genetic markers; RAPD; Randomly Amplified Polymorphic; PCR;

509 Chantana Nithimathachoke. 1996. **Immunoenhancement in giant tiger shrimp *Penaeus monodon* by *Clostridium butyricum*.** Master Thesis. Chulalongkorn University. 123 p.

The study of immunostimulants in *Penaeus monodon* was carried out by using the commercial product, IE-04 and formalin-killed cells of *Clostridium butyricum* supplemented into the feed. Following experimental infection of the shrimp by *Vibrio parahaemolyticus* via intramuscular injection and *Vibrio harveyi* and yellow Head Virus (YHV) via immersion (challenge test), the shrimp's resistance to infection was investigated by determining the cellular immune response, including phagocytosis

and the phagocytic index; and the humoral immune response, including bactericidin. The results indicated that feed supplemented with either IE-04 or *C. butyricum* at a concentration of 100 ppm, and with a 30 days feeding program, the shrimp's resistance to *V. harveyi* infection was increased, with the relative percent survival (RPS) of 37.93% and 27.59%, respectively; with both immunostimulants the duration of resistance was 7 days. IE-04 or *C. butyricum* mixed in the feed at 100 ppm. and fed for 30 days led to a slight increase the resistance to YHV infection, with the RPS of 16% and 20%, respectively. The bactericidin in both groups was 4 times higher than that of the control and also lasted for 7 days. Interestingly, in the group fed with *C. butyricum*, the phagocytosis and phagocytic index increased only 7 days after the end of the feeding regimen. Another experiments fed supplement of IE-04 @ 100 ppm, *C. butyricum* @100 ppm or the mixture of IE-04 and *C. butyricum* in the ratio |:|, @ 100 and @ 200 ppm, for 7 days. Results indicated that the resistance to YHV infection 7 and 14 days after the end of feeding increased in the group fed with IE-04; the RPS was 38.46% and 27.27%, respectively. In addition, the bactericidin was 4 times higher than that of the control 7 days after stop feeding. In the group fed with *C. butyricum* the resistance to YHV infection increased and lasted for 7 days, and RPS was 20.0% after feeding for 7 days and 53.85%, 7 days after ending the feeding program. No increase of bactericidin but an increase in % phagocytosis was found. In the group fed with IE-0.4 and *C. butyricum* mixture @ 100 ppm, the resistance to *V. harveyi* and YHV infection slightly increased, with the RPS of 26.32% and 25.0%, respectively. Whereas both bactericidin and % phagocytosis did not increase. At 200 ppm of the mixture, the bactericidin, % phagocytosis and resistance to YHV infection did not increase. However, the increase in the resistance to *V. harveyi* infection 7 days after the end of the feeding regimen with the RPS of 46.67% was found. This study did not find the increasing relationship between the resistance to YHV and *V. harveyi* infection and bactericidin or % phagocytosis. The feed supplemented with *C. butyricum* might increase the resistance to infection in *Penaeus monodon*.

Keywords: Prawns; Shrimps; *Penaeus monodon*; Giant tiger prawn; *Clostridium butyricum*;

Challenge test; Yellow Head Virus; *Vibrio harveyi*; Bactericidin; Phagocytosis; Immunology

510 Songkrit Prapagdee. 1995. **Acute toxicity of bis-tributyltin oxide on early stages of giant tiger prawn (*Penaeus monodon*)**. Master Thesis. Chulalongkorn University. 92 p.

Lethal effect of bis-tributyltin oxide on early stages of giant tiger prawn, *Penaeus monodon*, was tested by using static bioassay under laboratory conditions. The median lethal concentrations (LC₅₀) at 24 hours of nauplius, protozoa, mysis, postlarva 2 and postlarva 6 was 0.89 (0.67-1.09), 1.59 (1.50-1.67), 2.04 (1.87-2.21), 3.07 (2.96-3.17) and 3.39 (3.30-3.47) µg/l, respectively. Bis-tributyltin oxide at a concentration of 0.15 µg/l was found to decrease percent hatching of egg stage (P<0.05). Half-life of bis-tributyltin oxide in sea water under laboratory conditions was 3.7 days as detected by gas-chromatography.

Keywords: Prawns; Shrimps; *Penaeus monodon*; Giant tiger prawn; Acute toxicity; Bis-Tributyl-Tin Oxide; Chemicals; Toxicity

511 Pratak Tabthipwan, Nonthawith Areechon and Yonth Muksig. 2000. **Residues and effects on growth and diseases of some antibiotics in *Penaeus monodon* Fabricius**. Research Report 1989-1990. Office of the National Research Council of Thailand. 106 p.

Culture of tiger prawn (*Penaeus monodon*) in Thailand has been developed from conventional extensive to intensive culture system. Export of this frozen shrimp has been one of the top five revenues of the country. Unfortunately, this intensive culture method has always been retarded by many disease outbreaks. Shrimp farmers have to apply antibiotics to cope with bacterial diseases. Thus, it is essential to investigate on the residue and effects of some antibiotics on the growth and disease in this shrimp so appropriate application can be conducted. This study was designed to determine the mentioned effects of oxytetracyclin (OTC) and oxolinic acid (OA) in the laboratory scale. Shrimp fed with OTC or OA at concentrations of 0.5, 1.0, 5.0 and 10.0 gms/kg feed for 7 and 14 days showed the same pattern of drug residue in the tissue. Amount and length of residue would be directly related to the concentration and length of drug consumption. OA appeared to be deposited in shrimp tissue higher in amount and longer than OTC when same concentration and length of consumption was applied. For example, at 5 gms/kg feed for 7 days, the highest concentration of residue and length of complete degradation were 2.85 µg/g and 19 days for OA and 1.184 µg/g and 6 days

for OTC respectively. The effects on growth was conducted by direct application of these antibiotics in the sea water with postlarva 5 (p5) and mixing in feed with p 25-30 and two month old shrimp. For OTC, postlarva raised with 15 and 25 mg/l (ppm) for four weeks had significantly better growth than other groups while p30 fed with OTC for six weeks did not show any significant change of growth rate. However, two month old shrimp fed with 0.5 1.0 5.0 and 10.0 gms/kg feed for six weeks had significantly less growth rate than the control. OA did not show any impact on the growth of shrimp in all experiments. Shrimps that were fed with either OTC or OA at the concentrations of 5 gms/kg feed or higher for 7 consecutive days showed significantly higher resistant to experimental infection by *Vibrio parahaemolyticus*.

Keywords: Prawns; Shrimps; Black tiger shrimp; Growth; Diseases; Drugs; Antibiotics; *Penaeus monodon*; Drug residues; Residues; Oxytetracycline; Oxolinic acid

512 Panarat Phadee and Nontawith Areechon. 1997. **Application of benzalkonium chloride, glutaraldehyde and their mixture to control *Vibrio* spp. and their toxicities in *Penaeus monodon* (Fabricius) larvae.** In the 35th Kasetsart University Annual Conference, 3-5 February 1997. p. 56-67.

Efficacy of benzalkonium chloride, glutaraldehyde and their mixture (ratio of 4:1) on four *Vibrio* spp. including *Vibrio alginolyticus*, *V. cholerae*, *V. harveyi*, and *V. parahaemolyticus* containing approximately 5.5×10^5 cells/ml was studied. Minimal inhibitory concentration (MIC) of these three chemicals were at the range of 16-64, 8-32 and 8-32 ppm respectively. Minimal bactericidal concentrations (MBC) when tested on Mueller-Hinton broth were at the range of 32-128, 16-64, 8-32 ppm and 2-8, 2 and 1-2 ppm when tested in 1% NaCl respectively. *Vibrio alginolyticus* was the most sensitive bacteria to these chemicals while *V. cholerae* was the most tolerant one. Benzalkonium chloride was most effective at pH 9, glutaraldehyde at 5 and 6 and their mixture at 7. All three chemical were most effective at salinity of 5 ppt and would be less effective at higher salinity (10, 20, 30 and 40 ppt). Acute toxicity test on *Penaeus monodon* postlarva 15 by static bioassay revealed the LC₅₀ 24 hrs at 3.15, 2.85 and 1.70 ppm respectively.

Keywords: Prawns; Shrimps; *Penaeus monodon*; Benzalkonium chloride; Glutaraldehyde; Control; *Vibrio*; Toxicity; Chemicals; *Vibrio alginolyticus*;

Vibrio cholerae; *Vibrio harveyi*; *Vibrio parahaemolyticus*; Bacteria

513 Sapon Onkong and Tanawut Klowklieng. 1996. **Monitor of antibiotic residues in tiger shrimp, *Penaeus monodon* and sediment of shrimp farms in Satul province.** Technical Paper No. 21/1996. Satul Coastal Aquaculture Development Center. Department of Fisheries. 10 p.

Monitor of residual antibiotics in shrimp and sediment of shrimp farm in Satul province was carried out during January-August 1993. Using of antibiotics in shrimp farm of 93 farmers were interviewed. Seventy-six farms were periodically collected sample of shrimp, pond sediment and sediment of near by natural canals for 123, 123 and 41 samples respectively. Samples were tested residual antibiotic by microbiological assay. The results showed that farmers used antibiotics for 75.27% of all sample farm, all of them used by oral administration (fed with antibiotic medicated feed). An oxytetracycline was widely used for shrimp culture. Residual antibiotic of shrimp and pond sediment samples were 12.20 and 16.26% respectively, but it was unresidue in sediment of near by natural canal. Antibiotics were mainly used in dry season (February-April), widely used in the area of Muang and Tung-wa districts that was highly detected much more than the other area.

Keywords: Prawns; Shrimps; Black tiger shrimp; Antibiotics; *Penaeus monodon*; Shrimp farm; Satun; Sediment; Drug residues; Drugs; Residues; Microbiological assay

514 Sataporn Direkbusarakom, Angkana Herunsalee and Somporn Rungkomneradwong. 1996. **The virucidal activity of nine species of herb against yellow head baculovirus on black tiger shrimp (*Penaeus monodon*).** Technical Paper No. 6/1996. National Institute of Coastal Aquaculture, Songkhla. Department of Fisheries. 7 p.

Nine species of Thai traditional herbs including *Ocimum sanctum*, *Eclipta alba*, *Cassia alata*, *Tinospora cordifolia*, *T. Crispa*, *Phyllanthus acidus*, *P. emblica*, *Andrographis paniculata* and *Calophyllum inphyllum* were tested for their efficiency to inactivate yellow head baculovirus (YHV) after intramuscularly injected to black tiger shrimp (*Penaeus monodon*). The herbs were extracted by ethanol using a soxhlet apparatus. The virucidal activities of these extracts were tested by mixing the diluted virus (1:10,000) with 10 mg/ml of each extract and exposing for 2 hours at room temperature before injection. Virucidal activity was assessed by decreased mortality rates of the injected with herb's extracted samples when compared to the control

animals injected with diluted virus extract only. The results showed that the extracts of *O. sanctum*, *C. alata*, *T. crispa*, *P. acidus* and *C. inphyllum* were effective for control YHV by reducing mortality rate in shrimp. The minimum inhibitory concentrations for those five herbs were 1 mg/ml while the LD₅₀ of the extract to postlarvae 15 of black tiger shrimp at 24 hours were 1,987-3,548 ppm.

Keywords: Prawns; Shrimps; *Penaeus monodon*; Black tiger shrimp; Herbs; Yellow-head baculovirus; YHV; *Ocimum sanctum*; *Eclipta alba*; *Cassia alata*; *Tinospora cordifolia*; *Phyllanthus acidus*; *Phyllanthus emblica*; *Andrographis paniculata*; *Calophyllum inphyllum*; Probiotics; Diseases; Viruses

515 Jiraporn Kasornchandra, Sitdhi Boonyaratpalin, Raewat Khongpradit and Usanee Ekpanittanpong. 1995. **A bacilliform virus, The causative agent of Red Disease with White Patch in black tiger shrimp (*Penaeus monodon*)**. Technical Paper No. 3/1995. National Institute of Coastal Aquaculture, Songkhla. Department of Fisheries. 11 p.

During late October 1994 to early January 1995, a serious mortality among cultured *Penaeus monodon* occurred in Songkhla and Trang Provinces, Southern Thailand. Typical sign of the disease was the reddish to pinkish-red coloration of the body. The white patch on the inside surface of shell or carapace was found in some diseased shrimp. Experimental injected shrimp with a filtrated homogenized of gills obtained from diseased shrimp showed the reddish coloration, the typical sign of disease. Electron microscopic observation of gills, heart and lymphoid organ of both naturally and experimentally infected shrimps revealed a bacilliform virus within the hypertrophied nuclei. By normal histology, the eosinophilic nuclear hypertrophy of the organs from ectodermal and mesodermal origin was characterized from both shrimps observed. Thus, the bacilliform virus is considered to be the causative agent of the disease.

Keywords: Shrimps; Black tiger shrimp; Bacilliform virus; *Penaeus monodon*; White Spot Syndrome; White Spot Disease; Red Disease; Prawns; Viruses; Trang; Songkhla

516 Raewat Khongpradit, Jiraporn Kasornchandra and Sitdhi Boonyaratpalin. 1994. **Susceptibility of the post larval stages of black tiger shrimp (*Penaeus monodon*) to yellow-head baculovirus (YBV)**. Technical Paper No. 4/1994. National

Institute of Coastal Aquaculture, Songkhla. Department of Fisheries. 11 p.

The susceptibility of postlarval stages (PL15, PL20 and PL25) of Black Tiger Shrimp (*Penaeus monodon*) to Yellow-Head Baculovirus (YBV) was investigated by waterborne inoculation for 6 hours. Experimental shrimp larvae were kept in 27 ppt. treated seawater at 30°C. Mortality of PL15, PL20 and PL25 within 12 days postinfection compared to each control group were 0, 16.00 and 15.34% respectively. Bacterial free suspension of the homogenized infected postlarvae from each group was injected to healthy shrimp. The filtrate of PL15 cannot produce the yellow-head symptom whereas filtrate of PL20 and PL25 gave 100% mortality showing yellow gills and hepatopancreas within 10 days postinfection. Gills, hepatopancreas and hemopoietic tissues of the experimentally infected PL20 and PL25 exhibited basophilic cytoplasmic inclusions in the cytoplasm. Ultrathin sections revealed the presence of YBV in the tissue examined.

Keywords: Shrimps; Black tiger shrimp; *Penaeus monodon*; Yellow-head baculovirus; YBV; Postlarvae; Yellow Head Disease; Prawns; Viruses

517 Juadee Pongmaneerat, Sawitri Silakes and Jamaree Rakbangleam. 2001. **Monitoring of antibiotic residue in cultured black tiger shrimp (*Penaeus monodon*) in year 2000**. Technical Sub division. Coastal Aquaculture Division. Department of Fisheries. 25 p.

The antibiotics, oxytetracycline and oxolinic acid, residue in black tiger shrimp (*Penaeus monodon*) age over 90 days were monitored every month in 20 provinces of pond culturing areas during January to December 2000. The detection method used for tetracycline and oxolinic acid residue were microbiological method and HPLC methods, respectively. The positive oxolinic acid was detected at level over 0.05 ppm.

The results showed that oxytetracycline residue were detected in 121 samples of shrimp from the total sampling number of 4,676 samples. The residue number was found to be 2.59% of the total detection sample from 20 provinces in year round. While the oxolinic acid residue were observed in 509 samples of shrimp from the total detection number of 4,684 samples as 10.87%. The biggest number of oxytetracycline and oxolinic acid residues were respectively observed in the shrimp samples from Samutsakorn and Suratthani provinces at 19.19% and 45.03%. In addition, the highest number of residue in shrimp samples were detected in September and February for oxytetracycline (5.95%) and oxolinic acid (16.14%), respectively. However, the total

average number of oxytetracycline and oxolinic acid residue in shrimp samples from those 20 provinces in the 2000 year was decreased compared with the past 1996-1999 years.

Keywords: Prawns; Shrimps; Black tiger shrimp; *Penaeus monodon*; Antibiotics; Oxytetracycline; Oxolinic acid; Microbiological assay; HPLC; Residues; Drug Residues

518 Renu H. Yashiro and Upaporn Chisriha. 1991. **Effect of injection steroids hormone on gonad development of *Penaeus monodon*. I: Sex steroid levels in broodstock of tiger prawn *Penaeus monodon*.** Technical Paper No. 9/1991. National Institute of Coastal Aquaculture, Songkhla. Department of Fisheries. 16 p.

Sex steroid levels in haemolymph of *Penaeus monodon* broodstock from Andaman sea were measured using radioimmunoassay (RIA). Progesterone can be detected from both sexes. It played an important role on ovarian maturation in female broodstock. Progesterone increased sharply during advance maturation stages then declined right after spawning. Trend of progesterone levels in female of different maturity stages were as follow: 130.7 ± 44.42 , 165.9 ± 32.79 , 207.1 ± 82.85 , 281.9 ± 41.53 , 333.9 ± 59.45 and 105.7 ± 42.18 picogram/ml in immature ovary (Stage 0), early developed ovary (Stage 1), developing ovary (Stage 2), early ripe ovary (Stage 3), ripe ovary (Stage 4), and spent (stage 5); respectively. These levels were low compared to ablated broodstock from the same origin. Progesterone in male was 118.1 ± 55.23 pgm/ml which no significantly different ($P < 0.05$) from immature, early developed and spent female. This hormone may be used as an indicator for maturity in female *P. monodon*. Furthermore, inducing maturation by exogenous hormone may possible instead of eyestalk ablation. Testosterone was also found in all maturity stages in females. The average level was 54.56 ± 12.42 pgm/ml which significantly lower than in male ($P < 0.01$). Estradiol- 17β could not detected by RIA method from this study.

Keywords: Prawns; Shrimps; *Penaeus monodon*; Steroids; Hormones; Broodstocks; Tiger prawn; Progesterone; Radio Immuno Assay; RIA

519 Suwanna Worasing and Borisut Damruk. 1998. **Antibiotic sensitivity of bacteria isolated from Chanthaburi river, water in shrimp ponds and infected black tiger shrimps, *Penaeus monodon* Fabricius, in Chanthaburi province.** Technical Paper No. 16/1998. Trat Coastal

Aquaculture Station. Department of Fisheries. 14 p.

Antibiotic sensitivity test on isolated bacteria from 3 sources: Chanthaburi river, water in shrimp ponds and infected black tiger shrimps was held by disc sensitivity test method. The bacteria were found to be sensitive to Chloramphenicol and Norfloxacin but mostly resisted to Oxytetracycline. Oxytetracycline sensitivity by broth dilution test method were determined for minimum inhibitory concentration (MIC) values was found to be 0.1-50 $\mu\text{g/ml}$. In the latter test resistance to oxytetracycline was in the same manner as in disc sensitivity test.

Keywords: Prawns; Shrimps; Shrimp ponds; *Penaeus monodon*; Bacteria; Antibiotics; Chanthaburi; Black tiger shrimp; Disc sensitivity test; Broth dilution test; MIC

520 Varin Tanasomwang and Thaweechai Supaiwan. 1996. **Susceptibility of bacteria isolated from *Penaeus monodon* larvae, ambient water and feeds to 9 antimicrobial agents.** Technical Paper No.12/1996. Sumutsakhon Coastal Aquaculture. Department of Fisheries. 8 p.

A total of 119 strain of bacteria isolated from *Penaeus monodon* larvae, ambient water and feeds which were grouped into *Pseudomonas* (72), *Vibrio* (38), *Moraxella* (5), and *Acinetobacter* (4) were tested for their susceptibility to 9 antimicrobial agents. These agents included ampicillin, erythromycin, oxytetracycline, chloramphenicol, nalidixic acid, trimethoprim, trimethoprim/sulfamethoxazole, sulfadiazine, sulfasoxazole. The drug susceptibility was evaluated by using disk diffusion test on ZoBell's 2216e agar which dissolved in sea water and on Antibiotic Medium 8 dissolved in distilled water adding 3% NaCl.

The test on ZoBell's agar found that the strains of *Vibrio* were sensitive to chloramphenicol, *Moraxella* to chloramphenicol, trimethoprim/sulfamethoxazole, ampicillin and erythromycin, and *Acinetobacter* to ampicillin. On Antibiotic Medium 8 agar, the strains of *Pseudomonas* were inhibited by nalidixic acid, ampicillin and erythromycin, *Vibrio* by chloramphenicol and nalidixic acid, and *Acinetobacter* by ampicillin and chloramphenicol. The susceptibility of each bacterial group to these drugs was more than 70% of the total strains tested. The percentages of bacterial strains that were susceptible to the drugs on ZoBell's agar were generally less than that on Antibiotic Medium 8 agar suggesting that some factors in sea water might interfere the potency of the drugs. Thus, to evaluate the effect of a certain chemotherapeutant in sea water environments, media dissolved in sea water must be used for drug susceptibility test.

Keywords: Prawns; Shrimps; *Panaeus monodon*; Larvae; Bacteria; Susceptibility; Water; Feeds; Antiinfective agents; *Pseudomonas*; *Vibrio*; *Moraxella*; *Acinetobacter*; Ampicillin; Erythromycin; Oxytetracycline; Chloramphenicol; Nalidixic acid; Trimethoprim; Sulfamethoxazole; Sulfadiazine; Sulfasoxazole; Disk diffusion test; Antibiotic medium 8; Antibiotics

521 Twee Chindamaikui and Thanom Phimonchinda. 1990. **The studies on comparision of nursing *Penaeus monodon* Fabricius by treating antibiotic and untreating antibiotic.** Technical Paper No. 35/1990. Phuket Coastal Aquaculture Development Center. Department of Fisheries. 18 p.

The comparison studies on the *Penaeus monodon* nursery between treating antibiotic and untreating antibiotic had been done on may 1990 to June 1990. Three treatments and three replications were done by treating antibiotic everyday until PL1 treating with antibiotic before the larvae changed the stage and controled with untreating antibiotic. The twenty tons tanks covered with black canvas and controled temperature with heater had been used with one million larvae per tanks. Nursing the larvae with natural feed plus artificial feed. The results of the experiments; for the nursing *P. monodon* on untreating antibiotic, the larvae died in zoea stage by fluorescent bacteria and fungus (*Lagenedium sp.*) attacked. For the nursing *P. monodon* on treating antibiotic everyday until PL1; the survival rate of nauplius, zoea, mysis, postlarvae and nauplius to PL₁₅ were 82.50, 76.77, 92.41, 56.41 and 33.00 percentage respectively. For the nursing *P. monodon* on treating antibiotic before the larvae change the stage, the survival rate of Nauplius, Zoea, Mysis, Postlarvae and Nauplius to PL₁₅ were 82.00, 74.86, 70.38, 53.07 and 23.50 percentage respectively. For the comparision studied on the three treaments; the survival rate of nursing *P. monodon* with treating antibiotic everyday until PL₁ was the highest than treating antibiotic before changing the stage or untreating antibiotic.

Keywords: Prawns; Shrimps; *Penaeus monodon*; Antibiotics; Comparision; Nursing; Treatments; Fungi; *Lagenedium*; Oxytetracycline; Treflan; Chloramphenicol; Bacteria

522 มณเฑียร ส่งเสริม, บัญญัติ สุขศรีงาม และปภาศิริ ศรีโสภณภรณ์. 2533. การศึกษาแบคทีเรียที่เป็นสาเหตุของโรคเรืองแสงในกุ้งกุลาดำ. วารสารศรีนครินทรวิโรฒวิจัยและพัฒนา. 4(1): 15-24.

The purpose of this experiment was to study the bacteriological luminescent disease in Jumbo Tiger Shrimp (*Penaeus monodon*) from Wonapa Beach, Tumbol Sansuk, Amphoe Muang, Chonburi. There were 30 samples per month from each source making 150 total samples from August to December 1988. *V. harveyi* found in 92 samples (61.3) with morphology, physiological and biochemical characteristics such as luminecent on SWC agar, a round colony, yellow mucoid on TCBS agar and facultative anaerobes. Production enzymes such as catalase, oxidase, amylase, lipase and gelatinase, produced acid from the ferment glucose, maltose, sucrose, mannitol, galactose, lactose and fructose but not from ferment arabinose and dulcitol. It did not produce gas from the ferment glucose and need sodium chloride to grow. There was optimum growth at 30°C but not at 4°C. Sensitivity test were performed that *V. harveyi* was susceptible to chloramphenicol, kanamycin, gentamicin, amikacin, sulfafurazole, cephalothin and trimethoprim-sulfamethoxazole but was resistant to ampicillin, tetracycline, streptomycin and polymyxin B. It was intermediate to erythromycin and nalidixic acid and trend to resist. The capability to cause a disease with Jumbo Tiger Shrimp in nauplius and zoea when expose to the disease with different optical density of 0.84, 0.54, 0.34 and 0.18. The shrimp died 100% while the control group died 34.8 and 25%. In mysis stage it died 74.5, 70, 63 and 53.5%, and the control group died 25%. In the postlarvae stage shrimp died 50, 50, 40 and 35% and the control group died 20%. The total of death in each period of growth was different from the experimental group with various optical density at the 0.05 level.

Keywords: Prawns; Shrimps; *Penaeus monodon*; Bacteria; Jumbo tiger shrimp; Luminescent disease; Chonburi; Kanamycin; *Vibrio harveyi*; TCBS; Chloramphenicol; Sulfafurazole; Gentamycin; Amikacin

523 Jiraporn Kasornchandra and Sitdhi Boonyaratpalin. 2000. **Primary shrimp cell culture: applications for studying White Spot Syndrome Virus (WSSV).** Technical Paper No. 3/2000. Marine Shrimp Research and Development Center, Songkhla. Department of Fisheries. 5 p.

Primary shrimp cell culture from lymphoid organs of *Penaeus monodon* was successfully developed in our laboratory. Minced tissues of lymphoid organs were seeded and cultured in 2x Liebovitz-15 supplemented with 15% fetal bovine serum, 10% shrimp meat extract, and a salt mixture, with an osmolality of 710-730 mmol/kg. Plates were then incubated at 28°C until 70-80% cell monolayers were formed. Even though these primary lymphoid cell cultures could not be subcultured, they proved to

be useful for studying shrimp viruses which could induce unequivocal cytopathology in them. Cytopathic effect (CPE) induced by white spot syndrome virus (WSSV) showed characteristics of cell rounding, detachment and lysis. Quantitative analysis of WSSV infected *P. monodon* was determined using primary lymphoid cell systems. Among those tissues and organs observed, cuticular epidermis gave the highest titer of $10^{8.25}$ TCID₅₀/ml. Pathogenesis of shrimp viral infections and the relative virulence of WSSV infecting various species of crustaceans were also examined using this primary shrimp cell culture system.

Keywords: Shrimps; White Spot Syndrome Virus; WSSV; *Penaeus monodon*; Black tiger shrimp; Prawns; Viruses.

524 ไพศาล ลิทธิกรกุล, พุทธิ ช่วยชูวงศ์, สมบัติ รักประทานพร, ศิวาพร ลงยันต์, ปรินทร์ ชัยวิสุทธิทางกูร และ วีระวรรณ ลิทธิกรกุล. 2543. การวินิจฉัยการติดเชื้อไวรัสหัวเหลืองในกุ้งกุลาดำโมโนโคลนอลแอนติบอดี. วารสารวิทยาศาสตร์ มศว. 6(1): 34-45.

A monoclonal antibody specific to yellow head virus (YHV), namely V3-2B was used to detect YHV infection at various time in *Penaeus monodon* experimentally infected with YHV. Different types of indirect immunoperoxidase assays including dot blot and western blot were utilized for detection of YHV in haemolymph. Immunocytochemistry was used for detection of YHV infection in haemocyte smears and paraffin sections of various tissues including hepatopancreas, heart, lymphoid organ and gill. The presence of YHV was clearly demonstrated in all tested shrimps with all types of immunoassays after 24 hr of YHV injection. Especially the infection of cells in the haemocyte and all tested tissues were observed before the onset of histopathological symptoms. Therefore, the V3-2B monoclonal antibody can be used to facilitate the accurate diagnosis of early YHV infection.

Keywords: Shrimps; Black tiger shrimp; Yellow Head Virus; YHV; Yellow Head Disease; *Penaeus monodon*; Monoclonal antibody; Prawns; Viruses; Indirect immunoperoxidase

525 Suttinee Limthammahisorn and Kom Silapajarn. 1995. Antibiotic residue in cultured black tiger shrimp (*Penaeus monodon*) and pond soil in Prachuabkhirikhan province During 1992-1994. Technical Paper No. 16/1995. Prachuabkhirikhan Coastal Aquaculture Development Center. Department of Fisheries. 16 p.

The study on antibiotic residue in cultures shrimp *Penaeus monodon*, and pond soil of Prachuabkhirikhan province were conducted during 1992-1994. The residue was determined by using Microbiological Assay (antibiogram test). The results showed that the percentage of antibiotic residue farms in Prachuabkhirikhan province had declining. The antibiotic residue in cultured shrimp was declined from 7.50% in 1992 to be 1.49 and 1.38 in 1993 and 1994 respectively. The percentage of antibiotic residue in pond soil farms were 58.33 and 30.30 in 1993 and 1994. The residues in pond soil mostly found during 45-60 days after rearing in which the shrimp farmers used antibiotic for disease prevention. However, none of residue in pond soil was found during harvesting period.

Keywords: Prawns; Shrimps; Black tiger shrimp; Antibiotic residues; *Penaeus monodon*; Prachuab Khiri Khan; Residues; Drugs; Drug residues; Microbiological assay

526 Jiraporn Kasornchandra, Suda Tandavanitj, Raewat Khongpradit and Sarawut Sriwatanavarunyou. 2000. The possibility of vertical transmission studies on Systemic Ectodermal and Mesodermal Baculovirus (SEMBV) in *Penaeus monodon*. Technical Paper No. 5/2000. Marine Shrimp Research and Development Center, Songkhla. Department of Fisheries. 16 p.

The possibility of vertical transmission of systemic ectodermal and mesodermal baculovirus (SEMBV) was studied in black tiger shrimp (*Penaeus monodon*) broodstocks and their larval stages using PCR method, *in situ* hybridization and transmission electron microscopy (TEM). The SEMBV-free male and vitellogenic ovarian shrimp female brooders were divided into five groups and fed with infected-crab meat for consecutive two, three, four and five days, respectively. The control group was fed with uninfected-crab meat. A day before spawning, infected and uninfected shrimp brooders were examined for SEMBV infected using one- and two-step PCR. Only shrimp brooders fed with infected-crab meat for two days were positive only in two-step SEMBV PCR otherwise were one-step SEMBV PCR positive. The presence of virions in the cells of female reproductive organs was confirmed by *in situ* hybridization and TEM. SEMBV were found in follicle cells, perinucleolus oocytes, yolky oocytes and connective tissue. After spawning, eggs were collected and washed for 3-4 times with chlorinated sea water and transferred to the nursing tank. Nauplii, zoea, mysis and post larva-15 (PL-15) stages were collected and examined

for the presence of SEMBV using one- and two-step PCR and *in situ* hybridization diagnostic procedures. Only nauplii and zoea of lightly infected (i.e. two-step PCR positive) female brooders were found to be two-step SEMBV PCR positive. Offspring from the 3rd group were found to be one-step PCR positive. No eggs were hatched-out from the vitellogenic ovarian female brooders group fed consecutively with infected-crab meat for four days. Brooders fed with infected-crab meat for five days consecutively failed to produce the maturing ova, suggesting those heavy infected fertile eggs were unable to develop further. From our studies indicated the possibility of vertical transmission of SEMBV in *Penaeus monodon* by which virus entered ovary via hemal sinuses and connective tissue 3, the virus then attached to surface membrane and penetrate into follicles cells and oocytes. Only maturing ova having virus attached on it could develop further producing the SEMBV infected nauplii.

Keywords: Shrimps; Black tiger shrimp; *Penaeus monodon*; Vertical transmission; Systemic Ectodermal and Mesodermal Baculovirus; Prawns; Viruses; SEMBV; PCR; Polymerase Chain Reaction

527 Bhud Songsangjinda. 1989. **Relationships between vitellogenin, 20-hydroxyecdysone and oocyte development in banana shrimp (*Penaeus merguensis* de Man).** Technical Paper No. 2/1989. National Institute of Coastal Aquaculture, Songkhla. Department of Fisheries. 22 p.

An investigation of the relationships between vitellogenin, 20-hydroxyecdysone and oocyte development of banana shrimp obtained from Kao-Seng Beach, Songkhla, indicated that haemolymphatic vitellogenin level varied according to development stage of oocyte. It's levels increased at the 1, 2 and attaining it's peak with GSI of 5.18 at the termination of stage 3 and subsequently dropped probably due to the absorption of vitellogenin into the oocyte. The result complies with the histological study that revealed the presence of rod-shape bodies in the ovary of stage 4. It was also found that levels of haemolymphatic vitellogenin were influenced by molting hormone as observed during the molting period. A comparative study of 48-hour duration was undertaken by injecting 20-hydroxyecdysone at dose 50, 100, 150 ng/g body weight, normal saline injection and eye-stalk ablation, result of which pointed out that the 50 ng dose could elevate the haemolymphatic vitellogenin level whereas at higher doses of 100 and 150 ng, such levels tended

to be lowered and eye-stalk ablation was more effective in reducing vitellogenin than hormone injection. No ovary development was detected in all treatments. The research finding gave on evidence that 20-hydroxyecdysone functions as a secondary factor in banana shrimp's ovary development.

Keywords: Prawns; Shrimps; *Penaeus merguensis*; Vitellogenin; 20-hydroxyecdysone; Oocytes; Banana shrimp; Hormones

528 Suda Tandavanitj and Pikul Katrain. 1994. **Residue of antibiotics in bottom sediments from shrimp farms in Phuket, Phang-Nga and Ranong province.** Technical Paper No. 13/1994. Phuket Coastal Aquaculture Development Center. Department of Fisheries. 13 p.

The residue of antibiotics in bottom deposits from shrimp farms in Phuket, Phang-nga and Ranong provinces were investigated by Microbiological assay. The bottom sediment of 54 ponds were collected from November 1992 to September 1993. The results showed the residue of antibiotics in bottom sediment through the year in Phuket, Phang-Nga (Amphoe Muang) and Ranong. The highest amount of pond which indicated the residue of antibiotic in bottom sediment revealed 62.63% in January, 45.45% in December, 42.85% in February, and 18.75% in March at Phang-Nga (Amphoe Muang), Phuket, Ranong and Phang-Nga (Amphoe Takuapa), respectively. However, the residue of antibiotics in bottom sediment could be found in the pond with the various age of shrimp.

Keywords: Prawns; Shrimps; Black tiger shrimp; Residues; Antibiotics; Phuket; Phang-nga; Ranong; Drugs; Drug residues

529 Somprasong Kanthom. 1996. **Effect of Benzalkonium Chloride (BKC) on the mortality rate of tiger prawn (*P. monodon*) Larvae.** Technical Paper No. 7/1996. Chumporn Coastal Aquaculture Development Center, Coastal Aquaculture Division, Department of Fisheries. 18 p.

Benzalkonium Chloride (BKC) which is one of chemical is used in the treatment of shrimp disease. However, there are few report on application of BKC in treatment of shrimp larvae disease. There fore it is necessary to study the effect of BKC on the larvae of tiger prawn. the results from the study are:

Postlarva 3, 48 hr. LC₅₀ value is 0.28 ppm and safety concentration is 0.03 ppm

Postlarva 8, 24 hr. LC₅₀ value is 0.66 ppm and safety concentration is 0.07 ppm

Postlarva 11, 48 hr. LC₅₀ value is 0.64 ppm and safety concentration is 0.60 ppm

Postlarva 22, 48 hr. LC₅₀ value is 5.99 ppm and safety concentration is 0.60 ppm

Postlarva 26, 48 hr. LC₅₀ value is 8.33 ppm and safety concentration is 0.83 ppm

BKC concentration divided into 5 different concentration as 1, 3, 5, 8 and 10 ppm. Each concentration rested for 4, 5, 6 and 7 days, hence releasing PL26 with average length of 2.0 cm. and weight of 0.052 gm. These experimental concentrations did not affect mortality.

Keywords: Prawns; Shrimps; *Penaeus monodon*; Tiger prawn; Benzalkonium chloride; BKC; Chemicals

530 Suwanna Worasing and Pornlerd Chanratchakool. 1996. **Acute toxicity and effects of chlorine on black tiger shrimp, *Penaeus monodon* Fabricius.** Technical Paper No. 34/1996. Chanthaburi Coastal Aquaculture Development Center, Coastal Aquaculture Division, Department of Fisheries. 26 p.

Acute toxicity of chlorine as calcium hypochlorite on black tiger shrimp (*Penaeus monodon* Fabricius) and effects of chlorine during subacute exposures on shrimp growth, mortality rate and histology were studied. Water quality and bacterial count in different chlorine concentration levels were also studied. The 24-hour LC₅₀ of calcium hypochlorite on various stage of *Penaeus monodon* nauplius, zoea 2, mysis 2, postlarva 6 and 15 were 1.87, 2.12, 0.77, 2.66 and 2.77 mg/L respectively. There was no significant difference in growth ($P>0.05$) and mortality rate of black tiger shrimp exposed to chlorine of 0.276, 0.828 and 1.380 mg/L for 50 days from postlarva 15 stage. No histological change was found in shrimp exposed to 3 levels of chlorine concentration for 50 days.

Application of calcium hypochlorite of 1, 5 and 15 mg/L in filtrated seawater during the 24-hour period caused decreasing in total ammonia. Total ammonia at 24 hour was not found in chlorine concentration 1 mg/L and total ammonia at 4 hours were not found in chlorine 5 and 15 mg/L pH value slightly increased when chlorine was applied in water and decreased at 24 hour-period. Alkalinity slightly increased too. The different chlorine concentration levels effected on total bacteria and vibrio in seawater from shrimp pond. Chlorine concentration of 1 mg/L could inhibit bacteria and vibrio within 30 minutes but at 24 hour this level caused increasing bacteria in water 10 mg/L could also inhibit bacteria and *Vibrio* within 30 minutes through 24-hours period.

Keywords: Prawns; Shrimps; *Penaeus monodon*; Black tiger shrimp; Acute toxicity; Chlorine; Calcium hypochlorite; Water quality; Bacteria; Ammonia; *Vibrio*; Chemicals. Toxicity

531 Wanna Ruttanagosrigit and Suppachai Summawuthi. 1988. **Acute toxicity of Brestan-60 (Triphenyl tinacetate) on larva and post larva of *Penaeus monodon*.** Technical Paper No. 5/1988. Brackishwater Fisheries Division Department of Fisheries. 13 p.

Toxicity of a molluscicide, Brestan-60 on various stage of *Penaeus monodon* larva and post larva, were tested, using static bioassay. Twenty four hours LC₅₀ for nauplius, protozoa, mysis, post larva 5, post larva 12 and post larva 24 were 0.013, 0.0072, 0.0094, 0.064, 0.032 and 0.0716 mg/l respectively. Median lethal concentration (LC₅₀) at 48, 72 and 96 hrs for post larva 5 were 0.029, 0.0175 and 0.0135 mg/l. Median lethal concentration (LC₅₀) at 48, 72 and 96 hrs for post larva 12 were 0.021, 0.010 and 0.0066 mg/l. 48, 72 and 96 hrs-LC₅₀ for post larva 24 were 0.0275, 0.023 and 0.019 mg/l.

Keywords: Prawns; Shrimps; Black tiger shrimp; *Penaeus monodon*; Acute toxicity; Brestan-60; Triphenyl tinacetate; Larvae; Postlarvae; Drugs; Drug residues

532 Putth Songsangjinda and Sumeth Chaiwatcharagoon. 1998. **Molting and effect of 20-hydroxyecdysone on molting of *Penaeus merguensis* de Man.** Technical Paper No. 1/1988. National Institute of Coastal Aquaculture, Songkhla. Department of Fisheries. 12 p.

Thin uropods of *Penaeus merguensis* were used for molting observation in laboratory, five major molting stages were described. There were different in duration of each stage. The duration of stage D was approximately 12.1 days (65.1%) of whole molting cycle (18.6 days) while the duration of stage C, stage B and stage A were approximately 3 days (16.1%), 2 days (10.70%) and 1.5 days (8.1%) of whole molting respectively. By using 50 ng/gm (body weight) of 20-hydroxyecdysone, molting duration of *P. merguensis* was reduced approximately 6.4 days (42.5%) comparing with normal molting.

Keywords: Prawns; Shrimps; *Penaeus merguensis*; 20-hydroxyecdysone; Moulting; Hormones

533 ลีลา เรืองแป้น, ชัยวุฒิ สุดทองคง และ พัชรินทร์ เนียมหมอ ม. 2002. ประสิทธิภาพของ **Trifluralin** ในการควบคุมเชื้อ

เชื้อราและพิษเห็บบนพลันต่อลูกกุ้งแชบ๊วย. ใน การประชุมกุ้งทะเลแห่งชาติ ครั้งที่ 4. น. 108-123.

Trifluralin is one of 215 candidate aquatic fungicides screened for their efficacy against pathogenic fungi. The effective candidate fungicides will be replacement the usage of malachite green, a potential carcinogen. Today, trifluralin was widely used in marine and freshwater hatcheries, especially for shrimps, crabs and ornamental fishes larvae. However, its efficacy for control aquatic fungi and median lethal concentration (LC₅₀) to those aquatic larvae has been virtually uninvestigated. This study aims to test the sensitivity of *Lagenidium* sp. and other 2 marine fungi toward trifluralin 48% W/V-EC and its LC₅₀ to banana shrimp (*Penaeus merguensis*) larvae.

Range finding test was performed using larval shrimp of the stages mysis, postlarvae 5, 10, 20 and 30. The samples were exposed to 30 ppt seawater containing trifluralin at 0.5-30 ppm for 96 h. After exposure, it was found that larval shrimp were killed in trifluralin 1-30 ppm but no mortality was observed in 0.5 ppm. The results of full scale test showed LC₅₀ of the mysis, PL₅, PL₁₀, PL₂₀ and PL₃₀ at 2.96 ppm, 3.35 ppm, 7.97 ppm, 9.98 ppm and 13.13 ppm. at 24 h, respectively. Efficacy against 3 aquatic fungi were performed by 2 experiments. The first experiment, performing by exposure paper discs (10 mm diameter) with 12 h cultured fungi to trifluralin 10, 5, 3, 1 and 0.5 ppm for 12, 24, 36 and 48 h. before placing on potato dextrose agar plates. The second experiment, the discs were exposed to trifluralin then transferred to fungi suspension before placing on potato dextrose agar plates which containing trifluralin at the same concentrations. No trifluralin was added to control group. All experiments were carried by triplicated set. The results showed that the second experiment can inhibit the growth of fungi according to the respective of trifluralin concentrations.

These studies revealed clearly that a appropriated method on using trifluralin is preventive measure but not for cure after occurrence of the disease. In order to ensure the impact of usage, further study should focus on the residue of trifluralin in shrimp and water after treatment.

Keywords: Prawns; Shrimps; Banana shrimp; *Penaeus merguensis*; *Lagenidium*; Chemicals; Acute toxicity

534 Renu Yashiro, Vichai Vatanakul and Nivate Ruangpanit. 1992. **Effect of steroid hormone on**

maturation of tiger shrimp, *Penaeus monodon* II. Effect of some exogenous hormones and thoracic ganglion on ovarian maturation of *Penaeus monodon*. Technical Paper No.15/1992. National Institute of Coastal Aquaculture, Songkhla. Department of Fisheries. 10 p.

Experimental on the effect of 17- α Hydroxyprogesterone (17- α HP) Puberogen (PBG) and thoracic ganglion of *Penaeus monodon* Stage II, or developing ovary (TG), injected and implanted to *P. monodon* broodstock from Andaman sea. Progesterone level before and 48 hrs after treatment were used as tool for evaluating the effects together with external examination on ovary growth. Average level of progesterone from 17- α HP injected group was increased 2.2 times while PBG injected group was 5.5 times and TG implanted group was 1.3 from their initial levels. Aside from these, 2 shrimps of 17- α HP injected group had developed to Stage I and TG injected group had developed to Stage II on the 19th day after injected. Furthermore, the 17- α HP injected group had developed to Stage III and laid unfertilized eggs 22 days after injection. On the other hand, PBG injected group had no sign of ovarian development, therefore Puberogen may not be good for induction of *P. monodon* maturation. However, further experiment on optimum dosages and try the other hormones and organic substances should be done.

Keywords: Prawns; Shrimps; *Penaeus monodon*; Hormones; Thoracic ganglion; Steroid hormones; Maturation; Tiger shrimp; Puberogen; Progesterone; RIA

535 Kidchakan Supamattaya, Jiraporn Kasornchandra and Sitdhi Boonyaratpalin. 1994. **Comparative study of simple methods for the diagnosis of yellow-head baculovirus in the black tiger shrimp (*Penaeus monodon*).** Songklanakarin J. Sci. Technol. 16(1): 37-48.

Six current methods were used to detect the yellow-head baculovirus (YBV) infection in black tiger shrimp (*Penaeus monodon*). They were : total hemocyte count, wet mount of the gills, copper content in hemolymph, Giemsa staining of hemocyte, hematoxylin staining of the gills and scanning electron microscopic (SEM) studies of hemocyte surface. Wet mount of the gills and hematoxylin staining of the gills had poor results in detecting the early stages of yellow-head baculovirus infection. The techniques of copper content of hemolymph, Giemsa staining of hemocytes and total hemocyte count showed promising result which could be useful

for YBV dianosis. But more baseline data are needed to standardized these methods.

Keywords: Shrimps; Black tiger shrimps; *Penaeus monodon*; Yellow-head Baculovirus; Yellow Head Disease; Diagnosis; Prawns; Viruses

536 Sataporn Direkbusarakom, Kruewan Onthong, Somporn Rungkumnaudvong and Niput Chotikarn. 1997. **The virucidal activity of some Thai traditional herbs against Systemic Extodermal and Mesodermal Baculovirus in tiger shrimp (*Penaeus monodon*)**. In the 35th Kasetsart University Annual Conference, 3-5 February 1997. p. 145-150.

Eight species of Thai traditional herbs including *Clinacanthus nutans*, *Psidium guajava*, *Phyllanthus reticulatus*, *P. acidus*, *P. pulcher*, *P. amarus*, *P. debelis* and *P. urinaria* were tested for their efficiency to inactivate Systemic Ectodermal and Mesodermal Baculovirus (SEMBV). The herbs were extracted by ethanol using a soxhlet apparatus. The virucidal activity of these extracts were tested by mixing the diluted virus (10⁶) with 10 mg/ml of each extract and exposing them for 2 hours at room temperature before injection. Virucidal activity was assessed by decreased mortality rates of the injected samples when compared to control animas injected with diluted virus extract only. The results showed that all of herb extracts reduced mortality rate of shrimp. The most effective herb against SEMBV was *Phyllanthus urinaria*, the survival rate of the shrimp reach to 100%. While the survival rate of the shrimp tested by other species of herb were found between 58-85%.

Keywords: Prawns; Shrimps; Tiger shrimp; *Penaeus monodon*; Herbs; Systemic Ectodermal and Mesodermal Baculovirus; SEMBV; *Psidium guajava*; *Phyllanthus reticulatus*; *Phyllanthus acidus*; *Phyllanthus pulcher*; *Phyllanthus amarus*; *Phyllanthus debelis*; *Phyllanthus urinaria*; Diseases; Probiotics

537 Sathaporn Direkburakorn, Chandet Wangsaviboon and Yaowanit Danayadol. 1998. **Comparison on the efficiency of guava and oxytetracycline to eliminate luminous bacteria in black tiger shrimp, *Penaeus monodon***. In the 36th Kasetsart University Annual Conference, 3-5 February 1999. p.144-151.

Comparison on the efficiency of guava and oxytetracycline to eliminate luminous bacteria in black tiger shrimp, *Penaeus monodon* was studied. Experiment was designed to 4 treatment as follow;

control, guava at the concentration of 10 and 1 mg/ml and oxytetracycline 1 mg/ml. The shrimps were injected with guava or oxytetracycline, in control group 2.6%NaCl was used instead of guava at the sixth segment. Then, all of shrimps were injected with luminous bacteria (*Vibrio harveyi*) at the concentration of 1.4x10¹⁰ CFU/ml. After 30 min., hemolymph was collected from the base of 3 walking leg and the number of bacteria in haemolymph were counted by using spread plate method on BTB Teepol Agar. The results in dioated that the efficiency of guava to eliminate of luminous bacteria in black tiger shrimp, *Penaeus monodon* is better than oxytetracycline. The percent of decreasing bacteria of the group injected with guava at the concentration of 10 and 1 mg/ml were 68.05% and 62.99%, respectively. While the shrimp that injected with oxytetracycline was 51.4%.

Keywords: Prawns; Shrimps; Black tiger shrimp; *Penaeus monodon*; Guavas; Oxytetracycline; *Vibrio harveyi*; Bacteria; Probiotics; Elimination; Feed; Herbs

538 Sathaporn Direkbusarakom, Benja Somsukmalee and Uraiwan Chaochun. 1998. **Effect of some chemotherapeutic on *Vibrio harveyi***. In Proceeding the Seminar on Fisheries 1988 Department of Fisheries 21-23 September 1988. National Inland Fisheries Institute, Bang Khen. p. 35-40.

V. harveyi have been treat with 8 chemotherapeutics as fallow, Furanance, Nitrofurantoin, Oxytetracycline, Chloramphenicol, Dimeton Soda, Trimethoprim-salfamethoxazole, Chloroquine and Acriflavin, at the concentration 0, 1, 3, 5 and 10 ppm. The result showed that the effective chemotherapeutics were furanance and nitrofurantoin and the minimum concentration were 1 and 3 ppm, respectively.

Keywords: Prawns; Shrimps; *Penaeus monodon*; *Vibrio harveyi*; Nitrofurantoin; Oxytetracycline; Dimeton soda; Chloramphenicol; Trimethoprim; Sulfamethoxazol

539 Sathaporn Direkbusarakom and Ussanee Aekpanithanpong. 1992. **The efficiency of the crude extract from the leaf of guava (*Psidium guajava* L.) on *Vibrio* spp. isolated from disease tiger prawn (*Penaeus monodon*)**. In Proceeding the Seminar on Fisheries 1992 Department of Fisheries, 16-18 September 1992. National Inland Fisheries Institute, Bang Khen. p. 259-262.

The antibacterial activities of the crude extract from the leaf of guava was studied using 23 strains of pathogenic bacteria as the test microorganism; *V.*

harveyi 9 strains, *V. splendidus* 7 strains, *V. parahaemolyticus* 2 strains, *V. minicus* 1 strain, *V. vulnificus* 1 strain, *V. fluvialis* 1 strain, *V. cholerae* 1 strain and *V. alginolyticus* 1 strain. All strains of pathogenic bacteria were inhibited by 5 mg/ml of the crude extract of the guava's leaf. However, 21 strains of the tested bacteria were inhibited by 2.5 mg/ml

Keywords: Prawns; Shrimps; Tiger prawns; *Penaeus monodon*; Guava; *Psidium guajava* L; *Vibrio*; Diseases; Crude extract; Probiotics; Herbs.

540 Ussanee Aekpanithanpong and Sitdhi Boonyaratpalin. 1992. **Study on distribution and residues of sulfamonomethoxine sodium in tiger prawn (*Penaeus monodon*)**. In Proceeding the Seminar on Fisheries 1992 Department of Fisheries, 16-18 September 1992. National Inland Fisheries Institute, Bang Khen. p. 263-267.

The distribution and residues of sulfamonomethoxine sodium was studied by injection and feeding. After given the drug; shrimps were sampling for detection of sulfamonomethoxine sodium from hemolymph, muscle and hepatopancrease by using Bratton and Marshall method (1939). The result showed that the level of sulfamonomethoxine sodium in hemolymph was higher than muscle after injection and feeding. But the residues of sulfamonomethoxine sodium in hemolymph was less than muscle. However, the residues of sulfamonomethoxine sodium could not detect after stop feeding 7 days.

Keywords: Prawns; Shrimps; Black tiger shrimp; Tiger prawn; *Penaeus monodon*; Distribution; Residues; Sulfamonomethoxine sodium; Drugs; Drug residues

541 Temdoung Pungkachonboon. 1989. **Efficacy of formalin on *Vibrio harveyi* isolated from infected shrimp larvae**. In Proceeding the Seminar on Fisheries 1989 Department of Fisheries, 18-20 September 1989. National Inland Fisheries Institute, Bang Khen. p. 286-290.

Vibrio harveyi, isolated from moribund luminous shrimp larvae were cultured on SWC and TCBS media and tested biochemically. Efficacy of formalin to this bacteria at the concentration of 25, 50 and 75 ppm. was studied. The result of the experiment showed that formalin at 50 and 75 ppm. killed 100 percent 3×10^7 cells/ml of *V. harveyi* within 24 and 12 hours, respectively; but 25 ppm. of formalin killed only 50 percent of bacteria within 24 hours.

Keywords: Prawns; Shrimps; Diseases; Bacteria; *Vibrio harveyi*; Formalin

542 Jiraporn Kasornchandra and Sitdhi Boonyaratpalin. 1994. **Light and electron microscope evidence of systemic bacilliform virus infection in *Penaeus chinensis***. In Proceeding the Seminar on Fisheries 1994 Department of Fisheries, 19-21 September 1994. National Inland Fisheries Institute, Bang Khen. p. 503-506.

In late 1993, systemic bacilliform virus was detected from moribund shrimp *Penaeus chinensis*, held in aquarium at national Institute of Coastal Aquaculture, Songkhla. Histopathological changes exhibited eosinophilic to lightly basophilic intranuclear inclusion in tissues of ectodermal and mesodermal origin. Characteristics of nuclear hypertrophy were observed from those tissues examined. Transmission electron microscope revealed a presence of a nonoccluded bacilliform virus within nucleus of infected tissues. The virion was rod-shaped and surrounded by a trilaminar envelope. The dimension of the virion was 117 nm. in diameter and 250-267 nm. in length. *P. monodon* and *P. merguensis* were experimentally infected with the filtrate extracted from gill tissues of the affected animal. The reinfected shrimps died within 5-7 days after challenging, showing the same histopathological changes and also the type of virus presence.

Keywords: Prawns; Shrimps; *Penaeus chinensis*; *Penaeus monodon*; *Penaeus merguensis*; Electron Microscopy; Viruses; Songkhla

543 Tassanai Wahah. 1994. **Chitinase from bacteria isolated from black tiger prawn larvae (*Penaeus monodon* Fabricius) and prawn pond sediment**. Master Thesis. Prince of Songkla University. 115 p.

Sixty eight strains of bacteria were isolated from black tiger prawn larvae (*Penaeus monodon* Fabricius) and prawn pond sediment. Thirteen isolates were found to produce chitinases. The isolate CS30, CS34 and CS41 showed a very high chitinase activity. They were rod-shaped, Gram-negative and aerobic bacteria. From the taxonomical characteristics, they were identified as *Aeromonas* sp. Chitin was essential for them as an inducer to produce chitinase. Chitinase from these three isolates were partially purified by ammonium sulfate precipitation and dialysis. The optimum pH and temperature were in the range of pH 6-7 and at 50°C. On native polyacrylamide gel electrophoresis and after activity staining with fluorescent brightener 28, *Aeromonas* sp. CS30 and *Aeromonas* sp. CS34

showed similar pattern of two isozymes. Whereas *Aeromonas* sp. CS41 also demonstrated two isozymes but with different molecular size from those of *Aeromonas* sp. CS30 and *Aeromonas* sp. CS34.

Keywords: Prawns; Shrimps; Black tiger prawn; *Penaeus monodon*; Chitinase; Bacteria; Sediment; Ponds; *Aeromonas*

544 Jareeporn Ruangsri and Kidchakan Supamattaya. 1987. **Studies of pathogenesis and virulence of *Vibrio harveyi* in black tiger shrimp (*Penaeus monodon*)**. Research Report. Prince of Songkla University. 26 p.

Ten strains of bacteria were isolated from diseased black tiger shrimp collected from the farms in southern Thailand. All the strains belong to *Vibrio harveyi* forming rounded colonies with smooth periphery. The colonies appeared green and yellow on TCBS normally use as selective media and can be of luminescent as well as non-luminescent groups. Their growth and cell proliferation require salts in addition to culture media. The sensitivity tests against antibiotics showed that all ten strains were sensitive to Chloramphenicol, Norfloxacin, Trimethoprim-sulfamethoxazole, Oxolinic acid, Oxytetracycline and sarafloxacin at 80, 60, 50, 40, 40 and 30% respectively. When 12-15g juveniles were tested for the virulence by injecting the bacteria, the strains were highly virulent with OD at 640 nm in the range 0.007-0.139. The 1.60×10^5 – 7.27×10^6 CFU/0.1 ml bacteria caused 50% juvenile mortality in ten days. The physiological changes after susceptibility showed a decline in the blood cells, higher plasma pH, decreases in serum protein within 24 hrs but returned to normal within 48 hrs. There were no differences in blood sugar levels and phenoloxidase activity between the healthy and the susceptible individuals. Histological study showed that at early period of susceptibility, swollen tubular lumen, minor cell degenerating of the hepatic tubules and lymphoid organs and aggregation of blood cells around the degenerating cells were noted. In the juvenile within 7-day susceptibility period, there were large scale of cell degeneration of the hepatopancreas, lymphoid organs, gills and blood forming organs with greater extent of the blood cell aggregation and eventually mortalities occurred. In the juveniles with 14 days susceptibility period, there was almost entire degeneration of cells in hepatic tubules and lymphoid organs causing hepatopancreatic tubular necrosis. During this period, juveniles did not accept the feed and total mortality occurred.

Keywords: Prawns; Shrimps; Black tiger shrimp; *Penaeus monodon*; Pathogenesis; Virulence; *Vibrio harveyi*; Diseases; Bacteria; TCBS; Antibiotics; Chloramphenicol; Norfloxacin; Trimethoprim; Sulfamethoxazole; Oxolinic acid; Oxytetracycline; Sarafloxacin; Tubular lumen

545 Lila Ruangpan, V. Tanasomwang and K. Sangrnghruang. 1997. **Bacteria flora of intensively cultured black tiger shrimp (*Penaeus monodon*)**. In the 35th Kasetsart University Annual Conference, 3-5 February 1997. p. 3-10.

Bacterial flora in hepatopancreas, intestine and hemolymph of intensive cultured black tiger shrimp, *Penaeus monodon* were investigated at day 30, 50, 70, 90 and 120 after releasing post larvae to the ponds. *Vibrio* number was counted on Thiosulfate Citrate Bile-salts Sucrose agar, and Zobell's 2216 e agar was used for total bacterial count. The bacterial counts of hepatopancreas and intestine fluctuated during 90 day of rearing period, but were observed increase by day 120. Average numbers of *Vibrio* and total bacterial were 7.6×10^2 – 1.8×10^4 , 5.5×10^3 – 2.2×10^5 CFU/g and 2.1×10^3 – 1.7×10^6 , 5.1×10^5 – 2.7×10^8 CFU/g, respectively. The bacterial counts of hemolymph increased gradually throughout the sampling periods with ranging between 5.0×10 – 3.5×10^2 and 4.7×10 – 7.6×10^2 , respectively. *Pseudomonas* spp. and *Vibrio* spp. were found to be the dominant species. The genus *Vibrio* found in this study were identified to be *V. alginolyticus*, *V. cholerae* (non 01), *V. damsela*, *V. harveyi*, *V. parahaemolyticus*, *V. vulnificus*, and *Vibrio* spp.

Keywords: Prawns; Shrimps; Black tiger shrimp; *Penaeus monodon*; Intensive culture; *Vibrio*; Thiosulfate Citrate Bile salts Sucrose agar; Bacteria; *Pseudomonas*; *Vibrio alginolyticus*; *Vibrio cholerae*; *Vibrio damsela*; *Vibrio parahaemolyticus*; *Vibrio vulnificus*; *Vibrio harveyi*

546 Nipavan Bussarawit. 1994. **Toxicity testing of oil dispersants on *Penaeus monodon***. In Proceeding the Seminar on Fisheries 1994 Department of Fisheries, 19-21 September 1994. National Inland Fisheries Institute, Bang Khen. p. 638-642.

Due to increasingly application of oil dispersants namely Corexit 9527 and BP 1100-X in Thailand leading to the need of using the least toxic chemical accordingly. There are some studies on the effect of these two chemicals in temperate regions. However, findings are uncomparable as results depends on different ambient conditions and different organisms. The present testing employed the static acute bioassay on tiger prawn (*Penaeus monodon*) at post larval stage (28-30 days old). Oxygen level was maintained above 3 ppm as well as other parameters

(pH, temperature) were maintained to reduce affecting the testings. Standard reference toxicant (SDS) calibration was also secured. The probit analysis was also applied to the determination of 24, 48 and 96 hrs. LC_{50} at 95% confident limit. The results showed Corexit 9527 is more toxic than BP 1100-X, this also led to delay moulting. Data treatment of Chi-square performed as well as the slope function under the best for regression of mortality at specific probit scale were highlighted.

Keywords: Prawns; Shrimps; *Penaeus monodon*; Toxicity

547 Adul Mearah, Pradit Chonchuenchob, Boonkird Sompadtoom and Udom Boonchom, 1987. **Lethal concentration of formalin on *Penaeus monodon***. In Proceeding the Seminar on Fisheries 1987 Department of Fisheries, 15-17 September 1987. National Inland Fisheries Institute, Bang Khen. p. 112-116.

The lethal concentration of formalin on *Penaeus monodon* at Nauplius, Zoea, Mysia, Post larvae 1 (P1), Post larvae 6 (P6), and Post larvae 11 (P11) stages were set following standard method (APHA, 1980). The median tolerance limit (TLm.) at 24 hours of *P. monodon* at Nauplius, Zoea, Mysis, P1, P6 and P11 were 12.3, 9.8, 2.4, 14.5, 132.6 and 117.2 ppm respectively. And TLm. 48 hours of *P. monodon* at P1, P6 and P11 stages were 7.08, 128.8 and 110.8 ppm respectively. The effects of toxicity of formalin on *P. monodon* was significance after 1 hour of the experiment.

Keywords: Prawns; Shrimps; Black tiger shrimps; *Penaeus monodon*; Formalin; Nauplius; Zoea; Mysis; Toxicity; Drug residues; Drugs.

548 Lila Ruangpan, Chaiwud Sudtongkong and Yubonrat Srikaew. 1997. **Luminous bacteria in *Penaeus monodon* aquacultural area of Songkhla**. Technical Paper No. 18/1997. National Institute of Coastal Aquaculture, Songkhla. Department of Fisheries. 10 p.

Luminous bacteria in the *Penaeus monodon* aquacultural area of Songkhla province was studied from October 1994 to December 1995. The samples were obtained from 4 stations of each location including coastal area, rearing farms and hatcheries. The number of luminous bacteria ranging from $0-17 \times 10^1$, $9.1 \times 10^1-1.2 \times 10^2$ and $0.3 \times 10^1-1.4 \times 10^2$ cfu/ml, while the *Vibrio* spp. were $1.5 \times 10^2-8.7 \times 10^2$, $3.0 \times 10^2-5.5 \times 10^3$ and $0.4 \times 10^2-7.5 \times 10^2$ cfu/ml respectively. Based on 45 characteristic tests of 60 strains, the luminous bacteria were identified as *Vibrio harveyi* 54 strains and *V. cholerae* biotype *albensis* 6 strains. Minimal

inhibitory concentration of 6 chemotherapeutants including trimethoprim, chloramphenicol, oxolinic acid, oxytetracycline, norfloxacin and kanamycin against the bacteria ranged from 3.13-25, 3.13-50, 12.5-100, 6.25->100, 0.8-100 and 100->100 µg/ml, whereas, percentage of the drug resistance strains were 10, 20, 45, 40, 90 and 100, respectively.

Keywords: Prawns; Shrimps; *Penaeus monodon*; Luminescent bacteria; Songkhla; *Vibrio*; *Vibrio harveyi*; Trimethoprim; Chloramphenicol; Oxolinic acid; Oxytetracycline; Norfloxacin; Kanamycin; Drug resistance; Bacteria.

549 Karuna Satayamas. 1988. **Effect of diflubenzuron on cuticular structure during molt cycle of banana prawn larvae (*Penaeus merguensis* de Man)**. Master Thesis. Chulalongkorn University. 117 p.

This investigation is aimed at studying the effect of diflubenzuron on cuticular structure during molt cycle of *Penaeus merguensis* larvae. The experiment is divided into two parts. Part one, a preliminary study reveals that the duration of molting cycle is two to five days and the high percentage of the duration of the molt cycle falls between 2 to 3 days. The lowest concentration of diflubenzuron that could kill the the banana prawn larvae is 0.7 µg/l. The molting cycle is consisted of three stages, i.e. postmolt, and premolt. The postmolt and intermolt cuticular structure has three layers which are epicuticle, exocuticle and endocuticle. The intermolt three layers which are epicuticle, exocuticle and endocuticle. The intermolt endocuticle is thicker than the postmolt one. During the premolt, intermolt the new cuticle is formed underneath the old cuticle. The epicuticle, exocuticle and endocuticle under the compound microscope are homogeneous. Nevertheless, the ultrastructure fo the epicuticle under the transmission electron microscope is consisted of six layers while the exocuticle and endocuticle appeared lamellated with dark and light bands alternately arranged. The microfibrills of the exocuticle and endocuticle has helicoidal structure. The membranous layer and molting fluid are seen during the premolt stage. In addition, endocuticle and membranous layer are distinguishable at the ultrastructural level.

Part two is the study of the effect of diflubenzuron on cuticular structure during the molt cycle of *Penaeus merguensis* larvae. Ultrastructural studies of the prawn larvae from diflubenzuron treated groups show damages on the exocuticle and endocuticle during the postmolt and intermolt. However, it is found that diflubenzuron has no effect on the epicuticle.

Keywords: Prawns; Shrimps; *Penaeus merguensis*; Diflubenzuron; Banana prawn; Drugs; Chemicals

550 Sujittra Sahatnarepaipong. 1997. **Efficacy of tea polyphenol against Vibriosis in black tiger shrimp (*Penaeus monodon* Fabricius).** Master Thesis. Kasetsart University. 90 p.

Efficacy of tea polyphenol was evaluated for control of vibriosis in black tiger shrimp (*Penaeus monodon* Fabricius). In vitro sensitivity test, minimal inhibitory concentrations (MIC) of tea polyphenol against 39 isolates of *Vibrio* spp. ranged between 160-1250 ppm. and minimal bactericidal concentrations (MBC) studies indicated efficacy at 320->2560 ppm. Shrimp of 7-10 g were fed with tea polyphenol power at a dose of 2.0 and 5.0 g/kg feed for 14 and 30 days prior to intramuscular injection with *V. harveyi* at the LD₅₀ level (2.24×10^7 cells/ml). Results show no significant difference in the survival rate of shrimp fed tea polyphenol for 14 days and the control. Shrimp fed tea polyphenol at a dose of 5.0 g/kg feed for 30 days had significantly higher survival rate (74.7 percent) than shrimp fed tea polyphenol 2.0 g/kg (40 percent) and the control (38.7 percent) 24 hours post injection. However, no significant difference in the survival rate among three different groups at 48 hours. Histopathological changes in shrimp injected intramuscularly with this bacteria was studied. Hemocytic infiltration in the damaged area followed by small nodules and encapsulation was observed in all groups.

Keywords: Prawns; Shrimps; *Penaeus monodon*; Black tiger shrimp; Tea polyphenol; Vibriosis; *Vibrio harveyi*; Broth dilution test; Sunphenon

551 Amornchai Somjetlertcharoen. 1993. **A study of *Vibrio* species and oxolinic acid residues from *Penaeus monodon* Fabricius in Intensive Culture Ponds.** Master Thesis. Kasetsart University. 128 p.

Seventy four halophilic vibrios were isolated and identified from the hepatopancreas of moribund shrimp (*Penaeus monodon* Fabricius) obtained from various farms in Thailand. The study gives the first reported identification of *Vibrio damsela* from shrimp. *V. parahaemolyticus* was the most frequently isolated bacteria, followed by *V. vulnificus*, *V. harveyi*, *V. fluvialis*, *V. damsela* and *V. alginolyticus* respectively. In addition, there were 7 strains of unidentified *Vibrio* species. The sensitivity of oxolinic acid (OXA) was investigated against 74 strains of *Vibrio* bacteria isolated from shrimp. In vitro, the MICs values of almost all vibrios strains tested was range 0.025-0.25 ppm., with *V. vulnificus* showing higher MICs values

than the others. Residue of OXA was studied in shrimp under farm conditions after oral administration with OXA 2.5 gm/kg feed for 7 days. The result demonstrated that OXA persisted in hepatopancreas and muscle of shrimp fed with pellet mixed on farm with OXA for 14 and 10 days respectively; and for 22 and 18 days respectively in shrimp fed with factory-produced medicated feed. Sensitivity of this experiment for detection of OXA residues in shrimp tissue was limited at concentration 0.1 ppm.

Keywords: Prawns; Shrimps; *Penaeus monodon*; *Vibrio*; Oxolinic acid; Residues; Culture pond; Feed; Bacteria

552 Vichai Vattanukul. 1991. **Effect of 17 α -hydroxy-progesterone on sperm quality of *Penaeus merguensis* (de Man).** Technical Paper No. 7/1991. National Institute of Coastal Aquaculture. Department of Fisheries. 19 p.

The effect of 17 α -hydroxy-progesterone on sperm quality was investigated using *Penaeus merguensis* collects from Nakhon sritammarat province. Sixty-three males were held outdoor in concrete pond and evaluated for sperm quality on a weekly basis using the following criteria : (1) Spermatophore weight (2) sperm count, (3) percentage of live sperm (4) percentage of abnormal sperm and (5) specific activity of enzyme ATPase. There was no significant difference in sperm quality until the third week after the 17 α -hydroxy-progesterone injection. The results at the concentration of (50 ng/gm of body weight) 17 α -hydroxy-progesterone showed the highest spermatophore weight, number of sperms, percentage of live sperms and a lower percentage of abnormal sperm as follows: 179.67 gm: 57.01×10^6 cells; 98.51% and 4.3% respectively. ATPase plays an important role in sperm quality, specific activity of ATPase was 138.29 nmole/min/mg protein. Thus, hereby we can state that we can use measurement of specific activity of ATPase as an indicator of sperm quality.

Keywords: Prawns; Shrimps; *Penaeus merguensis*; 17 alpha-Hydroxy-progesterone; Sperm; Hormones; Penaeid; Drug residues; Drugs

553 Khamjut Ruenreungdee and Manop Mitsomwang. 1990. **Monoculture of *Penaeus monodon* in cage by difference density.** Kasetsart University Research Report. Kasetsart University Research and Development Institute. 11 p.

Penaeus monodon have been cultured in floating net cage at the density of 100, 125, 150, 175 shrimps/square meter and were fed on artificial diet

protein 33-38%. The initial average of test in each density were 0.20 gm. after 120 days the average weight gain in each density were 9.57, 10.76, 9.42, and 8.99 gm. the average growth rate in each density were 0.078, 0.080, 0.077, and 0.073 gm/day. The food conversion rate were at 2.07, 2.82, 2.37 and 2.84. The survival rate were at 60.44, 37.33, 59.11 and 48.38 percent in each density respectively. There were no statistical significant difference between *Penaeus monodon* cultured in floating net cage at difference density.

Keywords: *Penaeus monodon*; Cage culture

554 Chalida Chananon, Sompop Rungsapa, Montira Thavornnyutikarn and Weena Koeypudsa. 1999. **Study on effect of crude extract isolated from mango leaves (*Mangifera indica* L. c.v. Khiew Sawoey) against cellular immunity on *Penaeus monodon*.** In the 37th Kasetsart University Annual Conference, 3-5 February 1999. p. 233-239.

Study on effect of crude extract isolated from mango leaves (*Mangifera indica* L. c.v. Khiew Sawoey) against cellular immunity of *Penaeus monodon*. It was found that feeding of *P. monodon* (average 14.60 gm in weight) with diets including the crude extract at the concentration of 2,500 and 5,000 ppm twice daily for seven days could stimulate their the cellular immunity. This indicated by a significant elevation in phenoloxidase activity in the haemolymph of the treated *P. monodon* in comparison of that the control and the concentration of 1,000 ppm. ($P < 0.01$). There were no significantly differences ($P > 0.05$) in percent survival rate of *P. monodon* after feeding with diets the crude extract at all concentrations for seven days.

Keywords: Prawns; Shrimps; *Penaeus monodon*; Mango leaves; *Mangifera indica*; Herbs; Phenoloxidase; Probiotics; Feed

555 Piyalai Hemtanon, Sataporn Direkbusarakom, Opas Tantitakoon. 2002 **Study on the effect of antiviral substance of *Spirulina platensis* for prevention of the infectious disease in black tiger shrimp post larvae caused by white spot syndrome.** In the 40th Kasetsart University Annual Conference. p. 591-596.

A study on inhibiting effects of crude extract isolated from *Spirulina platensis* against white spot syndrome virus (WSSV) on *Penaeus monodon* was carried out. The concentrated crude extract was diluted in Lobster haemolymph medium (LHM) to be 1 and 0.1 mg/ml, mixed with WSSV solution diluted from stock to the concentration of 10^{-5} . The

resulting solution was singly intramuscular injected into *P. monodon* individual which are about 10-15 g in weight. The experimental *P. monodon* was carried on culture for 14 days. It was found that the diluted crude extract at the concentration of 1 and 0.1 mg/ml could inhibit the mortality effects from WSSV. The survival rate of *P. monodon* was 92 ± 17.89 and $88 \pm 10.95\%$. For application, *P. monodon* postlarvae 15 was feed with the steamed egg containing 0, 0.5 and 5% dry weight of *S. platensis* for 3 day and immerse in WSSV (1:100) 1 ml/30 l for 24 hours. The experimental *P. monodon* was carried on culture for 7 days. The survival rate of *P. monodon* was 73.75 ± 10.34 , 86.50 ± 8.80 and $83.17 \pm 3.87\%$, respectively. And checked WSSV infected by PCR method. It was found that *P. monodon* was infected by WSSV 100, 0 and 16.67%, respectively.

Keywords: Prawns; Shrimps; Black tiger shrimp; *Penaeus monodon*; *Spirulina platensis*; White Spot Syndrome Virus; WSSV; Herbs; Lobster Haemolymph Medium; LHM; PCR; Probiotics; Diseases

556 Amornrat Angajchariya; Chaivat Kittigul; Kreeson Packthongsuk; Sataporn Direkbusarakom and Nonthawith Areechon. 2001. **Protein analysis of white spot syndrome virus (WSSV) of black tiger shrimp and preliminary report on the production of monoclonal antibody to WSSV.** In the 39th Kasetsart University Annual Conference, 5-7 February 2001. p. 290-295.

White spot syndrome virus (WSSV) of black tiger shrimp was purified for protein analysis by SDS-PAGE and for monoclonal antibody production. Preparation of purified WSSV have proteins molecular weight 18, 22, 24, 26, 29, 38, 74, 80, 100, 108 and 130 KDa. Proteins which have molecular weight of 18, 22, 24 and 26 KDa are WSSV major proteins. The 18 and 26 KDa virus proteins give strong reaction in western blot analysis with polyclonal antibody from mice immunized with WSSV preparation. Monoclonal antibodies to white spot syndrome virus (WSSV) were produced by cell fusion of myeloma cells (P3-X63-Ag8.653) and spleen cells of Balb/c mice immunized with purified virus. Screening of monoclonal antibodies were determined by indirect ELISA test. There are 8 hybridoma clones produced monoclonal antibodies that give high different of optical density (ELISA O.D.) between purified WSSV and normal shrimp tissues. Preliminary characterization of monoclonal antibodies by western blot assay show that one of monoclonal antibodies recognized protein of WSSV which has molecular weight of 18 kilodalton (KDa).

Keywords: Shrimps; Black Tiger Shrimp; White Spot Syndrome Virus; WSSV; White Spot Disease; Monoclonal antibody; Proteins; Prawns; Viruses

557 Renu Yashiro, Pramaul Onlamai and Chantima Charoensri. 1995. **Effects of sex steroid on variation of sex ratio in *Penaeus monodon***. In Proceeding the Seminar on Fisheries 1995 Department of Fisheries, 18-20 September 1995. National Inland Fisheries Institute, Bangkok. p. 568-570.

Penaeus monodon PL15 400 inds/m³ were cultured with feed mixed sex steroid for 126 days, the results showed difference in sex ratio of female : male (from external sex characteristic). Group received female sex hormone (E2) was 2.14 : 1, group received male sex hormone (MT) was 1 : 1.48 and the control group (C) was 1.09 : 1 shrimp which can not identified sex in group E2, MT and C were 22.3% 13.7% and 4.02% respectively. The smallest shrimp which showed sex characteristic for male was 1.2 g and for female was 1.6g at the age of 8 weeks (from PL15). These result reveal the effect of sex steroid on secondary sex-determination in *P. monodon* which might be useful to develop into large scale to serve the future aquaculture trading purposes.

Keywords: Prawns; Shrimps; *Penaeus monodon*; Sex ratio; Variation; Hormones; Feed

558 Annop Ekachote. 1999. **Effects of trichlorfon on black tiger shrimp (*Penaeus monodon* Fabricius) and *Acetes* sp.** Master Thesis. Kasetsart University. 110 p.

Acute toxicity of trichlorfon on black shrimp post larva and *Acetes* sp. were studied by using static bioassay. The tests were conducted to compare the 24 hr LC₅₀ at different water pH including 8.5, 8.0 and 7.5 in both test animals. The 24 hr LC₅₀ of trichlorfon on shrimp post larva 15 (PL₁₅) at different water pH were 0.0235, 0.0325 and 0.044 ppm. and on *Acetes* sp. were 0.013, 0.0202 and 0.027 ppm. respectively. The safety period for shrimp post larva after trichlorfon treatment at 0.5 ppm. in water pH 8.0 were 12 days in aerated condition and 15 days for non-aerated.

Concentration of trichlorfon and dichlorvos in pond water and soil was analysed in 2 shrimp ponds at Rachaburi Province. The ponds were treated with 0.5 ppm trichlorfon. One hour post treatment, 0.0226 ppm of trichlorfon and 0.01009 ppm of dichlorvos was detected in pond water from pond 1 and only trichlorfon was detected from pond soil at 0.00715 ppm. Only dichlorvos was detected at 0.0159 ppm. on day 5 after treatment in pond water. In water from pond 2, only dichlorvos was detected at 0.0943 ppm. in one hour and at 0.011 ppm. in 5 days after treatment. Both trichlorfon and dichlorvos was not detected in pond soil at 5 days post treatment.

Effect of trichlorfon on growth and survival of juvenile shrimp were evaluated by comparison between groups, treated with 3 concentration of trichlorfon. Juvenile shrimp were treated with trichlorfon at 0.006, 0.02 and 0.08 ppm. for 2 months. Average weight and survival from treatment groups were compared with the control. The result revealed that no significantly different was observed in shrimp treated with 0.006 ppm. However, in higher concentration, 0.02 and 0.08 ppm., growth was significantly lower than the control group ($P < 0.05$). No obviously change was observed in shrimp tissue from different groups as well as no residual was detected from shrimp tissue in all groups after treatment period.

Keywords: Prawns; Shrimps; Black tiger shrimp; *Penaeus monodon*; Trichlorfon; *Acetes*; Acute toxicity; Toxicity; Chemicals

559 Sawitri Silakes. 1997. **Production of vaccine from *Vibrio harveyi* and its application in black tiger prawn (*Penaeus monodon* Fabricius).** Master Thesis. Prince of Songkla University. 1997. 159 p.

The luminescent bacterium *Vibrio harveyi* was isolated from infected black tiger prawns and identified biochemically. The bacterium was incubated at room temperature for 24 hours in Tryptic Soy Broth. The cells were then killed by ultrasonic homogenization. The sterility of the vaccine was confirmed by culturing on Tryptic Soy Agar. The vaccine was then lyophilized and preserved dry.

The vaccine was administered to the black tiger prawns using three methods ; oral, immersion and injection. Blood was collected from black tiger prawns at 10, 20 and 30 days post vaccination. It was analyzed for phenoloxidase activity, superoxide anion production, bacteria clearance from haemolymph and disease resistance against *V. harveyi*. Oral administration was with the dry vaccine mixed with feed at 0, 0.1, 0.5 and 1% of the total weight of the feed. The immersion solution was prepared by diluting 2.5% vaccine solution to 1 : 250 (vaccine : seawater). Prawns were immersed in the dilute solution for five hours. The treatment was repeated 14 days after the first immersion. For injection, prawns were injected intramuscularly with 0.1 ml of 0.1 or 0.25% of the vaccine solution in sixth abdominal segment.

These methods produced positive results in clearing bacteria from the hemolymph, and in disease resistance against *V. harveyi*. The overall survival (RPS) was less than 60%, leading to the conclusion that vaccine administered by either oral or immersion methods has a low protection factor for black tiger prawn in the oral trial, there was no significant difference among the 0.1, 0.5 and 1% vaccine added to the feed. However, vaccine

administered by injection show markedly high protection against disease. It enhanced the activities in the immune response such as production of superoxide anion, clearance of bacteria from the hemolymph and in disease resistance. There was overall 60% RPS in the 0.1 and 0.25% vaccine solution trials, with no significant differences between the two. It was therefore concluded that the injection method was superior to the oral or immersion methods.

Keywords: Prawns; Shrimps; Black tiger shrimp; *Penaeus monodon*; Vaccines; Immune; *Vibrio harveyi*; Bacteria; Tryptic Soy Broth

560 Potchanapond Graidist. 2000. **Genes involved in immune system of black tiger prawn (*Penaeus monodon*)**. Master Thesis. Prince of Songkla University. 113 p.

The invertebrate immune system contains cellular and humoral defense mechanism. However knowledge of substances that involved in shrimp immune system was remained limit. In this study cDNA subtractive hybridization was performed in order to identify the proteins that related to the immune system. cDNA was constructed from mRNA isolated from normal shrimp hemolymph and was subtracted with those from infected shrimp. Eight hundred and eight clones of cDNA fragments ranging from 200->1,500 bp were obtained. Among them, 202 clones were strongly hybridized with forward probe but not hybridization with reverse probe. The resultant clones were sequenced and then the sequences were compared with data from GenBank. It was shown that the sequences of pTE8, pTE66 and pTE70 clones were similar to scaffold protein (84%), tyrosine kinase (72%) and chromosome 21 (interferon/interleukin) (64%), respectively. pT21 and p43S1 clones had sequenced homology to translationally controlled tumor protein (TCTP) (66%). These genes were reported to involve in the signal transduction of organisms.

Keywords: Prawns; Shrimps; Black tiger prawn; *Penaeus monodon*; Genes; Immune; cDNA

561 Duangporn Vacharasemsin. 1989. **Acute toxicity of benzalkonium chloride, copper chelate, malachite green and treflan on *Penaeus monodon* (Fabricius) larvae**. Master Thesis. Kasetsart University. 99 p.

Acute toxicity of benzalkonium chloride, copper chelate, malachite green and treflan on *Penaeus monodon* (Fabricius) larvae were conducted by using the static bioassay. The 24-hour median lethal concentration (24-h LC₅₀) of

benzalkonium chloride on protozoa 2, mysis 2, post larva 5 and post larva 18 were 0.31, 0.41, 0.65 and 3.02 ppm respectively.

The 24-h LC₅₀ of copper chelate on Protozoa 2, mysis 2, post larva 5 and post larva 18 were 0.02, 0.31, 1.48 and 7.24 ppm, respectively. The 24-h LC₅₀ of malachite green on protozoa 2, mysis 2, post larva 5 and post larva 18 were 0.14, 0.19, 0.32 and 1.15 ppm, respectively. The 24-h LC₅₀ of treflan on protozoa 2, mysis 2, post larva 5 and post larva 18 were 1.39, 2.74, 3.17 and 4.67 ppm, respectively. Safe concentrations of these chemicals and the effect on water quality during acute toxicity studies are also discussed.

Keywords: Prawns; Shrimps; *Penaeus monodon* Fabricius; Larvae; Acute toxicity; Toxicity; Benzalkonium chloride; Copper chelate; Malachite green; Treflan; Chemicals; Drugs

562 Prapansak Srisapoom. 1999. **Study on acute toxicity of hydrogen peroxide in *Penaeus monodon* (Fabricius) larvae and efficacy on controlling *Vibrio* spp. and some phytoplanktons in shrimp pond**. Master Thesis. Kasetsart University. 146 p.

Study on 24-hrs acute toxicity of hydrogen peroxide 50% (W/W) technical grade in *Penaeus monodon* PL stage 15 indicated the LC₅₀ of 30.60 (22.95-40.81) part per million (ppm.) with slope function of 2.533 (1.901-3.375) at 95% confidence interval. Water qualities were studied during toxicity experiment in which total ammonia nitrogen, nitrite, nitrogen, pH and alkalinity were slightly affected. Effectiveness on controlling *Vibrio alginolyticus* (3 isolates), *V. harveyi* (3 isolates), *V. parahaemolyticus* (2 isolates) and *V. vulnificus* (3 isolates) in term of MIC and MBC were evaluated in Mueller Hinton Broth with 1.5% NaCl. The results showed that MIC for these bacteria were 9.57-19.14, 9.57, 38.27 and 38.27 ppm. respectively and MBC were 9.57-19.14, 9.57, 38.27 and 38.27-76.54 ppm. respectively. On the other hand when tested in 1.5% NaCl solution, MBC were decreased to 0.6-1.2, 0.6-1.2, 2.39 and 2.39-4.78 ppm. respectively. Additionally, variations of salinity, pH and alkalinity did not cause any significant impact on the effectiveness of hydrogen peroxide when tested with the luminescent *V. harveyi*. Moreover, *V. harveyi* and *V. parahaemolyticus* were tested in 25 ppt. seawater with and without soil with concentrations of hydrogen peroxide between 1.2-59.8 ppm. This experiment indicated that in unsoiled condition, *V. harveyi* could be eliminated at all concentrations after 6 hrs of exposure while it took 3 hrs at 7.48 ppm. for *V. parahaemolyticus*. However, in soiled condition, no level of hydrogen peroxide could eliminate these two Vibrios after 96 hrs of exposure. The algicidal property of the chemical for

Oscillatoria sp. and *Chlorella* sp. which are commonly found in shrimp pond was also evaluated. Microscopic observation revealed that concentrations of hydrogen peroxide at 4.19 and 7.18 ppm caused significant disintegration of *Oscillatoria* filament and reduction of about 36.35 and 38.93% of Chlorophyll A at 48 hrs. after exposure while *Chlorella* sp. was not affected.

Keywords: Prawns; Shrimps; Black tiger shrimp; *Penaeus monodon*; *Vibrio*; Toxicity; Chemicals; Phytoplankton; Bacteria

563 Sarun Rucksapram. 1996. **Studies on diseases of black tiger shrimp (*Penaeus monodon*) water quality and plankton in low salinity pond culture.** Master Thesis. Kasetsart University. 121 p.

Diseases of giant tiger shrimp (*Penaeus monodon*) culture in low salinity (2-5 ppt) in Nakorn Nayok province was studied. *Zoothamnium* sp. was the most common protozoa found on gills and shell in the grow-out period. *Vibrio parahaemolyticus*, *V. alginolyticus* and *V. vulnificus* were the three predominant bacterial species isolated from hepatopancreas of clinical healthy shrimp. These bacteria were sensitive to chloramphenicol, sulfamethoxazole with trimethoprim and nalidixic acid respectively. Histopathological examination revealed that the shrimp heavily infected with *Zoothamnium* sp. showed edema of gill lamellae.

Water quality in four giant tiger prawn ponds, in Nakorn Nayok province were studied during 12 weeks of the grow-out period. Secchi disc visibility ranging from 20 to 30 cm., temperature from 28.5 to 32°C, pH from 7.7 to 9.3, dissolved oxygen from 7.2 to 11.0 mg/l, salinity from 2 to 5 ppt., alkalinity from 46 to 76 mg/l, unionize-ammonia from 0.0175-0.1273 mg/l and nitrite-nitrogen from 0.000 to 0.0133 mg/l. Planktons in giant tiger shrimp ponds during the grow-out period were studied. *Spirulina* sp., *Microcystis* sp. and *Oscillatoria* sp. were the dominant species found throughout the culture period.

Keywords: Prawns; Shrimps; Black tiger shrimp; *Penaeus monodon*; Water quality; Plankton; Low salinity culture; Diseases; Drugs; Chemicals; *Zoothamnium*; Chloramphenicol; Sulfamethoxazole; Trimethoprim; Nalidixic acid

564 in Thai

565 Sirirat Rengpipat. 1999. **Purification of antimicrobial substance from *Bacillus* S11.** Research Report the Royal Thai Government Fund 1999. Chulalongkorn University. 61 p.

Bacillus sp. S11, used as probiotic in *Penaeus monodon*, produced antimicrobial substance in log phase of growth cycle. In this research, the optimum conditions for production of this antimicrobial substance are medium containing 2% (w/v) yeast extract, 0.25% (w/v) dipotassium phosphate; pH 7.0, 2.0% (v) inoculum, and aeration at 200 rpm; 40°C. The purification of this substance was performed by the steps of precipitating with 0-30% ammonium sulfate, running through Sephadex G-50 column chromatography and DEAE-Sephadex column chromatography. The specific activity of this substance increased from 29.10 AU/mg protein of cultured broth to 52.63, 75.36, and 95.23 AU/mg protein, in each step, respectively. The results from SDS-PAGE showed that this molecular weight was approximately 3.5 kDa and consisted of lipid. The antimicrobial activity decreased after incubating at 70 and 80°C for 15 minutes and could not be detected after 60 minutes. Its activity also disappeared after incubating at 100°C for 10 minutes or autoclaving at 121°C for 20 minutes. Antimicrobial substance showed its activity at the conditions of wild range of pH (3-10) and 0-5% (w/v) sodium chloride. Protease could reduce the activity of the substance whereas no effect of α -amylase and lipase have been detected.

Keywords: Prawns; Shrimps; *Penaeus monodon*; Bacteria; *Bacillus*; Probiotics; Dipotassium phosphate; Antiinfective agents

566 Khanittha Sang-ngam. 2001. **Use of bacteria *Alteromonas* sp. S9730 in controlling pathogenic *Vibrio harveyi* in larvae of tiger prawn *Penaeus monodon* Fabricius.** Master Thesis. Chulalongkorn University. 71 p.

Alteromonas sp. S9730 cultured in 20% dilution of marine broth can produce antibacterial substance against pathogenic *V. harveyi* 1526. Their fresh cells can also inhibit virulent *V. harveyi* 1526 in seawater. *Alteromonas* sp. S9730 showed antibacterial activity against shrimp pathogenic bacteria: *V. harveyi* 6 strains, *V. parahaemolyticus*, *V. vulnificus*, and non-pathogenic *V. alginolyticus* by using a double layer method. Adding *Alteromonas* sp. S9730 at 10^7 CFU/ml in the culture water did not increase survival of *Penaeus monodon* in the 3 different stages studied: zoea, mysis, and postlarvae. However, after challenging by immersion with *V. harveyi* 1526, shrimp larvae in mysis stage showed significantly higher survival rate than those of the control group ($P < 0.05$), but no different survival rates among the treatment and the control groups in zoeal and postlarval stages were found.

Keywords: Shrimps; Prawns; Probiotics; Biocontrol; *Alteromonas*; *Vibrio harveyi*; Bacteria; *Penaeus monodon*

567 Werawan Sithikornkul, Phaisan Sithikornkul, Siwaporn longyun. 2000. **Antibody production against gonad inhibiting hormone C-terminal decapeptide and its binding capacity to the natural peptide in the eyestalk of *Penaeus monodon***. Research Report the Royal Thai Government Fund. Faculty of Science. Srinakharinwirot University. 41 p.

Antisera against various hormones including vitellogenesis inhibiting hormone (VIH) of the American lobster *Homarus americanus*, gonad inhibiting hormone (GIH) of the grass shrimp *Metapenaeus ensis* and CMG-peptide (CHH-MIH-GIH) of the black tiger prawn *Penaeus monodon* were generated by immunization of mice with C-terminal 15-20 residues of synthetic peptide conjugated with bovine serum albumin. The antisera specific to VIH and GIH did not demonstrate specific binding to any structure in the eyestalk of *P. monodon* by means of immunocytochemistry. In contrast, anti-CMG peptide antiserum recognized two neurosecretory cells in which their processes terminated and arborized in sinus gland. These two neurons located in the same area as crustacean hyperglycemic hormone (CHH) containing cells, consisted of 34 ± 4 cells. The anti-CMG antiserum also demonstrated immunoreactivities in a few fractions of *P. monodon* eyestalk extract, different from the fractions containing CHH after one step separation with RP-HPLC. This evidence indicated that CMG-peptide and CHH may have different physiological roles in hormonal regulations of *P. monodon*.

Keywords: Prawns; Shrimps; *Penaeus monodon*; Antibodies; Hormones; Peptides; Eyestalks; Vitellogenesis Inhibiting Hormone; Gonad Inhibiting Hormone; Immunocytochemistry; *Metapenaeus*

568 Suda Tandavaniti, Chuleerat Sangsuwan, Laddawan Khamjarearn. 2000. **Residue of oxolinic acid in shrimp pond water**. Technical Paper No. 12/2000. Andaman Marine Shrimp Research and Development Center, Phuket. Department of Fisheries. 13 p.

The main objective of the present study was to obtain the information on degradation of three different concentrations oxolinic acid (1, 3 and 5 mg/l) in shrimp pond water under laboratory conditions using HPLC. The changes of total bacteria and *Vibrio sp.* and the sensitivity of the residue on the bacterium such as *Vibrio sp.* and *Bacillus subtilis* were observed after the drug addition. The results showed the degradation of oxolinic acid in shrimp pond water was much

faster than in the control sea water, either light or dark condition. The residuals after 3 days drug addition in light condition were 64.01, 68.29, and 66.58% whereas 60 days the residues were 21.39, 46.94, and 44.12% in the concentration of 1, 3, and 5 mg/l, respectively. Under the dark condition, within 3 days after drug addition the residues remained 88.00, 73.05, and 65.09%, whereas at the 60 days, it remained 49.07, 59.26, and 51.04% in the concentration of 1, 3 and 5 mg/l, respectively. On the otherhand, the total bacteria and *Vibrio sp.* decreased rapidly within 3 days after drug addition. In shrimp pond water, oxolinic acid residues showed a faster loss of antibacterial activity than in seawater. However, the oxolinic acid have no significant effect on the water qualities.

Keywords: Prawns; Shrimps; *Penaeus monodon*; Oxolinic acid; Residues; Ponds; Water; HPLC; Bacteria; *Vibrio*

569 Chainarong Wongtheerasub. 1997. **Development of diagnostic kit for detection of yellow-head virus in *Penaeus monodon***. Research Report. Faculty of Medicine. Srinakharinwirot University. 157 p.

Cultivated shrimps industry in Thailand, attracts several billions US dollars per year. However the production rate tends to be decreased due largely to the outbreak of white spot virus (WSV) and yellow head virus (YHV). This has brought an attention to develop a rapid and sensitive PCR-base assay for an early detection of the disease outbreak in shrimps. The RT-PCR method has been developed to amplify part of YHV RNA genome. The method was highly sensitive and capably of detection 0.01 pg of YHV genome multiplex RT-PCR has also been developed to detect the presence of YHV and WSV in hemolymph of shrimps simultaneously. We describes a method which allows rapid diagnosis by performing a single step of extraction of both RNA and DNA using the Trizol reagent. The detection of both viruses by multiplex RT-PCR is convenient, specific but less sensitive than the detection of either YHV or WSV alone. This technique will be applied to detect the infection of these 2 viruses in broodstock and carriers. The YHV from Thailand and gill-associated virus (GAV) from Australia were compared by RT-PCR and sequence analysis. The developed RT-PCR method can only detect YHV isolated from Thailand but not from Australia although these 2 isolates show a high degree of genetic similarities. Sequence analysis of RT-PCR products generated with generic yellow head virus primers will provide a more useful tool for distinguishing between isolates from different geographical regions.

Keywords: Prawns; Shrimps; *Penaeus monodon*; YHV; RT-PCR; Yellow Head Virus; Diagnostic kit; Multiplex RT-PCR; RNA; Viruses

570 Verapong Vuthiphandchai, Weerachai Singharniyom and Prapasiri Srisophaporn. 1990. **Influence of exogenous hormone, human chorionic gonadotropin, on the oogenesis of giant tiger prawn (*Penaeus monodon* Fabricius).** Research Report. Faculty of Medicine. Srinakharinwirot University. 35 p.

The effects of hormone ecdysone on the molting period of giant tiger prawn female broodstocks were investigated. Eight groups of broodstocks (weigh 92.5 - 169.4 gm) were designed to receive exogenous hormone, the ecdysone at 0, 0.01, 0.05, 0.125, 0.5, 1.0, 2.0 and 3.0 µg/gm body weight. Broodstocks receiving ecdysone more than 0.125 µg/gm body weight died due to the overdoses of ecdysone. Non - ablation groups receiving ecdysone treatments showed the molting periods as the sham control (non - ablation and non - ecdysone treatment) did. However, the molting periods of ablation groups receiving ecdysone treatments at 0.01 and 0.05 µg/gm body weight were faster than sham control (ablation and non - ecdysone treatments) by about 5-6 days. The ecdysone treatment on the ablation female broodstock at the level below 0.05 µg/gm body weight, stimulated the molting period.

Keywords: Prawns; Shrimps; Black tiger shrimp; Giant tiger prawn; *Penaeus monodon*; Oogenesis; Hormones

571 Chainarong Wongteeratrap. 2001. **Development of diagnostic kit for detection of yellow head and white spot virus in *Penaeus monodon* using multiplex RT-PCR.** Research Report the Royal Thai Government Fund. Faculty of Medicine. Srinakharinwirot University. 29 p.

The polymerase chain reaction (PCR) applied in diagnosis has the very useful advantages of sensitivity, specificity. We have developed a method for the simultaneous detection of both genomic RNA and DNA for two different species of shrimp viruses, yellow - head virus (YHV) and white-spot syndrome virus (WSSV), which are currently the cause of very serious and widespread losses in the shrimp industry in Thailand and in Asia. We describe a method which allows rapid diagnosis by performing a single step of extraction for both RNA and DNA using CTAB. The co-extract was then used for successful nucleic acid amplification in a multiplex RT-PCR reaction employing the super script, one multiplex RT-PCR process with primer 10F-144R for YHV and primer

nVP500F and VP500R for WSSV. This multiplex RT-PCR assay system is convenient and sensitivity and should be useful to shrimp aquaculturists for simultaneous detection of YHV and WSSV in post-larvae and broodstock of *P. monodon* and in other asymptomatic carriers.

Keywords: Prawns; Shrimps; Black tiger shrimp; *Penaeus monodon*; Diagnostic kit; Yellow Head Virus; White Spot Virus; Multiplex RT-PCR; PCR; Polymerase Chain Reaction; YHV; White Spot Syndrome Virus; WSSV; Viruses

572 Parin Chaivisuthankul, Paisan Sittikornkul, Siwaporn Longyan and Veerawan Sittikornkul. 2001. **Preparation of enveloped protein and determination of its partial amino acid sequence of yellow head virus from *Penaeus monodon*.** Research Report. Faculty of Science. Srinakharinwirot University. 19 p.

Yellow head virus (YHV) was prepared by injecting *Penaeus monodon* with YHV-infected haemolymph. A highly specific detection of YHV in the haemolymph of experimentally infected shrimps was obtained with dot-blotting using monoclonal antibody raised against 135 kD protein of YHV (V3-2B) as a probe. The SDS-PAGE of partially purified YHV displayed three bands of structural proteins consisting of 135 kD (putative envelope) 67 kD (putative capsid) and 22 kD (putative matrix). Determination of amino acid sequence at the N-terminal of the 135 kD protein was revealed as TILSGIPEKDSVLMA. The amino acid sequence at the N-terminal of 67 kD protein was also identified as LAPRQARVRG. Tryptic digestion of the 67 kD protein was performed and four fragments of smaller peptides were obtained. However, only three peptides were able to be sequenced. The N-terminal amino acid sequences of those peptides are GALFTQGT, YDAPPG, and YLPLGAIVQ.

Keywords: Prawns; Shrimps; *Penaeus monodon*; Proteins; Enveloped protein; Determination; Amino acids; YHV; Yellow Head Virus; Viruses; Haemolymph.

573 Thongchai Nitiratsuwan and Weeraporn Sriarkaprom. 2000. **Chemical and drug treat for tiger prawn (*Penaeus monodon*) culture in Sikao district, Trang province.** Faculty of Science and Technology of Fisheries. Technology Rajchamongkol Institute. 45 p.

Study on usage of drug, chemical and shrimp farming problems for the maximum efficiency. Total of 140 farmers in Sikao district Trang province were interviewed in 1999.

The most frequent problems are shrimp diseases, water qualities, used of chemical, antibiotic and supplementary feed especially BKC 80%, Norfloxacin and Vitamin C. Education level and education or training experience on aquaculture did not effected to the decision on drug and chemical use in their farm ($P>0.05$) except the use of some supplementary feed was used only by those who uneducated on aquaculture. Cost of drug and chemical used is 13,692±8,556 baht/rai/crop. Trend of management for drug and chemical use in shrimp farming are such as the water qualities should be pre monitoring before apply any more chemical. Extention on how to use some supplementary feed suitable. Awareness of cost benefit ration on drug and chemical use, etc.

Keywords: Prawns; Shrimps; Tiger prawn; *Penaeus monodon*; Chemicals; Drugs; Trang; BKC; Norfloxacin; Vitamin C;

574 in Thai

575 Chalida Chamanon, Sompop Rungsupa and Weena Koeyudsa. 1997. **The virucidal of *Mangifera indica* Linn. extracts against yellow-head virus and systemic ectodermal and mesodermal baculovirus on black tiger shrimp (*Penaeus monodon* Fabricius).** Research Report 1997. Aquatic Resources Research Institute, Chulalongkorn University. 73 p.

Acute toxicity of crude extract isolated from mango leaves (*Mangifera indica* L. c.v. Khiew Sawoey) on *Penaeus monodon* postlarvae (PL) 18, 30 and 42 stages was carried out using static bioassay system. The results indicated that the LC_{50} at 24 hr was 2,200 (1,966.04-2,461.80), 2,750 (2,387.15-3,168) and 2,900 (2,495.69-3,369.80) ppm for PL18, 30 and 42, respectively. The slope function at 95 % confident limit was 1.505 (1.393-1.625), 1.753 (1.506-2.040) and 1.602 (1.392-1.844) for such larval stages. Standard water quality parameters were analysed before the experiment, at 6 hr after the treatment and at the end of the experiment. While water temperature and salinity were not changed by crude extract, pH, dissolved oxygen and total alkalinity were decreased. Total ammonia nitrogen were elevated. Nevertheless, all changes in such water parameters were still be in safety limit and should not affect the mortality of the experimental *Penaeus monodon* larvae.

A study on inhibiting effects of crude extract isolated from mango leaves (*Mangifera indica* L. c.v. Khiew Sawoey) against yellow head virus (YHV) and systemic ectodermal and mesodermal baculovirus (SEMBV), on *Penaeus monodon* was carried out. The concentrated crude extract was

diluted in medium K-199 to be 10,000, 7,500, 5,000, 2,500, 1,000, 100, 10 and 1 ppm and mixed with viral solutions diluted from our stock to the concentration of 1×10^{-6} and 1×10^{-5} for YHV and SEMBV, respectively. The resulting solution was singly intramuscular injected into *P. monodon* individual which are about 7.09-15.68 gm. in weight. The experimental *P. monodon* was carried on culture for another week. It was found that the diluted crude extract at the concentration of 100 ppm can inhibit the mortality effects resulted from these viruses. The survival rate of *P. monodon* in this treatment was 50% which was not satistically significant from that of the 1 ppm.. diluted extract. On the basis of results from this experiments, the concentration of crude extract the completely inhibit the mortality effect of these viruses was 10,000 ppm.

More importantly, it was found that feeding of *P. monodon* (14.60 gm. in weight) with diet including the crude extract at the concentration of a least 2,500 ppm twice daily for seven days can stimulate their the cellular immunity. This indicated by a significant elevation in phenoloxidase activity in the haemolymph of the treated *P. monodon* in comparision of that of the control ($p<0.01$).

Keywords: Prawns; Shrimps; Black tiger shrimp; *Penaeus monodon*; *Mangifera indica*; Virus; Mesodermal Baculovirus; Probiotics; Acute toxicity; Toxicity; Yellow Head Virus; Systemic Ectodermal and Mesodermal Baculovirus.

576 Pusaya Sangvirun and Suthatip Vitchaivutivong. 2000. **Oxytetracycline residue in frozen exported black tiger shrimp.** Bulletin of the Department of Medical Sciences. 42 (2): 155-159.

Analysis of oxytetracycline residue in 5,205 samples of frozen exported black tiger shrimp were done during 1994-1998 using High Performance Liquid Chromatograph, HPLC, (Limit of Quantitation 0.10 mg/kg). The result showed that oxytetracycline was found in 1.15% of samples and range of contamination was 0.01-3.31 mg/kg. Only of 0.77% were contaminated higher than Codex MRL (0.20 mg/kg). The number of samples analysed in the year 1994, 1995, 1996, 1997 and 1998 were 1478, 1567, 1055, 628 and 477, and range of contamination were 0.16-0.49, 0.14-1.46, 0.13-3.31, 0.13-0.69 and 0.10-2.05 mg/kg respectively. Trend of the oxytetracycline detected samples dose not decrease from 1994-1998, so the government and the private section should continue to promote the good agricultural practice. In addition, the food for export should be examined for oxytetracycline residue in order to prevent problem that may occur.

Keywords: Prawns; Shrimps; Black tiger shrimp; Oxytetracycline; Residues; HPLC; Antibiotics; *Penaeus monodon*.

577 Songsri Mahasawasde, Nontawith Areechon and Laddavan Rasmidatta. 1998. **Effects of *Lactobacillus* on growth inhibition of *Vibrio* spp. and disease resistance of black tiger shrimp (*Penaeus monodon* Fabricius) larva.** Research Report. Kasetsart University Research and Development Institute. 8 p.

Efficiency of *Lactobacillus* spp. on growth inhibition of *Vibrio* spp. pathogenic bacteria of black tiger shrimp *Penaeus monodon* Fabricius was studied. Only the filtrate part of *Lactobacillus* showed the inhibiting activity while the whole cell part did not. Comparison of degree of inhibition among different species of *Lactobacillus* revealed that *Lactobacillus* sp. had the best inhibiting activity on *Vibrio harveyi* and *L. plantarum* on *V. parahaemolyticus*. Effects of *L. plantarum* on disease resistance of *P. monodon* postlarva was also investigated. Direct immersion of shrimp postlarva in sea water containing *L. plantarum* for 1, 2 and 4 hrs. did not cause any effect on the shrimp immunity. However, postlarva did show significant higher survival rate against pathogenic *V. parahaemolyticus* after raised with *Artemia* immersed in *L. plantarum* for 7 days.

Keywords: Prawns; Shrimps; *Penaeus monodon*; Black tiger shrimp; *Lactobacillus*; *Vibrio*; Bacteria; *Vibrio harveyi*; *Vibrio parahaemolyticus*; *Lactobacillus plantarum*; Disease Resistance; *Artemia*.

578 Premsak Wanuchsoontorn, Pongchan Ruamthvesub, Somrung Kruitong, Chanchai Nuanchan, Chang Kwei, Sujint Thammasart and Chingchai Lohawatanakul. 1993. **The use of water recycle system in *Penaeus monodon* culture.** In the Eighth National Seminar on Mangrove Ecology "Sustainable mangrove resources management, 25-28 August 1993, Wangtai Hotel, Suratthani. National Mangrove Committee, National Research Council. III-3: 1-11.

Water recycle or close system was used in *Penaeus monodon* culture at our shrimp farms in Mae-Khlong, Samut Songkram. The farm area was divided into two major sections: the grow-out and water treatment sections. The latter consisted of mussel pond (for biological filtration), aerated pond, sedimentation ponds, sea bass pond and a reservoir. Water from the reservoir was pumped into the grow-out ponds and was recycled to the treatment section. The levels of total ammonia nitrogen, phosphorus, total suspended solid,

chemical oxygen demand, nitrite and nitrate were monitored throughout a four month-trial period. All the parameters were decreased, ranging between 15-78%, in the treatment section. The shrimps, which had been stocked at 30/m² grew to an averaged size of 30.1 g with 81.1% survival rate, and feed conversion ration of 1.54, the mussels and sea basses also grew well; the mussels seemed to grow faster than when reared under a conventional culture.

Keywords: *Penaeus monodon*; Water recycle; Ponds

579 ประการ คุณหงษา. 1999. **อวนลากกึ่งไฟฟ้า (Electric net for the prawn harvesting).** การประชุมวิชาการทางวิศวกรรมไฟฟ้า ครั้งที่ 22 2-3 ธันวาคม 2542. มหาวิทยาลัยเกษตรศาสตร์. น. 593-596.

This paper describes a research and development of an electric net for prawn harvesting. The principle of the net is that electrodes which are attached along the lower edge of the net give out electrical impulses jerking the prawns to jump upward and thus are caught into the moving net. The results show that the net works satisfactorily considering the quality of the harvested prawns, it's reliability and consumption of electricity. In addition the net can be easily built low-cost local materials. It is also corrosion resistant in sea water.

Keywords: Shrimp

580 Nontawit Areechon and Suntaraporn Limsakul. 1996. **Application of vitamin C in the sea water as an anti-stress in tiger prawn (*Penaeus monodon* Fabricius) hatchery.** Research Report. Kasetsart University Research and Development Institute. 11 p.

Effect of vitamin C (L-ascorbyl dipotassium-2-sulfate dihydrate) on physiological response to some stressful conditions in *Penaeus monodon* Fabricius larvae was investigated. Vitamin C was added directly in sea water to raise *P. monodon* nauplius till postlarval stage at concentrations of 0, 50, 100 and 150 mg/l. Then postlarva (PL) were stressed with ammonia, methyl parathion, salinity change and low dissolved oxygen. Acute toxicity test of ammonia and methyl parathion revealed the LC₅₀ at 24 hrs of 53.5, 59.0, 57.0 and 63.0 ppm (as total ammonia nitrogen); 2.70, 3.40, 3.65 and 3.15 ppb for PL raised with 0, 50, 100 and 150 mg/l vitamin C respectively. Sudden change of salinity from 30 to 0 ppt caused significantly less mortality in PL 17 raised with 100 and 150 mg/l vitamin C during the forty-five minute period ($p > 0.05$), however, mortality rates amongst all experimental and control groups were not significantly different afterwards. There was no difference of mortality rates when salinity was

changed from 30 to 5 ppt. Similar result was found when PL was stressed by water containing no dissolved oxygen in which PL raised with 100 and 150 mg/l vitamin C had significantly less mortality during the first fifteen minute period. Results from this study indicated the beneficiaries of vitamin C as an anti-stress agent in *P. monodon* larvae especially at the early stage of stressful conditions and these positive effects were directly related to the elevated concentration of vitamin C.

Keywords: Vitamin C; Sea water; Anti-stress; Tiger prawn

581 in Thai

582 Jintamas Suwanjarat, Vanida Lim and Ussawadee Decha. 2000. **Ovarian development in relation to body weight of juvenile black tiger prawn *Penaeus monodon***. Songklanakarin J.Sci. Technol. 22 (Suppl.): 725-733.

The examination of ovarian development and ovarian stages in relation to body weight was carried out in the ovaries of the black tiger prawn *Penaeus monodon* with the body weight (BW) between 15 and 35 g. Histological sections were stained using haematoxylin and eosin, and Mallory trichrome stain. Ovaries of a 10 g to 15 g BW *Penaeus monodon* were in stage 2, or chromatin nucleolus stage. The ovary of 20 to 35 g BW was in stage 3, or perinucleolus stage, with the mean oocyte diameter measured 43.92 ± 7.75 μ m. There was no significant difference in the mean oocyte diameter between the ovaries in the C4 region of 15, 20 and 25 g BW *Penaeus monodon*, while the mean oocyte diameter of 10 g BW *Penaeus monodon* was significantly smaller than those of the 15, 20, 25 and 30 g BW *Penaeus monodon*. In addition, the mean oocyte diameter of 15 to 25 g BW *Penaeus monodon*. It was concluded that the ovarian development stage is related to the body weight. The female *Penaeus monodon* of 10 to 35 g BW consisted of stage 2 and 3 ovaries, and may not have reached the requirement for stage 4 in ovarian development with the body weight under 35 g.

Keywords: *Penaeus monodon*; Black tiger prawn; Ovarian development

583 Ong-ard Lawhavinit, Sunan Pinitkatisakul and Kishio Hatai. 2003. **Studies on pathogenic fungi in hatchery and nursery of giant tiger prawn, *Penaeus monodon***. In the 41st Kasetsart University Annual Conference, 3-7 February 2003. p. 10-19.

The fungal diseases, especially *Lagenidium* infection has been a problem in producing a seed of crustaceans in the world. The disease specifically occurs in the larva stages of *Penaeus monodon* and causes high mortality in Thailand. In this study, the infection of *Lagenidium* infection was found in the nauplius, zoea, and mysis of *Penaeus monodon* during raining and summer season in 2000 and 2001, respectively. The infected larva display a whitish body color. Non-septate branched hypha, 20-50 μ m in width were observed penetrating in the organs of infected larva under low magnification microscope, X40. The isolated fungus were cultured on PYGAS medium at room temperature, 28-30 °C and was identified like as *Lagenidium thermophilum* based on the morphological characteristics, vesicle producing and all the isolated could not grown at 25 °C. The artificial infection of isolated fungi was done in nauplius, zoea and mysis stages of *Penaeus monodon* and the results showed pathogenicity to all stages of larva in the laboratory.

Keywords: Prawns; Shrimps; *Penaeus monodon*; Hatcheries; Nursing; Giant tiger prawn; Diseases; Drugs; Chemicals

584 in Thai

585 Weerawan Sithigaorngul, Phaisarn Sithigaorngul, Santi Ruengmeneepaitoon, Sunisa Sangmongkolpipat and Peamsak Menasveta. 1994. **Localization of neuropeptide hormones in eyestalks of giant tiger prawn *Penaeus monodon***. Thai J. of Aqua. Sci. 1 (1): 1-19.

Antisera against 8 neuropeptides were used to determine the distribution of peptide-like immuno-reactive substances in the eyestalks of the giant tiger prawn *Penaeus monodon*. Positive results were obtained from antisera against α PDH, β PDH, FMRFamide and CCK. These antibodies recognized neuronal cell bodies and their processes in several regions including sinus gland. Three antisera against insulin, glucagon and somatostatin gave negative results. Antiserum against LHRH showed strong immuno-reactivity in only one neuron but the staining was not specific for LHRH since the pretreatment of the antiserum with LHRH-BSA was not able to eliminate the staining in this neuron. All CCK immunoreactive neurons were co-localized with PHD-like substances and about half of PDH immunoreactive neurons were co-localized with FMRFamide-like substances. Only 1-2 neurons were found to have all PDH, FMRFamide and CCK-like substance. This observation demonstrates an extensive peptidergic system in the crustacean eyestalks. The morphology of this peptidergic system suggests that one part is neurohormonal and

the other part neurotransmitter like or neuromodulatory.

Keywords: Prawns; Shrimps; Neuropeptides; Hormones; Eyestalks; Giant tiger prawn; *Penaeus monodon*; Immunity

586 Wanna Nontanapan, Praphatpong Petcharat and Suwadee Bhandasak. 1998. **Study on oxytetracycline residues in *Penaeus monodon* Fabricius from shrimp pond.** In the 15th Rajamangala Institute Annual Conference, 12-14 February 1998. p. 228-238.

Residue of Oxytetracycline (OTC) was studied in shrimp (average weight 12.5 g, 90 days) under farm condition after administration OTC 5 g/kg feed/ time/ 3 times a day for 7 days. The result demonstrated that OTC persisted in muscle of shrimp fed with pellet mixed on farm with OTC for 5 days. The maximum and minimum concentration OTC in shrimp muscle were 2.488 and 0.006 ppm, respectively by Microbiological assay method.

Keywords: Prawns; Shrimps; *Penaeus monodon*; Shrimp ponds; Oxytetracycline; Residues; Microbiological assay.

587 Weerawan Sithigorngul, Siwaporn Longyant, Nirun Boon-Ingerdpong and Phaisarn Sithigorngul. 1996. **Cross-reactivity of the eyestalk extracts from *Metapenaeus affinis*, *Penaeus monodon* and *Macrobrachium rosenbergii* on hemolymph vitellogenin levels of *M. affinis*.** Thai J. of Aqua. Sci. 3(1): 14-20.

Eye-ablated shrimps *Metapenaeus affinis* in the vitellogenic stage of ovarian development were treated with various doses of eyestalk extracts from *M. affinis* or *Penaeus monodon*. The eyestalk extracts from both species elevated hemolymph vitellogenin levels of eyed-ablated shrimps in dose-response fashion, however, the extract from *M. affinis* demonstrated higher efficiency than those from *P. monodon*. The extract *Macrobrachium rosenbergii* did not evoke this effect even higher dose was used. This results indicate that the gonad inhibiting hormones (GIH) of shrimps in different families are very distinct and do not cross-react. In contrast, the GIH among members of the same family are similar and able to cross-react but not complete.

Keywords: Prawns; Shrimps; *Penaeus monodon*; *Macrobrachium rosenbergii*; Eyestalk extracts; Hemolymph; Vitellogenin; Probiotics

588 Lerdchai Chintapitaksakul, Jantana Wongsantichon, Apinunt Udomkit, Sakol Panyim and Burachai Sonthayanon. 2002. **Transcriptional profile of yellow head virus (YHV) infected haemocytes of black tiger prawn (*Penaeus monodon*).** In the 28th Congress on Science and Technology of Thailand, 24-26 October 2002. p. 369.

Yellow Head Virus (YHV) is a virulent penaeid shrimp virus causing high economical losses to Thai aquaculture industry. We are interesting in studying host gene transcription in the phagocytic haemocytes which provide defense functions against invading pathogens. Macroarray hybridizations were used to screen transcriptional expression of selected haemocyte transcripts at 24 hours post-YHV infection, compared to a NTE (NaCl, Tris-EDTA) buffer injection, and zero time control. PCR products amplified from 96 selected cDNA clones isolated in our laboratory, were used as probes fixed as array on nylon membranes while ³²P labeled-cDNAs as targets were transcribed from total RNAs of shrimp's haemocytes under the three conditions. Our results revealed that certain known defense-related transcripts, notably an antilipopolysaccharide factor, a serine proteinase inhibitor, an anti-bacterial protein 11.5 kDa, and a proteinase inhibitor, did not significantly alter their expression level under the YHV-infected condition compared to controls.

Keywords: Prawns; Shrimps; *Penaeus monodon*; YHV; Yellow Head Virus; Black tiger prawn; Viruses; Genes

589 Wanchai Assavalapskul, Duncan R. Smith and Sakol Panyim. 2002. **Production of Infectious Yellow Head Virus Particles Precedes Cytopathic effects in *Penaeus monodon* Oka Organ Primary Cell Cultures.** In the 28th Congress on Science and Technology of Thailand, 24-26 October 2002. p. 367.

The yellow head virus in a shrimp virus that causes a rapidly fatal disease in several species of penaeid shrimps. In the absence of established shrimp cell lines, primary culture methodologies have been established for tissues of several origins, including the lymphoid (Oka) organ. Primary cell cultures of Oka organ are known to support the replication and propagation of the yellow head virus, resulting in characteristic cytopathic effects including rounding up and detachment of the cells. Using primary cultures of Oka organ from *Penaeus monodon*, this study sought to determine the propagation profile of the yellow head virus, using an *in vitro* quantal assay (Tissue culture infectious dose 50, TCID₅₀). Results indicate that detectable levels of the virus are present as early as 24 hours post after the onset of detectable cytopathic effects. Cytopathic effects are normally observable some 3 days post

inoculation. These results have considerable significance for the control of viral diseases in shrimps stocks, given that mature infectious progeny are produced significantly ahead of detectable cytopathic effects.

Keywords: Prawns; Shrimps; *Penaeus monodon*; YHV; Yellow Head Virus; Lymphoid organ; Pathology; Viruses

590 Pakawadee Sutthivaiyakit, Sarinma Chusaksri, Sunan Kitjaruwankul, Tharinee Augpradit, Pongsak Lowmunkhong and Saowapa Chumanee. 2002. **Determination of metabolite residue of nitrofurazone in shrimp.** In the 28th Congress on Science and Technology of Thailand, 24-26 October 2002. p. 541.

Nitrofurazone is an antibacterial agent classified as a mutagenic and genotoxic drug. Thus, European Union prohibited its use of it in food-producing animals. It has a very short life time *in vivo*, i.e. in the range of not more than a number of hours, therefore, its metabolite bound to protein was determined instead. In the developed method sample preparation was performed in three steps, i.e. hydrolysis derivatization with 2-nitrobenzaldehyde and solid phase extraction to clean the sample up. Internal standard calibration and LC-MS-MS were used for the determination. The method was applied to determine fortified sample of shrimp with good recovery of 84.0% at 50 ng/g and the detection limit of 1 ng/g.

Keywords: Prawns; Shrimps; Residues; Metabolites; Antiinfective agents

591 Potchanapond Graidist, Amornrat Phongdara, Phuwadol Bangrak, Wilaiwan Chotigeat and Kidchakan Supamattaya. 2002. **The screening of genes activated in response to white spot syndrome virus infection in *Penaeus monodon*.** In the 28th Congress on Science and Technology of Thailand, 24-26 October 2002. p. 535.

In this study, we selected 50 clones from subtracted cDNA library (1,2). It was constructed from mRNA isolated from hemolymph of normal shrimp and was subtracted with those from hemolymph of shrimp infected with white spot syndrome virus (WSSV). Selected clones were sequenced and subsequently compared with data from GenBank. Thirty-seven clones were found homology to coding region. No homology with other references was observed in 4 clones. The clone with putative sequence homology to Dynamin gene was selected. Expression of this gene was found in WSSV infected and bacteria

infected *P. monodon*. In bacteria infection, the expression was dropped after antibiotic treatment.

Keywords: Prawns; Shrimps; *Penaeus monodon*; Genes; White Spot Syndrome Virus; Viruses; WSSV

592 Uamanat Intaraphad, Wilaiwan Chotigeat and Amornrat Phongdara. 2002. **Screening of the interactive genes to white spot syndrome virus.** In the 28th Congress on Science and Technology of Thailand, 24-26 October 2002. p. 540.

White Spot Syndrome Virus (WSSV) cause considerable mortality in black tiger prawn (*Penaeus monodon*) in Thailand. Knowledge gained from previous studies have a hypothesis that the virus initiate infection of susceptible cells binding to cell surface of host cells. (1) In this study, we displayed peptides of cDNA library of WSSV –infected hemolymph of shrimp on the surface of phage and screened for genes which had an interaction with virus. The interactive clone (pC9) found to consisted of 171 bp which was unmatchable with NCBI database, however the produced protein from the clone showed binding with WSSV antigen by western blotting. Screening of the interactive genes to WSSV is an approach to produce some protein to prevent the virus to invade the host.

Keywords: Prawns; Shrimps; Genes; White Spot Syndrome Virus; Viruses; WSSV; *Penaeus monodon*

593 Somporn Ketpokasiri, Marasri Ruengjitchatchawalya, Chalermraj Wantawin and Sunun Siriraksophon. 2002. **Distribution of Cyanobacteria in shrimp pond.** In the 28th Congress on Science and Technology of Thailand, 24-26 October 2002. p. 541.

Distribution of several microalgae was found in semi-intensive shrimp pond. Blue-green algae or cyanobacteria, such as *Synechocystis*, *Phormidium*, *Scytonema*, *Calothrix*, *Lyngbya*, *Pseudanabaena*, *Nostoc* sp., and green algae, such as *Scenedesmus*, *Cladophora*, *Haematococcus* sp., were isolated. As a result, application of the microalgae grown in the shrimp pond for removal of nutrients, particularly nitrogen and phosphorus compounds was proposed.

Keywords: Prawns; Shrimps; Shrimp ponds; Water; Bacteria

594 Ampol Munsekvit, Sarote Sirisansaneeyakul and Sawitri Chuntranuluck. 2002. **The isolation of bacteria producing protease, amylase and lipase from shrimp farming.** In the 28th Congress on Science and Technology of Thailand, 24-26 October 2002. p. 551.

The isolation of microorganism producing protease, amylase and lipase from sewage and soil of shrimp farms was carried out on the agar plate at 37°C using skim milk, starch and tributyrin as substrates, respectively. As a result, 45, 29 and 4 isolates of protease, amylase and lipase producers were obtained, respectively. The colonies producing high clear zone were selected and confirmed for their activities of protease, amylase and lipase in liquid medium at 37 °C. Isolate Lp2 and SR-SK1 gave likely the highest production rate of protease (2.32 U/ml h) at 14 h of culture time and had the specific growth rates of 0.202 and 0.24 h⁻¹, respectively. On the other hand, isolate Lp1 with the specific growth rate of 0.344 h⁻¹ showed the highest production rate of amylase (9.90 U/ml h) and lipase (0.49 U/ml h) at 11 and 13 h of culture time, respectively. These three isolates were all identified as bacteria of genus *Bacillus*.

Keywords: Shrimps; Prawns; Bacteria; Enzymes; Farming; Protease; Amylase

595 Amornrat Tangprasittipap, Poonsuk Prasertsan, Wanna Choorit, Kidchakan Supamattaya and Ken Sasaki. 2002. **Effect of 5-aminolevulinic acid to stimulate immune system of black tiger shrimp (*Penaeus monodon* Fabricius).** In 28th Congress on Science and Technology of Thailand, 24-26 October 2002. p. 553.

Investigation on applying 5-aminolevulinic acid (ALA) to black tiger shrimp for 7 days revealed that the lethal concentration (LC₅₀) of ALA was about 17,000 ppm. For *in vitro* studies, ALA neither increased the degranulation (or exocytosis) nor activated phenoloxidase activity of black tiger shrimp blood. For *in vitro* studies in black tiger shrimp, ALA (0.1-5,000 ppm.) was found to have no effect on stimulation of immune response in which the total hemocytes count (THC) and phenoloxidase (PO) activity were not significantly difference (P>0.05). Nevertheless THC and PO activity trended to increase at 500 and 5,000 ppm. ALA, respectively.

Keywords: Prawns; Shrimps; *Penaeus monodon*; Immune; Immunity; Black tiger shrimp

596 Nontawith Areechon and Roongthip Rojjananavin. 1997. **Toxicity of povidone-iodine to *Vibrio* spp. and *Penaeus monodon* Larva.** In the 35th Kasetsart University Annual Conference, 3-5 February 1997. p. 41-48.

Povidone-Iodine (PI) has been applied as disinfectant to control many pathogenic microbes

in both hatchery and grow-out pond of black tiger shrimp (*Penaeus monodon* Fabricius). This study was conducted to determine the minimal bactericidal concentration (MBC) of PI with 20% iodine for seven species of *Vibrio* including *V. parahaemolyticus*, *V. vulnificus*, *V. damsela*, *V. alginolyticus*, *V. fluvialis*, *V. cholerae*, and *V. harveyi* with the total of 48 isolates and acute toxicity in *Penaeus monodon* post-larval stage 15. MBC study of 30 min exposure time with 48 isolates indicated the values ranging from 1.5626-12.5 ppm. in which 20 isolates could be inhibited at 3.125 ppm. Acute toxicity test to determine the concentration of PI that could kill 50% of the testing population within 24 hrs (Lethal concentration [LC₅₀ at 24 hrs]) yielded the value of 17.0 (13.26-21.76) ppm. Judging from the concentration of PI that the farmers are using which is 2-3 ppm. and result from this study, it may be suggested that application of povidone-iodine will be effective against some particular species of *Vibrio* and the recommended dose is safe for the shrimp. However, the percentage of active ingredient in PI should be taken into consideration before the application.

Keywords: Prawns; Shrimps; *Penaeus monodon*; Povidone iodine; Toxicity; *Vibrio*; Chemicals; Acute toxicity

597 O. Khongpakdee, S. Direkbusarakom, O. Tantitakurn and T. Pechmanee. 2001. **Effect of extra-cellular and intracellular product of *Skeletonema costatum* on growth of *Vibrio harveyi*.** In Bio. Thailand 2001 From Research to Market. p. 103-109.

Antibacterial activity from the extracellular and intracellular product of *Skeletonema costatum* was tested by using *S. costatum* cells immobilized in sodium alginate beads and crude extract of *S. costatum*. Approximately 104 CFU/ml. of three strains of *Vibrio harveyi* (1114GL, VH.046 and VH.1256) isolated from diseased shrimp inoculated into immobilized *S. costatum* in experimental 1 (T1-T3) and dissolution of crude extract in experimental 2 (T1-T3). Two control trials were using only immobilized *S. costatum* (T4) in experimental 1 and only crude extract in experimental 2 (T4) and only 3 strains of *V. harveyi* (T5-T7). Five replications of each trials were performed. After incubation for 6, 24, 48, 72 and 96 hr. the bacteria were counted by using spread plate method on BTB-teepol agar. The results of the experimental 1 indicated that the number of 1114GL and VH. 046 decreased after 24 hr. and VH.1256 decreased after 6 hr. of incubation time when compared with control (T5-T7). No *V. harveyi* were detected in the immobilized *S. costatum*

culture (T4) and the number of bacteria in the experimental 2 in the dissolution with crude extract of *S. costatum* (T1-T3) decreased after 24 hr. of the inoculation time to the end of experiment when compared with control (T5-T7). The results indicated that extracellular and intracellular products of *S. costatum* contained antibiotic activity which inhibited 3 strains of *V. harveyi*.

Keywords: Black tiger shrimp; Prawns; Shrimps; Bacteria; *Vibrio harveyi*; *Skeletonema*

598 Jiraporn Kasornchandra, Raewat Khongpradit and Sarawut Sriwatanavarunyou. 2000. **Primary shrimp cell culture: applications for studying Yellow Head Virus (YHV).** The 1st National Symposium on Marine Shrimps, 15-17 December 1999. B.P. Smila Hotel, Songkhla. National Center for Genetic Engineering and Biotechnology. p.58-64.

Primary shrimp cell culture from lymphoid organs of *Penaeus monodon* was successfully developed in our laboratory. Minced tissues of lymphoid organs were seeded and cultured in 2x Leibovitz-15 supplemented with 15% fetal calf serum, 10% shrimp meat extract, and a salt mixture, with an osmolarity of 720±20 mmol/kg. Plates were then incubated at 28°C. until 70-80% cell monolayers were formed. Even though we were not able to subculture this primary shrimp cell cultures however it proved to be useful for studying shrimp viruses. In this studies, we used the primary lymphoid cells to study yellow head virus (YHV) *in vitro*. Cytopathic effect (CPE) induced by YHV showed characteristics of cell rounding, aggregation followed by detachment and lysis. Quantitative analysis of YHV was determined using primary lymphoid cell systems, giving the titer of 10^{7.5} TCID₅₀/ml. Among those infected tissues and organs observed, lymphoid organ and gills gave the highest titer of 10^{7.5} TCID₅₀/ml while eyestalk and pleopods gave the lowest titer of 10^{4.0} TCID₅₀/ml. Using this primary shrimp cell culture, the pathogenesis of shrimp viral infections and the relative virulence of YHV infecting various species of marine shrimps were also examined.

Keywords: Shrimps; Black tiger shrimp; Yellow Head Virus; YHV; Yellow Head Disease; *Penaeus monodon*; Prawns; Viruses.

599 Julaporn Prasertphol. 1989. **Cotton disease in black tiger prawn (*Penaeus monodon*)** Technical Paper No. 11/2538. Technical Paper No.11/1989. Chanthaburi Coastal Aquaculture

Research and Development Center. Department of Fisheries. 5 p.

Cotton disease, a serious protozoan pathogen often infested pond cultured Black Tiger Prawn (*Penaeus monodon*), came under this study at Chanthaburi Coastal Aquaculture Research and Development Center. The pathogen, identified as *Thelohania* sp., is capable of causing striate muscles, hepatopancreas and intestine to turn opaque and white. Science no effective treatment of the disease is so far known, destruction of infected prawn is the only way of preventing the disease from spreading further prevention is recomened to Black Tiger Prawn the means of avoiding infection of the disease.

Keywords: Prawns; Shrimps; Black tiger shrimp; Cotton disease; Black tiger prawn

600 Pornlerd Chanratchakool, Noppadon Sukrakanchana and Pathanapong Kongyangyurn. 1998. **The effects of β-1,3 glucan on the immune response of black tiger shrimp, *Penaeus monodon* (Fabricius).** In the 36th Kasetsart University Annual Conference, 3-5 February 1998. p. 43-50.

The effect of β-1,3 glucan an immunenhaner, on some immuno-parameters of shrimp was studied by using top dressed feed at a rate of 5 and 10 g/kg feed, fed to the shrimp for 3 days. Phenoloxidase enzyme, phagocytosis and bactericidal activity (%inhibition) were checked everyday during the experimental period. Results revealed that β-1, 3 glucan at a rate of 5 g/kg feed failed to improve the defense response. However, at a high dosage (10 g/kg feed), β-1, 3 glucan significantly improved all three parameters after 3 days of feeding.

Keywords: Prawns; Shrimps; *Penaeus monodon*; Immune; Responses; Black tiger shrimp; Beta-1, 3 Glucan; Phenoloxidase; Bactericidal activity.

601 Pornlerd Chanratchakool, Noppadon Sukrakanchana and Sampan Pancharatana. 1998. **The effect of some environmental changes on the shrimp, *Penaeus monodon* (Fabricius) immune response.** In the 36th Kasetsart University Annual Conference, 3-5 February 1998. p. 35 - 41.

The effects of rapid changes of water temperature and pH on the shrimp immune response was studied. Increasing the temperature from ambient (26°C) to 35°C for 3 hrs. resulted in significantly reducing phenoloxidase enzyme and bactericidal activity. However, phagocytosis activity was not altered. No significant changes were observed in shrimp stressed by reducing temperature from 26°C to 15°C for 3 hrs. Shrimp subjected to the stress of increasing the pH

from 7.8 to 10.0 for 3 hrs., raised phenoloxidase enzyme activity but reduced the bactericidal activity. Reducing water pH from 7.8 to 6.0 for 3 hrs. resulted in reduction of phenoloxidase enzyme, phagocytosis and bactericidal activity.

Keywords: Prawns; Shrimps; *Penaeus monodon*; Environmental; Immune; Bacteria; Phenoloxidase; Responses

602 Pornlerd Chanratchakool, R.J. Roberts and Chalor Limsuwan. 1991. **Retention of oxytetracycline in juvenile tiger shrimp (*Penaeus monodon* Fabricius).** In Proceeding the Seminar on Fisheries 1991 Department of Fisheries, 16-18 September 1991. p. 105-108.

Oxytetracycline (OTC) medicated feed at concentrations of 1, 3 and 5 g OTC/kg feed was fed to juvenile tiger shrimp (*Penaeus monodon* Fabricius) for 3, 5 and 7 days. After the period of administration, the retention of OTC in muscle was studied. The OTC retention in the muscle for all treatments was 0.8-0.9 ppm. after 24 hours of last medicated feeding, and it was depleted rapidly. The retention period of each treatment varied from 3-7 days, depending on the doses and periods of feeding. Higher dose or/and longer period of administration required more time for elimination.

Keywords: Prawns; Shrimps; Black tiger shrimp; *Penaeus monodon*; Oxytetracycline; Drug residues; Drugs; Residues

603 Patsorn Sawatasuk, Kruewan Onthong and Sataporn Direkbusarakom. 2000. **Effect of the extract of *Phyllanthus amarus* Linn. on bactericidin in the black tiger prawn, *Penaeus monodon*.** In the 38th Kasetsart University Annual Conference, 1-4 February 2000. p. 11-16.

Effect of the extract of *Phyllanthus amarus* Linn. on bactericidin in the black tiger prawn (*Penaeus monodon*) was studied by muscle injection at the 6th segment. Three concentrations of the extract were given to *P. monodon* as following 0, 0.01 and 1.0 mg/ml. After injection for 1 and 6 hours, 11-12 prawns from each group were sampling for bactericidal activity according to the method described by Kallaya (1995). The analysis of data by ANOVA showed non-significant in every groups. From all the results indicated no effect of the extract of *P. amarus* Linn. on bactericidin in the black tiger prawn.

Keywords: Prawns; Shrimps; Herbs; *Penaeus monodon*; Black tiger prawn; Bactericidin; *Phyllanthus amarus*; Bacteria; Probiotics

604 Ratchada Kwawnuna. 1996. **Antibiotics residue in cultured tiger shrimp in Suratthani.** Thai Fisheries Gazette 49(5): 407-412.

Determination of antibiotics residue in cultured tiger shrimp in Suratthani using microbiological assay was done during October 1994-October 1995. The result showed that Oxytetracycline was detected from 8 out of 186 samples (4.30%) which the withdrawing period was 4-7 days. No antibiotic residue was detected from the samples which sampling at 9 days after stop using drug. From field observation three kinds of antibiotics drug, Oxytetracycline, Oxolinic Acid and Sulfadiazine are generally used at 89.63%, 7.93% and 2.44%, respectively. Most of the drugs using is for prophylaxis from 9-8 days of rearing while only a few were used after 3 months of rearing. The observation also showed that around 11.83% of the shrimp farmers never used antibiotics during the culture period.

Keywords: Shrimps; Black tiger shrimp; Antibiotic residues; Drugs; Oxytetracycline; Kanamycin; Microbiological assay; Surat Thani; Prawns; Viruses

605 Monrudee Sitthipun. 1998. **Extraction of beta-glucan from yeast and its application in black tiger prawn (*Penaeus monodon*).** Master Thesis. Prince of Songkla University. 69 p.

Saccharomyces cerevisiae TISTR 5088 cultivated at room temperature on the shaker (200 rpm) for 36 hours in YEPD medium had 9.00 g/l cell dry weight. After cell homogenization and extraction the yield from the cell wall was 13.65% of the cell dry weight. The beta-glucan was extracted from the cell wall by 2 methods : (1) extraction with 50 mM phosphate buffer (pH 8.0) provided crude beta-glucan 20.00% of cell wall with total sugar 129.00 mg/g and (2) extraction with 0.75 M sodium hydroxide at 75°C provided crude beta-glucan 30.00% of cell wall with total sugar 82.20 mg/g. Purification of the 0.02 g/l beta-glucan solution by Sephadex G-100 column (110x1.0 cm) showed that fraction numbers 18-29 had 2.85 mg/ml total sugar. Separation by thin layer chromatography showed that samples had the same R_f as the standard beta-glucan.

After beta-glucan separation this beta-glucan was added to the feed formula to grow Black Tiger Prawn (*Penaeus monodon*) for 45 days with 0.10% pure beta-glucan in the feed formula. Four formulations were tested. They were 8.40 g of cell wall/1 kg. feed, crude beta-glucan 1.70 g/1 kg feed, 1.00 g of pure beta-glucan/1 kg feed and control feed. The prawns that consumed feed with pure beta-glucan showed the best results with total haemocyte

count of 9.89×10^7 cells/ml, bacteria clearance from haemolymph of 0.60×10^4 cfu/ml, and disease resistance against *Vibrio harveyi* 90.00%.

Keywords: Prawns; Shrimps; *Penaeus monodon*; Black tiger prawn; Beta-glucan; Yeasts; Chemicals; *Saccharomyces cerevisiae*

606 Sithi Boonyaratthaparin, Sathaporn Deerekbud Sarakom, Jiraporn Kasornjchandra, Aussanee Aekpanithanpong, Chaityuth Junthanachukrin and Kitkhan Supamath. 1992. **Baculovirus causative agent of yellow-head disease in Penaeid shrimp (*Penaeus monodon*)**. In Proceeding the Seminar on Fisheries 1988 Department of Fisheries, 16-18 September 1992. National Inland Fisheries Institute, Bang Khen. p. 200-205.

The outbreak of yellow-head disease of penaeid shrimp (*Penaeus monodon*) was first found in Southern Thailand at Nakornsri Thammarat and Songkhla province, in early 1992. The affected shrimps exhibit the light yellow hepatopancreas and gills. The diseased shrimp show a marked reduction in food consumption. The disease caused high mortalities upto 70-100% within 5 days. Reinfection with the extracted filtrate from hepatopancreas and muscles of diseased shrimp, through 0.2 μ m membrane filter gave high mortalities with the diseased symptom within 4 days. A DNA virus particle with the bacilliform morphology, 40-50 nm in diameter and 150-170 nm in length, with an envelope was detected from both diseased and experimental shrimp, as a causative agent. This virus particles are sensitive to temperature 100-121°C but can be survived at 60°C. Diseased shrimp showed pathological changes such as degeneration and necrosis of lymphoid organ as well as the congestion of hemal sinuses and nucleolar hypertrophy of lymphatic tissues. Edema and necrosis of pillar cell and dilation of lacuna in secondary lamella were also observed.

Keywords: Prawns; Shrimps; *Penaeus monodon*; Yellow Head Disease; Penaeid; *Baculovirus*; Nakhon Sri Thammarat; Songkhla; Diseases; Viruses; *Zoothamnium*; *Vibrio*; Bacteria

607 Amonrat Sermwatanakul. 1994. **Antibiotic drugs residue in shrimp**. Thai Fisheries Gazette 47(6): 517-522.

Thailand was the world's leading shrimp producer for the third consecutive years (1991-1993). Since 1991, the imported countries like Japan and USA have strictly checked antibiotic drugs residue in shrimp. Oxytetracycline and

oxolinic acid are be taken to ensure that the medication is properly administered and the withdrawal period is long enough. The maximum allowance for oxytetracycline in shrimp by United States Food and Drug Administration (USFDA) is 0.1 ppm to ensure shrimp products before import to other countries, the guarantee certificate will be issued by the Department of Fisheries.

Keywords: Prawns; Shrimps; Black tiger shrimps; Antibiotics; Oxytetracycline; Oxolinic acid; Drugs; Drug residues; *Penaeus monodon*

608 Lila Ruangpan and T. Kitao. 1992. **Minimal inhibitory concentration of 19 chemotherapeutants against *Vibrio* bacteria of shrimp, *Penaeus monodon***. In Diseases in Asian Aquaculture I : Proceedings of the First Symposium on Diseases in Asian Aquaculture 26-29 November 1990 Bali, Indonesia. p. 135-142.

In vitro activity of 19 chemotherapeutants including Ampicillin (ABP), Amoxicillin (AMP), Cefazolin (CEZ), Streptomycin (SM), Erythromycin (EM), Oxytetracycline (OTC), Chloramphenicol (CP), Trimethoprim (TMP), FR₁₈₈₁, VR₂₆₇₄ (Byer), Miloxacin (MLX), Ciprofloxacin (CPX), Cephalexin (CEX), Flumequine (FLQ), Furazolidone (NF), Nalidixic acid (NA), Oxolinic acid (OA), Piromidic acid (PA) and Sulphamonomethoxine (SA) against five species of *Vibrio* bacteria isolated from diseased shrimp, *Penaeus monodon* were tested for their minimal inhibitory concentrations (MIC) using the serial dilution method in agar, standardized by Anon (1981). VP₂₆₇₄ was found to have the lowest MIC level against 90% of the isolates. Fifty to ninety percent of the isolates were inhibited by MLX, CPX, FLQ and OA at concentration of 0.3-0.6 μ g/ml. The majority of test isolates were resistant to SA, FR₁₈₈₁, CEZ and SM.

Keywords: Prawns; Shrimps; *Penaeus monodon*; Chemotherapeutants; Ampicillin; Amoxicillin; Cefazolin; Streptomycin; *Vibrio*; Erythromycin; Oxytetracycline; Chloramphenicol; Bacteria

609 Lila Ruangpan, Suppachai Prapadsorn and Kulvara Sangrungruang. 1996. **Minimal inhibitory concentration of 5 chemotherapeutants against *Vibrio* bacteria and their transferring of R-plasmid**. Thai Fisheries Gazette 49(6): 495-500.

Vibrio bacteria, a major problem of intensively cultured black tiger shrimp, *Penaeus monodon* typically cause massive mortalities. To control the diseases, a wide range of chemotherapeutants are applied. Among those, oxytetracycline (OTC) and oxolinic acid (OA) are the most commonly agents

used in many shrimp culture areas of Thailand. This study aims to investigate the minimal inhibitory concentration (MIC) of wellknown chemotherapeutants against *Vibrio* spp. and naturally transferring of their plasmid resistance. During the period June 1994 to April 1995, MICs of OTC, OA, NFLX (norfloxacin), CP (chloramphenicol) and KM (kanamycin) against 135 *Vibrio* strains isolated from the sediment of black tiger shrimp ponds were conducted. These studies were based on the Japan Society of Chemotherapy method (1981). A serial twofold dilution procedure was used to prepare the agents; concentration tests ranging from 0.0125 to 100 µg/mL. The transfer of R-plasmid strains were detected using *Escherichia coli* (RC85) as a recipient strain (Aoki, et al.1974). Results indicated that MICs value of OTC, OA, NFLX, CP and KM ranged respectively from 0.025->100, 0.0125->100, 0.0125->100, 0.1->100 and 1.6-100 µg/mL. The inhibitory concentration of these agents against 50 percent (IC₅₀) of studied strains were observed at 12.5, 1.2, 9.45 and >100 µg/mL. IC₉₀ values were recorded at 100, 17.5, 75, 37.5 and >100 µg/mL respectively. *Vibrio* strains carrying R-plasmid encoded with resistance for OTC were detected in 2 of 40 resistant strains, whereas a single specimen out 20 strains encoded for CP-resistance. This MIC study reveals a large number of strains resistant to chemotherapeutants. The study also reveals a number of R-plasmids in naturally occurring *Vibrio* that encoded for drug resistance. Proper guidance of chemotherapy application is badly needed to educate shrimp farmers.

Keywords: Prawns; Shrimps; *Penaeus monodon*; Black tiger shrimp; *Vibrio*; Chemotherapeutants; Oxytetracycline; Oxolinic acid; Minimal Inhibitory Concentration; MIC; Bacteria

610 Lila Ruangpan, Pitsanu Na-anan and Sathaporn Direkbusarakom. 1998. **Inhibitory effect of *Vibrio alginolyticus* on the growth of *V. harveyi*.** Fish Pathology 33(4): 293-296.

One strain (NICA 1031) of *Vibrio alginolyticus* was screened from 50 strains of normal bacterial flora isolated from rearing water in *Penaeus monodon* hatchery based on its inhibitory activity against the growth of 5 strains *Vibrio harveyi*. The inhibitory effects of *V. alginolyticus* NICA1031 on the growth of a *V. harveyi* strain were investigated by concomitant incubation of the two bacteria in artificial sea water under different conditions by monitoring colony forming unit of *V. harveyi* on BTB teepol agar. The inhibitory effect of *V.*

alginolyticus against the strain of *V. harveyi* was higher in the sea water at 10 ppt of salinity than in those at 20 and 30 ppt. Results also showed that the higher inhibitory effect was revealed at 30-37°C than at 25°C and at pH 8.5 than pH 7.5 and 9.0.

Keywords: Prawns; Shrimps; *Vibrio alginolyticus*; *Vibrio harveyi*; Bacteria; Black tiger shrimp; *Penaeus monodon*

611 Lila Ruangpan and T. Kitao. 1991. ***Vibrio* Bacteria Isolated from Black Tiger Shrimp *Penaeus monodon* Fabricius.** Journal of Fish Diseases. 14: 383-388.

Two hundred and five isolated of *Vibrio* bacteria were obtained from diseased black tiger shrimp, *Penaeus monodon* Fabricius, cultured in Thailand during the period from February 1988 to January 1990. Ninety-six isolates of the bacteria were identified as *Vibrio parahaemolyticus*. The others included 74 isolates of *V. vulnificus*, 18 isolates of *V. alginolyticus*, six isolates of *V. fluvialis* and 11 isolates of *Vibrio* spp. Comparisons of some characteristics of the bacteria studied are given.

Keywords: Prawns; Shrimps; Black tiger shrimp; *Penaeus monodon*; Bacteria; *Vibrio parahaemolyticus*; *Vibrio vulnificus*; *Vibrio alginolyticus*

612 M. Limpoka, S. Pongsakorn, S. Phongvivat, G. Thampipatanakul, D. Wongsommart, P. Chotipundu, C. Rongrodejarnarak, T. Pung, U. Sittiphuprasert, P. Chotipundu, T. Vichkovitten, L. Chuchit, O. Lawhavint, P. Chainanan, R. Kanchanomai and T. Wongkaluang. 1994. **Antimicrobial drugs in *Penaeus monodon* Fabricius.** In the 32nd Kasetsart University Annual Conference, 3-5 February 1994. p. 428-438.

Pharmacokinetic data and information on absorption, tissue clearance, tissue distribution and excretion of eleven proposed antimicrobial drugs were investigated in tiger giant prawn (*Penaeus monodon* Fabricius). The drugs that were selected for study were sulfathiazole, sulfamethazine, sulfamonomethoxine, oxytetracycline, oxolinic acid, chloramphenicol, amoxycillin, furazolidone, nitrofurazone, and virginiamycin. Two or more dosage levels of each drug were administered intramuscularly and orally to each experimental prawn and mixed through two different types of diet, pelleted-diet and fish-flesh diet and fed to the prawn for 5 consecutive days. The total of 120 field experiments were accomplished.

Results obtained from 120 experiments indicated that the uptake, excretion and accumulation of drugs

under studied are affected by drug concentrations, dosage levels, routes of administration, types of feed and feed component as well. Differences in pharmacokinetic behaviors following different routes of administration and dosage levels were observed with respect to Kel, Kab, Vd (area) and compartment model in this prawn species. For medicated-feed application treatments, it was necessary to increase the drug levels in pelleted-diet in order to obtain tissue drug concentrations comparable to those obtained when medicated fish-flesh diet was fed. Medicated fish-flesh diets give a 2.4 times higher drug concentrations in tissue than do pelleted-diet.

A magnitude of possible factors such as pH and concentrations of drug solution, drug formulation, and volume of drug administered to each individual prawn, and in addition, different types of feed, feed components and feed formulations needed to be examined for further elucidate the differences. Estimation cannot, however, other experimental design and different environmental conditions. There are a considerable number of complicating factors which make the study of drug kinetics in crustaceans more difficult than in land animals. Therefore, no single kinetic study is subject to all of the questions needed to be solved in using drugs in aquatic species.

Keywords: Prawns; Shrimps; *Penaeus monodon*; Antiinfective agents; Drugs; Sulfamonomethoxine; Oxytetracycline; Oxolinic acid; Chloramphenicol; Sulfadiazine

613 Lila Ruangpan. 1995. **Studies on marine *Vibrio* isolated from cultured shrimp (*Penaeus monodon*) in Thailand.** Doctor thesis, Kagoshima, Japan. 132 p.

Studies on marine *Vibrio* isolated from cultured shrimp (*Penaeus monodon*) in Thailand were carried out systematically to understand their characteristics, taxonomic relationship among the species members and habitation. The studies also included the application of chemotherapy against vibriosis. Two hundred and five strains of *Vibrio* bacteria were isolated from moribund shrimp collected from several culture farms located in 7 provinces along the coastal area of Thailand. Among four identified and one unknown species, *Vibrio parahaemolyticus* was the dominant consistently involved in shrimp diseases, whereas *V. vulnificus* and *V. alginolyticus* were the second prevalent species. A numerical taxonomic study of 180 *Vibrio* strains isolated from black tiger shrimp and 15 type cultures of *Vibrio* species were carried out to confirm their identification. Based on weight average linkage clustering analysis and simple

matching coefficient, the calculation was made for 82 characteristic tests. At 80% similarity level, 135 strains were clustered into 15 distinct phenons and 96 strains of which were classified into 8 species including *V. alginolyticus*, *V. parahaemolyticus*, *V. vulnificus*, *V. harveyi*, *V. fluvialis* biovar I, *V. damsela*, *V. cholerae* non 01 and *V. fischeri*. The results of cluster analysis were supported by guanine and cytosine contents of DNAs measured in representative strains of each cluster. Distinguishable characters and relationships between clusters and species were also presented. In order to understand the relationship between the existing microflora and health condition of shrimp rearing in a grow-out pond, bacterial flora in the hepatopancreas, intestine and hemolymph of shrimp were investigated. A total of 150 samples of shrimps were collected at 30, 50, 70, 90 and 120 days intervals after releasing to the ponds. The bacterial counts grown on Thiosulfate Citrate Bile Salts Sucrose (TCBS) agar plate from the intestines and hepatopancreas fluctuated over 90 days, but were observed to increase by 120 days. While the bacterial counts grown on ZoBell's 2216e agar plates from these organs showed little variations. The bacterial counts from the hemolymph increased gradually throughout the experimental periods. *Pseudomonas* was found as the most favorable flora in the hepatopancreas and intestine of the healthy shrimp, but a certain number of *Vibrio* was also commonly found in all studied organs. A survey of aerobic and facultatively anaerobic bacterial flora in rearing water of shrimp ponds was carried out to evaluate the bacteriological parameter which may correlated to the bacterial infection and disease outbreak in farmed shrimp. The farm selected for study was comprised of 2 ponds with 30 tail/m² and another 2 ponds with 45 tail/m² in their densities. The total bacterial and *Vibrio* counts range respectively from 10³ to 10⁴ and 10² to 10³ CFU/mL in the ponds stocking with low density, whereas 10⁴ to 10⁵ and 10³ to 10⁴ CFU/mL were found in the ponds stocking with high density. *Pseudomonas* was found as the dominant composition of the bacterial flora throughout the rearing period. Based on 42 biochemical tests, the isolated *Vibrio* were identified as *V. damsela*, *V. alginolyticus*, *V. parahaemolyticus*, *V. harveyi*, *V. fluvialis*, *V. cholerae* non-01 and *Vibrio* spp. Other bacteria were classified to be *Aeromonas*, *Moraxella*, *Pseudomonas*, *Flavobacterium*, *Plesiomonas* and *Acinetobacter*. It is of importance to note from the results of this study that whenever the number of *Vibrio* and total bacteria in the water reached over 10⁴ and 10⁵ CFU/mL respectively and constant at these levels for 1-2 weeks, the shrimp mortalities would then occur. No correlation between the bacterial number and water quality was found. An attempt to control the vibriosis in shrimps was done on minimal inhibitory concentrations of 17 well-known antimicrobial agents against 205 isolates

of shrimp *Vibrio*. Flumequine was the most effective drug for controlling of vibriosis, while miloxacin, oxolinic acid and ciprofloxacin were less effective.

Keywords: Prawns; Shrimps; *Penaeus monodon*; *Vibrio*; *Vibrio parahaemolyticus*; *Vibrio vulnificus*; *Vibrio alginolyticus*; Bacteria; Black tiger shrimp.

614 Lila Ruangpan, Yaowanit Danayadol and Sataporn Direkbusarakom. 1997. **Bacteriophage implicated in mortality of cultivated *Penaeus monodon* exhibiting tea-brown gill syndrome (TBGS).** In สัมมนาวิชาการ “เทคโนโลยีชีวภาพกุ้ง” วันที่ 13 ธันวาคม 2540 ณ ห้องประชุม 101 อาคาร สวทช. กรุงเทพฯ จัดโดย ศูนย์พันธุวิศวกรรมและเทคโนโลยีชีวภาพแห่งชาติ สำนักงานพัฒนาวิทยาศาสตร์และเทคโนโลยีแห่งชาติ. p. 91-96.

In Southern Thailand in 1996, intense luminescence in many shrimp rearing ponds was accompanied by massive mortality resulting in total crop loss within 3 or 4 days. Mortality was correlated with gross signs which shrimp farmer called (English translation) “tea-brown gill syndrome” (TBGS). Histological examination of moribund shrimp revealed massive lesions of the hepatopancreas characterized by haemocytic infiltration and encapsulation of bacterial cells. Bacterial isolation yielded several strains tentatively identified as luminous *Vibrio* on the basis of luminescence and growth on BTB Teepol agar. Representative isolated VH1039 was selected and identified as *Vibrio harveyi*. When strain VH1039 and the other luminescent isolated were injected into normal shrimp (1×10^7 cells/shrimp), no significant mortality was observed in comparison with control shrimp injected with carrier solution. Nor was any significant mortality observed after injection of supernatants from normal or sonicated bacterial cultures of VH1039. Transmission electron microscopy (TEM) of hepatopancreatic tissue from farmed TBGS shrimp revealed bacterial cells of *Vibrio* morphology together with large numbers of bacteriophage particles that had icosahedral heads of approximately 60 nm diameter and tails of approximately 100 nm length. These were either free, attached to cell walls of intact bacteria or in various stages of replication within bacterial cells, gills of farmed TBGS shrimp were subsequently homogenized in lobster haemolymph buffer (LHB) and membrane filtered (0.22 μ m). Compared to control shrimp injected with LHB, shrimp injected with the 1,000 times diluted gill filtrate (DGF), showed no significant mortality. However, when DGF was injected together with 1×10^7 cells of

strain VH1039, there was total mortality within 48 hr. High and rapid mortality, concurrent with brown gills was seen only in the mixed injection group. TEM of the artificially infected shrimp tissues did show the presence of bacterial cells, but no mature bacteriophage particles and lysed bacterial cells were found similar to those seen in farmed TBGS shrimp. In further tests, addition of DGF to cultures of VH1039 induced extreme but transitory toxicity of culter filtrates from 24 to 36 hr. Threatment of DGF with a germicidal lamp (UV) for 30 min or with heat at 100 °C for 15 min failed to stop shrimp mortality from mixed DGF/1039 injections. However, mortality was stopped if the DGF was treated with Dnase. Together, the results suggested that a bacteriophage may sometimes mediate the toxicity of *V. harveyi* in *P. monodon* by the transfer of a toxin gene(s) or a gene(s) controlling toxin production.

Keywords: Mortality; *Penaeus monodon*; Tea Brown Gill Syndrome: TBGS

615 Jirasak Tangtrongpiros, Somkiat Piyatratitivorakul, Rabin Rattanaphanee, Nikom Chaisiri, Vara Panichkriengkrai, Sumolya Kanchanapangka, Supatra Srichairat, Nantarika Chansue, Achara Tawatsin, Weena Koeypudsa, Panumas Ruantongdee and Sompop Rungsupa. 1998. **Effects of methyl parathion on shellfish culture important of the economy of Thailand.** In Shrimp Biotechnology in Thailand. (BIOTEC Publication 2/1997). p. 229-224.

The acute effect of methyl parathion (MPT) was studied by static exposure of juvenile *Penaeus monodon* to concentrations of 0, 1, 2 and 3 ppb. for 96 hours. The hemolymph, hepatopancreas, nerve tract, muscle and gills were collected for biochemical, enzymatic, histopathological, immunological, microbiological and ultrastructural studies. The amount of serum protein appeared to vary with MPT concentration. At least 15 bands of protein were observed, and two of these were of high molecular weight. The acetylcholinesterase activity in muscle and nerve tissues was significantly inhibited by MPT. Inflammatory responses in gill, muscle and hepatopancreatic tissue were observed in MPT exposed shrimp. We also found that the SGOT and creatinine levels were significantly different for the test and control groups. Chemotactic and phagocytic activity of haemocytes showed significant reduction after exposure to high MPT concentrations. Phagocytic activity was not observed in ultrastructural examinations but hepatopancreatic cells were altered in an MPT dose related manner. The results from our studies suggest that water should be monitored for insecticides before it is pumped into shrimp aquaculture units.

Keywords: Prawns; Shrimps; *Penaeus monodon*; Methyl parathion; Shellfish; Chemicals

616 Jiraporn Kasornchandra and Sitdhi Boonyaratpalin. 1997. **Electron microscopic observations on the replication of yellow-head baculovirus in the lymphoid organ of *Penaeus monodon***. In Shrimp Biotechnology in Thailand (BIOTEC Publication 2/1997). p. 103-109.

The replication process of the yellow-head baculovirus (YBV) was studied in the lymphoid organ of the black tiger shrimp, *Penaeus monodon*. Ultrastructural observations at various time sequences suggested that viral replication occurred in the nucleus and was followed by assembly in the cytoplasm. At 32 h post injection, cytoplasmic replication took place and cytoplasm became the major site for viral replication. Among the single enveloped virions in the cytoplasm, two nucleocapsids per enveloped were observed.

Keywords: Prawns; Shrimps; *Penaeus monodon*; Electron Microscopy; Replication; YHV; Yellow Head Virus; Lymphoid Organ; Viruses

617 Juadee Pongmaneerat, Jiraporn Kasornchandra, Sitdhi Boonyaratpalin and Mali Boonyaratpalin. 1997. **Effect of dietary shrimp head meal infected with systemic ectodermal and mesodermal baculovirus (SEMBV) on SEMBV infection in black tiger shrimp (*Penaeus monodon*)**. In สัมมนาวิชาการ “เทคโนโลยีชีวภาพกุ้ง” วันที่ 13 ธันวาคม 2540 ณ ห้องประชุม 101 อาคารสวทช. กรุงเทพฯ จัดโดย ศูนย์พันธุวิศวกรรมและเทคโนโลยีชีวภาพแห่งชาติ สำนักงานพัฒนาวิทยาศาสตร์และเทคโนโลยีแห่งชาติ. p. 83-90.

The effects of supplementary SEMBV – infected shrimp head meal (SEM-SHM) in the diet on SEMBV infection in *Penaeus monodon* investigated. The initial shrimp were tested for the SEMBV-free condition using polymerase chain reactions (PCR). In expt. I, fifteen shrimp with the mean body weight of 18.2 g were fed to satiation with each of four diets for 8 weeks. Diet 1 was the control diet containing no SEM-SHM; diets 2-4 contained wet-cooked SEM-SHM (autoclaved at 115 °C 15 min), dry-cooked SEM-SHM (oven-dried at 90 °C 1 h) and commercial SHM at level of 10% in the diets, respectively. In expt. II, five diets were used, diet 1 as the control diet without SEM-SHM; diets 2-5 contained steamed SEM-SHM (100 °C 15 min), oven-dried SEM-SHM (60 °C 8 h), raw fresh SEM-SHM and freeze-dried SEM-SHM at 10% in each diet, respectively. Shrimp, weighing 10.8 g, were fed each diet for 6 weeks to satiation. In both expt. I and II, the

hemolymph samples from each shrimp were taken after every 2-week feeding interval and the pooled samples of five shrimps were determined in triplicate for SEMBV infection using PCR assay. In both Expt. I and II, PCR products from hemolymph samples showed the negative results for all dietary treatment. There were no SEMBV specific bands on agarose gels was obtained after 8 and 6 weeks of feeding periods in expt. I and II, respectively. These results suggested that using commercial SHM and SEM-SHM in diets had no adverse effects on SEMBV infection in *P. monodon*.

Keywords: Shrimp head meal; Systemic Ectodermal and Mesodermal Baculovirus; SEMBV; Black tiger shrimp; *Penaeus monodon*

618 Panan Kanchanaphum, Vichai Boonsaeng, Sakol Ponyim, Chainarong Wongteerasupaya, Anchalee Tassanakajon, Boonsirm Withyachum narnkul and T.W. Flegel. 1997. **Experimental transmission of white-spot baculovirus (WSBV) from crabs to shrimp (*Penaeus monodon*)**. In สัมมนาวิชาการ “เทคโนโลยีชีวภาพกุ้ง” วันที่ 13 ธันวาคม 2540 ณ ห้องประชุม 101 อาคารสวทช. กรุงเทพฯ จัดโดย ศูนย์พันธุวิศวกรรมและเทคโนโลยีชีวภาพแห่งชาติ สำนักงานพัฒนาวิทยาศาสตร์และเทคโนโลยีแห่งชาติ. p. 62-72.

White-spot baculovirus (WSBV) of the black tiger prawn, *Penaeus monodon*, is a recently discovered baculovirus disease which currently the cause of very serious and wide spread losses in the shrimp industry in Thailand and in Asia. Crustaceans suspected as carriers of this virus were investigated, since they may bring the virus into shrimp farms and cause fatal infections in reared shrimp. Three crab species commonly found in shrimp rearing areas of Thailand were studied. These were *Sesarma* sp., *Scyllaea serrata* and *Uca pugilator*. All were found able to transfer the disease to *P. monodon* via water while physically separated in aquarium cohabitation tests. The crabs were infected with WSBV by injection and their infection was confirmed by normal histology, specific *in situ* DNA hybridization and PCR amplification. Transfer of the virus to the shrimp was monitored using the same techniques at 12 hour intervals after cohabitation began. With *Uca pugilator*, WSBV could be detected in the shrimp cohabitants by 24 hr using PCR amplification and by 60 hr using *in situ* hybridization or H&E staining with *Scyllaea serrata*, the shrimp were positive for WSBV by 36 hr using PCR and by 60 hr using DNA *in situ* hybridization or H&E staining, with *Sesarma* spp. they were positive by 48 hr using PCR and 72 hr using *in situ* hybridization or H&E staining. These laboratory studies demonstrated that crab carries of WSBV may pose a real threat to cultivated shrimp. However, the studies were carried out in containers of

small volume and with relatively clean sea water when compared to shrimp cultivation ponds. Pond-based studies are now needed to determine whether factors such as pond volume, pond water quality and shrimp and crab behaviour can influence the rate and success of transfer.

Keywords: White Spot Baculovirus; WSBV; Crabs; *Penaeus monodon*; Shrimps

619 กนกอร อินทราพิเชฐ และ สมเกียรติ เอี่ยมเหล็ก. 2535. การใช้สารฆ่าเชื้อเพื่อผลิตกุ้งแห้ง. รายงานการวิจัย การวิจัยโครงการนันทศึกษา ภาควิชาอุตสาหกรรมเกษตร คณะทรัพยากรธรรมชาติ. มหาวิทยาลัยสงขลานครินทร์. 77 น.

Dried shrimp was produced by the use of 3 different sanitizing agents; 1 and 4% solution of acetic and lactic acid and 100 and 250 ppm of sodium hypochlorite. Cooked shrimp was soaked 1 and 5 min, dried and stored for 21 days. Moisture, microbial contents and sensory aspect were investigated. Moisture contents of all treatments were in the range of 16-25% and were increased as storage time increased. Microbial contents of treated dried shrimps were lower than those of control products and were lower at higher concentration of the sanitizing agents and longer soaking. Sodium hypochlorite with 250 ppm and 5 min soaking was found the most to reduce bacterial contents for 93% from initial load of 1.44×10^7 colony/gram down to 9.95×10^5 colony/gram. Acetic acid with 4% and 5 min soaking was the least to reduce bacterial load for only 57% with initial load of 1.17×10^6 colony/gram down to 5.05×10^5 colony/gram. Molds were found very small numbers or none on dried shrimps. There was slightly different in sensory quality of all products and controls. All treated products and controls were accepted by panelists for all storage period.

Keywords: Dried products; Dried shrimp; Dried prawn; Sensory evaluation

620 Krissana Sophonphong. 1995. **Sensory assessment of frozen prawn.** Thai Fisheries Gazette. 48(6): 495-509.

Black Tiger Prawn (*Penaeus monodon*) were allowed to deteriorate at room temperature for 0, 6, 9, 12, 16, 20, 27, 32 and 43 hours and further processed into frozen products. The panellists comprising 2 sensory experts from U.S.A. and Canada and 31 quality controllers from Thai fish processing plants rejected the product held at ambient for 43 hours though its indole content was as low as 5.6 ug/100 g. However, the panellists still accepted the sample of the same storage period

when processed into frozen cooked products. Black Tiger Prawn were iced for 0, 1, 3, 4, 6, 8 and 10 days. The panellists failed the products when the raw materials were held on ice from 8 days onwards. Such sample contained 1.7 ug/100 g indole. The indole content increased significantly by 100 times within 2 days of storage (day 8 to day 10). Banana Prawn (*Penaeus merguensis*) were stored at ambient for 0, 3, 9, 12, 15, 17 and 18.5 hours. The 2 experts rejected the frozen prawn starting from 15 hours of storage while the majority of the Thai quality controllers still borderline passed the 15-hours-stored. This sample contained 14.1 ug/100 g indole. Banana shrimp were also iced for 0, 2, 4, 6 and 8 days. The panellists failed the shrimp held on ice for 8 days containing 10.5 ug/100 g indole. Linear regression analysis showed a significant correlation between sensory scores and indole contents in every sample excepted Banana Prawn stored on ice.

Keywords: *Penaeus monodon*; *Penaeus merguensis*; Frozen shrimps; Frozen prawns; Sensory evaluation

621 Krissana Sophonphong. 1997. **Sensory evaluation of canned shrimp.** Thai Fisheries Gazette. 50(6): 458-464.

Canned shrimp samples were processed from cooked and peeled sand shrimp (*Metapenaeopsis spp.*) stored in ice for 0 to 4 days. Sensory evaluation of the samples performed by trained 13 assessors revealed that day - 0 and day - 1 samples were borderline acceptable whilst day - 2 to day - 4 samples were of reject quality. The sample of initial quality contained 6.3 ug/100g indole. Indole contents of all samples increased dramatically with storage time. The samples processed from raw material stored in ice for 1, 2, 3 และ 4 days contained the indole contents of 10.7, 12.9, 13.0 and 61.0 ug/100g respectively. The chemical index was found highly significantly ($P < 0.01$) correlated with the sensory scores. The linear correlation coefficient between sensory scores and indole contents was 0.98. Nevertheless, the indole contents of reject samples were far below the Defect Action Level of 25 ug/100g and 30 ug/100g established by US Food and Drug Administration (USFDA) and Canadian Department of Fisheries and Oceans (DFO) respectively.

Keywords: *Metapenaeopsis*; Canned shrimp; Canned prawn; Sensory evaluation; Quality

622 กัณหา กระฉะ และ สืบศักดิ์ กลิ่นสอน. 2543. การใช้ประโยชน์โคตินในการปรับปรุงคุณภาพขนมปิ้ง. ภาควิชาวิทยาศาสตร์การอาหารและโภชนาการ คณะวิทยาศาสตร์และ

เทคโนโลยี. มหาวิทยาลัยสงขลานครินทร์ วิทยาเขตปัตตานี. 43 น.

Utilization of chitin in improvement of bread quality was studied. A method used to prepare chitin that provides a suitable protein content for bread making was investigated. This work evaluates the suitable microcrystalline chitin adding step in bread making process, by using microcrystalline chitin 2% by weight. Suitable step was studied for evaluation the effect of microcrystalline chitin 0.5%, 1.0%, 1.5%, 2.0%, 2.5% and 3.0% base on flour weight on bread quality. Furthermore effect of microcrystalline chitin on shelf life of bread was studied. The results found that the chitin which was prepared by deproteinization with 1% sodium hydroxide solution, the ratio of demineralized shell to basic solution was 1:10 (g.ml⁻¹), at 55 °C for 2 hours. Chitin with 9.63% protein content in microcrystalline form provided a maximum loaf volume and had more volume than non-microcrystalline chitin bread significantly ($P>0.05$) and got maximum texture acceptability at different significantly ($P>0.05$) with both unmixed and mixed lower level microcrystalline chitin bread. In bread making processes were compared step of microcrystalline chitin adding between straight dough and sponge dough methods, there found that loaf volume of bread in both two had no significantly difference ($P>0.05$). The experiments of using different volume of microcrystalline chitin of using different volume of microcrystalline chitin adding in bread had the result that microcrystalline chitin 1.5 % base on flour weigh got maximum specific loaf volume. Adding microcrystalline chitin in volume 0.5 %, 1.0 % 1.5 % and 2.0 % base on flour weight had no different significantly ($P>0.05$) in acceptable score of loaf colour, loaf appearance and bread inside appearance. About the effect of adding microcrystalline chitin on shelf life of bread, the result found that no microcrystalline chitin adding bread had higher fungi and A_w (water activity) value than microcrystalline chitin adding bread when bread were stored for 7 days. Moisture content of no microcrystalline chitin adding in bread, store in room and cool temperature had rate of moisture increasing and moisture content more than added microcrystalline chitin bread.

Keywords: Chitin; Bread; Shrimp shell; Prawn shells; Sensory evaluation; Quality

623 Jarin Sawangjang. 2001. **Development of shrimp flavor semi-processed soup from shrimp heads.** Master Thesis. Kasetsart University. 77 p.

The shrimp flavor powder was prepared by hydrolysing shrimp heads with 1.5% bromelain and 1% Flavourzyme[®] at pH 6, and at 60 °C for 2 hours. Maltodextrin was used as a binder for flavor at 30% (w/w) of hydrolysate. The concentration of the hydrolysate mixture was 30 °Brix. The hydrolysate mixture was spray-dried to get shrimp flavor powder for using in semi-processed shrimp flavor soup. The highest sensory evaluation scores were obtained from the shrimp flavor soup prepared with 20% shrimp flavor powder, 26% salt, 21% palm oil, 11% minced dried shrimp, 2% dried onion powder, 15% MSG and 5% soy protein. Proximate composition of the shrimp flavor soup was 23.86% protein, 21.30 % fat, 20.04% carbohydrate, 2.5% moisture and 32.30% ash. Free and total amino acid contents in the prepared shrimp flavor extract were 72.9 and 103.2 mg/100 g, respectively. The major free amino acids found were arginine, aspartic acid, glutamic acid and glycine. No pathogenic microorganism was found. The quality of shrimp flavor soup was according to the standard of the Thailand Industrial Standard Institute for precooked or dehydrated soups.

Keywords: *Penaeus monodon*; Shrimp head; Prawn head; Semi processed soup; Shrimp flavor powder; Minced dried shrimp;

624 Chanpen Sripumma. 2000. **Chemical compositions of tiger shrimp (*Penaeus monodon*) with an emphasis on the analysis of lipids and omega-3 fatty acids.** Master Thesis. Silpakorn University. 79 p.

The analysis of selected elements in the external organs of black tiger shrimp (*Penaeus monodon*) by the technique of Electron Microscopy and X-Ray Microanalysis found that six organs, namely, rostrum, antenna, antenna scale, carapace, telson and uropod all contained Ca as the most prominent element. Those organs also contained P, Al, Mg, Cl, Si, K, Na and S at varying amounts but significantly lower than Ca in all cases. Antenna which performed unique function for shrimps did not show Na as a component.

Fatty acid analysis using capillary GC revealed that both male and female shrimps from grow-out ponds contained lower levels of 20:4n-6 fatty acids than shrimps from wild habitats. The figures of 20:4n-6 in flesh and hepatopancreas were 22.58±7.56 and 493.57 ±187.17 vs 31.30±17.09 and 781.39±500.89 mg fatty acid/100 g tissue, respectively. The analysis of ω-3 fatty acids focusing on EPA-DHA found that shrimps from grow-out ponds contained, in their flesh, higher levels of EPA-DHA than shrimp from wild habitats. The values for flesh from male shrimps were 45.52 ±15.66-55.28±21.58 and 19.76±3.21-18.85±4.26 mg fatty acid/100g tissue, respectively. This difference was also evident in the

hepatopancreas where the values were 248.03 ± 157.15 - 1221.80 ± 1500.37 vs 357.20 ± 148.80 - 148.69 ± 133.25 mg fatty acid/100g tissue. Those differences could be explained by the nature of feeds available to those two groups of shrimp.

The analysis of overall fatty acid contents in flesh and hepatopancreas of shrimps raised in a grow-out pond for 74, 84, 94, 104 and 114 days showed that the levels of total fatty acids decreased with time of growth. The analysis of fatty acids in other animals also showed that sea animals contained lower levels of saturated fatty acids than a fresh water animal and coconut beetle larvae, respectively. In the case of 16:0, for example, the flesh of male tiger shrimp, mackerel, catfish and coconut beetle larvae contained this fatty acid at the levels of 89.03 ± 33.87 , 166.81 ± 73.04 , 383.01 ± 91.52 and $2,899.03 \pm 745.25$ mg/100 g tissue, respectively. The analysis of unsaturated fatty acids focusing on EPA/DHA indicated that sea animals contained higher levels of these two fatty acids than the fresh water catfish while coconut beetle larvae did not contain EPA and DHA at all.

Keywords: Omega 3; Fatty acids; Chemical compositions; Tiger shrimp; *Penaeus monodon*; Shrimp shell; Prawn shells; Hepatopancreas

625 Jaruwan Apimonraksa. 1994. **Effect of microwave heating on *Staphylococcus aureus* in frozen shrimp.** Master Thesis. Kasetsart University. 56 p.

Heating was one of effective methods for controlling the number of contaminated bacteria in foods and microwave oven is a popular heating equipment. This study focused on the effects of microwave oven on *Staphylococcus aureus*, the enterotoxin-producing normally contaminated, in frozen shrimps. At temperature of frozen food (-20°C), the number of cultures was slightly reduced during the very first weeks of incubation. After incubation period of 8 weeks the number was still high. Contaminated pathogenic bacteria in frozen foods may be hazardous to consumer health. When treated the *S. aureus* culture in liquid media with variable level of heat from microwave oven, the high level was found to be the most effective in reducing the number of *S. aureus* followed by the low level and the medium level respectively. The culture in frozen shrimp was tested as well. With 3 levels of heat, applied to frozen shrimp of either stage of cook, the number of the treated culture remained almost the same as the original number inoculated. The low level was found to be the most effective of all. The cultures in liquid media are more destroyed than in frozen shrimp because heat

convection in liquid is better than in solid. However, a large number of *S. aureus* was detected after sample was cooked. It indicated that food cooked with microwave was not safe from microorganism. Considering to food safety, the consumer should aware of raw material sanitation.

Keywords: Frozen shrimps; Frozen prawns; Microwave; *Staphylococcus aureus*; Contamination; Bacteria

626 Jiraporn Runglerdkriangkrai. 1988. **Survey of the handling of dried shrimp for exportation.** In Annual Report 1987-1988 Fishery Technical Development. Department of Fisheries. p.89-100.

The lack of sanitation control in the traditional dried shrimp process caused some microbial problem at terminal countries. The survey on handling and problems occurred during transportation of dried shrimp for exportation was carried out and printed in this report. At the present time, dried shrimp is exported in frozen stage to control microbial growth but the problems of filth, insect and dust are still existed. Therefore, quality control of the process, appropriate storage condition and transportation should be exercised. The researches on different processes and storage conditions of dried shrimp should be conducted.

Keywords: Dried shrimp; Dried prawn; Exports; Transportation; Quality

627 Jirawan Yamprayoon, Amornrat Sukso and Khorakot Sunpeth. 1996. **Production of snack foods supplemented with protein from dried tiger prawn head by extruder.** Technical Paper No.8/1996. Fishery Technological Development Institute. Department of Fisheries. 37 p.

The studies was conducted on the production of snack foods supplemented with protein from dried tiger prawn head. Two sets of composite flour were studied, there were glutanous rice, rice, mung bean, and corn, in the ratio 3:2:4:1 and the mixture of rice and corn in the ratio 3:1. The flour mixture was mixed with dried tiger prawn head which prepared by drying them at 80°C for 9 hrs. The dried tiger prawn head was ground and mixed with the composite flour 3, 6, 9, 12, 15 18 and 21 % respectively. Single screw extruder was operated for production with the extrusion temperature about 155 - 162°C . The physical and chemical properties of the products were determined namely expansion ratio, bulk density, water absorption, protein, fat, ash, moisture, fiber and water activity. Appearance, color and texture of products were also determined for sensory evaluation.

It was found that, dried tiger prawn head had corrected protein efficiency ratio, net protein

utilization, biological value and digestibility about 70-80% of standard protein food (caesine). The flour mixture from rice and corn provided the extrudates more crispy texture than the mixture of glutinous rice, rice, mung bean and corn. Moreover, the color of products were darker and expansion ratio decreased when increased the quantity of dried tiger prawn head. The product from composite flour mixed with dried tiger prawn 18% has less expansion ratio (1.89) than control (3.64) and the products were not accepted by panelists due to bitter taste and dark color. But the extrudates from composite flour mixed with 15% dried tiger prawn head had accepted in term of color, appearance, texture, and expansion ratio (2.39). Then extrudates were coated with chocolate, honey and strawberry flavors and packed in polyethylene bags for shelf life study. All flavors were not significant difference in acceptability during storage for one month. And the moisture, protein, fat, ash, fiber, carbohydrate and water activity in the products are 5.5%, 14.5%, 0.32%, 3.3%, 0.57%, 76.38% and 0.4% respectively. Protein in the products increased 6% when compared with control and the products from the market which have protein content about 3-8%. All extrudates had the same level of bulk density 0.5 gm/cm³.

Keywords: Shrimp head; Prawn head; Snack foods; Extruder; Production; Supplement; Proteins; Sensory evaluation

628 Chaowaneepon Boonchuay. 1996. **Factors affecting chitinase synthesis in *Aeromonas* sp. CS-34 and the characterization of the purified enzyme.** Master Thesis. Prince of Songkla University. 126 p.

Chitinase (EC 3.2.1.14) is an enzyme which plays an important role in hydrolyzing β -(1,4)-linkage of chitin into oligomers, mainly dimers, of N-acetylglucosamine (GlcNAc). A strain of bacteria, *Aeromonas* sp. CS-34, isolate from prawn-pond sediment at the moulting period showed high production of extracellular chitinase after grown in minimal medium containing chitin as a carbon source. Inaction of chitinase synthesis by powder chitin was better than that of colloidal chitin. The highest chitinase activity was detected when the bacteria was grown in medium with 1% powder chitin. The supernatant of cell culture (crude enzyme) was stable at temperature 4 or -20 °C for more than 20 days. The chitinase enzyme from *Aeromonas* sp. CS-34 was purified by ion-exchange chromatography (DEAE-Sephacel) and gel filtration (Sephadex G-100, G-200) techniques. The purified enzyme showed a single band on SDS-PAGE with molecular weight of 37,154 Da.

The optimum pH and temperature were 7.0 and 50 °C, respectively. This enzyme was stable at pH range between 5.0-8.0 and temperature up to 40 °C. Its K_m and V_{max} were 1.66 mg/ml and 0.56 μ mol/min, respectively.

Keywords: Enzymes; Chitinase; Chitin; Shrimp shell; Prawn shells; Bacteria; *Aeromonas*

629 Tritawan Kongkeaw. 1999. **Protein hydrolysate and crude oil from black tiger prawn head.** Master Thesis. Prince of Songkla University. 159 p.

Protein hydrolysate was produced from black tiger prawn head, by-product from prawn processing plant. Enzymatic hydrolysis of black tiger prawn head protein was studied using various proteinases, including alcalase, neutrase, and papain. Prawn heads were ground and defatted using isopropanol with the solid to solvent ratio of 1:3 (w/v) at 50 °C for 30 min. The optimum conditions for hydrolysis by alcalase, neutrase, and papain were 60 °C pH 9.5, 50 °C pH 7.0, and 35 °C pH 6.5, respectively. Enzyme concentration and reaction time affected the hydrolysis of prawn head protein. Hydrolysis products expressed as α -amino acid increased when higher enzyme concentrations were used. Alcalase showed a higher proteolytic activity towards prawn head protein when compared to neutrase and papain. Degree of hydrolysis directly affected yields, nitrogen recovery and functional properties of freeze-dried hydrolysate. At degree of hydrolysis (DH) of 35, 50, and 65%, The yields of 2.54 - 5.72, 3.75 - 10.14, and 5.81-11.25% were obtained, respectively. Protein hydrolysate contained 87.51 - 92.15% protein and less than 0.3 % fat. The major amino acids in hydrolysate prepared by using alcalase at 65% DH were glutamic acid, aspartic acid and glycine. Solubility of the hydrolysate with 65% DH prepared by all enzymes was higher than 80% over the pH range of 7-9, The hydrolysate prepared by using neutrase with DH of 35% showed the highest emulsion activity and emulsion stability. However, most of protein hydrolysates had poor foaming properties.

Storage stability of hydrolysate with 65% DH was investigated at room temperature (27-30 °C), 4°C, and -20 °C. It was found that moisture, color, non-enzymatic browning and TBARS slightly increased when kept at room temperature, whereas no change was observed at 4 °C and -20 °C

Crude oil from black tiger prawn head contained 46.09 % phospholipid and 53.99 % triglyceride. The oil had iodine value of 101.79 g.iodine/100 g.oil with peroxide value of 22.86 meq/kg.oil and carotenoid content of 40.46 mg.astaxanthin/ 100g.oil. Crude oil consisted of 39.4 % saturated fatty acids and 55.7 % unsaturated fatty acids. The major fatty acids in crude

prawn oil were palmitic acid (25.1 %), DHA (21.9 %) and EPA (4.1 %)

The stability evaluated by accelerated oxidation test was studied in prawn head oil in presence and absence of antioxidants. TBHQ and ethoxyquin were shown to be the effective antioxidants in prawn head oil.

Keywords: Shrimp head; Prawn head; Protein hydrolysate; Enzymatic hydrolysis; Crude oil; Black tiger shrimp; *Penaeus monodon*; Storage

630 Thawien Bourtoom. 1997. **Factors affecting metal binding capacity of chitin and chitosan.** Master Thesis. Prince of Songkla University. 90 p.

The binding capacity of the natural marine polymer chitin and its deacetylated derivatives chitosan from Black Tiger shrimp shell (*Penaeus monodon*) with chromium (Cr^{3+}) and lead (Pb^{2+}) has been investigated. Metal binding of chitin and chitosan was affected by pH, particle size, metal solution concentration and contact time, ratio of chitin and chitosan to metal solution and degree of deacetylation of chitosan. Increases in pH, metal solution concentration and contact time resulted in the increase of binding capacity of both chitin and chitosan. The larger particle size and higher ratio between chitin and chitosan to metal solution trend to give lower binding capacity.

Metal binding capacities of chitin and chitosan were affected by pH showing the maximum binding at pH 9. A higher metal solution concentration and longer contact time seemed to show higher binding capacity of chitin. The binding capacity of chitin and chitosan were decreased, however, when the larger particle size and ratio of chitin and chitosan to metal solution were increased. Chitosan with higher degree of deacetylation expected to result in more binding capacity, but in this study it showed non significantly increase ($P>0.05$).

Chromium and lead removing capacity from the prepared solution using single and double columns of chitin and chitosan were studied. The effect of flow rate on metal removing capacity of chitin and chitosan showed that when flow rate was increased from 800 to 1000 and 1200 mL/h., the metal removing capacity of chitin and chitosan were decreased, probably due to the shorter contact time of the higher flow rate.

The most efficiency in chromium and lead removing by both chitin and chitosan were observed when using single and double column at flow rate of 800 mL/h. Chromium and lead could be removed about 39 and 45% when single column of chitin was used and about 64 and 70% when single column of chitosan was used. The similar results occurred when double columns were used,

showing that chromium and lead could be removed at about 55 and 90% when double column of chitin was used whereas double column of chitosan could remove those two metals at about 82 and 92%, respectively.

The experiment on the removal of chromium and lead in the effluent from tuna canning factory showed the similar results as the prepared metal solution. However, there were decreases in removing capacity due to the contamination of other compounds i.e., organic matter, suspended solid and other ions such as magnesium and calcium in the effluent from the factory. The treated effluent after passing through single column of chitin and chitosan contained lower COD, total solid and turbidity than initial values, which were reduced about 31, 27 and 77% and 39, 30 and 73% for chitin and chitosan, respectively. The same results were observed when double columns were used. COD, total solid and turbidity were reduced about 44, 37 and 84% and about 56, 46 and 84% when double column of chitin and chitosan were used, respectively.

Keywords: Chitin; Chitosan; Shrimp shell; Prawn shells; *Penaeus monodon*; Metal binding capacity; Chromium; Lead; Polymers; *Penaeus monodon*

631 Nopparat Mahae. 1997. **Biodegradable film from chitosan: influence of processing variables on properties of film and application.** Master Thesis. Prince Songkla University. 119 p.

The influence of processing variables on the properties of chitosan and composite films were studied. For chitosan film, as chitosan concentration increased, the thickness, surface density and tensile strength were increased. The water vapor permeability (WVP) increased with an increasing of chitosan concentration up to 1 %, beyond that there was little change in WVP ($P>0.05$). Composite films between cellulose derivatives (methyl cellulose, MC and hydroxypropyl methylcellulose, HPMC) and chitosan showed the maximum tensile strength of 3.05 kN/m. for MC-composite film and 2.79 kN/m. for HPMC-composite film at 10 % cellulose derivative. HPMC composite film showed more flexibility than MC composite film.

Three different films were selected i.e. 1% chitosan film, 20 % MC-composite film and 20 % HPMC-composite film for improving the properties by adding plasticizer and fatty acid. The results showed that glycerol plasticized film exhibited higher extension at break and WVP, lower tensile strength than sorbitol plasticized film. Then addition of glycerol at 60% concentration was selected for further study. Addition of lauric acid showed better water barrier property than stearic acid. However, film added the mixture of these fatty acids exhibited higher water barrier property than stearic acid alone.

So mixed fatty acid with the concentration of 45 % was selected for further study.

Comparison between the produced film, chitosan and composite films with synthetic film, PVC showed that the produced film had higher tensile strength and water vapor permeability and lower extension at break than PVC film. Biodegradability of different films were different. The biodegradability of composite film added fatty acid was faster than chitosan film added fatty acid. After burying in soil for 35 days, weight loss of the produced films were about 90 %, while weight loss of PVC film was only about 17%. Glycerol plasticized film could be degraded completely when exposed to soil for 35 days (except chitosan film).

The application of chitosan and composite film as glazing on frozen fish fillet was investigated. After 60 days of frozen storage at -18 °C, there were little changes in chemical qualities of fish fillet. Also, there were very little and no significant changes in sensory evaluation, except color. After 50 days of frozen storage, uncoated sample appeared darker color than coated sample.

Keywords: Chitosan; Film; Quality; Sensory evaluation; Fatty acid; Storage; Coating

632 นิตยา พันธุ์บัว และ อรุณี ศรพรหม. การปนเปื้อนของเชื้อ *Vibrio parahaemolyticus* ในอาหารแช่แข็งเพื่อการส่งออก. วารสารเกษตรพระจอมเกล้า. 13(1): 19-26.

This study was to investigate the contamination of *V. parahaemolyticus* in frozen foods for export. The 630 samples of frozen foods were analyzed and found that 14.13% of frozen foods were contaminated with *V. parahaemolyticus*. The samples were classified into 4 kinds ; frozen raw shrimp, frozen cooked shrimp, frozen fish, and frozen value added food which were contaminated with *V. parahaemolyticus* 41.05%, 1.64%, 6.26%, and 15.58% of each kind of products respectively. The investigation of 76 samples of raw materials; showed that *V. parahaemolyticus* were detected at 86.54% and 33.33% in shrimp and fish respectively. Therefore the producers of frozen foods for export should determine the quality of raw materials and improve the procedures of production by using HACCP for eliminating and/or reducing the *V. parahaemolyticus* in order to reach the standard and quality regulations of each import country.

Keywords: Frozen shrimps; Frozen prawns; *Vibrio*; *parahaemolyticus*; Contamination; Exports

633 Niracha Wongchinda. 1997. **Effects of irradiation on *Escherichia coli* O157:H7 of peeled and cooked frozen shrimp.** Technical

Paper No.3/1997. Fishery Technological Development Institute. Department of Fisheries. 9 p.

Peeled and cooked frozen shrimp imported from Thailand were inoculated with a five-strain mixture of *Escherichia coli* O157:H7 and frozen. the cotamination levels of *E. coli* O157:H7 were 1.7 and 2.747 log CFU/g The frozen samples(-20 °C) were exposed to irradiation treatment by using electron beam accelerator with doses 0, 1, 2 and 3 kGy. The irradiated sample was investigated for *E. coli* O157:H7

Survivors (<10 CFU/g) were not detected in samples exposed to 2 and 3 kGy of irradiation at the level of contamination at 2.747 log CFU/g. In one of three replicate of contamination at 2.747 log CFU/g, 10 CFU/g was found in sample that were irradiated at 1 kGy. However, no survivors (<10 CFU/g) were found in samples exposed to 1,2 and 3 kGy at the level of contamination at 1.7 log CFU/g. Irradiation at dose 2-3 kGy could controlled this pathogen. Therefore, irradiation is one of the effective methods to control *E. coli* O157:H.

Keywords: Frozen shrimps; Frozen prawns; Irradiation; *Escherichia coli*

634 Niracha Wongchinda, Tidaporn Nitiphaichit and Somchai Rungjirathananon. 1996. **Comparison of standard conventional method, MSRV method and ELISA for the detection of *Salmonella* in frozen shrimp.** In Proceeding the Seminar on Fisheries 1996 Department of Fisheries, 18-20 September 1996. Anon Meeting Hall. National Inland Fisheries Institute, Bang Khen. p.688-700.

Relative performance of three *Salmonella* detection methods viz. the Standard Conventional Method (SCM), Modified Semi-solid Rappaport Vassiliadis (MSRV) and Enzyme Linked Immuno-Sorbent Assay (ELISA) were investigated and compared. For SCM methods, two pre-enrichment medias namely lactose broth and buffer peptone water, two selective medias namely Tetrathionate Broth (TTB) and Selenite Cystine Broth (SC), and two incubation temperatures viz. 35 °C and 42 °C were evaluated.

The result from SCM method showed that the pre-enrichment media of lactose broth gave better yield recovery on *Salmonella* than the buffer peptone water. The selective enrichment media of tetrathionate broth at 42 °C incubation temperature was given better result than TTB at 35°C and SC at 35 °C. The MSRV method is needed 48 hours to detect the *Salmonella* on shrimp comparison to 96 hours for SCM. The method of ELISA gave the best results on percentage of recovery, sensitivity and specificity among the three methods. The total time

requirement on detection by ELISA was only 28 hours.

Keywords: Frozen shrimps; Frozen prawns; *Salmonella*; Standard; Conventional; MSRV; ELISA; SCM

635 Nitra Masswiwat. 2000. **Purification and characterization of chitinase and chitobiase from the black tiger prawn's (*Penaeus monodon*) hemolymph.** Master Thesis. Prince of Songkla University. 107 p.

Chitinolytic system involving the activity of at least 2 enzymes, namely chitinase (EC.3.2.1.14) and chitobiase (EC 3.2.1.30). The system plays an important role in hydrolysis of chitin, which is known to exist as a second most abundant natural polymer next to a cellulose and final product in N-acetylglucosamine (NAG).

Results from the studying in hemolymph of the black tiger prawn (*Penaeus monodon*) suggested that both chitinase and chitobiase distribute more in serum than in cellular fraction, which were 84 and 96%, respectively. The optimum pH and temperature on activities of former and latter enzymes were 5.0 and 5.5 and were 40 °C and 50 °C, respectively. Kinetic analysis for chitinase using chitin powder extracted from squid pen as a substrate revealed that K_m was 3.57 mg/ml and V_{max} was 3.13 U/ml/hr. Similar analysis for chitobiase using *p*-nitrophenyl N-acetylglucosaminide as a substrate showed that K_m was 11 mM and V_{max} 5 U/ml/min. It appeared at temperature below 4 °C that chitobiase was more stable than chitinase. The activities of chitobiase and chitinase were not significantly changed when they were kept at that temperature for 30 and 20 days respectively.

Partial purification of the enzymes from hemolymph of the prawn could be carried out by ultrafiltration (Centricon-30), Sephadex G-200 gel filtration and followed by ion-exchange chromatography. After the final process, purity of chitinase and chitobiase were 18.33 and 38.00 fold, while the percent recovery were 63.14 and 62.70 % respectively. Chromatographic profile from gel filtration and ultrafiltration suggested chitinase in hemolymph of prawn might be composed of 3 isozymes, which showed molecular weight of 199,000 50,000 and less than 30,000 daltons. However, a single isozyme of chitobiase were eluted at molecular weight 83,000 daltons.

Keywords: Enzymes; Chitin; Chitinase; Chitobiase; Chitinolytic system; Blood; Shrimp shell; Prawn shells; Hemolymph

636 Busakorn Palagul. 1993. **Efficiency of chlorine dioxide to reduce *Salmonella typhimurium* in shrimp before freezing process.** Master Thesis. Kasetsart University. 143 p.

The efficiency of ClO_2 in reduction of *S. typhimurium* in shrimps before freezing was studied. In pure culture of *S. typhimurium*, 0.1 ppm ClO_2 killed 5.9×10^3 CFU/ml in 300 s. and 0.3 ppm ClO_2 killed 3.2×10^5 CFU/ml in 420 s. at 10 °C. An increase in ClO_2 concentrations enhanced the bacteriocidal efficiency. The treatment most effective during the first 15 min. of washing. The temperatures, 5 and 10 °C, did not effect the bacteriocidal properties of the 5, 10 and 20 ppm ClO_2 solutions. Washing the shrimps that contained *S. typhimurium* 10^5 CFU/g and 10^3 CFU/g for 15 min. with 20 ppm ClO_2 reduced the microorganisms to 46.26 % and 34.07 %, respectively. The time to reduce 50% of *S. typhimurium* in unpeeled shrimps and peeled shrimps were 11.70 and 33.70 min., respectively. An increase in the washing time increased the pH but decrease the concentrations of ClO_2 solution. That was clearly observed during the first 15 min. of washing the peeled shrimps. *S. typhimurium* could be eliminated by washing unpeeled shrimps with 5 ppm ClO_2 for 4 times and 6 times for peeled shrimps.

Keywords: Frozen shrimps; Frozen prawns; Chlorine dioxide; *Salmonella*; Storage

637 ประภาศรี สิงห์รัตน์ และ เฉลียว หดหรรษพงศ์. 2532. **ศึกษาเปรียบเทียบผลของการละลายต่อคุณภาพกุ้งแช่แข็ง.** ทุนอุดหนุนการวิจัยสำหรับโครงการของนักศึกษาประจำปี ภาควิชาอุตสาหกรรมเกษตรคณะทรัพยากรธรรมชาติ. มหาวิทยาลัยสงขลานครินทร์วิทยาเขตหาดใหญ่. 46 น.

The comparative study on effects of thawing methods on quality of shrimp was done. The compared methods and thawing times were room temperature for 12 hrs., refrigerator for 24 hrs., cold water at room temperature for 3 hrs. and microwave 2450 MHz for 45 mins. Thawed shrimp quality in term of protein content, extractability, TVB, TMA, pH, expressible drip and organoleptic evaluations showed that it was effected by methods and thawing time. Microwave thawing method gave the best result in term of chemical and physical quality of thawed shrimp. While microwave and refrigerator thawing methods were most accepted by panel test.

Keywords: Thawing; Quality; Microwave; Frozen shrimps; Frozen prawns

638 ปรีชา จิงสมานกุล, ดวงดาว วงศ์สมมาตร และมณฑนา พันธุ์บัวหลวง. 2538. ***Listeria* ในกุ้งแช่แข็ง.** วารสารเกษตรพระจอมเกล้า. 13 (2): 8-11.

The study of incidence of *Listeria* contaminating in frozen shrimps was performed during April 1993 to October 1994 using the U.S. Food and Drug Administration (FDA) *Listeria* isolation method. From total of 120 samples, 96 cooked and 24 raw shrimps examined, *L. monocytogenes* was not found in any sample but *L. innocua* was detected in 10 samples of raw shrimp. It also revealed that the prolonged incubation period influenced the detection of *Listeria*, i.e., 7 positive samples were obtained from 27 days incubation and only 10 positive samples from 7 days' incubation.

Keywords: *Listeria*; Frozen shrimps; Frozen prawns; Incidence; Contamination

639 Preeya Vibulsresth and Rasita Jittam. 1991. **Storage of dried shrimp under controlled relative humidity.** Kasetsart University Research Report. Kasetsart University Research and Development Institute. 11 p.

To investigate shelf life extension, dried shrimp were held in relative humidities (RH) of 75, 80 and 85 % at 25 °C and at ambient temperature (29±1 °C). The study of stored dried shrimp indicated that the samples held in RH of 75 and 80% at both temperatures had a mold-free shelf-life of more than 12 weeks. The mold-free shelf-life of sample in 85% RH was only nine weeks. Storage of samples in RH of 75 and 80% were better effective in inhibiting bacterial growth and reducing ammonia production than sample held in RH 85%. The dried shrimp samples stored at 25 °C in RH 75 and 80% had levels of ammonia less than 600 ppm whereas the samples, which held in RH 85%, contained more than 800 ppm of ammonia.

Keywords: Dried shrimp; Dried prawn; Relative humidity; Ammonia; Storage

640 Preeya Vibulsresth, Nautong Vananuvat, Saisanom Praditdoug and Warapa Worapong. 1988. **Modified atmosphere storage of dried shrimp.** Department of Food Science and Technology. Faculty of Agro-Industry. Kasetsart University. 59 p.

To investigate ways of shelf life extension, dried shrimp were held in EVA/SARAN/EVA laminated bags (ethylene vinyl acetate/polyvinylidene chloride/ethylene vinyl acetate) under Modified Atmosphere (MA) containing 100% CO₂ (C 100), 100% N₂ (N 100) and mixtures of CO₂ plus N₂ in the ratios of 80:20, 60:40, 40:60 and 20:80 by volume (CN82, CN64, CN46 and CN28) at ambient temperature (30 °C)

The study of stored dried shrimp indicated that atmospheres containing 60% CO₂ and nitrogen was effective in reducing ammonia production and astaxanthin oxidation in dried shrimp. Samples held in air were faded and had strong ammoniacal odor in four weeks and had levels of ammonia in the range of 800-1,000 parts per million (ppm.) throughout storage for nine weeks.

The fresh dried shrimp had bright color of astaxanthin pigment of 0.9-1.0 units/g (1 unit = Absorbance at 475 nm/Absorbance at 360 nm). During storage the astaxanthin oxidation occurred in air packed sample and the color turned pale rapidly, whereas after 12 weeks storage the color of MA samples at C100, CN82 and CN64 retained fairly well with the amount of astaxanthin pigment more than 0.2 units/g. In addition sensory evaluation indicated that there was good correlation between the level of ammonia and the acceptability in odor evaluations and between the amount of astaxanthin pigment and acceptability in color evaluations.

Keywords: Dried shrimp; Dried prawn; Storage; Ammonia; Modified atmosphere; Astaxanthin; Color; Laminated bag; Sensory evaluation

641 Pongtorn Pitakgosolpong. 1992. **Smoked black tiger prawn development.** Master Thesis. Kasetsart University. 165 p.

Results of raw material quality testing showed that black tiger prawn sample were fresh as indicated by TVB value of 21.67 mg nitrogen/100g and also organoleptic tested. The chemical compositions of black tiger prawn were 76.16% moisture, 21.3% protein, 0.15% fat, 1.33% ash, 1.23% carbohydrate. Four types of prawns were prepared for smoking. Results of ranking for type preference indicated that peeled undevein prawn was the most preferred. The bagasse was the acceptable smoking material. The appropriate processing factors were drying temperature at 55 °C and time for 100 minutes and followed by smoking time for 70 minutes. The smoked prawn was analysed and found that product contained 66.75% moisture, a_w of 0.855, color value of L = 25.67, a = 12.03 and b = 10.65, shear force of 4.9 pounds/cm² and water phase salt content 4.25 %. The total plate count were 5.7 X 10³ colonies/g, coliform less than 3 MPN/g and pathogenic microorganism was not detected. It was found that the product packed in aluminium foil bags, could be stored at 4 °C more than 2 months when comparing to -20 °C without any effecting the qualities of the product. Results of acceptable test using 120 consumers showed a moderate preference whereas 77.5% found the product was acceptable and 48.4% would be willing to pay 40 Baht for 100 g of the products.

Keywords: Smoked prawn; Smoked shrimp; Smoking; Black tiger prawn; *Penaeus monodon*

642 Patcharee Teerasuntonwat. 1993. **Production of food flavoring agent from shrimp head.** Master Thesis. Kasetsart University. 118 p.

Flavoring agent was prepared from shrimp head by extraction of nitrogen compounds. Appropriate conditions of extraction with water, sodium chloride, hydrochloric acid, bromelain, papain, and neutrase were studied using soluble protein, formaldehyde nitrogen, solid contents, and sensory evaluation score as indicator. Flavor extract obtained was dried using sodium chloride, dextrin or dextrose as binder.

The results showed that bromelain was the most appropriate extraction media. The appropriate extraction conditions for bromelain were concentration of 0.25 % pH 6 for 5 hours at 50 °C. The suitable binder was sodium chloride.

Free amino acid profiles of flavor powder extracted with water and bromelain were similar but total amino acid content in flavor powder extracted with enzyme was higher (2 folds). The major free amino acid in both flavoring agents were alanine, glycine and arginine. The major total amino acid in both flavoring agents were glutamic acid, glycine and alanine.

Sensory evaluation of aqueous solution of the prepared flavor powder and the reference flavor (krill extract, Rieber & Son, Co.) were not significantly different ($P>0.05$) but cracker prepared with 2% krill extract had higher preference score ($P>0.05$) than those prepared with 2% shrimp head extract.

Keywords: Food flavoring agent; Shrimp head; Prawn head; Amino acids; Production; Sodium chloride

643 Piangchai Hanwatanawuthi. 1994. **A study on utilization of shrimp wastes products.** Master Thesis. Kasetsart University. 121 p.

Waste products from sea food processing industries are consisted head and shell portions. The percentage of head, shell and meat portion of black tiger prawn are 38, 7 and 55 percent respectively. Shrimp waste products contain 63.8 percent protein, 1.73 percent fat and chitin/chitosan. Chemical composition depend on age of shrimp especially fat content. The rest are chitin and chitosan. The compositions of put protein and lipids vary with age in partially fat content it increase from 1.5 percent in 1 month old prawn to 3.4-4.5 percent in the fully grown prawn.

The process to utilize these waste product or the combination enzymatic hydrolysis combined with

solvent extraction and alkali/acid extraction to recover proteins and amino acids, fats and chitin/chitosan.

This study shows that raw shrimp waste is readily digested by the enzyme protease that be cooked shrimp waste. The hydrolysis in a pilot scale reactor with 9 % neutrase or 2.85×10^5 CDU/kg shrimp was at 50 °C and the pH is controlled at 7 with 5N hydrochloric acid and soluble protein are increased from 3.8 to 5.96 percent in three hours : The soluble protein was increased by 53.8 percent compared with 39.6 percent in using cooked waste product. These condition is the best condition compared to the hydrolysis with 3, 6 and 12 percent enzyme with only 33.7, 36.6 and 51.3 percent increase of protein in the extract. The performance of enzymatic hydrolysis is greatly improved neutrase was replaced with koji protease of *Aspergillus oryzae*.

The main amino acids in shrimp waste hydrolysates are aspartic and glutamic acid, lysine and alanine. They are present at the level suitable to be used for formulation shrimp sauces seasoning and shrimp protein powders.

The solid portion contain about 35 percent fat after extraction with hexane, the rest are chitin and chitosan with the yield of 2.48 and 2.09 percent respectively.

Keywords: Enzymes; Chitosan; Chitin; Proteins; Shrimp oil; Shrimp waste products; Food flavoring agent; Shrimp shell; Prawn shells; Utilization; Aspartic acid; Glutamic acid; Lysine; Alanine

644 Mayuree Paklamjeak, Shuthep Lohacharoon and Anant Thephasadin Na Ayudhaya. 1992. **Development of export packaging for individual-quick-frozen boiled shrimp.** 34 p.

Two types of individual-quick-frozen (IQF) boiled black tiger shrimp- 400/500 in size, headless, peeled, deveined and 31/40 in size, headless, peeled, tail on, deveined- were selected as the target products. The proper consumer packaging was plastic pouch in paperboard box. The size of the pouch was 200X160 mm, made of laminate film PA 15 μ /LDPE 65 μ , containing 500 g of shrimp, vacuum packed and heat-sealed. The type of box was folding carton, 190x140x40 mm of outside dimension, made of 380 g/m² white-back board. The box was closed by hot melt process. The graphic design of the box was done by 4 colours offset printing and coated with UV or plastic on the print. The design was emphasized on promotional sale basis, having the text of the label conformed to the EC regulations.

The transport packaging was corrugated fibreboard box, regular slotted container, made of double wall board, KA 185/3CA 125/KA 185 with an outside dimension of 400x300x215 mm. It could contain 20 consumer packs and was closed by 6 strips

of pressure-sensitive tapes. The result showed that this box was suitable in terms of strength as well as effective utilization of Europallet and freight space. The graphic design of box was one colour (dark blue) flexographic printed, stressing on the necessities for efficient handling and transportation.

Keywords: Frozen cooked shrimps; Frozen shrimps; Frozen prawns; Packing; Exports

645 Y. Waiprib; V. Tulyathan, C. Thunpithayakul and P. Menasveta. 1994. **Seperation of chitin and chitosan from shrimp shell**. Department of Food Technology, Faculty of Science, Chulalongkorn University. 15 p.

Chitin were seperated from five varieties of shrimp (*P. monodon* Fabricius, *Metapenaeus* sp., *P. semisulcatus*, *P. merguensis* and *P. latisulcatus*) shell. The shells were demineralized with HCl and deproteinized with NaOH. Chitins were evaluated base on low ash and protein content. IR spectrums of the five seperated chitins and purified chitin (Sigma, USA) showed identical major functional peaks. Then chitins were deacetylated with NaOH 50 % w/w for, 4 hours at 140 ± 10 °C under N_2 atmosphere. The results showed that chitosans from five varieties had significantly different ($P \leq 0.05$) deacetylation. All 5.0 % w/v solutions of chitosan in diluted acetic acid had viscosity of 41.0-60.2 cps. and showed good stability. Viscosity was reduced 45 % when stored a 30 ± 2 °C for one month.

Keywords: Chitin; Chitosan; Shrimp shell; Prawn shells; *Penaeus monodon*; *Metapenaeus*; *Penaeus semisulcatus*; *Penaeus merguensis*; *Penaeus latisulcatus*

646 Yaowalux Ruttanapornvareesakul. 1996. **Effect of citric acid on the quality and shelflife of dried shrimp**. Master Thesis. Kasetsart University. 158 p.

Dried shrimp was processed by dipping fresh shrimp in 0.1, 0.3, 0.5% citric acid solution then boiling in 5% brine to select appropriate concentration of citric acid shelflife storage of dried shrimp under vacuum and air packed at 30 ± 2 °C and 10 ± 2 °C was studied. Chemical (astaxanthin, ammonia, moisture, NaCl, pH), microbiological (TVC, anaerobe TVC, yeast and mold, *E. coli*, *S. aureus*, *Salmonella*, *Vibrio*), physical (Aw, colour using L, a, b system) analysis and sensory evaluation were conducted. It was found that astaxanthin content and overall acceptability of samples dipped in 0.1, 0.3 0.5 % citric acid solution were not significantly different

($P > 0.05$) but they were significantly better than samples without citric acid dipping. Therefore the lowest concentration of citric acid solution, 0.1% was selected for studing the changes of quality during storage under vacuum and air packed. The results had shown that dried shrimp under all conditions of packaging stored at 10 ± 2 °C had shelflife longer than 14 weeks, and had better quality than samples stored at 30 ± 2 °C. Sample stored under air packed and vacuum at 30 ± 2 °C had shelflife of 6 and 8 weeks, respectively. Moreover dried shrimp dipped in citric acid solution had better colour, higher astaxanthin content and higher acceptability score as well as lower ammonia content than samples without citric acid dipping ($P < 0.01$) both stored under vacuum and air packed at 30 ± 2 °C and 10 ± 2 °C.

Keywords: Dried shrimp; Dried prawn; Storage; Citric acid; Packaging; Quality; Color; Temperature

647 Ravipim Chaveesuk and Praphan Pinsirodom. 1995. **Production of protein hydrolysate from shrimp cooking water as food flavor**. King Mongkut's Agricultural Journal. 13 (1): 1-18.

The production of protein hydrolysate form shrimp cooking water using enzyme Neutrase® 0.5 L was studied. Variations of enzymatic hydrolysis conditions consisted of enzyme concentration at 0, 0.5, 1.0, 1.5 and 2.0 % V/V; pH 5.5, 6.5 and 7.5; temperature 50, 55 and 60 °C; and the hydrolysing time; 15, 30, 45, 60, 75 and 90 minute. The optimum condition for production of hydrolysate which gave the maximum amino acid nitrogen at 3.50 mg N/ml were 0.5 % neutrase, pH 6.5, 50 °C and 30 minute. The hydrolysate was dried by freeze-drying. The dried product had dark brown color with considerable shrimp flavor and absorbed moisture quite readily. The product contained 3.80 % moisture, 51.89 % protein, 6.57 % fat, 24.76 % ash and 12.99 % carbohydrate. Sensory evaluation on the color and shrimp odor of dried product comparing to the freeze dried unhydrolysed cooking water product showed that the freeze-dried hydrolysate obtained higher scores in color and odor. However, sensory evaluation of the products after dissolving in water revealed that neither the hydrolysed nor unhydrolysed products had the significant differences in color, shrimp odor, sweet taste, bitter taste and overall flavor.

Keywords: Protein hydrolysate; Shrimp cooking water; Food flavors; Enzymes; Amino acids; Nitrogen

648 Lukkana Sornchumni. 1996. **Product development of frozen batter-fried prawns**. Master Thesis. Kasetsart University. 166 p.

Upon profiling the desirable product characteristics of frozen batter-fried prawns, it was determined that consumers like to have a product with low fat absorption, a light yellow color before frying, a dark brown color after frying, a medium texture, complete and uniform coating and a very crispy batter. The quality test of the same product in the market showed that the size of prawns varied from medium to large (6.0 and 9.5 g/piece). In this study, small size prawns were studied to improve the value of the smaller sized product. The average weight of the prawns was 3.5 g/piece. The development of batter for the frozen batter-fried prawns resulted in a formulations of 50% wheat flour, 30% rice flour and 15% modified starch. The process steps were developed as follows : preboiling prawns for 10 sec, dipping prawns in the flour blend mixed with water (1.1:1.0), prefrying in deep fat at a frying temperature of 175 °C for 5 sec, air blast freezing at -18 °C, packing in polyethylene bags and storing at -18 °C. The products were sold in the frozen form. The serving suggestion was to deep fry the frozen batter-fried prawns at 175 °C for 3.5 min. The ready to eat products give the characteristics as required by the consumers at the profiling stage and contained no pathogenic bacteria. Results from the consumer acceptance test showed that the degree of acceptance of appearance, crispness, hardness and cooking convenience moderate. Palm oil was preferred for frying when compared to soybean oil. The storage test showed that this product could be stored for more than 2 months at -18 °C.

Keywords: Frozen battered prawns; *Penaeus monodon*

649 Worapong Usawakesmanee.1995. **Production of peptone from shrimp heads.** Master Thesis. Kasetsart University. 83 p.

Some factors affecting autolysis and enzyme hydrolysis of black tiger prawn heads were studied i.e., temperature, time and enzyme concentration. The optimal conditions for autolysis at pH 6.8-7.0 were at 60 °C for 4.5 hours. The optimal conditions for pepsin hydrolysis at pH 2.0 were at 37 °C for 6.0 hours with enzyme concentration of 0.7 %. The optimal conditions for papain at pH 6.5 were at 60 °C for 4.5 hours with enzyme concentration of 0.7 %. For bromelain, the optimal conditions at pH 5.0 were at 60 °C for 1.5 hours and at enzyme concentration of 0.7 %. The soluble protein in the hydrolysate from autolysis, pepsin, papain and bromelain hydrolyzation were 8.62, 10.62, 9.05 and 9.71 mg/ml, respectively. According to the soluble protein obtained, hydrolyzation by pepsin was the most effective and was used in further study.

Pepsin hydrolysate was spray dried. The proximate compositions of dried hydrolysate were 34.37 % protein, 0.21 % fat, 4.43 % moisture content, 41.34 % ash and 16.77 % sodium chloride. The amino acid composition of the dried hydrolysate comprised 18 amino acids. The dried hydrolysate was as good as the commercial peptone in supporting growth of bacteria. The production yield was 6.71 % of the raw material used.

Keywords: Peptones; Shrimp head; Prawn head; Temperature; Enzymes

650 ศักดา ไตรศักดิ์. 2539. การสกัดไคตินและไคโตซานและความจุของการแลกเปลี่ยนไอออนบวก. ภาควิชาเคมี คณะวิทยาศาสตร์ สถาบันเทคโนโลยีพระจอมเกล้าเจ้าคุณทหารลาดกระบัง. 62 น.

The aim of this research is recovery of chitin and chitosan from prawn penaeid and to study the cation exchange capacity of chitosan in individual and mixed solutions. The selected cations were Fe^{3+} Cu^{2+} Zn^{2+} Cd^{2+} and Pb^{2+} .

From the experimental data found that *Penaeus monodon* Fabricius has highest amount of chitin and chitosan, with the following of *P. semisutcatatus*, *P. merguensis*, giant freshwater prawn, *Metapenaeus* sp., respectively. Cation exchange capacity of chitosan was determined by Atomic Absorption Spectroscopy method. It was also found that chitosan of 2 hours extraction had better ability of cation chelating than chitosan of 1 hour extraction. Capacity of chitosan to the studied cations could be put in order as follow: $\text{Cu}^{2+} > \text{Zn}^{2+} > \text{Pb}^{2+} = \text{Cd}^{2+} > \text{Fe}^{3+}$ for both individual and mixed solutions. Moreover, the cation exchange capacity data obviously suggested that size and charge of elements had greater influence on cation exchange capacity of chitosan than the nature, electronic configuration, of the elements.

Keywords: Chitin; Chitosan; Ions; Shrimp shell; Prawn shell

651 Sootawat Benjakula and P. Sophanodora. 1990. **Production of chitosan from banana prawn shells (*Penaeus indicus*).** Songklanakarin J. Sci. Technol. 12(4): 439-443.

Different manufacturing variable influenced on the quality of chitosan produced from Banana prawn shells (*Penaeus indicus*) using viscosity as indicator of quality were studied. The results showed that various variables including particle size of chitin, temperature, time and atmospheric condition in deacetylation of chitin affected the quality of the product. The optimum condition for chitosan production was deacetylation of chitin from prawn shell of particle size 1.4-2.0 mm with 50 % NaOH

(w/w) with a ratio of solids to solvent 1:15 (w/v) at 100 °C under vacuum for 30 min. The yield of chitosan which was shiny pale-yellow flakes, could be smoothly dissolved in 2 % acetic acid resulting in a viscosity of 10,183 centipoises.

Keywords: Chitosan; Chitin; Prawn shells; Shrimp shell; Prawn wastes; Shrimp waste products; Quality; Banana prawn; *Penaeus indicus*; Temperature

652 Sumalai Srikumlaithong, Parichat Laixuthai, Rewadee Nakdee, Paros Vicharnthakan, Narongdej Asa, Sei-ichi Aiba and Shun-ichi Shinagawa. 1997. **Production of chitosan from carapace of black tiger shrimp and its utilization for heavy metal adsorption.** Thailand Institute of Scientific and Technological Research. 16 p.

Effective conditions for chitosan production was accomplished by deproteinizing with 1.0 N NaOH at the ratio of carapace to NaOH of 1:6 w/v at 95-100 °C for 1 h and demineralizing with 1.25 N HCl at the ratio of solid to HCl of 1:10 w/v at room temperature for 1 h. The resulting chitin was deacetylated with 50% w/v NaOH at the ratio of chitin to NaOH of 1:15 w/v at 120 °C for 1 h. The chitosan with 28.6 % yield was achieved with ash content of 0.16%, solubility of 100%, degree of deacetylation of 82.04%, viscosity of 1372 cp, and nitrogen content of 7.9%. Its properties complied with the imported chitosan. The application of chitosan produced as toxic-metal binding agents in aqueous environment of electroplating plants was carried out. Its ability to adsorb Cu^{2+} , Ni^{2+} and Zn^{2+} was 70.00%, 10.12% and 20.49% respectively, which was similar to that of imported ones.

Keywords: Chitosan; Chitin; Polysaccharide; Shrimp waste products; Prawn wastes; Prawn head; Shrimp head; Heavy metal; Utilization; Absorption

653 Sumalai Srikumlaithong; Parichat Laixuthai; Rewadee Nakdee; Paros Vicharnrathakan and Narongdej Asa. 1997. **Effect of process conditions on properties of chitosan.** Thailand Institute of Scientific and Technological Research. 12 p.

In this report study, the factors effecting properties of chitosan from shell of black tiger shrimp, which are deproteinization and demineralization time, quantity and concentration of NaOH used, have been undertaken. The optimum condition for chitin production has been accomplished by deproteinizing with 1.0 N NaOH at the ratio of shell to NaOH of 1:6 w/v at 95-100 °C for 1 h and demineralizing with 1.0 N HCl at

the ratio of solid to HCl of 1:10 w/v at room temperature for 2 h. The resulting chitin was deacetylated with 50% w/v NaOH at the ratio of chitin to NaOH of 1:20 w/v at 120 °C for 1 h. The chitosan with 22.9% yield was achieved with degree of deacetylation of 82.56%, viscosity of 430 cp, molecular weight of 13.3×10^5 and solubility at 100%.

Keywords: Chitosan; Shrimp shells; Prawn shells; Protein; Prawn head; Shrimp head; Prawn wastes; Shrimp waste products; *Penaeus monodon*; Polysaccharide; Nitrogen

654 Surapart Luesukprasert. 2000. **Enhancement for productivity of frozen shrimp in the seafood industry.** Master Thesis. King Mongkut's Institute of Technology Thonburi. 119 p.

The purpose of this study is to improve the processing rate for frozen seafood industry. The processing line of frozen fresh water shrimp, especially a weighing and laying process, was chosen as a sample line for improvement. After analyzing the production system and process of this line by recording the processing line at each step for producing one block of frozen fresh water shrimp, it was found that there was idle delay time during processing which will affect to product's quality. In addition, the unbalance line lead to the bottle necks or build up of raw materials on the conveyors. Therefore, the principals of work study, standard time, and line balancing were adopted to improve the production system by increasing the production rate and line efficiency. From these improvements, balance delay, the use of required worker, and work-in-process inventory were reduced. This was beneficial to product quality in which product deterioration results from microorganism. Furthermore, the bottle necks were improved by a line balancing to enhance work efficiency. The standard time of each step was set up and used for daily production planning. This research has shown that the production rate was increased by 25.05 percent and labour cost was reduced by 16.13 percent. Finally, this study can be applied to the other products having a similar production processes, like fresh water shrimp ones.

Keywords: Frozen shrimps; Frozen prawns; Rate processes; Processing Rate; Work study; Work Improvement Idle Time; Standard Time; Line Balancing

655 in Thai

656 Soottawat Benjakul and Aroon Lilapantisithi. 1998. **Production of water soluble chitosan from black tiger shrimp shell and carapace (*Penaeus***

monodon). Songklanakarin J. Sci. Technol. 20(1) : 95-102.

Water soluble chitosan, chitosan formate and chitosan lactate, from shell and carapace of black tiger shrimp were obtained by dispersing chitosan (0.85 mm) into either formic acid and ethylacetate with the ratio of 0.5 : 1.5 : 20 (w/v/v), or a solution containing lactic acid and 1,2-dichloroethane with the chitosan to solution ratio of 0.5 : 25 (w/v). The mixtures were shaken at room temperature for 2 hr followed by washing with the organic solvent, filtering, and drying at room temperature. Chitosan lactate solution had slightly higher pH but lower viscosity than chitosan formate. In addition, chitosan salts produced from carapace showed slightly higher viscosity than those from shell.

During storage of both water soluble chitosan produced from shell and carapace at room temperature and 4 °C, significant decrease in moisture and viscosity was observed ($P < 0.01$). The rate of decrease was higher at room temperature than at 4 °C. The pH of the solutions and solubility, however, were rather constant during the 30 days storage.

Keywords: Chitosan; Chitin; Shrimp shell; Prawn shell; Shrimp head; Prawn head; *Penaeus monodon*; Biopolymer;

657 Nopparat Mahae and Pairat Sophanodora. 1998. **Effect of film additives on properties of biodegradable film from chitosan.** Songklanakarin J. Sci. Technol. 20(4) : 445-454.

The effects of film additives e.g. cellulose derivatives, plasticizers and fatty acids, on the properties of chitosan and composite films was studied. For chitosan film, as chitosan concentration increased, the thickness, surface density and tensile strength were increased. The water vapor permeability (WVP) increased with an increasing of chitosan concentration up to 1%, beyond that there was little change in WVP. Composite films between cellulose derivatives (methyl cellulose, MC and hydroxypropyl methylcellulose, HPMC) and chitosan showed the maximum tensile strength at 10 % cellulose. HPMC composite film showed more flexibility than MC composite film with a higher extension at break. At the same concentration of plasticizer, sorbitol exhibited higher tensile strength, and lower extension at break and WVP than glycerol. There was very little effect of fatty acid on the water barrier property of film. Lauric acid showed a better water barrier property than stearic acid.

Keywords: Chitosan; Biodegradable film; Shrimp shell; Prawn shell

658 Pongpen Rattagool, Niracha Wongchinda and Naruemon Sangthong. 1988. **Using radiation to eliminate *Salmonella/Shigella* in commercial frozen peeled and cooked shrimp stored at chilled room.** In Annual Report 1988. Fishery Technological Development Division. Department of Fisheries. p. 231-243.

Two small sizes of shrimp (*Trachypenaeus* sp. and *Metapenaeus* sp.) were caught from the gulf of Thailand and stored in ice for 3-5 days on board before landed at Chumporn port. After auction the shrimp was re-iced during transported to factory. Shrimp was carried out at the plant for manufacturing processes and also good manufacturing practise (Lap treatment) was applied before cooked, frozen and packed into polyethylene (PE) bags.

The sample were irradiated at 0, 1, 2 and 3 kGy. by Cobalt 60 (150 KCi) under frozen condition. The irradiated sample was repacked into small bags for storage study at 8 ± 2 °C the same treatment as irradiated sample with no repacked.

The results showed that the radiation dose at 3 kGy. will extend the shelf-life to 4-5 days longer on the irradiated peeled and cooked shrimp (PCS) under refrigerated condition. Also the total volatile base of the samples at 0, 1, 2 and 3 kGy. Were 6.73, 3.66, 1.57 and 3.33 mgN/100 gm. sample while the repacked ones were 22.86, 16.2, 3.59 and 9.34 mgN/100 gm. respectively. It showed that 3 kGy. is enough to extend shelf-life of PCS under refrigerated condition.

Keywords: Frozen shrimps; Frozen prawns; Storage; *Salmonella*

659 Pongpen Rattagool, Niracha Wongchinda and Naruemon Sangthong. 1991. **Located *Salmonella* contamination in Thai shrimp.** In Proceeding the Seminar on Fisheries 1991 Department of Fisheries, 16-18 September 1991. National Inland Fisheries Institute. Bang Khen. p. 61-64.

Salmonella contamination was investigated from raised farm shrimp (*P. merguensis*) marine shrimp (*P. merguensis*, *P. monodon*, and *Trachypenaeus* sp.) after harvesting and at each step of marketing and processing (after being caught, iced on board, at landing place, auction at FMO, during transportation and on the processing line as well as the frozen product). Shrimp flesh, whole shrimp and frozen were examined for *Salmonella*. All sample were conducted by using pre-enrichment broth, then selective enrichment media before selective plating to isolate and purify a suspect colony, then biochemical screening before Serological typing (WHO/ National *Salmonella/Shigella* Center, Department of Medical Science).

Also shrimp from local markets, landing places and sea-food factories were tasted. *Salmonella welterred* and *S. derby* were found on frozen white shrimp (a farm at Samuth Sakorn) and (marine) peeled and cooked shrimp respectively. Not only the gut will be collected for *Salmonella* analysis, but also all the samples that had been checked and found *Salmonella* would be rechecked again on the frozen stage. The good, medium and quality of 31 shrimp samples (Samuth Sakorn) have been identified for *Salmonella* but only twice have been found *Salmonella* and 17 of white shrimp from Samuth Sakorn landing port and also shrimp raised pond farm.

Keywords: *Salmonella*; Contamination; *Penaeus merguensis*; *Penaeus monodon*; *Trachypenaeus*; Samuth Sakorn;

660 in Thai

661 Attaya Kungsuwan, Poratip Kiatkangwalkrai, Suwalee Chandkrachang and Willem Stevens. 1996. **Protein from shrimp heads**. In the Seminar on Fisheries 1996 Department of Fisheries, 18-20 September 1996 Anon Meeting Hall and National Inland Fisheries Institute, Bang Khen. p. 711-714.

Two strains of lactic acid bacteria (*Lactobacillus plantarum* 541 and *Lactobacillus* sp. L23T) were used to compare their ability to free protein from shrimp heads by partial fermentation. Two series of experiments were performed. First one was performed at small scale (200 ml culture : 200g shrimp head) to investigate pH change during fermentation. Second series were performed at a 50-100 fold larger scale with culture to shrimp ratio of 1 : 1 and 1 : 2. Fermentation was done at room temperature for 17-24 h. During fermentation LAB growth pH were checked. After termination of fermentation, hydrolysate was separated by filtering and then drying and testing for proximate composition. The results showed that we could obtain hydrolysate with 44% protein and 12% yield. Some snack type products was developed from thus obtained hydrolysate.

Keywords: Shrimp head; Prawn head; LAB; Protein; Hydrolysate

662 Attaya Kungsuwan, Pannee Khonchatri and Somyod Ratchaniyom. 1993. **Chitosan from fish industrial offal**. In Proceeding the Seminar on Fisheries 1993 Department of Fisheries, 15-17 September 1993. National Inland Fisheries Institute, Bang Khen. p. 726-735.

Since offal from fish industries, especially shrimp and head, have been reaching over 40% of

raw material used, including others of interest which are squid pen and crab shell. Utilization of some polysaccharides such as chitosan from these shells instead of using as animal feed would be more valuable for other industries as medicine and food preservation. Attempts were made to extract chitosan from various materials as shrimp head and shell; squid pen and crab shell. Extraction was performed by boiling the sample with 3% NaOH for 2 hr and then decalcified with 1 N HCl for 2 hr. The chitin thus obtained was further extracted with 50% NaOH to develop chitosan. Ash, moisture content and deacetylation number of each sample were determined to see the quality obtained.

The results showed that the highest yield of chitosan (30%) was obtained from squid (*Loligo*) pen and secondly, from the *Sepioteuthis* pen (28%). Shrimp shell gave higher yield of 22.5% than that of shrimp head (14%). The yield of 13% was obtained from crab shell. Chitosan obtained from all samples gave the ash content between 0.1-0.4% ; moisture of below 10% and deacetylation number between 50-65%. These general properties of chitosan obtained were quite satisfactory comparing to the qualities demand of the market. Further process development for shrimp shell and head should be more emphasized together with industrial promotion to have full utilization of this huge abundant offal.

Keywords: Chitosan; Shrimp shell; Prawn shell; Offal

663 Supapun Brilliantes and Rattiya Promkhum. 1998. **Effect of heat on oxytetracycline levels in shrimp muscle tissue**. Thai Fisheries Gazette. 51(3): 211-217.

Effect of heat on Oxytetracycline (OTC) levels in standard solutions, minced shrimp and whole shrimp meat at 155 °C and 165 °C for periods of 1, 2 and 3 minutes were studied. The results showed that heat at both temperatures could reduce OTC levels in all samples. The higher temperature could reduce more than the lower temperature. The longer time periods could reduce more OTC.

Rate of reduction varied in each type of sample. In standard solutions, OTC levels were reduced by more than 66% after 2 minutes and almost 100% after 3 minutes. The rate of reduction was constant at around 29% and 36% per minute at 155 °C and 165 °C respectively. In minced shrimp, rate of reduction was also constant but at a much lower rate of only 10-14 % per minute. After 3 minutes total reduction was only 31 - 37%

OTC levels in whole shrimp meat also decreased at each time duration, but in contrast to the previous samples, the rate of reduction did not show any constant pattern. This may be due to variation in the original levels of OTC in the individual shrimps.

Therefore, it is very difficult to predict the rate of reduction in whole shrimp.

Keywords: Oxytetracycline; Minced shrimp

664 Pongpen Rattagool. 1987. **Combination effects between radiation, packaging and N₂-GAS for shelf-life extension of shrimp.** In Annual Report 1987. Fishery Technological Development Division. Department of Fisheries. p. 60-72.

To evaluate the influence of different parameters on the shelf-life of cooked shrimp experiments were made, introducing radiation in the shrimp (peeled and unpeeled) at different temperature (deep frozen at -35 ° and chilled at 5 °C) and using different packing materials (EG-Q and CP). To reduce the oxidation effects, the experiments were performed under the addition of the Nitrogen gas.

The irradiation was done with gamma rays emitted by a Cobalt-60 source of 5.55×10^{15} Bq (150 KCi) at a dose rate of 6 kGy. per hour. The usual irradiation doses of 1.5 and 3 kGy. were applied as well as a ranges of 0.5, 1, 2, 3, 4, 5, 6 and 8 kGy.

The experiments confirmed that the radiation sensitivity of microorganisms like coliforms and aerobic microorganisms and enterobacteriaceae is temperature depending.

The peroxide value showed also to be temperature depending and in addition of the packaging material.

The TMA-N value was not significantly influenced by the applied radiation doses. Shrimp irradiated at chilled conditions showed off-flavours at 1.5 kGy. Off-flavours could be detected at a dose of 3 kGy when the shrimp was irradiated at deep frozen condition. No difference was observed on the radiation effects of peeled and unpeeled shrimp.

Keywords: Frozen shrimps; Frozen prawns; Storage

665 อัมพวัน ตันสกุล. 2000. ผลของวิธีการอบแห้งต่อเวลาที่ใช้ในการอบแห้งและคุณภาพกุ้งแห้ง. ใน การประชุมกุ้งทะเลแห่งชาติ ครั้งที่ 2. น. 150-156.

Dried shrimp is one of the most important food products of Thailand for both domestic and international markets. However, the prices of dried shrimp are varied due to its appearance and quality, especially texture and color.

The main objective of this research was to compare the drying time and quality of dried shrimp from the hot air drying and the microwave-vacuum drying. The latter method combines advantages of both the microwave drying and the

vacuum drying. The microwave-vacuum drying applies microwave energy under vacuum; therefore, the water in the product evaporates at lower temperature. It was found that the dried shrimp from the microwave-vacuum drying has crispier texture and better color than that from the hot air drying. Furthermore, the drying time required for the microwave-vacuum drying was much shorter than that of the hot air drying due to the higher drying rate.

Keywords: Dried shrimp; Dried prawn; *Penaeus monodon*; Giant tiger prawn; Giant tiger shrimp; Drying; Microwave

666 Krissana Soponpong. 1996. **Establishing a guide to the grading of seafood freshness.** Fish Technology Research & Inspection. Vol. 1: 56-85.

The study on quality changes in four-fingered threadfin (*Eleutheronema tetradactylum*), red snapper (*Lutjanus altifrontalis*) and black tiger prawn (*Penaeus monodon*) stored in ice was carried out as a part of the establishment of a guide to the grading of seafood freshness. Sensory evaluation of raw and cooked fish and shellfish was performed in conjunction with chemical (pH, moisture, K-value, VB-N and TMA-N) and microbiological analyses. The keeping times of four-fingered threadfin, red snapper and black tiger prawn were 17 days, 12 days and 4 days respectively. Sensory evaluation of cooked fish proved to be less indicative of the state of freshness. The K-value was suitable for measuring freshness of all the seafood in this study. The VB-N and TMA-N were not reliable freshness indicators for four-fingered threadfin, but useful indices for red snapper. For ice stored black tiger prawn, the TMA-N showed a good correlation with storage time whereas VB-N did not.

Keywords: Black tiger prawn; Sensory evaluation; Frozen shrimps; Frozen prawns; Freshness

667 Pisit Dhamvithee, Anuvat Jangchud, and Vichai Haruthaitanasanti. 2002. **Effect of pH and potassium sorbate on properties of chitosan film.** In The 39 th Kasetsart University Annual Conference. Subject: Agro-Industry. p. 487-494.

Chitosan film is an edible polysaccharide film which could dissolve at low pH. Film is smooth yellowish and transparent. The thickness is 0.054-0.074 mm. Results showed that pH and concentration of potassium sorbate affected properties of chitosan film significantly ($P \leq 0.05$). Water vapor permeability (WVP) and oxygen permeability (OP) decreased when pH was increased. Water vapor permeability (WVP) and oxygen permeability (OP) increased with increasing potassium sorbate concentration. The mechanical properties showed that tensile strength

decreased but elongation increased with increasing pH. When potassium sorbate concentration increased, both mechanical properties were decreased.

Keywords: Chitosan; Film; Potassium sorbate; pH

668 Saowaluck Vanichsuwan. 2000. **Extraction and some properties of carotenoprotein from shrimp waste.** Master Thesis. Prince of Songkla University. 136 p.

Carotenoprotein from black tiger shrimp shell can be prepared by hydrolyzing ground dry shell with particle sizes of 2.0–4.0 mm by either alkaline or proteases. Optimum condition for hydrolyzing carotenoprotein by alkaline included reacting the ground shell with 1.5 N NaOH for 3 hrs at 100 °C. For proteolytic hydrolysis, optimum condition for hydrolysis by alcalase, neutrase and papain involved pH 8.0, 60°C for 2 hrs, pH 7.0, 50°C for 1.5 hrs. and 40 °C pH 6.0, 40 °C for 1.5 hrs, respectively. Higher yield and carotenoid content were obtained in sample extracted with NaOH, compared to those extracted with enzymes. Higher yield was obtained when the protein in hydrolysate was precipitated with ammonium sulphate, compared to pH adjustment. However, carotenoprotein precipitated using ammonium sulphate had yellow color. Among carotenoprotein recovered by pH adjustment, sample obtained at pH 7.0 showed the red color with the highest carotenoid content at 233 µg/g. As determined using the absorbance, λ_{max} of carotenoprotein was obtained at 465 nm. Carotenoprotein prepared using NaOH and precipitated by adjusting pH to 7.0 contained 80.6% protein, 9.6% ash, 6.2% chitin and 165.45 µg/g total carotenoid content. Carotenoprotein was yellow reddish ($L=34.12$, $a=22.21$, $b=13.81$). Major amino acids in carotenoprotein prepared by using NaOH were glutamic acid and aspartic acid.

When carotenoprotein was analyzed by thin layer chromatography, astaxanthin was found as a major pigment. Among all carotenoprotein precipitated at different pHs, sample obtained at pH 3.0 had the highest nitrogen solubility, emulsion capacity, emulsion stability, whippability and foam stability, compared to those precipitated at other pHs. Increase in these functional properties was generally observed as the concentration of carotenoprotein increased.

Storage stability of carotenoprotein detected by color changes was investigated under various conditions. Sample kept at 4 °C with vacuum packaging was more stable when compared to those stored at room temperature (27–31 °C) with the atmosphere packaging.

Keywords: Carotenoprotein; Carotenoids; Hydrolysate; Pigments; Shrimp shell; Prawn shells; Shrimp waste products; Prawn wastes

669 ไพรัตน์ โสภโณตร, วรณา ชูฤทธิ์ และ เสาวลักษณ์ จิตรบรรเจิดกุล. 2534. รายงานการวิจัยเรื่อง แนวทางการสกัดและการใช้ประโยชน์ไคโตแซนจากเปลือกและหัวกุ้ง. ภาควิชาอุตสาหกรรมเกษตร คณะทรัพยากรธรรมชาติ มหาวิทยาลัย สงขลานครินทร์ วิทยาเขตหาดใหญ่. 73 น.

Effective procedures for obtaining highly deacetylated chitosan from black tiger prawn carapace and shell (*Penaeus monodon*) have been developed. The optimal deacetylation was attained by intermittently washing the intermediate product in water two times during the alkali treatment involved reacting chitins with 50% NaOH (w/w) under vacuum for 45 min. each time with a solids to solvent ratio of 1 : 15 (w/v) at 100 °C. Chitosan products from both carapace and shell showed 31.89 and 43.21% degree of N-acetylation, respectively and contained 7.60–7.63% nitrogen with low fat and ash content. Both chitosan showed relatively higher viscosity than chitosan from “Fluka” which had a lower nitrogen content but a higher degree of N-acetylation.

Water soluble chitosans from carapace and shell of black tiger prawn were obtained by adding chitosan (0.85 mm) into either formic acid and ethyl acetate in the ratio of 0.5 : 1.5 : 20 (w/v/v), or solution containing lactic acid and 1,2-dichloroethane in the chitosan to solution ratio of 0.5 : 25 (w/v). The mixtures were shaken at room temperature followed by washing with the organic solvent, filtering and drying at room temperature. Chitosan lactate solution had slightly higher pH but lower viscosity than chitosan formate. In addition, chitosan salts produced from carapace showed slightly higher viscosity than that from shell. However, pH of the two solutions were not significant different.

During storage of both water soluble chitosans produced from carapace and shell at room temperature, higher decrease in moisture and viscosity were obtained compared to the storage at 4 °C. The pH of the solutions and solubility, however were rather constant during the 30 days storage.

Keywords: Chitosan; Chitin; Shrimp shell; Prawn shells; Shrimp head; Prawn head; Black tiger prawn; *Penaeus monodon*

670 Sarayout Chumnikul. 1994. **Thermal properties of giant tiger prawn (*Penaeus monodon* Fabricius) and banana prawn (*Penaeus merguensis* de Man).** Master Thesis. Chulalongkorn University. 86 p.

This research focused on , firstly, designing and improving the proper equipment for measuring the

thermal conductivity (k), specific heat (C_p) and thermal diffusivity (α) of giant tiger prawn and banana prawn and secondly, studying the effects of breeds (*Penaeus monodon* Fabricius and *Penaeus merguensis* de Man), freezing methods (air-blast freezing and dry-ice freezing) and temperature (-30 ± 1 , -18 ± 1 and -10 ± 1 °C) on their thermal properties. The k , C_p and α were measured by thermal conductivity probe, modified method of mixture and thermal diffusivity plate, respectively. The corresponding k , C_p and α of giant tiger prawn frozen by air-blast freezing were 1.109–1.288 W/m k, 0.423–1.148 cal/g °C, and 5.116×10^{-7} – 6.942×10^{-7} m²/s while the giant tiger prawn frozen by dry-ice freezing were 1.066–1.291 W/m k, 0.433–1.147 cal/g °C and 5.837×10^{-7} – 7.851×10^{-7} m²/s respectively. The values of k , C_p and α of banana prawn frozen by air-blast freezing were 1.116–1.304 W/m k, 0.516–1.206 cal/g °C, and 5.908×10^{-7} – 7.141×10^{-7} m²/s and those of banana prawn frozen by dry-ice freezing were 1.122–1.313 W/m k, 0.509–1.198 cal/g °C, and 5.942×10^{-7} – 7.800×10^{-7} m²/s, respectively. The k and α were found to be polynomial functions with breeds, freezing methods and temperature, while the C_p was found to be polynomial functions with breeds and temperature.

Keywords: Thermal Properties; Giant tiger prawn; Banana prawn; *Penaeus monodon*; *Penaeus merguensis*

671 Soottawat Benjakul. 1990. **Potential utilization of prawn shell : Chitin and chitosan.** Master Thesis. Prince of Songkla University. 221 p.

Development on potential utilization of prawn shell including chitin and chitosan production, storage stability and some applications of chitosan in prolonging of limes by coating and recovery of organic compounds from seafood processing wastewater was studied. The results showed that Banana prawn shell (*Penaeus indicus*) could be used for chitin production by extracting the dried shell ground to 1.4–2.0 mm. Particle size with 2.0 % NaOH (w/v) at 100°C for 1 h with a solids to alkali solution ratio of 1:10 (w/v), further demineralization with 1.25 N HCl at ambient temperature for 1 h with a solids to acid solution ratio of 1:10 (w/v). The yield was 26.84% (dry basis). The chitin was white-yellow flakes and contained 96.15 % chitin, 6.80% nitrogen and 0.18% ash. To produce chitosan, chitin was deacetylated properly with 50% NaOH (w/w) at 100 °C with a ratio of solids to alkali solution 1:15 (w/v) under vacuum for 30 min. The obtained chitosan was 21.04% yield based on dried shell and

characterized with shiny pale-yellow flakes and represented 7.80% nitrogen and 0.29% ash. It could be smoothly dissolved in 2% acetic acid and had a viscosity of 10,183 cps.

Storage stability studies showed that there were some changes in composition and property of chitin and chitosan during storage for 3 months at ambient temperature. The moisture content of both samples was significantly increased ($P>0.05$) whereas the nitrogen content of chitin was slightly decreased. Viscosity used as an indicator of chitosan property showed a significant decrease ($P>0.05$) during storage.

Use of chitosan to prolong shelf-life of lime was carried out. Coating limes one time with 1.25% of chitosan in 2% acetic acid solution could significantly retard degreening but not weight loss during storage at ambient temperature (27-30 °C) for 15 days. The affecting factors on keeping quality of lime indicated that temperature of 10 ± 2 °C significantly increased the storage life of limes. Weight loss was controlled by keeping fruits in low density polyethylene bag (40 micron thickness) but degreening was slightly decreased. Coating limes with chitosan before keeping in the bags and storing at 10 ± 2 °C could therefore reduce degreening and weight loss efficiently within 8 weeks of storage. However, combination of FMC 7055 application with storage in bag adversely affected the limes quality.

Recovery of organic compounds from seafood processing wastewater by chitosan was affected by the amount of chitosan used, pH and compositions of wastewater. Chitosan from red-tailed prawn shell (*Penaeus merguensis*) showed effective reduction of turbidity in 5 kinds of wastewater : tuna stickwater, sardine stickwater, tuna wash water, prawn wash water and treated wastewater under various amount of chitosan and pH of wastewater as follows : 400 mg/L, 7.0 , 100 mg/L, 5.0, 100 mg/L, 7.0, 100 mg/L, 7.5 and 50 mg/L, 5.0, respectively. Gravity settling for 3 h. gave satisfactory reduction of turbidity in most wastewater. By comparing the efficiency in recovery of organic compounds by different sources of chitosan under the same condition, it was found that chitosan from Banana prawn shell and chitosan "Fluka" achieved superior reductions of COD values to chitosan from red-tailed prawn shell but resulted in increased turbidity and suspended solids due to the excess of chitosan. The efficiency of chitosan from Banana prawn shell was generally higher than the others. The coagulated solids consisted of considerable amount of protein and fat which can be potentially used for animal feed.

Keywords: Chitin; Chitosan; Shrimp shell; Prawn shell; Coating; Coation limes; Banana prawn; *Penaeus indicus*; Red tailed prawn; *Penaeus merguensis*

672 Pisitpong Punyabandh. 1996. **Production of value added product from surimi: shrimp analogue**. Master Thesis. Prince of Songkla University. 105 p.

The formulation of shrimp analogue consisted of surimi, salt, ice water, sugar, potato starch, monosodium glutamate, ribotide, sodium succinate and shrimp flavour 1000, 25, 400, 50, 70, 5, 0.1, 0.3 and 15 g., respectively. The production procedure is as follow : partially thawed surumi was cut for 2 min in silent cutter, after that other ingredients were added during mixing within β min. The mixture was further mixed for another 10 min, which make the total mixing time of 18 min. The mixture paste was divided into two portion, one portion was processed into an elastic texture gel and then combined with the second portion in the ratio of 30:70. The final mixture was molded into shrimp-shape and heated in electric oven at 160 °C for 7 min. After removing from the mold, the shrimp were colored and baked in electric oven at 160 °C for 7 min, then steamed at 90 °C for 10 min and cooled to room temperature.

The products were frozen by two different methods, i.e. the contact plate freezer at -30 °C results in the freezing time of 59 min and cryogenic method using liquid carbon dioxide as refrigerant within 7 min. The quality of the products from both methods were not significantly different ($P>0.05$) in organoleptic, chemical, physical and microbiological parameters. Organoleptic acceptability was good with the ratio score of 0.82 comparing to 1 of the ideal product. Chemical and physical parameters e.g. drip loss, moisture, protein, fat, ash and salt content of the products from two methods were not significantly different ($P>0.05$), the values were in the range of 78.85–75.88, 5.50–2.53, 9.24–9.02, 38.18–38.73, 1.20–1.18 and 1.76–1.70 % on dry weight basis, respectively. Total plate counts were between 2.64×10^3 to 2.83×10^3 colony/g.

The storage stability of the analogue product at -20 °C for 12 weeks showed that the average organoleptic quality scores were not significantly different ($P>0.05$) with the value of 0.82–0.94. Drip loss value was increased when the storage time increased, ranging from 1.00 to 5.50% by weight, and found that the products from cryogenic freezer had more consistency drip loss than those from contact plate freezer. Chemical qualities e.g. moisture, protein, fat, ash and salt content were not significantly different ($P>0.05$) with the value of 78.85–75.12, 38.18–38.73, 1.04–1.20, 8.94–9.24, and 1.68–1.76% (w/w), respectively. Total volatile base tended to increase as storage time increased from 6.38 to 9.45 mgN/100 g sample. Total plate counts were not exceed the standard of frozen cooked shrimp (TSI, 115-2529) and unable to

detect coliform, *Escherichia coli*, *Salmonella* spp., *Staphylococcus aureus* and *Vibrio parahaemolyticus* throughout the storage time.

Keywords: Shrimp Analogue; Surimi; Sensory evaluation

673 Chakree Thongraung. 1994. **Development of the processing of a value added seafood product : Frozen Tom Yum Kung**. Master Thesis. Prince of Songkla University. 92 p.

Development of process for Frozen Tom Yum Kung production including the preparation of soup and raw materials (shrimp and mushroom), the production (developed and conventional process) process of Frozen Tom Yum Kung as well as the quality of product changes during storage at -20 °C were investigated. Tom Yum Kung soup was prepared by boiling shrimp head in water with ratio of 2.5:1 and flavoured with spices and seasonings. The result of sensory evaluation showed that the most acceptable soup which comparable to the consumer's product profile consist of the following ingredients : 4.97% chilli paste, 0.69% salt, 0.38% monosodium glutamate, 2.68% lemon juice, 1.53% lemon grass, 1.53% sterilized milk, 6.12% kaffir lime leaves, 1.37% fresh chilli, 3.06% shallot, 1.53% galanga and 0.54% sweet basil leaves.

Effects of the preparation process on the quality of shrimp and mushroom were studied. The result showed that treating fresh shrimp by soaking in the mixed solution of 1.5% mixed phosphate and 5% sodium chloride for 10 min. and followed by steam blanching gave better yield and better sensory quality than control. Mushroom treated by dipping in water under 3 inch Hg pressure for 10 min. and followed by 29.92 inch Hg atmosphere for 7 min. and steam blanching showed better yield but not significantly different in sensory quality when compared to the control.

Quality evaluation of the Frozen Tom Yum Kung including chemical, microbiological and sensory quality showed that the product prepared by the developed process contained significantly higher ($P<0.01$) amount of fat and total viable count as well as sensory quality than the product prepared by the conventional process. Changes in chemical, microbiological and sensory quality of the products during storage at -20 °C for 3 months were also studied. The results showed that the TBA value of the products prepared by both processes were significantly increased ($P<0.01$) but not total viable count which was significantly decreased ($P<0.01$) during storage. The quality of products produced from both processes after 3 months storage were still acceptable and safe for consumption.

Keywords: Frozen Tom Yum Kung; Sensory quality

674 Soottawat Benjakul. 1993. **Improvement on quality of chitosan from black tiger prawn by-products**. Faculty of Natural Resources. Prince of Songkla University. 99 p.

Continuously increasing of prawn processing industry in Thailand produced enormous amount of wastes causing waste handling and pollution problems. Thus, producers are searching for cost-effective disposal method or viable utilization of those wastes. Conversion of waste material into valued marketable products not only increases production efficiency and profitability but also reduces waste disposal problems.

Development on potential utilization of prawn head and shell into chitin and chitosan has been interested among producers. Although research has shown the possibility in production of chitin and chitosan, there is no chitin/chitosan production industry in Thailand, probably due to a lot of variation in production method and source of raw material. Therefore, this research work was aimed to produce chitin and chitosan from prawn shell and examine both chemical and physical properties and storage stability of the products.

The results showed that Banana prawn shell (*Panaeus indicus*) could be used for chitin production by extracting the dried shell ground to 1.4–2.0 mm. particle size with 2.0% NaOH (w/v), at 100 °C for 1 h. with a solids to alkali solution ratio of 1 : 10 (w/v), further demineralization with 1.25 N HCl at ambient temperature for 1 h. with a solids to acid solution ratio of 1:10 (w/v). The yield was 26.84% (dry basis). The chitin was white-yellow flakes and contained 96.15% chitin, 6.80% nitrogen and 0.18% ash. To produce chitosan, chitin was deacetylated properly with 50% NaOH (w/w) at 100°C with a ratio of solids to alkali solution 1:15 (w/v) under vacuum for 30 min. The obtained chitosan was 21.04% yield based on dried shell and characterized with shiny pale-yellow flakes and represented 7.80% nitrogen and 0.29 % ash. It could be smoothly dissolved in 2% acetic acid and had a viscosity of 10,183 cps.

Chemical analysis showed that chitin from Banana prawn shell contained moisture, ash and nitrogen lower than those in chitin from “Fluka”. But higher chitin content and solubility were found in chitin from Banana prawn shell. Although the chemical compositions of chitosan from Banana prawn shell were comparable to those in chitosan from “Fluka”, the solution of chitosan from Banana prawn shell in acetic acid achieved superior viscosity to solution of chitosan from “Fluka”.

Storage stability studies showed that there were some changes in composition and property of chitin and chitosan during storage for 3 months at ambient temperature. The moisture content of both

samples was significantly increased ($P>0.05$) whereas the nitrogen content of chitin was slightly decreased. Viscosity used as an indicator of chitosan property showed a significant decrease ($P>0.05$) during storage.

Keywords: Chitosan; Chitin; Quality; Banana prawn; *Penaeus indicus*; Prawn shell; Shrimp shell; Prawn head; Shrimp head

675 Apiwan Somboondumrongkul. 1994. **Prevention of blackening in canned shrimp using phytic acid**. Master Thesis. Prince of Songkla University. 69 p.

Prevention of blackening in canned shrimp using phytic acid in the preparation steps before canning process were investigated. First, blanched peeled shrimps were dipped in the solution of phytic acid of four different concentrations of 500, 1000, 2000 and 4000 mg/kg with the ratio of 1 : 1 for 10, 20 and 30 minutes before canning by process I. The results showed that the levels of absorbed phytic acid in shrimp flesh from canned shrimp were significantly linear related to the concentration of phytic acid used for each dipping time. The correlation coefficient were 0.9964, 0.9972 and 0.9974 for dipping time of 10, 20 and 30 minutes, respectively. In the otherhand, the relationship between dipping time and absorbed phytic acid was linear only for the phytic acid concentration of 500 mg/kg which found that the correlation coefficient was 0.998 while the concentration of 1000, 2000 and 4000 mg/kg were nonlinear with the dipping time. For those treatments showing non-linear relationship, the quantity of phytic acid in the shrimp flesh increased rapidly in the first ten minutes and gradually increased at the slower rate in the later dipping time. Average phytic acid content in canned shrimps was 63.77 percents compared with the blanched peeled shrimps dipped in phytic acid solution. The blanched peeled shrimps had total iron content between 101.62–168.70 mg/kg and total copper content between 11.36–17.60 mg/kg. The pH of canned shrimps were between 6.05 to 6.43 and total sulfur dioxide content were between 14.74 to 25.93 mg/kg. The colour of canned shrimps varied from slight blackening to good colour. Another experiment, blanched peeled shrimps were dipped in three concentration levels of phytic acid solution 1000, 2000 and 3000 mg/kg. With the ratio 1 : 1 for 10, 20 and 30 minutes before canning by process II. The results showed that the pH of canned shrimps were between 6.11 to 6.52 and the total sulfur dioxide contents were between 17.14 to 22.88 mg/kg. All samples had moderate blackening.

Prevention of blackening in canned shrimps by using phytic acid in packing step was also studied. The cooked blanched and peeled shrimps were processed in five different procedures. First, the

shrimps were dipped in 500 mg/kg phytic acid solution (shrimp to solution ratio was 1 : 5) for twenty minutes. It was found that the shrimps were slight blackening. Second, 1000 mg/kg phytic acid was added in packing brine. The result showed that the shrimps were good colour. Third, the shrimps were dipped in 500 mg/kg phytic acid solution for twenty minutes together with adding 1000 mg/kg phytic acid in packing brine. It was found that the shrimps were good color, Fourth, no phytic acid was used in any steps. The result showed that all samples were slight to moderate blackening. Fifth, 1000 mg/kg EDTA was added in packing brine and best colour shrimps were obtained in every samples.

Keywords: Canned shrimp; Canned prawn; Phytic acid; Blackening

676 Yardrun Suwannarat. 2001. **The antibacterial activity of some herbs on pathogenic bacteria in frozen black tiger prawn.** Master Thesis. Kasetsart University. 96 p.

The ability of crude extracts from 14 herbal plants to inhibit the growth of bacteria 8 species : *E. coli*, *Staphylococcus aureus*, *Salmonella enteridis*, *Sal. para A.*, *Sal. typhi*, *Sal. Typhimurium*, *Vibrio cholerae* and *V. parahaemolyticus* was investigated by paper disc diffusion technique. It was found that crude extracts of fresh garlic were the most effective. The fresh garlic extracts were thus used in subsequent experiment to determine a shelf life of frozen black tiger prawn samples. The results showed that the extracts could reduce the total plate counts of samples from 2.33×10^4 CFU/g to 3.1×10 CFU/g compared to a reduction from 7.10×10^4 CFU/g to 7.90×10 CFU/g for the untreated samples after 90 days [$P > 0.05$] in the both cases. The *Salmonella* spp. counts were reduced from 1.50×10^2 CFU/g not detectable after 10 days ($P > 0.05$) for the treated samples while reduced from 3.63×10 CFU/g and not detectable after 20 days ($P < 0.05$) for the untreated samples. The sensory test was carried out on cooked black tiger prawns for consumer acceptability of odor, flavor and overall acceptability and the results were slightly to moderately acceptable both on the first day and after 90 days. Similarly cooked black tiger prawn samples treated with each eight bacteria were tested. The results obtained from either treated or untreated samples were found nearly the same for the following individual case : the samples treated with *E. coli*, *S. aureus*, *Sal. enteritidis*, *Sal. para A.*, *Sal. typhi* and *Sal. typhimurium* had a decreased total bacteria counts after 90 days [$P > 0.05$] while those treated with *V. cholerae* were undetectable after 60 days and lastly those with

V. parahaemolyticus were undetectable after 10 days.

Keywords: Herbs; Bacteria; Frozen shrimps; Frozen prawns; Garlic; *Vibrio*; *Salmonella*

677 Rasita Jittam. 1990. **Storage of dried shrimp by controlling relative humidity and using oxygen absorber.** Master Thesis. Kasetsart University. 135 p.

To study the microorganisms in dried shrimp, seven different water activity (a_w) media for enumerating molds and eleven media for enumerating bacteria were compared. The most suitable medium was then chosen for enumerating and isolating the microorganisms in dried shrimp. The results indicated that DG 18 (Dichloran 18% Glycerol Agar) was the best medium for determining molds while TSA 5 (Trypticase Soy Agar 5% NaCl) was the most suitable medium for determining bacteria.

The majority of molds found in spoiled dried shrimp were *Aspergillus*, *Penicillium*, *Rhizopus*, *Cladosporium* and *Paecilomyces*. Neither *Cladosporium* nor *Paecilomyces* was found in PDA (Potato Dextrose Agar), however they were found in DG 18. The bacteria found in dried shrimp were halophiles of the genera *Bacillus*, *Staphylococcus*, *Micrococcus* and *Corynebacterium*. The species present were *B. brevis*, *B. megaterium*, *S. xylosum*, *S. hyicus*, *S. auricularis*, *S. sciuri*, *S. capitis*, *M. lylae* and *M. sedimentarius*. In addition, reduced a_w media containing the like concentration of NaCl as in dried shrimp were suitable for enumerating and isolating the significant microorganisms in spoiled dried shrimp.

Chemical analysis of dried shrimp help in relative humidities (RH) of 75, 80 and 85% at 25 °C and at ambient temperature (29 ± 1 °C) showed that a_w and moisture content became greater and pH also increased, presumably due to the ammonia production throughout the storage period of 12 weeks. The sample held in RH of 75 and 80% at both temperatures had a mold-free shelf-life of more than 12 weeks and ammonia content of not greater than 800 ppm. The mold-free shelf-life of samples in 85% RH was only nine weeks. Therefore, it was concluded that the storage of dried shrimp in controlled RH 75-80 % could extend the mold-free shelf-life and retard ammonia production, which were the important problems in the spoilage of dried shrimp.

Also studied was the keeping quality of dried shrimp stored in KON/PE laminated bags (polyvinylidene chloride coated nylon/polyethylene) with an oxygen absorber for 15 weeks. It showed that the numbers of molds remained fairly constant throughout the study period, the ammonia content did not become greater than 450 ppm. and the pH remained less than 8.0 as compared to control

samples packed in PP bags (polypropylene) which had a mold growth of 1.5×10^3 CFU/g, ammonia content of more than 1,000 ppm. and pH of about 8.2. Neither *Staphylococcus aureus* nor anaerobic bacteria were detected in any of the samples. The color of dried shrimp packed with an oxygen absorber was acceptable for the entire study period of 15 weeks, but the color of the normally packed samples was acceptable for only two weeks of storage.

Keywords: Dried shrimp; Dried prawn; Relative humidity; Oxygen; Absorption; Microorganisms; Fungi; Bacteria

678 Sunisa Sripongpankul. 1991. **Quality Changes of Black Tiger Shrimp (*Penaeus monodon* F.) during Harvesting and Frozen Storage.** Master Thesis. Prince of Songkla University. 98 p.

This report examines quality changes of black tiger shrimp (*Penaeus monodon* F.) during harvesting and frozen storage. Specifically, this report looks at : 1) water property and shrimp quality in the culture pond, 2) quality of seawater and brackishwater shrimp, 3) shelflife of shrimp stored in ice, and 4) effects of handling and frozen storage on shrimp quality.

The study on property of water and of quality shrimp in the culture pond showed that the water salinity was 37-42 part per thousand. One day before harvesting, the water had a pH value of 8.10-8.44 and a total viable count (TVC) of $1.00-6.30 \times 10^3$ colonies/ml. Before the end of the harvesting period 0.5-1 hr, the water had a pH value of 7.90-8.35 and TVC of $2.1-7.5 \times 10^3$ colonies/ml. However, one day before harvesting, the shrimp had a pH value of 6.50-6.70 and a TVC of $3.0-7.5 \times 10^4$ colonies/g., while before the end of the harvesting period the shrimp had a pH value of 6.52-6.69 and a TVC of $1.4-9.1 \times 10^4$ colonies/g. None of the coliforms, *Escherichia coli*, *Staphylococcus aureus*, *Vibrio parahaemolyticus* and *Salmonella* spp. were found in the water or shrimp used in this study.

The quality of seawater shrimp was better than that of brackishwater shrimp. During 4 days of storage in ice the pH values of the seawater shrimp increased from 6.60-6.70 to 7.30-7.40, with total volatile base nitrogen (TVB) ranging from 11.80-12.10 mg/100 g to 18.50-19.00 mg/100 g and a TVC ranging from $8.20-9.50 \times 10^3$ colonies/g to $7.10-8.60 \times 10^4$ colonies/g., while the pH of brackishwater shrimp increased from 6.80-6.90 to 7.30-7.50 with TVB ranging from 13.70-14.20 mg/100 g to 23.20-24.00 mg/100 g and a TVC ranging from $1.50-2.30 \times 10^4$ colonies/g to $8.90-9.80 \times 10^5$ colonies/g. Sensory evaluation of seawater

shrimp was higher than those of brackishwater shrimp in every attribute.

The study on seawater shrimp quality changes during storage in ice showed that shrimps as controlled harvested from the contract farmer had better quality than shrimp from the open market broker. The contract farmer's shrimp had a shelf life of 8 days with pH value of 7.33, a TVB of 25.55 mg/100 g, a TVC of 2.50×10^5 colonies/g and appearance score of 5.08. On the other hand, the open market broker's shrimp had a shelf life of less than 6 days. pH, TVB, TVC and appearance scores for these shrimp on the fourth day were 7.42, 19.80 mg/100 g, 2.70×10^5 colonies/g and 5.66, respectively.

The effects of handling on shrimp quality were also studied. It was found that before harvesting shrimp had the best quality with a pH value of 6.50-6.60, a TVB of 6.30-6.70 mg/100 g, a TVC of $2.43-3.57 \times 10^4$ colonies/g and an appearance score of 8.27. After freezing, pH, TVB, TVC and appearance scores of frozen shrimp were 6.80-7.10, 8.10-8.70 mg/100 g, $3.13-7.56 \times 10^4$ colonies/g and 7.88, respectively.

After 3 months of frozen storage at -18°C , pH and TVC of frozen shrimp did not change significantly, but TVB increased from 8.00-8.50 mg/100 g to 10.20-11.40 mg/100 g and the free drip increased from 3.4-4.0 % to 4.5-6.0 %. However, the sensory evaluation was still acceptable.

Keywords: Frozen shrimps; Frozen prawns; Quality; Storage; Black tiger shrimp; *Penaeus monodon*; Sensory evaluation

679 Puangchompoo Chukiatwattana. 2002. **Partial purification and characterization of protease from shrimp (*Penaeus monodon*) hepatopancreas.** Master Thesis. Kasetsart University. 77 p.

The optimal conditions for extraction of protease enzyme from hepatopancreas of shrimp (*Penaeus monodon*) were studied. Protease extracted with 0.05 M Tris-HCl, pH 7.4 at 4°C gave maximum enzyme activity. The optimum pH of the enzyme was 8.0 and the protease was stable in wide range of pH between 5.0-11.0. At pH 7.0 the enzyme exhibited maximum stability, after incubation at 25°C for 30 min. The extracted enzyme was partially purified by precipitating with 70% ammonium sulfate. The concentrated enzyme was separated by conventional column chromatography on Sephadex G-100. The resulted partially purified enzyme showed 31.62% yield with 2.14 purification fold. The enzyme was kept freeze-dried to facilitate storage. Characterization of partially purified protease was performed by solubilizing the enzyme powder in Tris-HCl 0.05 M, pH 7.0 to give optimum concentration of 25 mg/ml. The results showed that the optimum pH and temperature for enzyme activity were 9.0 and $60-70^\circ\text{C}$. After incubation at 25°C for 30 min

enzyme was stable at pH 4.5–10.0 and after heating at 30°C for 60 min, more than 97% of the enzyme activity remained. The extracted enzyme was applied to shrimp shells powder to study its ability in removing protein from shrimp shells. The experiments were carried out by adjusting enzyme solution to pH 9.0 and incubation at 40, 50 and 60 °C. One part of lyophilized enzyme to 100 parts of dried shrimp shell (w/w) was used in 300 parts (w/v) of buffer. After incubation for 5 hours, the most effective temperature for digestion of protein was 40°C with 32% reduction of protein content. The protein reduction at 50 and 60 °C were 25.80 and 19.20% respectively

Keywords: Protease; Hepatopancreas; Proteins; Shrimp shell; Prawn shell; Shrimp head; Prawn head; *Penaeus monodon*

680 Warapa Woraphong. 1988. **Modified atmosphere storage of dried shrimp.** Master Thesis. Kasetsart University. 129 p.

To investigate ways of extending shelf life, dried shrimp were help in Modified Atmosphere (MA) containing 100% CO₂, 100% N₂ (C 100, N 100) , and mixtures of CO₂ plus N₂ in ratios of 80:20, 60:40, 40:60 and 20:80 by volume (CN 82, CN 64, CN 46, CN 28) in EVA/SARAN/EVA laminated bags (ethylene vinyl acetate/polyvinylidene chloride/ethylene vinyl acetate) at ambient temperature (30°C). Controls were stored in air in similar bags. Product quality was measured by chemical and microbiological indices, and by sensory evaluation of MA-packed and air-packed samples. In addition, chemical properties and microbiological qualities of the survey samples were determined in an effort to establish standards for dried shrimp.

The study of stored dried shrimp indicated that atmosphere containing $\geq 60\%$ CO₂ and nitrogen was effective in reducing ammonia production and astaxanthin oxidation in dried shrimp. Samples held in air were faded and had strong ammonical odor in four weeks, whereas the samples held in MA retained color fairly well for twelve weeks and had levels of ammonia in the range of 800-1,000 parts per million (ppm.) throughout storage for nine weeks. Tissue pH of dried shrimp increased, presumably due to the ammonia production. The CO₂ was tension in the samples held in MA decreased because CO₂ was absorbed by the dried shrimp. Thus, the keeping quality of MA-packed shrimp was better than that of air-packed. Sensory evaluations indicated that there was good correlation between the level of ammonia and the acceptability in odor evaluations and between the amount of astaxanthin pigment and acceptability in color evaluations. It was found that dried shrimp

assessed as of good quality in sensory evaluations had a pH lower than 8, contained not more than 800 ppm of NH₃ and had the pigment more than 0.2 units of astaxanthin per gram.

Storage in modified atmosphere containing $\geq 60\%$ CO₂ was affective in retarding microbial growth in dried shrimp. The total viable count in samples held in MA were at least 90% in an order of magnitude lower than controls held in air over the storage period. Both *Staphylococcus aureus* and mold count decreased as the period went on storage and anaerobic bacteria were not detected in any sample because of the low water activity (a_w) in dried shrimp.

From the analysis of chemical and microbiological properties of survey samples, which were collected from the retail market in Bangkok and in provincial towns in the production area, the draft of microbiology standard for could be established for dried shrimp as follow : Total viable count 500,000 CFU/g, *S. aureus* 100 CFU/g, Mold 50 CFU/g, Coliform bacteria 0 CFU/g and *Salmonella* 0 CFU/25 g.

The results indicate that modified atmosphere can play a role in prolonging the shelf life and the microbiology standard could be improving the quality of dried shrimp as well as providing better safety for consumers.

Keywords: Modified atmosphere; Dried shrimps; Dried prawns; Storage; Pigment; Sensory evaluation; Color; Laminated bag; Astaxanthin

681 Supranee Buranont. 2002. **Production and storage of broken shrimp – hybrid catfish meat burger.** Master Thesis. Kasetsart University. 131 p.

Production of shrimp burger from broken shrimp and hybrid catfish meat was studied. The main components : broken shrimp meat, hybrid catfish flesh and corn flour were varied by mixture design proportion. The product made from 70% broken shrimp meat, 20% fish flesh and 10% corn flour was the most acceptable. Using tapioca or wheat flour at the same amount of corn flour did not show the different texture ($P > 0.05$). Therefore tapioca flour was chosen due to its a cheaper price and domestically produced. The storage study show that at 4–6°C, the product packed in polyethylene bag under air and laminated plastic bag (LA/LDPE) under modified atmosphere (60% CO₂ and 40% N₂) and vacuum conditions could be kept for 6 days. The bacterial counts at the sixth day were 5.6×10^6 , 5.6×10^6 and 2.8×10^6 colony/g, respectively. The thiobarbituric acid value, moisture content as well as water retention were gradually increased. Under frozen condition at -18 °C, all types of package could be kept for more than 5 months. The bacterial counts were 4.5×10^5 , 2.0×10^4 , 4.5×10^3 colonies/g from the normal sealed polyethylene, vacuum and modified

atmosphere packages, respectively. However, the thiobarbituric acid value increased to 0.30, 0.23 and 0.21 mg malonaldehyde/kg in those three conditions, respectively. On contradiction, moisture content and water retention decreased especially in the normal air seal which was the most changed. Pathogenic bacteria were not found in all samples.

Keywords: Shrimp burger; Preservation; Storage; Laminated bag; Polyethylene bag

682 Wichulada Chuaichim. 2001. **Selection of proteolytic bacteria for shrimp head digestion.** Master Thesis. Kasetsart University. 92 p.

Proteolytic bacteria (150 strains) were isolated from 44 different samples. Of these, one strain, W 24.02 was isolated from waste water at the dairy plant of Kasetsart University, produced the highest enzyme activity (25.6 unit/ml). The morphological and biochemical properties of this strain of bacteria were similar to *Pseudomonas aeruginosa*. Some factors affecting hydrolysis of shrimp head with the produced enzyme were studied i.e., pH, enzyme concentration, temperature and time. The optimal initial conditions for enzyme hydrolysis were pH 7.0 with enzyme concentration of 9 % at 55 °C for 12 hours. The increase soluble proteins in the hydrolysate was 8.10 mg/ml. The proximate composition of sprayed dried hydrolysate were 52.6% protein, 0.56% fat, 14.9% moisture and 15.6% ash. The amino acid composition of the dried peptone comprised 18 amino acids. The dried peptone was as good as the commercial peptone in supporting growth of *Bacillus subtilis*, *Escherichia coli* and *Staphylococcus aureus*

Keywords: Bacteria; Shrimp head; Prawn head; Peptones

683 Sirintra Boonsumrej. 2001. **Effects of freezing process on the quality changes of tiger shrimp (*Penaeus monodon*) frozen by air-blast and cryogenic freezing.** Master Thesis. Chulalongkorn University. 103 p.

The effects of freezing by air-blast freezer and cryogenic freezer, as well as the effects of thawing methods and freeze-thaw cycles on the chemical and physical changes of the tiger shrimp (*Penaeus monodon*) were investigated. The air-blast freezing was done at the temperature of $-28 \pm 2^\circ\text{C}$ and the air velocity of 4-8 m/s while the cryogenic freezing was done at the temperature of -70° - $(-100)^\circ\text{C}$. The optimum conditions for both freezing methods were considered from the freezing rate, % freezing loss (%FL) and cutting force (CF) of thawed samples. The samples frozen under the selected

conditions were thawed under microwave and under refrigerator (temperature -5°C). The freeze-thaw effect was studied up to 4 cycles and the changes in chemical and physical properties, i.e. thiobarbituric acid number (TBA), total volatile base (TVB), pH, salt-soluble protein content (SSP), % thawing loss (%TL), and cutting force were measured. The results showed that freezing by the air-blast freezer gave the freezing rate of 6.85-7.42 cm/h while using the cryogenic freezer gave 11.82-21.98 cm/h. Samples frozen at the air velocity of 6 m/s had the least %FL and similar CF to the fresh samples. All temperatures used for cryogenic freezing showed no effect on %FL with the samples frozen at -70°C had the similar CF as the fresh samples. For the shrimps frozen under the selected conditions of both freezing methods, it was found that thawing method did not affect pH, SSP and CF. Samples thawed under the microwave thawing had higher TBA than those thawed under refrigerator temperature. Increasing the number of freeze-thaw cycles increased the TBA, pH and CF values but decreased the SSP. The combined effect of thawing method and freeze-thaw cycles showed to affect TVB and %TL. Samples thawed under the microwave had higher %TL than those thawed under refrigerator temperature. Increasing the number of freeze-thaw cycles increased TVB and %TL values. For the Scanning Electron Microscopy (SEM) and histological studied under light microscope of shrimps frozen under cryogenic at the selected conditions, it was found that the spacing between the muscle fiber increased and the muscle fiber bundles were torn as the number of freeze-thaw cycles increased. These changes were obvious when the samples were freeze-thawed more than two cycles.

Keywords: Tiger shrimp; *Penaeus monodon*; Frozen shrimps; Frozen prawns; Quality; Thawing; Freeze-thaw cycles; Physico-chemical changes

684 Ajin Pansantare. 1996. **Effect of raw material pretreatment and freezing methods on the quality of frozen giant tiger prawn *Penaeus monodon* fabricius.** Master Thesis. Chulalongkorn University. 113 p.

This research is intended to study the optimum conditions for production of frozen shrimp. Soaking time and concentration of sodium tripolyphosphate (STPP) were studied for raw material preparation to reduce loss of water and shrinkage of shrimp muscle. After cooking, disadvantages are still encountered with translucent and raw appearance. Calcium chloride and sodium acidpyrophosphate (SAPP) were added to STPP solution. It was found that the suitable condition for the preparation were soaking in 2% STPP and 0.75% CaCl_2 solution for 4 hours at temperature not exceeded 5°C . Quality changes of frozen cooked shrimp by different preparation

method with two different freezing method during 6 months. It was found that product soaked in 2 % STPP and 0.75 % CaCl_2 gave thawing loss. Total Volatile Base Nitrogen (TVB-N), force to pierce shrimp muscle and microorganism content lower than unsoaked product but higher sensory score ($P \leq 0.05$). Liquid nitrogen cryogenic freezing gave thawing loss, TVB-N and force to pierce shrimp muscle lower than air blast freezing but microorganism and sensory score higher than air blast freezing method ($P \leq 0.05$). The Thawing loss, TVB-N force to pierce shrimp muscle increased, microorganism content and sensory scores decreased with storage time ($P \leq 0.05$). Compare the tissue of frozen cooked shrimp by different freezing methods were investigated by scanning electron microscope to see structural texture damage caused by ice crystal formation and growth. With air blast freezing method, severe structural texture due to growth of large ice crystal causing tissue shrinkage and compaction was seen. With liquid nitrogen cryogenic freezing, structural texture of frozen cooked shrimp is virtually close to cooked fresh shrimp.

Keywords: *Penaeus monodon*; Frozen cooked shrimp; Frozen prawns; Frozen shrimps; Air blast freezing; Liquid nitrogen; Cryogenic freezing

685 Akanit Thammincha. 2002. **Batter mixes mainly from cassava flour for frozen battered giant tiger shrimp (*Penaeus monodon*)**. Master Thesis. Kasetsart University. 209 p.

Development of batter mixes mainly from cassava flour used minor ingredients to improved the chemical and physiochemical properties of cassava flour. Fixed quantity ingredients were 12 minutes alpha-amylase modified cassava flour for 8% to reduced batter peak viscosity and 2 hours pullulanase modified cassava flour for 5% to increased batter gel strength. Another two minor ingredients were Soy Protein Isolate (SPI) and Carboxy methylcellulose (CMC). The experiment varied SPI from 0-20% and CMC from 0-0.8%. When SPI and CMC increased, batter mixes need more additional water in mixing process and batter would gain higher adhesion percentage, CMC had greater adhesion efficiency than SPI. Higher SPI made batter peak viscosity decreased but higher CMC made batter's viscosity increased significantly. Both SPI and CMC made batter's setback decreased but the result from freeze-thaw stability experiment indicated that batter with SPI and CMC showed a higher retrogradation than the non SPI and CMC formula. Frozen battered shrimp products were made from 15 formulas of batter mixes from designed experiment. SPI and CMC had a negative interaction in oil absorption and

sensory evaluation score, batters which had both SPI and CMC would yield a higher oil absorption and less sensory evaluation score than batter which had only SPI or CMC. But SPI and CMC made batter able to reserve the shrimp water activity and made batter's texture more fracture. Commercial batter mixes needed more additional water, and got a higher adhesion percentage and retrogradation. Frozen products from commercial batter had lighter color, higher oil absorption and less fracturability than cassava flour batter. But commercial batter able to reserved shrimp's water activity as good as cassava flour batter. Cassava flour batter with 8% soy protein from SPI had higher sensory evaluation score than commercial batter but cassava flour batter with 0.8% CMC had lower score.

Keywords: Frozen battered shrimp; Giant tiger prawn; Giant tiger shrimp; *Penaeus monodon*; Batter; Cassava flour

686 ประภาพร อุทาร์พันธุ์ และ นิษา ไพจิตร. 2544. **สมบัติของเลคตินจากฮีโมลิมฟของกุ้งแช่บ๊วย**. ทูลอดหนุนการวิจัยจากงบประมาณคณะวิทยาศาสตร์ ประจำปี 2544. ภาควิชาเคมี, คณะวิทยาศาสตร์. มหาวิทยาลัยสงขลานครินทร์. 37 น.

Lectins are carbohydrate-binding proteins. They show specific binding to carbohydrates and have more than one binding sites which allow them to agglutinate cells and/or precipitate glycoconjugates. Lectins are found in plants, animals and also in microorganisms.

Serum lectin from hemolymph of banana prawn (*Penaeus merguensis* de Man) contained the highest specific hemagglutinating activity against rabbit red blood cells. It was strongly specific to N-acetyl neuraminic acid, mucin and fetuin. The optimal pH for its hemagglutination was 7-8.

Purification of lectin from banana prawn hemolymph was achieved by one-step chromatography on Fetuin-agarose column. The purified lectin showed a single band in polyacrylamide gel electrophoresis (PAGE) under nondenaturing condition. It had a molecular weight of 316,200 Daltons, as determined by gel filtration. When analysed by SDS-PAGE in the presence or absence of β -mercaptoethanol, the purified lectin was found to exist in 2 forms of proteins, with M_r of 32,300 and 30,900. It was estimated to consist of pentamers of each of M_r 32,300 and M_r 30,900, and contain no disulphide linkage between subunits. The purified lectin had a total carbohydrate content of 180 μg glucose/mg protein and 260 μg mannose/mg protein.

The purified lectin expressed higher specific hemagglutinating activity against rabbit red blood cells than human red blood cells. Its hemagglutination was completely inhibited by mucin,

fetuin and N-acetyl neuraminic acid at 1.0 mg/ml, 1.5 mg/ml and 1.56 mM, respectively. N-acetyl galactosamine, N-acetyl glucosamine and N-acetyl mannosamine were less potent inhibitors. Hemagglutination of the purified lectin was Ca^{2+} dependent. Ethyleneglycoltetraacetic acid at 0.075 mM completely inhibited its activity.

The purified lectin was stable at pH 7.5-8.0. The optimal pH for its hemagglutination was 7.5-8.0. The purified lectin was labile at temperatures over 50 °C. Its stability was increased upto 65°C in the presence of 50 mM CaCl_2 .

Both the purified lectin and serum lectin could agglutinate pathogenic bacteria of some *Penaeus* prawns such as *Vibrio harveyi*, *Vibrio parahaemolyticus* and *Vibrio vulnificus* but not their non pathogenic *Vibrio cholerae*, *Samonella typhi* or *Escherichia coli*. In addition, lectin level in hemolymph of banana prawns infected with *V. harveyi* was 1.62 folds higher than that of controls which were injected with 0.9% NaCl instead. These results indicate that the increased lectin level in hemolymph may respond to the infection as a defense mechanism in banana prawns.

Female mature prawns contained lectin level in hemolymph at 1.55 folds higher than those of mature males. It seems that hemolymph lectin of females may be involved in ovarian maturation as shown in acorn barnacle or grouper.

Keywords: Lectin; Hemolymph; Banana prawn; *Penaeus merguensis*

687 Aran H-Kittikun, Prapasri Singrat and Sumeth Chaiwatcharakul. 1995. **Effect of postharvesting techniques on the quality of frozen shrimp (*Penaeus monodon*)**. Prince of Songkla University. 51 p.

This report examined quality changes to black tiger shrimp (*Penaeus monodon* F.) through harvesting, processing and frozen storage. Specifically, this report looks at : 1) water property and shrimp quality in the culture pond, 2) quality of seawater and brackishwater shrimp, 3) shelflife of shrimp stored in ice, and 4) effects of handling and frozen storage on shrimp quality.

The study on water quality and shrimp quality in the culture pond showed that water salinity was 37-42 part per thousand. One day before harvesting, the water had a pH value of 8.10-8.44 and a total viable count (TVC) of $1.00-6.30 \times 10^3$ colonies/ml. Before the end of the harvesting period 0.5-1.0 hr, the water had a pH value of 7.90-8.35 and TVC of $2.1-7.5 \times 10^3$ colonies/ml. However, one day before harvesting, the shrimp had a pH value of 6.50-6.70 and a TVC of $3.0-7.5 \times 10^4$ colonies/g, while before the end of the harvesting period the shrimp had a pH value of

6.52-6.69 and a TVC of $1.40-9.1 \times 10^4$ colonies/g. None of the coliforms, *Escherichia coli*, *Staphylococcus aureus*, *Vibrio parahaemolyticus* and *Salmonella* spp. Were found in the water of shrimp from the pond.

The quality of seawater shrimp was better than that of brackishwater shrimp. During 4 days of storage in ice, the pH of the seawater shrimp increased from 6.60-6.70 to 7.30-7.40, with total volatile base nitrogen (TVB) ranging from 11.80-12.10 mg/100 g to 18.50-19.00 mg/100 g and a TVC ranging from $8.20-9.50 \times 10^3$ colonies/g to $7.10-8.60 \times 10^4$ colonies/g, while the pH of brackishwater shrimp increased from 6.80-6.90 to 7.30-7.50 with TVB ranging from 13.70-14.20 mg/100 g to 23.20-24.00 mg/100 g and a TVC ranging from $1.50-2.30 \times 10^4$ colonies/g to $8.90-9.80 \times 10^5$ colonies/g. Sensory evaluation of the seawater shrimp was higher than those brackishwater shrimp in every attribute.

The study on seawater shrimp quality changes during storage in ice showed that controlled harvest shrimp from the contract farmer had better quality than shrimp from the open market broker. The contract farmer's shrimp had a shelf life of 8 days with pH value of 7.33, a TVB of 25.55 mg/100 g, a TVC of 2.50×10^5 colonies/g and an appearance score of 5.08. On the other hand, the open market broker's shrimp had a shelf life of less than 6 days. pH, TVB, TVC and appearance scores for these shrimp on the fourth day were 7.42, 19.80 mg/100 g, 2.70×10^5 colonies/g and 5.66, respectively.

The study of use of chemicals with shrimp shows that shrimp dipped in sodium metabisulfite had better quality than shrimp dipped in sodium tripolyphosphate and control group.

The effects of handling on shrimp quality were also studied. It was found that before harvesting shrimp had the best quality with a pH value of 6.50-6.60, a TVB of 6.30-6.70 mg/100 g, a TVC of $2.43-3.57 \times 10^4$ colonies/g and an appearance score of 7.88. After freezing, pH, TVB, TVC and appearance scores of frozen shrimp were 6.80-7.10, 8.10-8.70 mg/100 g, $3.13-7.56 \times 10^4$ colonies/g and 7.35 respectively.

After 3 months of frozen storage at -18°C, pH and TVC of frozen shrimp did not change significantly, but TVB increased from 8.00-8.50 mg/100 g to 10.20-11.40 mg/100 g and the free drip increased from 3.4-4.0 % to 4.5-6.0 %. However, the sensory evaluation was still acceptable.

Keywords: Frozen shrimps; Frozen shrimps; Black tiger shrimp; Quality; Storage

688 Cheunjit Junwattanawong. 1995. **Rapid method for estimation of total number of catalase producing bacteria in fresh black tiger prawn *Penaeus monodon* Fabricius**. Master Thesis. Chulalongkorn University. 114 p.

The rapid methods for estimation of the total number of bacteria in fresh black tiger prawn were developed by detecting activity of enzyme catalase. The method were assessed in 2 ways by using Catalasemeter constructed in this project and Gas column method. Two detecting systems were tested in Catalasemeter using filter membrane system and paper disk system. The bacterial catalase was separated from the prawn's tissue by rinse method. Catalasemeter method was able to detect commercial catalase (Microcatalase®) at the level between 10^{-1} to 10^2 International Units.ml⁻¹. Paper disk Catalasemeter was able to detect activity of catalase in *Pseudomonas fluorescens* between 10^4 to 10^8 CFU.ml⁻¹, while Filter membrane Catalasemeter method could detect activity of catalase only at 10^8 CFU.ml⁻¹. For Gas column method, detection level of pure catalase and catalase from *Pseudomonas fluorescens* were 10^{-2} to 10 International Units.ml⁻¹ and 10^5 to 10^7 CFU.ml⁻¹ respectively. Using paper disk Catalasemeter, the total number of bacteria of fresh black tiger prawn from Nakon Si Thammarat, Rayong and Surat Thani were estimated to be in between 10^4 to 10^9 CFU.g⁻¹. Which is not significantly different at $P>0.05$. Identification of predominant bacteria was found to be those which give strong catalase activity (+++). Mixtures of strong (+++) and weak catalase (++ or +) producing bacteria at ratio of 2:1 gave the same catalase activity as the strong catalase positive bacteria (+++). Predominant bacteria of black tiger prawn from Rayong was the genus *Micrococcus*, whereas predominant bacteria from Nakon Si Thammarat and Surat Thani was the genus *Acinetobacter*. Both genera are strong catalase positive.

Keywords: Catalase; Black tiger prawn; *Penaeus monodon*; Bacteria

689 Ratmanee Harnwanichsak. 1997. **Preliminary design of chitin and shrimp flavor production process from shrimp waste.** Master Thesis. Chulalongkorn University. 131 p.

This research makes a preliminary design of chitin and shrimp flavor production process by dividing the research into 3 stages. Firstly, the optimum protein hydrolysis condition using enzyme neutrase was found by testing at 4 temperature levels that is 45, 50, 55 and 60 degree celsius. It was found that the temperature at 55 degree celsius yielded the maximum hydrolysis when compared to the other temperatures. Testing at 5 enzyme dosing levels, that is, 0.04, 0.06, 0.08, 0.10 and 0.12 % w/w and at 4 time periods, that is, 30, 60, 90 and 120 minutes, revealed that the enzyme doing and time had significant effect on the tyrosine concentrate. When they increase, the tyrosine also

increases. The chosen optimum conditions are enzyme dosing 0.08 % w/w, time 60 minutes. Secondly, various chitin production processes were reviewed. This research then selected the optimum for industrial production using acid and caustic solutions. The optimum demineralization condition is a ratio of shrimp waste : 1-M HCl equaling 1 : 10, time 1 hr at ambient temperature. The optimum deproteination condition is a ratio of shrimp waste : 2-M NaOH equaling 1:10, time 2 hrs at 55 degree celsius. Finally, preliminary industrial process design and investment cost estimation were carried out. Raw shrimp 20,000 kgs/day yields shrimp waste 2,600 kgs/day. When processed to the finished product, there will be chitin 468 kgs and hydrolysate 2,028 kgs. The project requires a total investment of 37,477 MB. Economic analysis reveals that this project had a breakeven point equal to sales of 172,000 kgs/year. Next the following criteria for economic feasibility are used. that is, payback period, net present value, internal rate of return and profitability index. It was found that these criteria equaled 4 years, 100.148 MB, 52.1 % and 3.04 baht respectively.

Therefore it is concluded that project should be interesting to invest in and to proceed with detailed design.

Keywords: Preliminary design, Chitin, Chitosan, Shrimp flavor, Shrimp waste

690 Sirima Kiatsrichart. 1991. **Production of frozen ready-to-eat and semi-ready-to-eat breaded shrimps.** Master Thesis. Chulalongkorn University. 100 p.

Appropriate conditions for production and storage of frozen ready-to-eat and semi-ready-to-eat breaded shrimp were studied. Initially, best formulae for batter, egg product and breading were selected by sensory evaluation and analyzing for fat content in the finished products. Later, variables comprising substitution of wheat flour with rice and corn flour in batter; ratio of flour to water at 1:0.8, 1:1, 1:1.25, 1: 5; prefrying temperature at 155, 165 and 175 °C; prefrying time at 0, 20, 40, 60 and 90 seconds; fresh vs frozen-thawed shrimps; and blanching of raw shrimp in boiling water for 20 seconds before breading; were studied. The best products from all studies were selected by sensory evaluation and analyzing of the fat content, the cutting force and the production yield. Storage stability of the products in high density polyethylene (HDPE) and Eval film bags were estimated at -20 °C. At one month interval samples from each treatment were evaluated for the moisture content, the total plate count, the thiobarbituric acid (TBA) value, the cutting force and the organoleptic quality.

The most appropriate formula for batter was composed of 78% all purpose wheat flour, 2.5% salt,

2.5% baking powder, 13.3% whole egg powder, 3.7% sugar, in combination with coarse bread crumb. The binding properties of fresh whole egg and whole egg powder were better than those of fresh yolk and yolk powder. The selected batter provided the good appearance and the least greasy product. Less fat and food texture property in the product was obtained when substitute all purpose wheat flour with 16% corn flour, 9% rice flour and using the flour to water ratio of 1:1.5 and 1:1 for the ready-to-eat and semi-to-eat products, respectively. The optimum prefreezing frying temperature and time found were 155 °C, 20 seconds. The quality and fat content of products from fresh and frozen-thawed shrimp were not different but higher production yield was resulted when using fresh shrimp. Semi-ready-to eat product from blanched shrimp was better in textural characteristic and acceptability. Frozen ready-to-eat and semi-ready-to-eat products in HDPE and Eval film bags when stored at -20 °C for 4 months were not significantly different in the organoleptic quality, the total plate count and the cutting force, from freshly produced products. Higher moisture loss and higher TBA value were observed in samples packed in HDPE bags. Sensory panelists could not detect rancid off flavor at the TBA level found in this experiment.

Keywords: Frozen breaded shrimps

691 Siritat Jongrattiporn, Attaya Kungsuwan and Sudip Kumar Rakshit. 2003. **Inhibition of growth of pathogenic bacteria by chitosan.** Thai Fisheries Gazette. 56 (2):139-143.

Inhibition and inactivation of four pathogenic bacteria (*Escherichia coli*, *Staphylococcus aureus*, *Vibrio cholerae* and *Salmonella weltevreden*), by chitosan were studied. Chitosan which has deacetylation number 90% and molecular weight of 10^6 dalton was used. The experiment were performed *in vitro* with chitosan concentration of 0%, 0.001%, 0.01%, 0.1% and 1% in 1% acetic acid. *In vitro*, the result showed that 0.1% chitosan could inhibit the growth of all four organisms. The growth of *Staphylococcus aureus* was inhibited even at 0.01% chitosan. The effectiveness of chitosan against *Staphylococcus aureus* was the greatest, followed by *Vibrio cholerae*, *Salmonella weltevreden* and *Escherichia coli* respectively. The effect of chitosan is to inhibit the growth of organism in fish ball and to extend the lag phase of all four organisms when compared with control.

Keywords: Chitosan, Bacteria, Shrimp shells, Prawn shells

692 Siri Tookwinas, Niwat Suthemechaikul and Atchara Wongsangchan. 1996. **The**

Environmental impact of intensive marine shrimp farming effluent and carrying capacity estimation at Kung Krabaen Bay, Chanthaburi, Eastern Thailand. Technical Paper No.5/1996. Coastal Aquaculture Division, Department of Fisheries. 29 p.

The water quality parameters in the intensive marine shrimp farming around Kung Krabaen Bay and in the bay have been surveyed since 1989. The yearly average result shown that the transparency was in the range of 0.425 to 1.635 cm. The dissolved oxygen was in the range of 5.85 to 6.90 mg/l. The ammonia-nitrogen was in the range of 0.011 to 0.144 mg/l. The average total plate count (TPC) which was analyzed monthly from 1993 to 1994, was in the range of 8.0×10^3 to 3.8×10^3 CFU/ml. The BOD was in the range of 1.750 to 2.997 mg/l. The phosphate was in the range of 0.006 to 0.325 mg/l. The silicate was in the range of 0.013 to 0.707 mg/l. Statistical analysis indicated that transparency, phosphate, alkalinity, pH and BOD₅²⁰ were significantly different ($P > 0.05$) during from 1991 to 1994.

However, water salinity, nitrite, ammonia, total plate count and vibrio count were found non-significantly difference ($P > 0.05$). The intensive marine shrimp farming at Kung Krabaen Bay was around 142.76 ha. The total effluent discharge loading into the bay was around 67,400 ton/ha/crop. The BOD and ammonia loading were 699.60 kg/ha/crop and 12.81 kg/ha/crop, respectively. The carrying capacity of Kung Krabaen Bay which has the total water surface area of 640 ha was estimated by mass balance model. Ammonia-nitrogen in receiving water or in the bay was set as the optimum safe concentration for sea water standard at 0.1 mg/l. The carrying capacity for intensive marine shrimp farming at Kung Krabaen Bay can be allowed upto 543.93 ha. However, the water balance model for carrying capacity and the water quality prediction in the bay (Beveridge, 1987 and NCC, 1989) will be discussed in details

Keywords: Environmental impacts; Intensive culture; Marine shrimps; Carrying capacity; Estimation; Kung Krabaen

693 Kanit Suttisak. 2000. **An Analysis of input demand for black tiger prawn intensive farming : A case study of Nakhon Si Thammarat province crop year 1998.** Master Thesis. Kasetsart University. 153 p.

The main objectives of this study is to analyze the function of demand for black tiger prawn intensive farming of Nakhon Si Thammarat province crop year 1998. The primary data was collected by interviewing farmers at Pakphanang 39 farmers and Huatri 41 farmers. An analysis of production function is to be

analyze through the technique of multiple regression model.

The analysis of Cobb- Douglas production function shows that numbers of feed, labor, post larvae, medical and chemicals, harvested area and management are as variables which significantly affected the prawn quantity by 60.45% From the results of analysis, indicating that increasing return to scale from prawn farming, and elasticity of demand for input is 1.226. In generally, increase in feed, labor, medical and chemicals and harvested area conduct to increase of prawn output. However, it is not increased by post larvae. From the analysis

of demand for input, the results show that demand elasticities for feed, labor and medical and chemicals are claimed as in elasticities, indicating that the change in price of input will not be affected upon the demand for input.

Keywords: Analysis; Demand; Black tiger shrimp; Intensive culture; Farming; Nakhon Sri Thammarat

694 Kanok Rumdej. 1994. **Investment Evaluation of Tiger Prawn Farming in Eastern Part of Pak Phanang District Nakhon Si Thammarat Province.** Master Thesis. Dhurakijpundit University. 124 p.

The objectives of investment evaluation of tiger prawn farming in eastern part of Pak Phanang District, Nakhon Si Thammarat province. Are as follows :

1. To study socioeconomic of tiger prawn farmers in eastern part of Pak Phanang District, Nakhon Si Thammarat Province.
2. To study cost and returns of tiger prawn farming in the study area.
3. To results of the study can be used as a reference for further study and for planning in tiger prawn farming.

The results of the study reveals that ;

1. Total income and total cost of production for tiger prawn in Pak Phanang District, Nakorn Si Thammarat are 122,765.65 and 62,8021.52 baht per rai per year on the average. Therefore net profit is 61,963.17 bath/rai/year. Moreover, cost and returns of tiger prawn production in each tambon areas are as follows :

Tambon Ban Bangtuad : Total income of production is 101,338.76 baht/crop/rai, total cost is 63,235.75 bath/crop/rai and net profit is 38,103 baht/crop/rai respectively.

Tambon Ban Bangtuad : Total income of production is 119,990.12 baht/crop/rai, total cost is 61,962.94 baht/crop/rai and net profit is 48,027.18 baht/crop/rai respectively.

Tambon Ban Praknum : Total income of production is 114,120.52 baht/crop/rai, total cost is

64,525.24 baht/crop/rai and net profit is 49,595.28 baht/crop/rai respectively.

Tambon Ban Tonhard : Total income of production is 145,843.49 baht/crop/rai, total cost is 59,799.78 baht/crop/rai and net profit is 86,043.71 baht/crop/rai respectively.

Tambon Ban Bangthapra : Total income of production is 142,535.63 baht/crop/rai, total cost is 64,488.89 baht/crop/rai and net profit is 78,046.74 baht/crop/rai respectively.

2. An investment analysis of Tiger prawn Project shows that the internal rate of return (IRR) is 37.25%, net present worth (NPW) and benefit-cost ratio (BCR) at 12% discount rate are 138,223.73 baht/crop/rai and 1.16 respectively. This implies that the project is financially feasible.

As far as the sensitivity analysis is concerned it is found that

2.1 If benefit is decreased by 10% then IRR is 16.4%, NPW = 41,959.81 baht/rai and BCR =1.05 at 12% discount rate respectively. Project is financially feasible.

2.2 An increase by 10% of total cost of investment reveals that IRR = 20.88%, NPW = 55,782.27 baht/rai and BCR = 1.06 at 12% discount rate respectively. Project is financially feasible.

2.3 If benefit is decreased by 10% and cost is increased by 10% then IRR = 5.44%, NPW and BCR = -40,481.66 baht/rai and 0.95 at 12% discount rate which would imply that project is not feasible.

3. The problem of tiger prawn farming in the study area is lack of knowledge to feed, poor management and natural calamities.

It is, therefore, suggested that the government should train the techniques to feed, provide credit and supervision to farmers and also encourage farmers to form as a group of cooperative to perform marketing of tiger prawn production.

Keywords: Investment; Evaluation; Shrimps; Farming; Tiger prawn; Nakhon Sri Thammarat

695 Khorkiat Koolkaew, Potjanee Auttagitmongkon and Surachai Hemmapatana. 1988. **Study on cost and return of *Peneaus monodon* culture by intensive system.** Technical Paper No. 17/1988, Songkhla Brackishwater Fisheries Station. 9 p.

Experiment on culture Tiger prawn (*Peneaus monodon* Fabricius) by intensive system in three earthen pond half rai in size each which stocking density are 25, 20 and 22.5 prawn per square metre. The harvest production are 628.1%; 536.8 and 372.3 kilogram, the survival rate are 95.89%, 91.60% and 55.64; the conversion rate are 1.63, 1.71 and 1.93. The result showed that the most variable cost is pellet feeds which are 28,531.30 ; 26,163.06 and 20,121.62 baht. The profit are 96,724.81; 86,420.66 and 46,548.41 baht respectively.

Keywords: Costs; Returns; *Peneaus monodon*; Culture; Intensive culture; Tiger prawn; Stocking density

696 Kitiwong Sasuad. 2002. **An analysis of factors affecting profit or loss from cultivating black tiger shrimp in Chachoengsao province.** Master Thesis. Krirk University. 73 p.

The objectives of this thesis were (1) to study the trend of revenue and cost of cultivating Black Tiger Shrimp in Chachoengsao Province, and (2) to study factors affecting profit and loss from this cultivation.

The primary data were collected by simple random sampling and interview with 37 farmers in Chachoengsao during B.E. 2543 - 2544 and were analyzed to find certain values as required by the objectives.

The results from study showed that the average revenue (AR) per rai per year from this farming was 42,996.98 baht whereas their average cost (AC) per rai per year was 42,880.90 baht. Of 37 farmers, fourteen were gain and twenty three were loss. The median farmer had 5,999 baht loss per rai per year. It should be noted that by average there was profit of 5,464.40 baht. This was because few farmers could gain a lot of profit even most of them were loss.

The recommendations are as follows. The median loss of Black Tiger Shrimp farming should be publicized for those who are willing to do this career and better ways to reduce the mortality rate of raising them should be found.

Keywords: Black tiger shrimp; Factors; Profits; Loss; Shrimp culture; Chachoengsao

697 Kiattisak Kositchaiwat. 1999. **Assessment of attitude towards occupational change of shrimp culture farmer living on the Western Bank of irrigation canal in Pakpanang Watershed Development Royal Project.** Technical Paper No.2/2542 Fisheries Extension Division. Research and Development. Department of Fisheries. 65 p.

Pakpanang Watershed Development Royal Project is one of the most important projects of the Department of Fisheries due to its nature which involves the conflicting use of land between farmers engaged in fresh water activities (mainly rice culture) and farmers engaged in sea water activities, (i.e. *Peneaus monodon* culture). Maximum precaution must be exercised in efforts to inform and persuade shrimp-culture farmers to switch to other activities, as after completion of Pakpanang Dam in 1999, no activities which need sea water will be allowed on the western bank of irrigation canal.

Consequently, a study of the attitudes of local residents, especially those engaged in the shrimp business is necessary to assess the situation and to define any frame work, including action plans, to help shrimp-culture farmers switch to a substitute occupation, relocation for those who insist on continuing shrimp culture activities.

Results indicated that with regards to general status, the average age of the head of household was 47.45 years. Approximately 65% have a primary education, most (89.6%) domiciles of origin are within the same district as the shrimp ponds. Only a few (2.42%) came from out of the province. The majority (85.6%) own the land they use for the shrimp culture, with an average area of 6.29 rais (roughly equal to 1 hectare). One-third used to do rice farming before turning to raising shrimp. Almost all respondents (96.98%) were aware of Pakpanang Watershed Development Royal project, primarily through village leaders (28.30), neighbours (23.03%) and other individuals.

Out of total 1654 respondents, there were 1267 farmers (75.39%) who intended to switch from shrimp culture to other activities, of which 28 (1.69%) would like to move out of the project area. There were 1219 (73.70%) who did not want to move away, 45 undecided, and 274 (16.56%) who wanted to continue shrimp culture. Of the 274, 162 (9.79) were willing to relocate in order to continue their work, but 112 (6.77%) who insisted they would continue shrimp culture activities on their present land site, something which will not be allowed with completion of the dam in 1999.

Of the 1267 farmers who intended to leave shrimp culture business, 962 (75.9%) wished to engage in fresh water aquaculture activities primarily including giant fresh water shrimp (65.80%) and sea bass (7.90%) cultures.

A study of the factors which affect the decision making of respondents regarding occupational changes indicated there is a causal relationship between age ($X^2=38.46$, $P=0.00000^{**}$), education ($X^2=17.21$, $P=0.004^{**}$), income from shrimp culture ($X^2=21.50$, $P=0.00065^{**}$), income from previous occupation ($X^2=53.58$, $P=0.00000^{**}$), ownership of land ($X^2=19.28$, $P=0.00001^{**}$), expected income from new occupation ($X^2=32.56$, $P=0.0000^{**}$), and the attitude towards occupational changes of shrimp farmers at $P \leq 0.01$. Physical condition of the land ($X^2=8.80$, $P=0.03199^*$) and perception of project information ($X^2=5.30$, $P=0.021947^*$) also have a causal relationship to attitudes toward occupational change of shrimp farmers, but at lower levels of confidence ($P \leq 0.05$). Finally, it was also found that the number of members in a household ($X^2=10.79102$, $P=2.1382$) and type of information source ($X^2=9.24622$, $P=0.32195$) are insignificantly

related to attitude toward occupation change at ($P \leq 0.05$).

Keywords: Attitude; Occupational change; Shrimp culture; Farmers; Irrigation; Pak Panang; Nakhon Sri Thammarat

698 Kajonwan Itharattana and Wirawan Jamsil. 1993. **Demand for Thai marine prawn**. Journal of Agricultural Economics Research 15 (48): 51-71

Objectives of the analysis of the demand for and the market structure of the Thai marine prawn is to gain knowledge on the consumption behavior, factors affecting the behavioral pattern, exports and prices with an aim of reviewing in the country when the development becomes regionally suitable and specific and is in line with the demand.

The analysis relies on the secondary data, 1977–1989. The consumption function is constructed with reference to the economic theory of the consumers' behavior whose spending decision for any goods is based on their limited income and for a maximum utility. Five behavioral equation were set as the model representing the demand for the Thai marine prawn. The ordinary least square method is employed for estimation of the coefficients needed. Test of the model's performance involved Gauss–Seidel Simulation bringing in Theil U–Statistics for the test of fit.

Keywords: Demand; Marine prawns; Markets; Exports; Social; Economics

699 Chanphen Wichakhaphan. 1996. **Feasibility study of the improvement in marine shrimp culture project at Kung Kraben Bay, Amphoe Tha Mai, Changwat Chanthaburi**. Master Thesis. Kasetsart University. 136 p.

An average shrimp yield in shrimp culture project at Kung Kraben Bay has been declined due to the deterioration of water quality. To improve the yield, the government has formulated the shrimp culture improvement project by construction the new water system. The main objective of this study was to conduct the economic feasibility study of the project. The study was divided into two cases;

(1) The economic analysis at market prices : costs and benefits are valued at market prices. The study found that at 12% of discount rate, the NPV of the project was negative, BCR was less than one. And, The financial internal rate of return was 4%. It was concluded that the project is not financially viable.
(2) The economic analysis at shadow prices: costs and benefits are valued at efficiency prices. The study found that at 12% of economic discount rate,

the NPV of the project was negative, BCR was less than one. And, the economic internal rate of return was 10%. It was concluded that the project is not economically viable. The sensitivity analysis showed that if the average shrimp yield increases more than 940 kilograms per rai, the project is economically viable.

Keywords: Improvement; Marine shrimps; Marine shrimp culture project; Kung Krabaen Bay

700 Khathalit Sittikul. 1997. **The study of price behavior and forecasting of important agricultural commodities : case studies on rice, rubber, cassava products, corn and Black tiger shrimp**. Master Thesis. Kasetsart University. 239 p.

The main objectives of this study were to analyze the efficiencies of price transmission of 5 important agricultural commodities : rice, rubber, cassava products, corn and black tiger shrimp, to analyze and to forecast the mangrove of those prices of utilizing the ARIMA model.

The results of the study showed that the transmission of price from export market level to Bangkok wholesale market of almost commodities studied were rather efficient with elasticities of price transmission between 0.8658 to 0.9336 but it was only 0.3382 for cassava product, the price transmission from wholesale market to farmer market of rubber, cassava products, black tiger shrimp were very efficient with elasticities of price transmission between 0.8487 to 0.9968 but they were 0.453 and 0.7568 for rice and corn, respectively.

The study of ARIMA model showed that every time series of all commodities could be adjusted to get stationary series in which they could be utilized in forecasting. There was uptrend in each series. Moreover, there were 12 month seasonal variation in price of 5% paddy received by farmer and Bangkok wholesale price of maize. The movement of fresh cassava price received by farmer and Bangkok wholesale price of cassava were cyclical with 16 month period. The black tiger shrimp prices received by farmer and at processing manufacture were both seasonal pattern with only 5 month period.

Keywords: Prices; Behavior; Forecasting; Black tiger shrimp; Agricultural commodities

701 Kom Silapajarn. 1995. **Marine shrimp culture area identification and classification of Prachuapkhirikhan province**. In Proceeding the Seminar on Fisheries 1995 Department of Fishereis, 18-20 September 1995 DOF Meeting Hall, National Inland Fisheries Institute, Bang Khen. p. 560–564.

The report on coastal area identification and classification for marine shrimp culture was done

along Prachuapkhirikhan coast, 3 kilometers from shore line as the boundary limit. The study was done in every district except Hua hin where provincial plan is for tourism. Sieve analysis was the principal for decision making which mainly on physical factor consideration. While socioeconomic factors were only used as supplemental factors.

The results showed that with 240,668.79 rais studied area, the most 6 suitable area for marine shrimp culture was in Maung district where there is 18,093.44 rais highly suitable area for shrimp culture including with socioeconomics factors supporting. The second was Kuiburi district where 9,977.5 rais was highly suitable area while Bangsapannoi district was the last one that only 3,675 rais was highly suitable area for marine shrimp culture. However, Bangsapan district 51,247.06 rais was moderated suitable and most potential area for shrimp culture expansion in the future.

Keywords: Marine shrimps; Culture; Identification; Classification; Prachuap Khiri Khan

702 Charunchai Korsriphithakkul. 1996. **Factors determining Thai frozen shrimp-export demand of Japan and USA.** Master Thesis. Ramkhamhaeng University. 76 p.

The objectives of this thesis are to study inputs, marketing and Thai frozen shrimp-export of Japan and USA, and to study factors determining Thai frozen shrimp-export demand including elasticities of factors determining Thai frozen shrimp-export demand of both countries. Data employed in this analysis is time series data from 1978–1994. Multiple Regression Procedure is the method used for analyzing the relationship between independent and dependent variables.

The hypothesis of this study is that Thai frozen shrimp-export demand is determined by the ratio of Thai export price and competitors' and Gross Domestic Product of import country. Thai competitors in Japan are China, Indonesia and India, and our competitors in USA are Equador, China and India.

An analysis of Thai frozen shrimp-export to Japan found that the ratio of Thai export price and competitors' and Japan Gross Domestic Product are the two significant factors determining Thai frozen shrimp-export demand of Japan about 96%. Price elasticity and income elasticity of Thai frozen shrimp-export demand of Japan are 1.0355 and 1.8268 respectively.

An analysis of Thai frozen shrimp-export to USA found that the two important factors determining Thai frozen shrimp-export demand of USA nearly 98% are ratio of Thai export price

and competitors' and USA Gross Domestic Product. Price elasticity and income elasticity of Thai frozen shrimp-export demand of USA are 1.8715 and 4.1163 respectively.

This analysis also found that the price elasticity of Thai frozen shrimp-export demand is very high; therefore, if Thai Exporters can reduce price by controlling cost especially in labour wage and shrimp feed, their exports may then increase. However price elasticity of Thai frozen shrimp-export demand of USA is quite higher than Japan's. Thai exporters may expand more in USA if Thai export price in Japan is not stable.

Keywords: Factors; Exports; Frozen shrimps; Demand; Japan

703 Chantana Thanasawangkul. 1989. **Cost and return on investment of Giant tiger prawn farming.** Master Thesis. Chulalongkorn University. 222 p.

The objective of this thesis is to study the cost and return on investment of Giant Tiger prawn farming for the feasibility size of farm to invest. The operations of three different size farms were analyzed: the small-sized farm ranging between 1-15 rais, the medium-sized ranging between 16–30 rais and the large-sized ranging between 31–70 rais. The survey data were collected from the entrepreneurs of intensive farming located around the Gulf of Siam.

According to the result of the study, the most important cost is prawn-feeding. About 60% of the total production cost. The surviving rate of prawns affects the cost and return on investment of Giant Tiger prawn farming if there is no problem of pricing and quality of prawn on selling day.

Regarding the return on investment, the medium-sized farms averaging 18.29 rais gave the highest return on investment. Therefore, the return on investment of Giant Tiger prawn farming does not vary with the size of farm but varies with the surviving rate of prawns and the good efficiency of farm management to effect control on production cost.

The problem of Giant Tiger prawn farming is marketing problem. The entrepreneurs, government and relevant business entities should build the equilibrium market between the buyer and the seller by producing good quality product at fair price and developing product for export in the foreign markets.

Keywords: Costs; Returns; Investment; Giant tiger prawn; Prawns; Farming

704 Jintana Iamlaor. 1998. **Effect of trade measures on frozen shrimps exports of Thailand.** Master Thesis. Kasetsart University. 140 p.

The main objective of this study is to analyse of the possibility potential market for frozen shrimp from Thailand, in addition the study of effects of trade measure in such market on Thai frozen shrimp is also taken into account. The study shows that the most potential market for Thai frozen shrimp is Japan market, while USA, England, Germany and France are respectively. The analysis also indicates that for Japan, a decrease in GATT measure contributes to an increase in Thai's exports of frozen shrimp by 0.13% while in USA, a cancellation of GATT measure but Non-Tariff measures contributes to a decrease in Thai's exporting. A change in GSP, case of EU, contributes to a decrease in Thai's export frozen shrimp for 2.41-5.78% in England, 0.38-0.92% in France, and 0.58-1.39% in Germany. An analysis of forecasting of Thai's frozen shrimp demand shows that trend of volume of demand during 1997-2000 will be accelerated, in Japan and USA, while for England, France and Germany the results are not as anticipated, regarding to a change GSP.

Keywords: Trade measures; Frozen shrimps; Shrimps; Exports

705 in Thai

706 Chirawan Khotcharit. 1999. **WTO and the unilateral trade measure to protect the global commons : a case study of US embargo shrimp and shrimp products from Thailand.** Master Thesis. Chulalongkorn University. 271 p.

This research was carried out purposely to study that the unilateral trade measure to protect the global commons is unacceptable action under the WTO trade rules.

The researcher prescribed the core of WTO trade rules and the environmental protectional exception : Article I, III, XI and XX (b), (g). Moreover, the researcher analysed the GATT and WTO panel report and appellate body report in a related case. Beside that the researcher shown the global commons protectional tendency according to the Multilateral Agreements. Finally, the researcher analysed the panel and appellate body report : the United States-Import Prohibition of Certain Shrimp and Shrimp Products case.

The research result shown the unilateral trade measure is unacceptable action. If it no concern with domestic environmental protectional measure which that country already apply for. The appellate body report was defined and interpreted the condition of Article XX more flexible than in the part. This might effect to the environmental and trade policy of Thailand. So we must adjust and speed up the development of environmental policy more than ever.

Keywords: Trade measures; WTO; Shrimp products; Trade; Exports; USA

707 Chutamard Choitvilaivanich. 1990. **The cold storage investment for shrimp export : a case study of Pak-Nam Walu Land reform area in Chantaburi province.** Master Thesis. Chulalongkorn University. 124 p.

This thesis aims to study the investment of cold storage for shrimp export at Pak-Nam-Walu land reform area in Chantaburi province by using the concept of feasibility study which consists of market, technical, financial, economic and social analysis.

The results of this study show that the market trend of demand and supply for Thailand export shrimp will grow every year from 1991-2000. Technical analysis indicates that a suitable size for cold storage of shrimp production at Pak-Nam Walu Land reform area is 400 ton. By using the benefits and costs of this cold storage size in financial and economic analysis, it is found that the investment in this cold storage is feasible and profitable bases on the positive net present value and internal rate of return which is more than the discount rate. The social analysis reveals that the farmer in land reform area will receive the high income and have a stable long term contract price of shrimp production.

Keywords: Cold storage; Investment; Shrimps; Exports; Pak-Nam Walu; Chanthaburi

708 Chul Sinchaipanich. 2001. **Perception of and participation in responsible fisheries of shrimp farmer living in Pakpanang watershade area, Province of Nakhonsrithamarat and Songkhla.** Technical Paper No.5/2001 Research and Development Group, Department of Fisheries.100 p.

The food and agriculture Organization (FAO) has adopted the Code of Conduct for Responsible Fisheries (COC for RF) proposed by member countries on October 31, 1995 as a new concept of promoting sustainable fisheries development. By 1999, most of the countries have agreed upon the COC for RF and how to follow the guideline stipulated in the Rome declaration of COC for RF.

As a member of United Nations and FAO, Thailand has not over look the important of promoting the COC for RF to involved people, especially to shrimp farmers. Had Thailand to maintain top exporter of frozen shrimp products, it must be able to demonstrate that those products is produced in a sustainable way and is by all means in accordance with the COC for RF.

As an initiative, The Department of Fisheries (DOF) has urged the Marine Shrimp Culture Association of Thailand, the Frozen Shrimp Export Association, and the Shrimp Feed Producer

Association to sign an agreement in February, 2000 and declare to uphold the COC for RF.

The purposes of this research were 1) to study the level of awareness of COC for RF of shrimp farmer, and 2) to study their level of participation in following the guideline of COC for RF which DOF established specifically for Thai shrimp farmer.

Shrimp farmer doing the culture along the western bank of irrigation canal in Pakpanang Watershed Royal Development Project were selected as the target population as the area is the biggest shrimp culture area in the country allowed for marine shrimp culture, which covers 9 districts in 2 provinces i.e. district of Pakpanang, Chianyai, Muang, Huassai, Tasala, Singhanakorn, Chalempakiat, and Sichol in Nakornsriphamarat province, and the district of Ranod, Songkhla province. Out of 2430 shrimp farmer, 415 were selected as a sample by multistage random sampling technique.

It was found out that most of the respondents (98.6) were the owner and that shrimp culture was their only main occupation (92.8%) with more than 3 years of experiences in shrimp culture (69.7%). Most of them (75.9%) had low degree of openness to receiving information. Of which, 47.5% were not aware of the COC for RF. For those 52.5% who were aware, 34.2% got the information, once every 2-3 months, from other shrimp farmer as oppose to 10% from DOF staff. Most of respondents had moderate knowledge on the COC for RF with average score of 5.98 out of 10 score.

When considering the level of participation in following the guideline for RF in doing their shrimp culture, it was found that 4.8% were participated in planning stage, 17.1% in supporting activities, 16.6% in public relation, 100% in culture stage, and 20% in gaining benefits. It is interesting to note that the reason for 100% participation rate in culture stage was not of shrimp farmer intention to take part in following the guideline of COC for RF, but from the fact that those practices are essential to the survival of shrimp cultured and they had to do it in every day operation. Regardless of this fact, the most common practice in accordance with the guideline for RF was the "immediate pond dehydration after harvest" tied with "culture pond aeration at the surface of the water" (96.9%). On the other hand, the least practice was providing aeration in discharge water treatment pond (4.1%)

Regarding factors which affect the level of participation in conducting responsible shrimp culture, it was found that role of village leader/extension officer, and the degree of awareness of the COC for RF were related to the level of participation at the .05 significant level ($r=1.175$, .417, and .123 respectively). When

considering all the independent factors together i.e. age, educational level, role of village leader/extension officer, intensive, needs/expectation, knowledge and awareness of the COC for RF, it was found that there were significant relationship between the set of factors and the level of participation at the .05 level of significant (multiple $R=.517$), and that the level of awareness was the strongest factor affecting individual's participation.

It is recommended that vigorous public relation should be promoted, by community leader as well as extension officer, to raise the awareness and to build a good understanding/attitude of shrimp farmer toward the COC for RF. Additional support from government sector such as training, input and fund support will help to push shrimp farmer to be more participated in conducting sustainable shrimp culture as guided in the guideline established as part of the COC for RF.

Keywords: Perception; Participation; Responsible fisheries; Marine shrimps; Culture; COC for RF; Code of conduct for responsible fisheries; Pak Phanang Watershed Development Royal Project; Nakhon Sri Thammarat; Songkhla

709 Julaporn Prasertphol, Boonson Sirikul, Akapong Nakapong and Thong-ab Boonard. 1989. **The status of jumbo tiger prawn (*Penaeus monodon*) culture in Chanthaburi Province in 1989**. Technical Paper No. 13/1989. Chanthaburi Coastal Aquaculture and Development Center. Department of Fisheries. 16 p.

Surveying on the status of jumbo tiger prawn (*Penaeus monodon*) culture in Chanthaburi Province were carried out during November 1988- August 1989. The result found that there were 1,959 farms in operation with the area of 65,359 rai¹. Average production of prawn culture was 759 kg/rai/4 months. Total investment cost was 87,193.42 baht/rai or 114.88 baht/kg prawn weight. Net profit could get 25,138.58 baht/rai or 33.12 baht/kg. The average return cost was 28.83%

¹/ 1 rai = 1600 m² or 0.16 hectare

Keywords: Jumbo tiger prawn; Shrimp culture; Status; Chanthaburi

710 Chalong Tangtung. 1999. **An economic analysis of black tiger shrimp culture in Changwat Surat Thani 1998/99 crop year**. Master Thesis. Kasetsart University. 96 p.

The rapid expansion of the shrimp farming along Thailand's coastal provinces was mainly due to the foreign demand for Thai shrimp and its price. The economic aspects of shrimp farming was studied. The objectives of this study were : to study of the socio-

economic features of the shrimp farmer, to investigate the resource allocation of semi-intensive and intensive shrimp farming by estimated the Cobb-Douglas production function, and to examine the profitability through cost and return analysis. The survey has been conducted in Changwat Surat Thani by interviewing 60 shrimp farmers in 1998/99 crop year.

As for the cost-turn analysis : for the semi-intensive farming system, the results were found that the average production was 334.66 kg./rai, the total cost was 40,583.68 Baht/rai and the net profit was 20,909.50 Baht/rai. For the intensive system, the results found that the average production was 1,008.65 kg./rai, the total cost was 120,415.50 Baht/rai and the net profit was 66,781.50 Baht/rai.

As for the results of the production function by each type of production system, it was found that only three independent variables ; value of seed, value of chemical and drug and value of power were significantly relate to the shrimp output which product by semi-intensive system. The elasticity of value of seed, value of chemical and drug and value of power were 0.56, 0.12 and 1.45 respectively. The shrimp production by this system was in the increasing return to scale. It was found that the value of seed, value of feed, value of chemical and drug, value of operating facilities, value of power, labor intensive and the disease outbreak in previous cropping significantly related to the shrimp output intensive system production and theirs elasticity were 0.64, 0.34, -0.09, 0.09 and 0.13 respectively and the production function is in constant returns to scale.

The analysis of technical efficiency of inputs as value of seed, value of chemical and drug and value of power were 0.004, 0.27 and 0.39 respectively by semi-intensive system. On the other hand, the value of seed, value of feed, value of chemical and drug, value of operating facilities, value of power and labor intensive were 0.01, 0.01, -0.0114, 0.05, 0.01 and 275.02 respectively for the inputs using in intensive system. The analysis of economic efficiency of inputs as value seed value of seed, value of chemical and drug and value power were 6.03, 4.93 and 71.43 respectively in the semi-intensive system. This indicate that the farmers should increase the use of stocking rate, chemical, drug and power to obtain the economic optimum. And the results of the analysis of economic efficient of inputs as the value of seed, value of feed, value of chemical and drug, value of operating facilities, value of power and labor intensive were 11.56, 1.57, -2.11, 9.76, 1.57 and 340.27 respectively for the intensively for the intensive system. This indicate that farmers should increase the use of inputs except for the use of chemical and drugs which tend to reduce the output.

Keywords: Economic analysis; Black tiger shrimp; Shrimp culture; Surat Thani

711 Chonticha Chaichana. 1996. **The study of cost and return in shrimp culture of members of Nikom Samutsakhon Cooperative Ltd. Changwat Samut Sakhon.** Master Thesis. Kasetsart University. 156 p.

The main objectives of this study were to compare and analyze the financial cost and return and to study feasibility Extensive, Semi-Intensive and Intensive shrimp culture system of Nikom Samutsakhon Cooperative Ltd.'s members. Data was in the study was primary and secondary data.

The study used quantitative analyze on two methods, simple and discount rate of cash flow. Cost were divided into two patterns : investment cost and operation cost. The revenue of members was from shrimp product selling.

The results of this study indicated that financial analysis with 12% discount rate. Net Present Value of shrimp culture of Extensive, Semi-Intensive and Intensive system was 17,476.66, 24,632.59 and 29,281.22 baht, Payback Period was 1 year and 1 month, 2 year and 3 month, and 3 year and 2 month, and Internal Rate of Return was 468.86%, 565.28% and 434.46% respectively. The feasibility study indicated that the shrimp culture gave the acceptable return. Therefore the investment in shrimp culture of members of Nikom Samutsakhon Cooperative Ltd. should be encouraged because of its positive returns.

Keywords: Costs; Returns; Shrimp culture; Members; Samut Sakhon

712 ชวนพิศ ลิทธิมั่งคั่ง, มลฤดี นิพนธ์พงษ์ และ ณาตยา ศรีจันทิก. 2539. การศึกษาวิเคราะห์ธุรกิจการเลี้ยงกุ้งกุลาดำในเขตน้ำจืด. เอกสารวิชาการฉบับที่ 1/2539. กองเศรษฐกิจการประมง. กรมประมง. 65 น.

Business on Tiger shrimp (*Penaeus monodon* Fabricius) culture in freshwater areas were studies. This study were analyzed investments and returns including its problems concerned. Its were found out to index the feasibility of Tiger shrimp culture in freshwater area.

79 farms were sampled as 10% of total which the culture area was about 23,825.5 rais located in 9 provinces. The findings show that there are 3 models of culture. They are the culture with seawater mixed, with salt added and culture in salty soil area. Average pond size of the third farm culture is the biggest with about 6.33 rais and the second farm culture is the smallest as about 2.39 rais. Average pond size of the first fram is about 3.77 rais. Rearing period are most the same as 100–115 days/crop at the stocking density of 48–62 fry/sqm. Culture with seawater

mixed give the highest survival rate 53%, while the survival rate of culture with salt and culture in salty soil area are 33.07% and 30.96% respectively. The average production of culture with seawater mixed, with salt added and culture in salty soil area are 834 kg/rai, 586.81 kg/rai and 505.88 kg/rai and shrimp size are average 56 pcs/kg, 61 pcs/kg and 47 pcs/kg, respectively.

Shrimp culture with seawater mixed, with salt added and culture in salty soil can give net profit of 40.69 ฿/kg and 25.84 ฿/kg, respectively and show that investment return rate are 38.2%, 43.73% and 18% respectively.

Keywords: Business; Freshwater area; Black tiger shrimp; Culture

713 Jariya Pinyorattanachote. 2002. Determination of fish agent offering price and trading quantity of black tiger shrimps : a case study of Bangkok fish market. Master Thesis. Kasetsart University. 140 p.

Black tiger shrimp is a high export earning product. This study investigates the behaviors in determining black tiger shrimp offering price and trading quantity among fish agents in Bangkok Fish Market, using primary daily data of 92 days from 4 fish agents. Shrimp are divided into 6 sizes according to Bangkok Fish Market i.e., small shrimp (100-120 pieces/kg), medium small shrimp (60-70 pieces/kg.), medium shrimp (50-55 pieces/kg.), medium large shrimp (35-40 pieces/kg.), large shrimp (30 pieces/kg.) and jumbo shrimp (22-25 pieces/kg.). The major factors determining offering price are daily Bangkok Fish Market price and difference in daily offering price from Bangkok Fish Market price. The export price significantly effects only price determination medium-small shrimp (60-70 pieces/kg.) and medium shrimp (50-55 pieces/kg.).

Trading quantities of fish vary by their trading characters whether the business is for export or domestic market. In case of export, the difference of fish agent's trading quantity from the total trade volume of 60-70 pieces/kg shrimp and 50-55 pieces/kg shrimp are important factors determining the firm trading quantity. In case of buying for domestic market the difference in fish agent's trading quantity from the total trade volume of 100-120 prices/kg shrimp is a significant factor determining fish agent trading quantity.

Keywords: Determination; Fish Agent Offering Price; Trade; Quantity; Black tiger shrimp; Bangkok Fish Market

714 Chaiyot Lohapasai. 2002. Farmer's adoption of recommended practices in raising giant tiger

shrimp in Changwat Pattani. Master Thesis. Prince of Songkla University. 162 p.

The study aimed to investigate : 1. The economic, social, psychological and communicative characteristics of farmers raising giant tiger shrimp, 2. Factors associated with farmers' adoption of the recommendations, 3. Associated problems in production and technology transfer, 4. The relationship between economic, social, communicative and psychological factors and farmers' adoption of the recommendations. The total number of the population was 167. A simple random sampling was used for the sample selection. A number of 110 farmers, approximately 69 percent of the total population, was used for samples. Personal interviews were used for data collection. The interviews were started in November 2000 and lasted until the end of January 2001. Data analysis was undertaken by using the SPSS program.

The finding revealed that most farmers were male and married, Buddhists, with an average age of 37.6 years. They had formal education at a tertiary level. Raising shrimp was regarded as a major occupation. Most farmers were members of a shrimp farmer association. Their source of farm information was from magazines, journals and their shrimp farmer association. Most farmers adopted the recommendations in terms of pond construction, pond preparation, stocking density, feeding, damage and water utilization systems, use of drugs and chemical equipment, and environmental control and management.

The outbreak of epidemics, low rate of fertility and low standard of production quality were mentioned as major problems. An inadequate number of extension officers, a low rate of farm visits paid extension officers and irrelevant guidance for farmers' needs were cited as major constraints of (technology) transfer between farmers and extension officers.

Keywords: Farmers; Adoption; Shrimp culture; Giant tiger shrimp; Economics; Social; Pattani

715 Charlie Navanugraha, Pisit Sukreeyapongse, Suvaluck Satumanatpan, Chumlong Arunlertaree and Chumporn Yuwaree. 2001. Land use conflict on black tiger shrimp farming and plantation in fresh water area of Bangpakong watershed. In Proceedings: Symposium on Aquatic Resources and Environment: Integrated Management and Utilization. p. III : 136-145

Study on land use conflict on black tiger shrimp farming and plantation was carried out in the watershed areas of Bangpakong, covering 4 provinces of Nakorn Nayok, Prachinburi,

Chachungsao and Chonburi. The study sites were divided into the area of upper and lower parts of Bangpakong Dam. The information was collected by interview 240 shrimp farmers and 229 agriculturists. Interesting details on shrimp farming are as follows: most of the areas of shrimp farming were used to be paddy fields, only a small number of muddy ponds and treatment ponds are found, 91% and 48% of pen culture with salt water were recorded in the upper and lower parts of the Dam respectively, problems of shrimp farming are related to an epidemic of shrimp diseases, water pollution, low price of shrimp and lack of investment. A very few existing areas of plantation that used to be shrimp farming were found only on the upper part of the Dam. Most of shrimp farmers indicated that shrimp farming would not affect the saline concentration in soil, natural water system and subsurface water. In contrast, 55–67% of agriculturist believed that shrimp farming would impact soil and natural water system's salinity. However, agriculturists uncertain about impact of shrimp farming on salinity of subsurface water.

Shrimp farmers on the upper and lower parts of the Dam highly confident that shrimp farming will not affect paddy fields and plantation areas (such as fruits, vegetables). Whereas, agriculturists have a marked different attitude, shrimp farming will have a negative impact to paddy field, especially in the lower area of the Dam, 41% of agriculturists emphasized that paddy field may have been damaged at high level. They also indicated that plantation would not be affected from shrimp farming if wastewater and saline water were not released to natural water system.

Shrimp farming can be farmed in any areas according to high income, no discharge of wastewater and muddy sediment and have buffer canal (saline protective canal). Thus no environmental problems occurring, shrimp farmers explained. Similar reason, high incomes also attracted agriculturists to support this idea. However, 32% of agriculturists at the lower part of the Dam argued that shrimp farming should be farmed only in the area where salt intruded.

Keywords: Bang Pakong Dam; Black tiger shrimp; Farming; Plantation; Buffer canal; Muddy pond; Treatment pond; Freshwater area

716 Chuenjit Sornmanapong. 1996. **An economic analysis of rearing *Penaeus monodon* Fabricius larvae ; a case study of Muang District of Chon Buri province in 1995.** Master Thesis. Chulalongkorn University. 148 p.

The major objective of this study is to analyze the socioeconomic status of hatchery farmers,

specifically, a relationship between means of production and output, costs and benefit analysis, and return on investment. To do so, primary data (in 1995) from hatchery farms in Muang district, Chon Buri province is used as a case study. In essence, 212 samples are subdivided into 2 groups : small-scale farms and large ones.

By adopting Cobb-Douglas production function, the analysis showed that hatchery farms outputs of both size of farms are positively correlated with their input quantities. And the production elasticity of small and large farms were 1.1264 and 1.5711 respectively, which imply an increasing return to scale.

According to the survey of farms' costs and incomes in 1995, large farms earned profits, whereas small ones encountered substantial losses. However, internal rate of return and benefit-cost ratio of both farm sizes in the long-term investment are somewhat lucrative.

As of break-even analysis of the small and large farms, it is found that in the first year of investment, farmers should sell the larva at 0.11 baht per unit. Afterwards, pricing at 0.10 baht each is still profitable.

Keywords: *Penaeus monodon*; Economic analysis; Nursing; Larvae; Chonburi

717 Chuchat Polbandit. 1997. **Impact of tiger prawn farming on socio-economic setting of Amphoe Ranot, Changwat Songkhla.** Master Thesis. Prince of Songkla University. 155 p.

The objective of this research are (1) to study the socio-economic setting and natural resources and environment conservation and (2) to assess the impact of tiger prawn farming upon socio-economic and natural environment setting in Tambon Tabon; Paktrae and Klongdan of Amphoe Ranot, Changwat Songkhla. The study area is considered to be a intensive aquaculture area. The samples were drawn from 81 households engaging in tiger prawn farming and 245 households of other occupations.

The study employed a review of relevant documents from various sources, a questionnaire survey conducted during September-December 1993, as well as observation and in-depth interview. The result of data analysis was presented by percentage and arithmetic mean.

The study revealed that most of household respondents were male and had domicile in the study area. Prior to 1989, majority of the respondents were paddy rice farmers; their annual income was in the range of 40,000 and 50,000 baht per household. Social characteristics were rural-oriented and way of life was simple. During 1986 and 1987, prawn farming was introduced into the study area. Majority of farmers, who owned their farm land, have rapidly

shifted to prawn farming. The total prawn farming area increased from 6,938 rai in 1990 to 13,376 rai in 1991.

Majority of farmers expressed their opinion that prawn farming could generate high revenue, in comparison with other occupations. This resulted in improved overall economic situation including home improvement, new buildings and commercial shophouses. Banks and financial establishments were added to Ranot community. The demand for labor was high. Prawn farmers were able to achieve a better standard of living, with new amenities in their homes.

Social aspects of life began to change from rural to urban. Social get together in local development declined. The level of expectations for better and higher education for their children rose. Inclination to help each other declined.

Most farmers lacked knowledge in environment and resource utilization. These led to waste water problem, deteriorating sea water and fresh water quality, as well as shortage of household water supply. Prawn farming created a conflict of interest, between prawn farmers and paddy farmers and others. The provincial government of Songkhla has tried to solve the problem by establishing zoning for prawn farming and paddy farming. Most of the respondents however, were not aware of zoning system. Most respondents nonetheless agreed the prawn farming had a substantial impact on natural resources and environments.

Keywords: Impact; Tiger prawn; Shrimp culture; Farming; Socioeconomic status; Wastewater; Problems; Songkhla; Ranot

718 Tapanee Malisorn. 1996. **An analysis of export competitiveness of Thai frozen and chilled shrimps.** Master Thesis. Kasetsart University. 169 p.

The objectives of this study were to study the production and marketing situations of frozen and chilled shrimps to analyze Revealed Comparative Advantage (RCA), to analyze export expansion by using Constant Market Share Model (CMS), and to analyze the important factors determining import demand for frozen and chilled shrimps of Thailand from important importing countries and to recommend how to increase capability of competition.

The results of study about Revealed Comparative Advantage (RCA) of Thailand and important competitors which were Vietnam, Ecuador, India, Indonesia, Mexico and China and by using the average values of data in 3 periods: 1982-1986, 1987-1996 and 1992-1993 showed that every country got RCA more than 1. For

Thailand, these advantages were continuously increasing but at the decreasing rates which were the same as of Vietnam, Ecuador and India. For Indonesia, Mexico and China, these advantages were decreasing. The study results of export expansion of Thai frozen and chilled shrimps between the periods above showed that the value of exports between the first two periods was increased resulting from the effect of real competition followed by the interaction and world expansion effects but was slightly decreased because of the distribution effect. The comparison between the export values of the later two periods showed that it was also increased resulting from the real competition the world expansion and the interaction effects, respectively but was slightly decreased from the distribution effect. The results of import demands analyses of Japan, United States and Singapore in frozen and chilled shrimps of Thailand between the period of 1980-1991, 1966-1994 and 1974-1994, respectively, showed that the per capita income of each country was the main factor determining the import demand of this product of Thailand. The per capita income elasticities of demands of these countries were 7.1836, 7.0844 and 5.0065, respectively, and elasticities of demands with respect of export prices of Thailand were -2.3662, -0.8361 and -1.7393, respectively.

Keywords: Analysis; Competitiveness; Exports; Frozen shrimps; Chilled shrimp

719 Nartaya Srichantuk and Molrudee Nipanpong. 1999. **An analysis on shrimp farming: Andaman coastal zone.** Technical Paper No.13/1999. Fishery Economics Division, Department of Fisheries. 41 p.

An analysis on shrimp farming in Andaman coastal zone at Ranong, Phang-nga and Krabi provinces were studies in the last crop year of 1996 by sampling 57 shrimp farmers. The results can be summarized as follows: The average farm size was 17.31 rai. The number of ponds were 4.37 ponds which were average 3.96 rai/pond. The period of culture is shown at 126 days/crop. The stocking density were average 66 pieces/m². The survival rates were 64.26 percent. The shrimp production were 1,475.28 kg/rai/crop. The size at harvest were average 46 pieces/kg which are sold for 187.56 baht/kg.

The total cost per crop per rai were 196,937.38 baht which are composed of the fixed cost 17,160.93 baht and the variable cost 179,776.46 baht or 8.71 and 91.29 percent respectively. The total revenue per crop per rai were 276,703.52 baht. The net operating profit were 96,927.06 baht/rai/crop or 65.70 baht/kg. The net cash profit were average 107,365.59 baht/rai/crop or 72.78 baht/kg. The net profit were average

79,766.14 baht/rai/crop or 54.07 baht/kg. The rate of return for investment was 40.50 percent.

Although the shrimp farmers got the high rate of return, the study also shown that they still have the problems especially for the diseases problem which they thought its can be solve by changing their culture system.

Keywords: Analysis; Business; Shrimps; Shrimp culture; Farming; Andaman coast; Coast

720 Nattaya Srihantuik and Siri Tookvinas. 1993. **Study on the investment and return of marine shrimp culture under King project at Kung Krabaen Bay.** In Proceeding the Seminar on Fisheries 1993, Department of Fisheries, 15-17 September 1993, National Inland Fisheries Institute, Bang Khen. p. 682-696

The study on the investment and return of marine shrimp culture under King project at Kung Krabaen bay from 20 shrimp farmers were conducted in 1992 crop year. The stocking density were average 58 pcs/m². The survival rates was 37.5%. The production was 659 kg/rai/crop. The cost per rai per crop were estimated as follow; variable cost 53,697 baht and fixed cost 29,033 baht. The net profit per crop was 11,101 baht or 16.85 baht/kg. It can be concluded that the survival rate of shrimp is very low comparing to the result of intensive marine shrimp culture in Ranot, Songkla province. The Cobb-Douglas production function was applied to determine the influence of factors on shrimp production. It is found that value of shrimp feed, value of chemical substance and value of fuel are significantly import variables on shrimp production.

The shrimp production is in the increasing returns to scale. And the farmer would obtain the economic optimum if they increased the use of shrimp feed and fuel and reduced the use of chemical substance.

Keywords: Investment; Returns; Marine shrimps; Culture; King Project; Kung Krabaen Bay

721 Doungchai Boontarikraksa. 1990. **The socio-economic impact of prawn culture development on the fishing community in Tambon Sanam Chai, Amphoe Tha-Mai, Changwat Chanthaburi.** Master Thesis. Kasetsart University. 130 p.

One of the main problem of Thai fishery is the depletion of marine resource. The recognition of the 200 nautical mile Exclusive Economic Zone of the neighbouring countries has caused the decrease of fishery products. The Thai government had

made an attempt to promote aquaculture along the coast by using modern technology in order to compensate the decrease of catch. Among all types of aquaculture, prawn culture had been the most popular activity because of its higher market value.

The objective of this research was to study the Socio-Economic condition of people in the area of Tambon Sanam Chai, Amphoe Tha-Mai, Changwat Chanthaburi and also to study the socio-economic impact of prawn culture development on this fishing community, as well as to suggest proper plan to give long term benefit to this community.

The method of study was qualitative research by using interview guide along with 3 months of observation in the community. The report was presented in a descriptive analysis form rather than proving by figure.

The research found that prawn culture development had the following socio-economic impact on the community. There had been a big increase of income and decrease of debts. There was change of land use and the price of land increased drastically. There had been an increase of employment in the shrimp farms as well as in other related activities. There was higher consumption of modern products and the way of life had changed. The children tended to persue higher education. There was an obvious increase in the "Kae bon" ceremonies (a traditional belief and practice to pay back to the supernatural power who caused their economic success). An interest group had developed to protect public benefit especially to guard against any activity that would cause a negative effect to prawn culture. The people in the community had substantive awareness of environmental change caused by prawn culture especially concerning water pollution. The degradation of environment had been very serious and needed prompt action to counter future devastation.

Keywords: Socio economic status; Impact; Prawn culture; Development; Fishing community; Chanthaburi

722 Tul Raubrhoo. 2002. **Effects of EU's GSP exclusion on the export of Thai frozen shrimp.** Master Thesis. Dhurakijpundit University. 88 p.

Thailand has been entitled to obtain the benefits on GSP from the European Union for more than 30 years. GSP is a reduction of customs taxes levied from the imported goods originating from the developing countries. The European Union will solely provide the special right and can also cancel or change this special right. The economic competition in Thailand has grown up extensively during the year 1995 (B.E. 2538) resulting in exporting the goods to EU markets to be continually expanded. When the exported goods from Thailand was of the equivalent to or competitive to the goods

from other countries, the EU has then finally set up a measure to cancel the right of Thailand from obtaining the GSP, as follows :-

1. Agricultural goods: The rights have been reduced to half of the normal rights since January 1, 1997, and the entire existing rights have been cut off since January 1, 1999.
2. Industrial goods: The rights have been reduced to have of the normal rights since January 1, 1997 and the entire existing rights have been cut off since January 1, 1998.

When the EU has cancelled the rights on GSP, The most adverse impact is the frozen shrimp product because the frozen shrimp product is replaceable. If there is a change of increased price, it will decrease to exporting quantities decrease.

The study found that the frozen shrimp industry is kind of labor intensive because of experience and skills are required to be used for selecting and trimming the goods to meet customers' requirements. The major problem of frozen fresh shrimp industry is the lack of raw materials for production. However, the advantage of the frozen fresh shrimp from Thailand is that it is a good quality product and is required by the markets in the EU, especially the larger size of shrimp, including the reliability of Thai exporters. This research has been estimated by employing the data gathered from the past to calculate the outcome to be happened in the future, for the purpose of getting to know the general situation of the frozen fresh shrimp export problems from Thailand to the EU, including the trade competitors outside the EU markets of Thailand. In the first 5 ranks, namely Republic of India, Republic of Ecuador, People Republic of China, People Republic of Bangladesh. This research used the method of Leamer and Stern (1970), to determine the impacts resulted from the denying of the EU on the EU on GSP rights of Thailand which is generally established by the EU to obstruct the exportation. The frozen fresh shrimp product exported from Thailand to the EU will be affected as follows :-

1. Trade diversion–The result from denying of the EU on GSP rights of Thailand will cause Thailand to pay import taxes in the higher rate on the frozen fresh shrimp products. This will cause the EU to divert to import the frozen fresh shrimp products from other countries which are still entitled with the GSP rights, or from the countries which are still paying the original rate of import taxes in stead of importing from Thailand, for some parts of the importing products.

Due to the difference of tax rate affects the difference of the increased price, resulting in the

EU market demand of shrimp consumption from Thailand to decrease comparing with the competitors outside EU of Thailand, in the first 5 ranks.

The calculation found that when EU has cut off the whole GSP rights from Thailand since January 1, 1999, it would result in reduction of frozen fresh shrimp product importation, in the amount of 1,207,807,856.29 Baht.

2. Trade reduction–When the EU has denied the GSP rights from Thailand, it has caused the Thai frozen fresh shrimp exporting products, which used to be entitled to obtain GSP to pay for import taxes in the normal rate (MFN rate) to decrease, The result is that the EU demand on frozen fresh shrimp products for consumption will then be lessened, some consumers will divert to buy the products produced with in the EU instead.

The calculation found that the EU denying on GSP of Thailand since January 1, 1999 caused the reduction of importing the frozen fresh shrimp products from Thailand in the amount of 501,404,126.89 Baht.

Keywords: Effects; EU; GSP; Exclusion; Exports; Frozen shrimps

723 Thira Thavornbutr. 2000. **A study on effects of shrimp farming in mangrove tariff on Thailand's externalities and welfare.** Master Thesis. Kasetsart University. 120 p

Shrimp farming in Thailand has changed from extensive system to semi-intensive and intensive system, in response to consumer demand in foreign countries. Since shrimp farming gives high benefit and can recover cost in short-time, some shrimp farmers encroaches mangroves and convert them for shrimp farming. This generates adverse effect to externalities environments and human as well. Therefore maximum welfare to society would not occur.

The main objective of this study is to consider the change of externalities and social welfare if the Thai government imposes shrimp farming in mangrove areas.

Data used in this study are collected from various government agencies during 1988-1997 using econometric model is employed and externalities in form of mangrove value are estimated. In addition the tax rate on shrimp farming in mangrove area and change in social welfare are evaluated.

The results show that the appropriate tax rate is 48,778.09 Bath/ton or 21,311.15 Bath/rai, at an average yield of 0.4369 tons/rai.

Keywords: Shrimp culture; Mangroves; Tariffs; Welfare; Externalities; Social welfare; Environment

724 Taweewit Pakawanit. 2001. **Costs and the production function of Black tiger shrimp (*Penaeus monodon*) in Nakhon Sri Thammarat province.** Songklanakarin Journal of Social Sciences and Humanities 7 (1): 1-11.

The objective of this research is to evaluate economically the ongoing situation of black tiger shrimp farming in Nakhon Sri Thammarat province. The study is carried out through an analysis of various cost types with an aim of finding ways to reduce the cost of production. In addition to various cost types, the economic efficiency of the inputs used in the production was also analysed in order to work out maximum economic efficiency of the production process. The research results can be used by the private sector, particularly the farmers to restructure their investment and farm management. At the same time, the government sector can also make full utilization of the results for planning to support the farmers to raise black tiger shrimp independently and efficiently in the long run.

The research found that on average the production of the first crop in 1998 was 935.40 kilogram/rai, while the farm price was 284.09 baht/kilogram with a total cost of 106,277.62 baht/rai. Thus, the profit gained was 159,460.17 baht/rai. Regarding the results of the cost function analysis, it was found that the farmer would have to produce 51.06 tons in order to reach maximum profit while at present the farmer produces only 3.3 tons on average.

Keywords: *Penaeus monodon*; Black tiger shrimp; Shrimp culture; Production; Costs; Marginal revenue; Nakhon Sri Thammarat

725 Thongchai Nitiratsuwan. 1997. **Current situation of Tiger prawn (*Penaeus monodon*) farming in Sikao District of Trang province (1996).** In Proceedings of the 14th Annual Conference of Rajamangala Institute of Technology (RIT), 26-29 January 1997 at Pawillian Hotel, Songkhla. p. 11-23.

Since 1994, 49 new farmers have begun to raise tiger prawns (*P. monodon*) in the Sikao district of Trang province. There are presently 344 ponds under cultivation covering an area of 1,413.5 rai. In this area, only 16.1 percent of the cultivated area is being used for treatment ponds. This is considered very low by shrimp culture researchers. Presently most of the area used for tiger prawn cultivation is located outside of the mangrove forest reserve area, and is not densely cultivated. Local farmers employ labor from Trang province. Of the 161 farmers interviewed in this survey, only 8.7 percent said that they would like to increase the number of

laborers on their farms. Farmers must plan the yield from their ponds by choosing production plans which maximize either the size or the quantity of prawns produced. Local shrimp farmers have requested that the Faculty of Science and Fisheries Technology assist them by providing shrimp diagnostics and water quality analysis expertise.

Keywords: Current situation; Black tiger prawn; Shrimp culture; Farming; Trang; Sikao

726 Thongchai Nitiratsuwan, Patcharee Soonsan and Piboon Boonlipatanon. 2003. **Attitude of shrimp farmers to sustainable management of shrimp culture : case study in Krabi province.** In The Proceedings of 41st Kasetsart University Annual Conference (Subject : Science ; Subject : Natural Resources and Environmental Economics), 3-7 February 2003. p. 567-575.

The managing of shrimp farms to make high efficiency needs to be considered the shrimp farmers' attitude on the management practices. From the interview of shrimp farmers at Krabi province in the year 2001, it was found that the education of shrimp farmers was mostly received primary school level 6. Those were usually occupied 1 shrimp pond and the knowledge of shrimp culture practices were received from their past experience.

The shrimp farmers had strongly agreed to form the shrimp farmer cooperative society undertaken by government official. The advantage of farmer cooperative society will be contributed as follows: 1) data collection, 2) checking the antibiotic residue and stop using their antibiotic before harvesting, 3) report information, and 4) Non application of the chemicals and drugs, which directly impact on the environment. However, the farmer cooperative society will not be cooperated as follows: 1) operation cost, 2) no shrimp culture activity during the time regulated by shrimp farmer group, and 3) in-cooperation when the government will allot the new area to procure the new system etc. The shrimp farmer cooperative society should be led by government official in accordance with invitation to the large scale shrimp farm and high education level to be a member from shrimp farmer.

Keywords: Attitude; Shrimps; Farmers; Sustainable management; Shrimp culture; Krabi

727 Tidalak Pinsuwana. 1991. **An analysis of market stability for export of Thai frozen shrimps by logarithmic variance method.** Master Thesis. Kasetsart University. 117 p.

Frozen shrimp is one of the aquatic living export which has been promoted and accelerated by the government. Its export value now ranks as the first

among fishery products exports. However, annual volume and value of frozen shrimp export have always been fluctuated, thus affecting income of producers and exporters. The objectives of this study are as follow: first to study market structure of frozen shrimp export from Thailand by analysing changes of the market shares; second, to analyse instability index of Thai frozen shrimp export; and third to recommend policies for improvement in measures for the promotion of this export.

Methodologies are divided into two parts. First, to analyse the market shares of Thai frozen shrimp in Japan and the United States using Ochsner and Cramer's method. Second, to analyse instability indices in terms of volume, price and value of export in nine major foreign markets, i.e. Japan, the United States, Singapore, Hong Kong, the United Kingdom, Italy, Australia, France and Federal Republic of Germany. Joseph D. Coppock's method was applied for the second part.

From the analysis results, comparing the market share of Thailand's frozen shrimp in Japan during 1976-1981 with that of 1982-1987 the market share of Thailand's shrimp market in Japan slightly decreased from 6.6 percent to 5.1 percent. This was due to the loss of market share from competition 50.2 percent while receiving advantages from the market expansion was merely 49.8 percent. As for market share of the same product in the United States, during the same corresponding period, Thailand's market share markedly increased from 3.1 percent to 4.8 percent, mainly due to market competition and expansion by about 53.7 and 46.3 percent respectively.

Regarding to the analysis of instability indices of Thai frozen shrimp export in nine major foreign markets, it was found that instability in term of export value was mainly due to changes of demand, while supply was stable and inelastic. Exception was for two countries : Singapore and Italy, where instability in term of export value was mainly due to changes of supply. Moreover, influence of changes in term of volume has greater effect on value than influence of changes in term of prices.

Results of this study lead to five recommendations as follows: 1) In order to maintain market share, exporters should maintain export quality in compliance with standards set by each importing country. 2) In order to increase stability of value for Thai frozen shrimp export, there should be measures to allow regularity in demand. 3) As demand did not depend on any conditions in Thailand, reducing reliance on a certain market or expansion in frozen shrimp market including forward market can help decreasing the instability problem. 4) In some foreign market, instability was attributed to

changes of supply. As a result, there should be measures to allow regularity in frozen shrimp supply. 5) There should be studies on characteristics of instability by types, sizes and grades of products in order to obtain more apparent measures.

Keywords: Analysis; Markets; Exports; Market share; Frozen shrimps; Logarithmic variance method; Quality

728 Nopparat Panichayatham. 1999. **A comparative study on cost and return of the investment on paddy and black tiger shrimp farming in Bang Phaung Irrigation Project, Changwat Prachin Buri and Changwat Chachoengsao 1997/98 crop year.** Master Thesis. Kasetsart University. 126 p.

Black tiger shrimp has long been cultivated in the coastal areas. At the present time, it can also be cultivated in the non-coastal area (fornal rice farming area) by adding saline water. Because of higher return, many farmers switched from rice crop area to shrimp farming area. Nevertheless, there are a lot of bad impacts on the environment and water resources.

The main of objective of this study is to analyze the financial and economic feasibility of black tiger shrimp culture compare to paddy cultivation in order to set a plan for sustainable resources used.

From the financial analysis of cost and return, it was found that the net benefit from shrimp farm was 13,366 baht/rai/crop and 990 baht/rai/crop for paddy crop. The financial and economic analysis revealed that the shrimp cultivation is feasible for investment. The break-even year of investment is in 2.5 years. In considering of the external impacts cost from shrimp farming such as the close-system by constructing of recycled water pit, the internal rate of return (IRR) is still 19 % In comparison of net benefit increase (NBI) in shrimp culture with paddy culture, the result showed that the net benefit increases 6 times in financial analysis and the net benefit increases 3 times in economic analysis.

Keywords: Costs; Investment; Paddy field; Shrimps; Farming; Bang Phaung Irrigation Project; Prachin Buri; Chachoengsao

729 Naritsara Chanchingchit, Sunchai Klinpikul, Sutonya Thongrak and Kidchakan Supamattaya. 2003. **A study of appropriate management for marine shrimp farm estates in Thailand.** Thai Fishereis Gazette 56 (1): 19-22.

Shrimp cultivation in Thailand had contributed about 100,000 million Baht per annum. However, it created several environmental problems such as diseases and pollution. Therefore, research and development and several cooperations had been made

to develop sustainable shrimp cultivation. One of these is the master plan developed by the Department of Fisheries to construct 59 shrimp farm estates which cover the area of 650,000 rai with an investment of 43,800 million Baht using Asian Development Bank (ADB) and Oversea Economic Cooperation Fund (OECF), and it was estimated that the government has to contribute the operation cost about 1,500–1,600 million Baht per year.

After the survey was conducted at 3 existing marine shrimp farm estates, an appropriate management model for marine shrimp farm estates was proposed which consisted of, (1) A proper design and layout of sea-water irrigation system and waste water treatment, (2) Each farm estate should earn revenue to support its operations, (3) An effective cooperative management system, which can control all cultivators, should be developed, (4) The government should support only essential academic contributions, (5) All shrimp farm estates should operate according to the code of conduct for sustainable marine shrimp farming. This proposed management model requires much less contribution from the government from the government which is estimated about 130-150 million Baht per year.

Keywords: Management; Marine shrimps; Shrimps; Farms; Models; Sea water irrigation system

730 Nareumon Fataweeporn. 1992. **An analysis on marketing system of fisheries products from artisanal fisheries and shrimp farming in Amphoe Pak Phanang, Changwat Nakhon Si Thammarat, 1991.** Master Thesis. Kasetsart University. 109 p.

The objectives of this study are to know the market structure, conduct and performance of artisanal fishermen and shrimp farmers in Amphoe Pak Phanang, Changwat Nakhon Si Thammarat. Results of the study can be concluded as follows. Marketing channels of shrimp from shrimp gill net, and push net, begins from fishermen selling to local collectors or wholesalers from other districts who tie the fishermen on credit. Wholesalers sell shrimp to retailers, wholesaler and exporters. Buyers determine price. Market is oligopsony. Fishermen sell mullet. From gill net to retailers, wholesalers and processors at municipal market. Sales are on cash and can be negotiated. Market is monopolistic competition. Tiger shrimp farmers sell to 1–5 regular local collectors. Buyers determine price. Market is oligopsony.

For market performance, gill net, shrimp collectors has the highest marketing margin, follow by tiger shrimp collector. Captured shrimp retailer,

mullet retailer and gill net shrimp collector accordingly. Retail market is more efficient than collector market. To improve market efficiency, then must be improvement in infrastructure and basic facilities for marketing, eg market place, financial institution, communication and services on gasoline and ice, as well as marketing information.

Keywords: Analysis; Marketing system; Fishery products; Artisanal fishing; Fishing community; Shrimps; Farming; Nakhon Si Thammarat

731 Nootcharee Saarduc. 2000. **Farmers' opinion towards shrimp culture in Samut Songkhram province.** Master Thesis. Chiang Mai University. 102 p.

The objectives of this research were to study the opinion of farmers towards shrimp culture, the relationship between the opinion of farmers and their personal characteristics and economic factors of farmers.

Data were gathered from 112 farmers in Samut Songkhram province. Data were analyzed by using Percentage, Arithmetic means, Standard Deviation and Chisquare test.

From research findings, it was found that most farmers were male with an average age of 38.78 years old. Their average family size was 3.83 persons with only 1.36 persons per family as work force. All farmers sampled were primary school graduated with 4.04 years experience in shrimp culture. The cultivation land used for each family was 5.54 rai. Average annual income was 948,142 Baht per family.

Average annual expenses were 388,580 Baht per family with net income 518,180 Baht per year. All shrimps kept by farmers were block type. Farmers raised shrimps in rectangle pond with irrigation gates.

They raised shrimp twice a year. Antibiotics were also used. The ponds were 1.5 m deep. Each farmer operated about 3.6 rai of land. The pond was cleaned by paddlers in order to add oxygen into water and remove mud to the center of the pond.

Farmers kept about 25,000-30,000 shrimps per rai. They fed shrimps with dry pelleted feed four times a day. Shrimps were raised for 120 days with an average harvesting weight of 200-300 kg per rai. The harvest was done by closing the irrigation gates and using fish traps when the pond was dry. Laborers were employed to harvest. Some prawn brokers came to buy them at farm gate. Farmers had a good knowledge of mangrove forest conservation.

As for farmer's opinion towards the effect of shrimp culture on ecosystem of mangrove forest in terms of water turbidity and pollution the decreased number of wildlife, trees and soil fertility, it was shown that farmers were well aware of these issues.

The hypothesis test showed that farming area was associated with farmer's opinion in terms of

soil fertility at mangrove forest. While sex, age, marital status, educational background, income, number of years of farming, knowledge about mangrove forest conservation had no relations with farmers' opinion at all. The drastic problems for the farmers in raising shrimps were insufficient farmlands, high cost of young shrimps feed and antibiotics, lack of capital and high interest rate and low price of shrimp. Moderate problem was insufficient market place to sell their products. Minor problems include lack of land-ownership, water supply used in the farm was not clean, inadequate work force, no alternatives and lack of agricultural knowledge.

Keywords: Farmers; Shrimp culture; Economics; Samut Songkhram

732 Nuruth Phanichamnuay. 1990. **Buying behavior of black tiger shrimp intensive culturist for formulated feed in Samut Songkram province.** Master Thesis. Dhurakijpundit University. 98 p.

The purpose of this is to study the buying behavior toward the formulated feed used for the intensive culture of black tiger shrimp in the Samut Songkram province. Specifically it aims to find out purchasing decision criteria used by the choice of retail feed store, payment term, post-purchase satisfaction, sources of information and related marketing aspects. The study is expected to provide the guidelines for the marketing management of the formulated feed which could better fulfill the customer's need. Moreover, the industry which should lead to the development of related business. Due to the fact that the intensive farmings of black tiger shrimp was firstly initiated and developed in Samut Kongkram. This province was selected as the study area in this thesis. In this area, most local farmers have at least two years of experience in shrimp raising. This condition enables shrimp culturists to provide meaningful operational data to be used for the analysis.

Finding from the study show that, the feed quality is the most important decision criteria used by the shrimp's cultruists, and the farmers will select the feeds that are expected to generate the highest yield. As a result, other aspects become in significant in their purchase decision. The culturists prefer to buy shrimp feed from the retail store where sellers posses good human relations and aquacultural knowledge. The study show that culturists are satisfied with the brands currently used and they like to continue using the same brand.

Three main suggestions can be provided from this study. First the feed quality should be upgraded to the acceptable level and should be

continuously improved through research and development, since the poor quality brands would finally be unacceptable by these farmers. Secondly, since most culturists do not posses adequate aquacultural knowledge, the technical assistance should be also provided thoroughly to improve their performances. It is recommended that the demonstration farm should be set up in cooperation with related government agencies. Finally, for academic purpose, it is suggested that some studies should be conducted regarding changes in buying, due to differences in geographic area and time periods. In addition, factors influencing brands loyalty should be thoroughly investigated as well.

Keywords: Behavior; Black tiger shrimp; Feed; Formulated feed; Intensive culture; Samut Songkram

733 Nuson Song-iat. 1999. **Problems solution of small farmers after stop practising black tiger prawn cultivation: case study of the villages in Tambon East Pak Panang, Amphoe Pak Panang, Changwat Nakhon Sithammarat .** Master Thesis. Thammasat University. 147 p.

The study on problems solution of small farmers after stop practising Black Tiger Prawn cultivation: case study of the villages in Tambon East Pak Panang, Amphoe Pak Panang, Changwat Nakhon Sithammarat. The main objectives were to study the socio-economic of small farmers after stop practising black tiger prawn farming; to identify the problems and constraints of those households; and to find the appropriate solution for the economic difficulty. Qualitative approach was used by interviewing selected small farmers who have changed their jobs from practising black tiger prawn cultivation to other jobs. They are local and still living in the areas. The respondents were comprised of 15 households.

It was found that most turned back to practising their previous jobs such as fishing and labor working using their limit skill before prawn farming. Most of them have been facing the hardship. Some are able to solve their difficulties wholly or partly. The main problem was debt, part-time working, minimal income earning, etc. They tried to help themselves by means of asking some helps from relatives, using cooperative saving programs. Also the helping from NGOs were observed in the study area. However, there was no indication that the collective bargaining was used to solve this problem. The farmers did not petition to the concerning officials. The ignorance of solving the local natural resources was also observed. Moreover, none of agencies were involved in the process of problem solving such as gathering existing data, monitoring the development, helping farmers by means of introducing new commodity production or exposing them with new working skill. The appropriate procedure for the extension and

development of government sectors were not carried out accordingly.

From the study, the researcher would like to recommend the following alternatives. The concerning extension officials should encourage farmers to assess their skills before new commodity production; to study the appropriate careers for them as well as the repercussion, socio-economically and environmentally, in respective fields. There should be thoroughly study for appropriate planning in order to solve the economic problems, i.e. loaning, financing, organizing community development, agricultural extension services, recovery of resources depletion in case of tiger shrimp farming, as well as guiding the concept of sustainable development.

Recommendations for successive study should be in line of operational research to find the suitable career in terms of socio-economic and environmental awareness, to study the potential of family support in lessening of risk due to new farming production, and finally to find the appropriate measures for resources recovery.

Keywords: Problems; Farmers; Black tiger prawn; Pak Phanang; Nakhon Sri Thammarat

734 Buntoon Srethasirote. 1995. "Using simulation modeling and remote sensing technique for impact study of shrimp farms on mangrove area and some aquatic animal production at Welu Estuary, Khlung District, Chantaburi province." In The Ninth National Seminar on Mangrove Ecology "Mangrove Conservation for Thai Society in the Next Decade, 6-9 September 1995, National Research Council of Thailand. p. III-15 : 1-13

The satellite images of Welu estuary at Khlung district, Chantaburi province during 1982-1992 were classified using Nearest Neighbour Algorithm. The results were delineated into 7 categories, namely (1) Mangrove (2) Standing tree (3) Paddy field (4) Shrimp farm (5) Grass land (6) Mangrove cleared (7) Swamp and/or Mangrove cleared. Analysis of these data sets indicates that shrimp farm area had increased from 29.98 km.² in 1982 to 105.48 km.² in 1992 (251.83% increased). About 82.62 km.² of shrimp farm (78.33% of total shrimp area) operated in the mangrove area. During the same period, mangrove area had decreased from 190.34 km.² to 63.23 km.² (66.78% decreased). From this multitemporal study, also showed a 65% of decreased mangrove resulted from shrimp farm expansion.

The result of relationship analysis between mangrove area and the production of the nearshore mangrove-dependent fisheries revealed that obvious decreased of fisheries production in 1989

occurred follow extensive conservation of mangrove area in 1988. Average of fisheries production decreased from 16,076.4 tons (1974-1988) to 10,281 tons (1989-1992) or declined 36.05% which worth about 30,762,008 baht per year. To develop a knowledge driven model representing shrimp farm expansion, the following variables were considered : landuse, soil type, distance from road, distance from source of water and legal status of the area. Result from justifying a validation of the model showed their potential in simulation and prediction shrimp farm expansion in other coastal area.

Keywords: Remote sensing; Simulation models; Shrimp culture; Impact assessment; Mangroves; Welu estuary; Chanthaburi

735 Buntoon Srethasirote. 1995. **Using simulation modeling and remote sensing technique for impact study of shrimp farms on mangrove area and some aquatic animal production at Welu Estuary, Khlung District, Chantaburi province.** Master Thesis, Chulalongkorn University. 78 p.

The satellite images of Welu estuary at Khlung district, Chantaburi province during 1982-1992 were classified using Nearest Neighbour Algorithm. The results were delineated into 7 classes of landuse, namely (1) mangrove (2) standing tree (3) paddy field (4) shrimp farm (5) grass land (6) mangrove cleared (7) swamp and/or mangrove cleared. Analysis of these data sets indicates that shrimp farm area had increased from 29.98 km.² in 1982 to 105.48 km.² in 1992 (251.83 % increased). About 82.62 km.² of shrimp farm (78.33 % of the total shrimp area) located in the area used to be covered with mangrove. During the same period, mangrove area had been decreased from 190.34 km.² to 63.23 km.² (66.78 % decreased). From this multitemporal study, also showed a 65 % of decreased mangrove resulted from shrimp farm expansion. The result of relationship analysis between mangrove area and the production of the nearshore mangrove-dependent fisheries revealed that obvious decreased of fisheries production occurred follow extensive conversion of mangrove area in 1988. Average of fisheries production decreased from 16,076.4 tons (1974-1988) to 10,281 tons (1989-1992) or declined by 36.05 % which worth about 30,762,008 baht per year. To develop a knowledge driven model representing shrimp farm expansion, the following variables were considered : landuse, soil type, distance from road, distance from source of water and legal status of the area. Result from justifying a validation of the model showed their potential in simulation and prediction shrimp farm expansion in other coastal area.

Keywords: Remote sensing; Simulation models; Shrimp farm; Shrimp culture; Impact assessment;

Mangroves; Aquatic animal; Production; Welu estuary; Chanthaburi

736 Prachuab Leeruksakiat. 1996. **Application of geographic information system for shrimp farm and mangrove forest in Trat province.** Technical Paper No. 42/1996, Kung Krabaen Bay Fisheries Development Study Centre, Chanthaburi. Department of Fisheries. 13 p.

Trat Province is the east coast provinces of Thailand which has been rapidly developed to several human activities without planing and improperly coastal resources management. Especially, mangrove forest in Trat Province has been converted to intensive shrimp culture. Since 1996, the total intensive farm and mangrove forest have been 45,051.50 and 62,133.25 rai, respectively. The 19,135.50 rai of intensive shrimp farms were developed in mangrove forest area and 25,916.00 rai outside.

Keywords: Application; GIS; Geographic Information Systems; Shrimp farm; Mangroves; Trat

737 Prachuab Leeruksakiat. 2000. **Application of geographic information system for the estimation of shrimp farm and mangrove forest areas in Chachoengsao and Chonburi Provinces.** Technical Paper No.9/2000. Kung Krabaen Bay Fisheries Development Study Centre, Chanthaburi. Department of Fisheries. 23 p.

Chachoengsao and Chonburi Provinces are on the east coast of Thailand which were increasingly developed for various human needs without properly coastal resources planning and management. Especially, mangrove forest in Chachoengsao and Chonburi Provinces were converted for the purpose of intensive shrimp culture. In this studied on the satellite images of Landsat-5 TM in 1997, found that the total intensive shrimp farms and mangrove forest of Chachoengsao Province were 96,536.00 and 12,720.00 rai, respectively. The 10,885.00 rai of total intensive shrimp farms were developed in Economic B zone of mangrove forest.

The total intensive shrimp farms and mangrove forest of Chonburi Provinces were 42,560.50 and 2,302.50 rai, respectively. The 6,862.00 rai of total intensive shrimp farms were in Economic B zone while the rest shrimp farms existed outside of mangrove forest.

Keywords: Satellite imagery; Intensive culture; Shrimp farm; Mangroves; Chachoengsao; Chonburi

738 Prachuab Leeruksakiat and Siri Tookwinas. 1994. **Application of remote sensing and geographic information system for area estimation of shrimp farm and mangrove in Chanthaburi Province.** Technical Paper No.7/1994, Laem Sadet Coastal Fisheries and Environmental Research Center, Coastal Aquaculture Division, Department of Fisheries. 14 p.

Chanthaburi Province is a high potential area for marine shrimp culture development. The farming has been rapidly expanded without planing and lack of proper natural resources management. Therefore, most of the mangrove in Chanthaburi Province has been converted to shrimp culture farms. Since 1991, the total mangrove and shrimp culture areas have been 16,894 and 155,545 rai, respectively. Furthermore, the shrimp farms in the Conservation zones, Economic Zones A and Economic Zones B of mangrove are being occupied as 4,669, 95,813 and 30,250 rai, respectively. In this study, shrimp farm areas include dike, water system and other constructions. However, the exact total shrimp pond areas and number of ponds are aspectively 106,425 rai and 11,627 ponds.

Keywords: Application; Remote sensing; GIS; Geographic Information Systems; Area estimation; Shrimp farm; Mangroves

739 Prachuab Leeruksakiat and Supicha Mungsakon. 1996. **Application of geographic information system for shrimp farm and mangrove forest in Rayong Province.** Technical Paper No.41/1996. Kung Krabaen Bay Fisheries Development Study Center, Chanthaburi, Department of Fisheries. 12 p.

Rayong Province is the east coast province of Thailand which coastal area has been developed to many human activities. Therefore, there are conflicting among several landuse. The improperly intensive shrimp culture development is one of human activities which has impacted to mangrove forest of Rayong Province. In this study found that the total intensive shrimp farm and mangrove forest have been 20,399.50 and 10,726.75 rai, respectively. Furthermore, there are 11,146.75 rai of shrimp farms, exist in mangrove forest and 9,252.75 rai of shrimp farms outside mangrove forest.

Keywords: Geographic Information Systems; GIS; Shrimp farm; Mangroves; Rayong

740 Prachuab Leeruksakiat. 2000. **Estimation of suitable areas for shrimp farming and mangrove rehabilitation in Trat Province by Geographic Information System.** Technical paper no.38/2000, Kung Krabaen Bay Fisheries Development Study Center, Chanthaburi. Department of Fisheries. 24 p.

Geographic Information System with Mangrove utilization of cabinet in 1987, Soil series, Soil texture, Soil permeability, Slope, Soil pH, Proximity to brackishwater or seawater and Landuse of Trat Province were applied for selection of shrimp farm suitable area and mangrove rehabilitation suitable area in Trat Province. It found that the total shrimp farm suitable areas and mangrove rehabilitation suitable areas were 28,600.00 and 68,606.25 rai, respectively.

Keywords: Geographic Information Systems; GIS; Shrimp farm; Marine shrimps; Mangroves; Trat

741 Prapatson Samapat. 1994. **The study of export for Thai shrimp.** Master Thesis. Dhurakijpundit University. 120 p.

Frozen shrimp has generated the largest earnings among fishery products next to can seafood products. However, its export tends to decline as well as its market share in the world market. Due to a strong competition especially in term of export price with other exporters.

The objectives of the study : 1) to study the production and export of Thai shrimp, 2) to study the factors that affect export demand of Thai shrimp in the world market, and 3) to proposed the ways and means in expanding the export of Thai shrimp.

The study employed a multiple regression analysis in estimating export demand of Thai shrimp. The results reveal that production of Thai shrimp both from inland and offshore is increased 2.62% per year and inland production is increased 75% of total production. Domestic demand shares 52% of total production. Japan and U.S.A. import 46.3% and 25.6% of total export of Thailand.

Export demand of Thai shrimp to Japanese market depends on the gross national product of Japanese, and population. The results reveal that the coefficient of these two variables are 10.3432 and 74.5247 respectively.

Therefore, the following recommendation are being proposed; 1) Thailand should have a policy in improving the quality of the frozen shrimp products, 2) The policy in packaging development and marketing channel as well as export promotion should be given the priority and emphasized as far as export of Thai frozen shrimp is concerned.

Keywords: Exports; Frozen shrimps; Shrimps; Production; Marketing system

742 Prapud Aksornphan. 1997. **Cost-return of giant tiger prawn (*P. monodon* Fabricius) farming : a case study of Surat Thani Province.** Master Thesis. Kasetsart University. 123 p.

Giant Tiger Prawn is one of the commodities that has been in increasing demand both in domestic and in international markets. Despite this increasing demand, the supply from the natural sources is depleting. It is therefore important for the private and government agencies to support and improve Giant Tiger Prawn farming to increasing the supply.

The main objective of the study is to examine the general condition and problem of Giant Tiger Prawn farming and the potential for export; and to do cost and return analysis of different farm size in Surat Thani Province.

The analysis is based on the primary data collecting in a survey of 60 farms, randomly stratified into small, medium and large farms according to the farm area in Surat Thani Province. Other supporting information is collected from the government agencies and various published reports.

The study found that the yield and the amount exported still exhibited an unstable trend due to problems continually encountered by the farmers. The per crop analysis showed that total cost and total return to the large-size farm were the highest. The medium-size farm had the highest net profit. The per year analysis suggested that total cost of the small-size farm was the highest. The plausible explanation is that the small-size farm had the highest number of crops per year. The return to the large-size farm was the highest. The most crucial problem was prawn diseases found in all farm size. Besides, all farm sizes need government assistance in many ways. The government should the role in assisting prawn farmers to achieve higher level of production and management efficiency.

Keywords: Costs; Returns; Analysis; Giant tiger prawn; Farming; Surat Thani

743 Prapud Sirisumpunnava. 1990. **An economic analysis of giant tiger prawn (*Penaeus monodon*) production in Changwat Chanthaburi 1987/1988 crop year.** Master Thesis. Kasetsart University. 120 p.

The clear and continuous promotion of the government and availability of environmental condition that support *P. monodon* aquaculture has entranced the *P. monodon* culture in Thailand. However, the industry is suffering the problems in production, marketing, high investment cost and high risk.

The objectives of this study were : 1) to study status of the shrimp farmers; 2) production function and return to farms size; 3) efficiency of economic factors on production farms; 4) cost and return on investment from *P. monodon* culture. This study is investigated only in four districts of Chanthaburi in the year 1988/1989. The 50 grow-out farms (22 small, 20 medium and 8 large sizes) were selected as

the samples. The analysis of Cobb-Douglas production function showed that feed cost, culture experience and seeds were significantly affected the shrimp product with returns to scale of 1.0909 and coefficient of determinant of .73.

Considering the efficiency of input use, it was found that the value of marginal products of both feed and seed were greater than their prices while the VMP of the labor was less than wage rate. Therefore, profit can be maximized by increasing the use of feed and seed and reducing the use of labor.

Total cost of production per square metre of small, medium and large farms were 48.53, 37.90 and 34.69 baht with the cash cost of 38.02, 32.33 and 30.09 baht respectively. Total cost per kilogram of small, medium and large farm were 99.96, 97.65 and 105.35 baht with the cash cost of 76.14, 83.02 and 89.50 baht respectively.

Total income/sq. metre from the selling price at the production site for small, medium and large were 23.72, 34.17 and 33.26 baht, respectively. Average income/kg. small, medium and large farms were 63.90, 87.42 and 98.67 baht, respectively. Average profit margin/kg. small, medium and large farm were 53.34, 84.33 and 95.48 baht, respectively.

Keywords: Economic analysis; Costs; Returns; Giant tiger prawn; Production; Chanthaburi

744 Prasert Paradonpanichakul. 2001. An analysis on economic efficiency of giant tiger prawn farm in Chanthaburi and Nakhon Si Thammarat Provinces. Master Thesis. Kasetsart University. 118 p.

The objective of this research was to study the cost and return structure comparison of the giant tiger prawn farm including the economic efficiency by using Cobb-Douglas profit function as the indirect method to elasticity estimation of the factor demand and the production supply with 105 samples.

The result of this study was revealed that the investment cost of giant tiger prawn farm was mostly as variable cost, specifically prawn feed expense and a prawn larvae cost. The average returns per farm and rai of developed giant tiger prawn farm of Chanthaburi and Nakhon Si Thammarat Provinces was found that the large-scale farm had the returns exceeding the small-scale farm. The profit function and variable factor share analysis of all equations were estimated by Zellner's seemingly unrelated regression method. The result of statistical significance testing on coefficient value of all equations of hypothesis test, the responsiveness towards the economic efficiency, profit maximization, and the constant

returns to scale used by comparison t-test statistic, method of Ordinary Least Squares calculation, all of the coefficients possessed the statistic significance of the confidence level at 99%, exceptionally the coefficient of experienced factor contained the opposition sign towards the theory. The result of elasticity estimation of the factor demand and giant tiger prawn production supply capacitated to utilize in price policy planning of the production factor and the giant tiger prawn production. Using price policy by increasing price of giant tiger prawn product and decreasing price of inputs would enhance the supply accordingly; therefore, the reduction of inputs' price and an increase price of giant tiger prawn product simultaneously enhanced the net income of the giant tiger prawn agriculturists.

Keywords: Analysis; Economics; Efficiency; Giant tiger prawn; Farms; Chanthaburi; Nakhon Si Thammarat

745 Preecha Potathanapong. 2002. Factors affecting export quantity of Thai frozen shrimps and prawns to the United States of America. Master Thesis. Kasetsart University. 138 p.

The objectives of this study were to study the production and marketing situations of frozen shrimps and prawns, to analyze Revealed Comparative Advantage (RCA), to analyze factors affecting export quantity of Thai frozen shrimps and prawns to the United States of America, and to recommend how to increase capability of competition. This study using secondary data with time series (annual) data, an analysis Revealed Comparative Advantage (RCA) covering the period of 1994-2000 and an analysis factors affecting export quantity of Thai frozen shrimps and prawns to the United State of America covering the period of 1986-2000. The method study using descriptive and quantitative analysis.

The result of study on Revealed Comparative Advantage (RCA) of Thailand and other important competitors which were Ecuador, Mexico, Indonesia and India during the period of 1994-2000 found that all countries got comparative advantage in the whole study period for export frozen shrimps and prawns to the United States of America. For Thailand, the comparative advantage was continuously decreasing during the period of 1998-2000, while Ecuador got the comparative advantage continuously increasing during the period of 1994-1998 and then the comparative advantage was decreasing in the later periods. Mexico, the comparative advantage was continuously decreasing during the period of 1994-2000. For Indonesia and India, the comparative advantage were continuously increasing during the period of 1994-2000. The results of study on factor affecting export quantity of Thai frozen shrimps and

prawns to the United States of America during the period of 1986-2000, found that factor of US protectionist measures in natural resources and environmental conservation of sea turtles conservation was the main factor determining the import demand of this product from Thailand. Price was less important factor determining the import demand because of the United States of America considers quality of frozen shrimps and prawns was the main factor determining the import demand of frozen shrimps and prawns from Thailand. The factor of income and population amount found that were not much important to determining the import demand of frozen shrimps and prawns from Thailand.

Keywords: Factors; Exports; Quantity; Frozen Shrimps; Prawns; USA

746 Preecha Watanyoo. 1995. **"The study on the effect of changing in land use for paddy to giant prawn in Amphoe Ranod, Changwat Songkhla."** In The Ninth National Seminar on Mangrove Ecology "Mangrove conservation for Thai Society in the Next Decade, 6-9 September 1995, National Research Council of Thailand. p. III 14 : 1-11

Since land use for Paddy in Amphoe Ranod, Changwat Songkhla are decreasing and the farmers turn to raised Giant Prawn which gives net return higher than 48%. However, the areas of Paddy field and Giant Prawn farm are not definitely separated. So, it effects on changing of land unevitable. The factor of production in both Paddy and Giant Prawn use different kind of water whereas Giant Prawn farm raising use more capital. So, the farmers have to try to get more benefit without caring about the Natural Surrounding. So, in land use planning, the agencies concerned have to zoning each kind of land use for suitable and maximize benefit.

Keywords: Land use; Paddy fields; Giant black tiger prawn; Songkhla; Ranot

747 in Thai

748 Piti Kantangkul. 1997. **An economic and environmental analysis of Southern Thailand's Coastal resource uses : a study of unsustainable shrimp mariculture.** In The Tenth National Seminar on Mangrove Ecology 25-28 August 1997, National Research Council of Thailand. p. V-18 : 1-55.

Southern Thailand's coastal resources, particularly mangroves, have been degraded as a

result of unsustainable development. Ecological values of mangroves have been ignored by shrimp farmers and other involving people in development projects related to coastal resource uses. Shrimp mariculture has been expanded rapidly and given rise tremendous economic, environmental and social impacts. The objective of this study is to examine these impacts in relation to coastal resource uses especially mangroves in Trang province. The optimum coastal resource uses and allocation for economic efficiency within a sustainable development framework will be analyzed. Primary data from field survey and secondary data from various sources will be employed.

The theoretical framework for this study deals mainly with resource and ecological economics. The key analytical methods are environmental capacity assessment, mangrove and fishery productivity coastal resource uses in Trang, the theoretical framework, and analytical tools, economic model and ecological economic model are developed.

The empirical results reveal that shrimp mariculture in Trang has already exceeded the assimilative capacity of the coastal ecosystem. To achieve sustainable development, the shrimp farmers have to alter their farming practices by adopting lower stocking rate and the reduction in feed and chemical input uses. The shrimp farm area in Trang province has to be limited at a certain level. Certain level of shrimp farm area might be able to further expand in paddy and rubber plantation land. Further conversion of mangrove land for shrimp mariculture should be prohibited and operation of shrimp mariculture in mangrove zone should be allowed only for those farms have already existed. Mangrove logging in mangrove zone 'A' has to be halted since the foregone values are greater than direct benefit from logging. Mangrove plantation program should be accelerated since ecological values and direct benefit of mangroves are greater than benefit from shrimp mariculture.

Keywords: Analysis; Mangroves; Shrimps; Mariculture; Fishery; Coastal resources; Sustainable development; Economics; Environment

749 Piyanut Rattanajarn. 1999. **Changes in the tiger prawn farm community in Tombon Khanapnak Amphoe Pakphanang Nakhonsithammarat Province.** Master Thesis. Mahidol University. 189 p.

This study focus on the changes in economy, society and ecology of Khanapnak community in Amphore Pakphanang Nakhonsithammarat province. The thesis is divided into 4 parts. 1. History and ways of life of khanapnak community. 2. Tiger Prawn Aquaculture. 3. Its society after changes in the community's economic production process. 4.

Analysis of community. Qualitative research is used as the methodology.

The studied results found that the changes in economy, society and ecology were related to the economic production of the community. In the past, the khanapnak community's way of life was related to nature and simple living. Once an aquatic animal project on the Tiger Prawns was introduced into the village by the government officials, community's production processes were changed to produce more for selling instead of as household consumption. At the same time, modern production technologies were used for higher profit. It was a turning point that brought changes in the community's economy, society and ecology.

The community's production processes provoked tremendous changes especially on its ecological and economic aspects. However, the internal linkage among relatives in the community is a positive value in the middle of rapid change. It brings the community with peace and harmony rather than conflict as happened elsewhere.

Keywords: Economic change; Social change; Shrimp farm; Fishing community; Villages; Farmers; Entrepreneur; Employees; Pak Phanang; Nakhon Sri Thammarat

750 Piyawadee Chatchen 1997. **The impact of environmental tax on Thailand's shrimp export.** Master Thesis. Chulalongkorn University. 201 p.

The purpose of this research is to estimate the impact of the environmental tax in the form of border tax adjustment on the export volume and value of Thailand's shrimp. The study had focused on particular cases of important trading partners such as Japan and the US which had applied such a tax to the Thailand's shrimp exports. In this research, price elasticity of Thailand's shrimp export supply and in-depth interviews of those interviews of those interested persons in Thailand have been taken into consideration. The interview part of the research carried out ground work involving more than 40 officers working in government agencies and private companies related to the industry.

The study applied the multiple regression equation model in the form of Cobb-Douglas or log-log function, in order to find out the relationship between Thailand's shrimp export supply to Japan and the United States as a "pendent variable" and five factors as "independent variables" including the price of Thailand's exported shrimp to Japan and the US, the price of shrimp nutrition or feeding for shrimps, the area of mangrove forest, the productivity per rai, and the export volumes to other countries besides Japan

and the US. Time-series secondary data have covered the period from 1981 to 1995.

The result of the above study shows that price elasticity of export is 1.314 for the US which is higher than price elasticity of export supply to Japan which is equal to 1.102. This implies that the environmental tax, if applied, would have a stronger effect on the volume of Thailand's shrimp export to the US than that of Japan. Due to the fact that the US is more likely to apply the environmental tax rather than Japan, it is possible for that Thailand in the near future would bear a great impact from the US environmental tax. The result shows, overall, that if both countries impose such a tax on Thailand's shrimp export, Thailand will face an export reduction to those markets more than 2,200 million baht. Therefore, the government of Thailand should rapidly improve their policies accordingly to prevent such a tax imposition from major trading partners such as Japan and the US. This was the opinion overwhelmingly expressed in the interviews.

Keywords: Environmental tax; Shrimp culture; Shrimps; Exports; Mangroves; Impact; Border tax adjustment

751 Kiaticchai Vesdapunt, Nongnut Soratana and Boonterm Tiravatnaprasert. 1988. **Factors affecting major foreign demand for Thai fresh frozen shrimps** Research report, Research and Development Institute. Faculty of Economics and Business Administration. Kasetsart University. Bangkok. 65 p.

This study aims to construct an econometric model of factors affecting major foreign demand for Thai rice, i.e., Japan, United State, Singapore, Hong Kong, Australia and United Kingdom. The authors also aim to find the elasticities and to forecast the quantities of Thai fresh frozen shrimps export to the major importing countries. Time-series data from 1970 to 1986 was employed in the analysis. Analysis results showed that the coefficient of deflated Thai fresh frozen cuttlefish export price was the significant factor affecting the Japan import demand for Thai fresh frozen shrimps. The coefficients of U.S. population, U.S. deflated gross domestic product and the index of India quantity export of fresh frozen shrimps were the significant factors affecting the U.S. import demand for Thai fresh frozen shrimps. The coefficient of index of India quantity export of fresh frozen shrimps was the significant factor affecting the Singapore import demand for Thai fresh frozen shrimps. The coefficient of deflated fresh frozen cuttlefish export price was the significant factor affecting the Hong Kong import demand for Thai fresh frozen shrimps. The coefficients of Australia population and the index of India quantity export of fresh frozen shrimps were the significant factors affecting the Australia import demand for Thai fresh

frozen shrimps. The coefficient of the U.K. deflated gross domestic product was the significant factor affecting the U.K. import demand for Thai fresh frozen shrimps

The elasticities of deflated Thai fresh frozen shrimp export price, the deflated Thai fresh frozen cuttlefish export price and the Japan deflated gross domestic product were -0.60, 1.02 and 1.36 respectively. The elasticities of deflated Thai fresh frozen cuttlefish export price and the U.S. deflated gross domestic product were 0.84 and 3.38 respectively. The elasticities of deflated Thai fresh frozen cuttlefish export price and the Singapore deflated gross domestic product were elastic (4.75 and 1.97 respectively). The elasticities of deflated Thai fresh frozen cuttlefish and the Hong Kong deflated gross domestic product were inelastic (0.49 and 0.25 respectively). The elasticity of deflated Thai fresh frozen shrimp export to Australia was inelastic (-0.09). The elasticities of deflated Thai fresh frozen cuttlefish export price and the U.K. deflated gross domestic product were 0.27 and 12.47 respectively.

The forecasting of Thai fresh frozen shrimp export to major foreign countries has the increasing trend for each country and each year during 1987 to 1991. The average quantity export of Thai fresh frozen shrimps to Japan, U.S., Singapore, Hong Kong, Australia and U.K. were 11,776 tons; 10110 tons; 3,373 tons; 2,776 tons; 1,252 tons and 1,496 tons per year respectively.

Keywords: Factors; Demand; Frozen shrimps; Exports

752-753 in Thai

754 Pongthep Jomthamniyom. 2000. **Opinions of farmers toward the impact of waste from giant tiger shrimp culture in Ranot District, Songkhla Province.** Master Thesis. Kasetsart University. 87 p.

The objectives of this research were to study some background of giant tiger shrimp farmers, their opinions toward the impact of waste, reduction the impact of waste from giant tiger shrimp culture, including their problems and suggestions. The samples in this research were 192 giant tiger shrimp farmers. The data were collected by interview schedule. A statistically analysis was done for percentage, arithmetic means, standard deviation, correlation coefficient and chisquare with SPSS/PC⁺ program.

The result of the study revealed that the average age of the farmers was 44.76 years, most of the farmers finished education Prathomsuksa 4, having family labors with the average of 3.36 persons, the average land for shrimp pond was 5.32 rai and the

average income was 536,259.42 baht per year. It was found that most of the farmers had opinions the highest degree toward the impact of waste from giant tiger shrimp cultured.

The hypothesis testing found that age and educational level had correlated with opinions toward the impact of waste from giant tiger shrimp culture at 0.05 level of significant, the number of labors, shrimp pond size and farmer incomes had not correlated with opinions toward the impact of waste from giant tiger shrimp cultured.

Keywords: Farmers; Wastes; Giant tiger shrimp; Songkhla; Ranot

755 Photchanat Pitipunya. 2000. **Externality from giant tiger prawn (*Penaeus monodon* Fabricius) cultivation in fresh water area : case study of Amphoe Bang Pla Ma, Changwat Suphan Buri.** Master Thesis. Kasetsart University. 116 p.

The main objective of this study is to find externality from giant tiger prawn cultivation on fresh water area in Changwat Suphan Buri. Primary data in 1997/98 crop year which were used in this study were collected from 22 giant tiger prawn farms, 20 paddy farms adjacent to prawn farms, and 18 paddy farms at a distance of not less than 50 meters from prawn farms. Simple random sampling was used to obtain those sample farms.

Prawn cultivation in the study area was closed intensive system. Two cultivations per year were practiced with the duration for each cultivation was 100-150 days. The average prawn farm size was 30.84 rai of which 16.77 rai was cultivation pond and 14.07 rai was waste water treatment pond. Main problems faced by prawn farmers were expensive prawn feed and unhealthy prawn seeds.

Average prawn total production cost per cultivation of prawn was 43,068.46 baht per rai of which 38,784.62 and 4,283.84 baht per rai were variable cost and fixed cost, respectively. Gross income per cultivation was 59,733.65 baht per rai. Therefore, net private income was 20,949.03 baht per rai net private profit was 16,665.19 baht per rai.

Paddy farms adjacent to prawn farms yielded 625.69 kilograms per rai or equivalent to 3,203.53 baht per rai resulting in net income and net profit of 1,254.57 and 772.65 baht per rai, respectively. Paddy farms at a distance of not less than 50 meters from prawn farms yielded 703.57 kilograms per rai equivalent to 4,221.42 baht per rai resulting in net income of 2,253.75 baht per rai and net profit of 1,798.59 baht per rai.

Externality from giant tiger prawn cultivation was estimated to be a reduction of 77.88 kilograms of paddy per rai or equivalent to 467.28 baht per rai. The externality did not vary with distance from prawn farm to paddy farm. This study can not

indicate whether or not the externality varied with number of years of prawn cultivation and paddy variety since prawn had been cultivated in the study area for only two years and similar paddy varieties were used by the two groups of paddy farms.

Area of giant tiger prawn cultivation on fresh water area should be controlled and/or reduced in order to reduce the externality and prawn supply so as to prevent declining prawn price which may cause loss to prawn cultivation. Area of waste water treatment pond of prawn farm should be increased to prevent waste water overflows to other areas. Moreover, a reasonable rate of tax on prawn cultivation should be enforced so as to reduce cultivated area and externality.

Keywords: Giant tiger prawn; Shrimp culture; Freshwater area; Impact; Suphan Buri

756 Panitta Pongprayoon. 1999. **The study of competitive advantage of Thailand's frozen shrimp to Japan.** Master Thesis. Kasetsart University. 115 p.

Frozen shrimp is one of Thailand's important exports but currently the export volume is declining, especially to Japan, the major market. The main objective of this study is to investigate the competitive advantage of Thailand's frozen shrimp export to Japan. Focus was directed to the factors that create competitive advantage such as factor condition, demand condition, related and supporting industries and company strategy structure and rivalry. Besides, there are external factors that affect the competitive advantage of the country. For example, political uncertainty of government policy that might either support or put to disadvantage the ability to export. In order to make the comparative view clearer, the study has compared Thailand's frozen shrimp industry with that of Indonesia and India, particularly the exporting of frozen shrimp to Japan. In addition, recommendations were given to producers, exporters and the government.

The finding of the study indicate that the factors which favor Thailand to have competitive advantage over Indonesia and India in view of the internal factors in the country are : abundant raw materials, transportation and infrastructure, related and supporting industries especially the frozen food industry, company strategy structure and rivalry from new comers which are conducive to the development of the industry. On the other hand, Thailand has no competitive advantage over Indonesia and India with regards to such factors as working capital and higher wages. Moreover, the study showed that there are some factors that exert the same influence both in Thailand as in Indonesia

and India such as low demand in the country and small numbers of related and supporting industries. Inadequate raw feed materials for shrimp necessitates the importation from other countries as well as the need for government support.

The cooperation between government and private sector is required in order to solve the problems and obstacles, and to further develop Thailand's frozen shrimp industry. The government should disseminate new knowledge and new technology to the farmers. Research and development of shrimp species, and public relations for frozen shrimp should be implemented. Quality and health aspects should be stressed. There should be close coordination with among private agencies and government agencies to set high standard of product with high nutrition and health qualities, and to develop foods with more value-added impact.

Keywords: Competitiveness; Advantage; Industry; Frozen shrimps; Japan

757 Pantipa Khwunker. 2002. **Shrimp farmer's need for academic service and farm information in Amphoe Ranote, Changwat Songkhla.** Master Thesis. Prince of Songkla University. 165 p.

The study aimed to investigate economic social, psychological and communicative characteristics of shrimp farmers who raised Black Tiger Shrimp (*P. monodon*) information service needed by farmers and factors associated with the information needed. The systemic sampling were employed for sample selection and personal interviews were assigned as a method of data collection. One hundred and seventy farmers in Amphoe Ranote, Changwat Songkhla were interviewed.

Most farmers were males with the average of 40.8 years. They obtained formal education at Grade 4. Black Tiger Shrimp (*P. monodon*) raising. Most had a status of land tenure as owner and accessed to credit form salesman and followed by printed materials. Seminar, demonstration and study tours were required by extension most farmers while printed material and contact paid by extension officers. Were as low priority. Farmers needed marketing information most followed by disease, protection and shrimp strain. For correlation analysis use of local resources and exposure and to personal sources for farm information were positively correlated with the need of academic services.

The development of shrimp raising industry should be concentrated on personal development research and paid much attention to the use of local resources in terms of labors, practice skill, emotion, and technology. Cooperation of entrepreneurs academic officers, public organizations sections private section should be of a prime concern in order

to protect the environment for sustainable development of the shrimp industry.

Keywords: Shrimps; Farmers; Services; Farm information; Services; Ranot; Songkhla

758 Panipa Hanvivatanakit. 1989. **Economic analysis of giant tiger prawn (*P. monodon* Frabicius) culture in Thailand.** Master Thesis. Kasetsart University. 146 p.

Extention of *P. monodon* aquaculture has been one of the important government policies to increase fisheries product for the substitution of decrease in marine catch and to earn the foreign currencies. Presently, *P. monodon* culture has been rapidly enlarged. The investment in this industry has been increasing at a very high rate. However it is a high risk business since there has been many problems concerning the production and marketing. The objectives of this were 1) to study socio-economic status of the shrimp farmers; 2) to determine cost and returns of hatchery and grow-out farmings and 3) to estimate the grow-out farming production function. The 32 hatcheries and 99 grow-out farms from 12 coastal provinces were selected as the samples. Hatcheries were classified into 3 sizes; small, medium and large. Grow-out farms were classified into 3 types; extensive, semi-intensive and intensive farms.

From the analysis of costs and returns of hatcheries, the annual total cost of hatcheries were 96,075, 177,561 and 384,434 baht for small, medium and large respectively. Every sizes have almost the same cost structive, that was the percentage of fixed costs and variable costs were 53 and 47. Cost per unit of fry for small hatcheries was .24 baht while the medium and large were both .17 baht. Therefore, small scale had the lowest net income, net profit over cash cost and net profit which were .20, .19 and .09 baht respectively. The medium and large scales had .07 to .10 baht higher returns. Cost and returns of grow-out farming were total cost per rai per year of the extensive, semi-intensive and intensive farms were 9,322, 41,314 and 96,136 baht respectively. Percentage of fixed costs and variable costs of all types were 32 and 68. Production per rai per year of extensive, semi-intensive and intensive farms were 30, 227 and 666 kilograms respectively. According to the low production, income of extensive farm was only 6,733 baht per rai while income of semi-intensive and intensive farms were higher, 45,371 and 147,434 baht respectively. Net income per kilogram of extensive, semi-intensive and intensive farms were 18, 76 and 124 baht, net profit over costs were 32, 82 and 101 baht and net profit were -86, 18 and 77 baht respectively. Although, the extensive farm had the net loss of 86 baht but still

able to operate because of the positive net income and net profit over cash cost.

The analysis of Cobb-Douglas production function showed that number of seeds, feed cost and culture experience were variables which significantly affected the shrimp product and could explain production level in extensive farming by 55.09 percent being in decreasing returns to scale with summation of input elasticity being .6736. Production of semi-intensive farming could be explained by number of seed, feed cost, paddle wheel using in farm, and education level of farmer by 70.08 percent. It was increasing returns to scale with the sum of input elasticities being 1.7458.

From the study on increasing production or increasing input size, the extensive farm, case of farmer had not longer than 12 month-experience, the marginal product of seed and feed were .0067 and .0153; case of farmer had longer than 12 month-experience, the marginal product of both inputs were .0095 and .0329. In semi-intensive farm, the marginal products of labor and capital investment in equipment were 4.4117 and .0573 respectively. In the four cases of intensive farm; case 1 farm without paddle wheel and farmer graduated compulsory level, case 2 farm without paddle wheel and farmer graduated higher than compulsory level, case 3 farm with paddle wheel and farmer graduated compulsory level, case 4 farm with paddle wheel and farmer graduated higher than compulsory level. It was found that the marginal products of seed were more than feed in all cases. Marginal products of seed ranged from .0043 to .0360 and marginal products of feed ranged from .0033 to .0141.

In measuring the efficiency of each input uses by comparing the value of marginal product to the input prices, it was found that values of marginal product of inputs in almost every cases were higher than input prices. This showed that having the other input fixed at this scale of operation the farmers should increase using those inputs in order to maximize profit. Extensive and intensive farms should increase using seed and feed. Semi-intensive farm should increase using labor and capital investment in equipment. There were two exceptions, extensive farm the case of farmer had longer than 12 month-experience and intensive farm the case of farm with paddle wheel and farmer graduated higher than compulsory level should decrease using feed in order to maximize profit of using each input.

Keywords: Economic analysis; Giant tiger prawn; Culture; Thailand

759 Pisit Sukreeyapongse, Pisase Senawongse, Siri Tookwinas, Suwit Tientong and Puthachart Chunsakorn. 1995. **Attitude on the impacts of sea water irrigation for shrimp farming project : a comparative study of Amphoes Chaiya and Don**

Sak, Surat Thani and Amphoe Muang, Nakhon Si Thammarat. In The Ninth National Seminar on Mangrove Ecology "Mangrove conservation for Thai Society in the Next Decade, 6-9 September 1995, National Research Council of Thailand. p. IV-03 : 1-13

Sea water irrigation for shrimp farming is another approach of shrimp farming development by treating waste water before draining it. Expectedly, this farm management will better the environment and encourage sustainable utilization of coastal resources.

The objective of the research was to study the attitude of people from various occupations on impacts and changes of sea water irrigation project for shrimp farming.

Data collection was carried in Surat Thani Province in March 1994 and in Nakhon Si Thammarat Province in July 1994. Samples in this study were 583 cases of shrimp farmers, farmer and sea shore fisherman : 219 samples in Tambon Donsak, Amphoe Donsak Surat Thani Province, 187 samples in Tambon Takrub, Amphoe Chaiya, Surat Thani Province and 177 samples in Tambon Paknakhon, Amphoe Muang, Nakhon Si Thammarat Province.

The outcome of the study showed local people's attitude to the project was positive. Marine pollution decreased as opposing to fish and shell population increased. In addition, local people gained more income by being farm labourer, improving mangrove forest, increasing of land price, and having beneficial coastal fishery.

Local people's consideration on soil salinity and salinity of natural canal varied in different areas and occupations. However, their attitude on salinity of bore water for consumption and drainage of surface water to the sea would not change after the project started.

It was also found that there was no other impacts caused by the project such as on sea shore fishery, agriculture, cockle farming, fish cage culture, shrimp farming and tourism.

The tendency of change from present shrimp farming and agriculture to shrimp farming by sea water irrigation was increasing. Moreover the beautiful scenery of the sea was not destroyed by the installation of pumping pipe line 1-2 km. off the shore.

Keywords: Attitude; Impact; Sea Water Irrigation for Shrimp Farming Project; Surat Thani;

760 Pawadee Vaiyarabud. 2000. **An analysis of market share of Thai frozen and chilled shrimps in major markets.** Master Thesis. Kasetsart University. 133 p.

The main objective of this study is to analyze exporting expansion of Thai Frozen and chilled shrimps to the major markets (USA, EU and Japan) by using Constant Market Share Model (CMS), comparing with the competitive countries in the major markets, which are Ecuador, Indonesia and India.

The analysis will be separated into 2 periods, that are during 1987–1994 and 1995–1998 by using the period of 1982–1986 as the base year. The results of analysis in part one, Show that during period of 1987–1994, the exporting of value of frozen and chilled shrimps have been significantly increased to 503.79 million US\$ which effecting from the world exporting expansion (368.07 million US\$), the competition (108.31 million US\$) and the export promotion (57.63 million US\$), while the effect of the market distribution shows the decreasing in exporting value of 30.22 million US\$. During the period of 1995–1998, the exporting value of frozen and chilled shrimps have been significantly increased to 814.97 million US\$, which effecting from the works exporting expansion (584.64 million US\$), the export promotion (173.74 million US\$) and the competition (129.78 million US\$), while the effect of the market distribution shows the decreasing in exporting value of 73.19 million US\$. The second part of analysis will be emphasised upon the market share of Thai frozen and chilled shrimps in the major markets by comparing with the major competitors, which are Ecuador, Indonesia and India. The results of analysis during the period of 1987–1994 show that the value of frozen and chilled shrimps of Thailand has been significantly increased by 503.79 million US\$, comparing to Indonesia's (337.04 million US\$), Ecuador's (261.67 million US\$) and India's (141.34 million US\$). The analysis also indicates that Thailand has been potentially competitive in the world exporting expansion and the competitiveness, while the market distribution will be lost to India and Indonesia. The period of 1995–1998, Thailand's value of exporting has been also the mostly increased to 814.97 million US\$, comparing to Indonesia's (585.50 million US\$), Ecuador's (558.77 million US\$) and India's (435.60 million US\$). Meanwhile, Thailand shows that the export potential has been relied on the world exporting expansion, while Ecuador have been potentially on the market distribution, the competition and the export promotion.

Keywords: Market share; Frozen shrimps; Chilled shrimp; Major markets; Exports; CMS; Constant Market Share Model; USA; EU; Japan

761 Manu Potaros.1993. **The study on the status of black tiger prawn *Penaeus monodon* farming of farmers in Amphoe Klong Tom and Amphoe Koe Lan Ta, Changwat Krabi.** Technical Paper No. 2.

Office of Fisheries Technical Advisor, Department of Fisheries. 80 p.

The study on the status of Black Tiger Prawn, *Penaeus monodon* farming of farmers in Amphoe Klong Tom and Amphoe Koe Lan Ta was made due to the failure of repayment of private loan for investment in this farming. The purposes of the study were to find out about the cost of prawn production and the causes of poor return. In addition to, the methodology for solution of those causes had been considered. The study was conducted during February to May, 1993 by the survey on the cost of production and practice for pond culture of this prawn. From the study, the production costs were shown as well as the high cost compared to the other area and the problems of farm management were described in the paper. The methodology on solving the problems was clarified and various means to improve the technology for farm management were recommended. The Department of Fisheries, The Bank of Agriculture and Cooperatives and the Department of Cooperatives Promotion will be joined together in supporting the farmers to continue the prawn culture.

Keywords: Black tiger shrimp; Culture; Farmers; Krabi; Farm management

762 มลฤดี นิพนธ์พงษ์ และ ชวนพิศ ลิทธิมิ่งค์. 2541. การวิเคราะห์ธุรกิจการเลี้ยงกุ้งกุลาดำในพื้นที่ชายฝั่งทะเลภาคใต้ฝั่งอ่าวไทย. เอกสารวิชาการกองเศรษฐกิจฉบับที่ 8/2541. กองเศรษฐกิจการประมง. กรมประมง. 51 น.

This study assesses the costs and returns of the tiger shrimp business on the coastal of Thai Bay of Thailand and examines the feasibility and problem arising from tiger shrimp business

The culture about 97,423 rai were in Chumphon, Surat Thani, Nakhon Si Thammarat, Songkhla, Phatthalung, Pattani and Narathiwat. Nakhon Si Thammarat and Songkhla were selected as sample areas because the high density of tiger shrimp farms. Simple Random Sampling was to select 25 percent of 13 tiger shrimp cultured amphur, resulting in 4 amphur samples there were Pakphanung, Huasai, Ranod, and Hatyai. And then Simple Random Sampling 5 percent of whole producers 3,352 from each amphur samples, resulting in 104 samples.

The study found that the average farm area was 8.34 rai, with the area for culture being 5.78 rai and the other 2.56 rai for rest pond, farm shack, office and dike. The average size of culture pond was 2.86 rai. Each farm had average 2 ponds, 120 days of culture period per crop at a stocking density of 70-80 fry per square metre a survival rate about 46

percent. The average yield was 1,200 kilograms per rai with 50 pieces per kilogram.

The average cost of production was 127 baht per kilogram, consisting of 110 baht per kilogram cash and 17 baht per kilogram of non cash. The average price at farm was 166 baht per kilogram, hence, net profit was 39 baht per kilo, a 30.47 percent rate of return.

The problems facing shrimp culture are diseases both affected by bacteria and virus as well as water pollution from waste water of the farm. Only a small group of farmers, about 2.9 percent, keep this waste water and change its condition before releasing it. Marketing problems consisted of consistently underpriced as it is a perishable product, needing to be sold within one day. Dishonest middlemen, bouncing cheque and unfair scale measurement were also problems facing tiger shrimp farms.

Keywords: Black tiger shrimp; Analysis; Business; Coastal resources; Coast; Thai Bay

763 Manop Prathoomthong. 2001. **The environmental understanding of the black tiger shrimp farmers in Amphoe Bang Pakong, Changwat Chachoengsao.** Master Thesis. Prince of Songkla University. 165 p.

The objectives of this study were to investigate the environmental understanding of black tiger shrimp farmers, some factors effecting their understanding, black tiger shrimp management system and the role of group organizing in stimulating farmers' environmental understanding that will promote sustainability of black tiger shrimp farming.

Two research methods, namely, qualitative and quantitative approaches, were employed integratedly in the study. The qualitative approach was used to study the successful production and sustainable management system of the black tiger shrimp farmers. The Bang Samak Freshwater Black Tiger Shrimp Farmers Club for the Environment, which has been established for more than 7 years, was selected as a case study. The quantitative approach was used to evaluate the environmental understanding of the farmers. A sample of 250 black tiger shrimp farmers from 11 tambons in Bang Pakong District was selected from the total 663 farmers by using the stratified sampling technique. A questionnaire was used for data collection. Statistics used for data analysis included percentage, mean and Chi-square test. This was undertaken using SPSS Program V.9.01 for Windows/PC.

Results show that 60.40% of the black tiger shrimp farmers have a medium level of environmental understanding in their farming practices. Five factors identified for hypothesis testing were not significantly different at 95% level

of confidence. These factors include age, education, experience, place of residence, and monitoring of news.

In the qualitative analysis, it was found that the Bang Samak Freshwater Black Tiger Shrimp Farmers Club for the Environment played a very significant role in the distribution of knowledge for sustainable black tiger shrimp farming. Most of the club's members have also participated in soil and water resource conservation. Club membership has currently increased from 10 families to a total of 53 families covering tambons in Bang Pakong District.

Keywords: Environment; Black tiger shrimp; Farmers; Chachoengsao; Bang Pakong

764 Malinee Witchawut. 1994. **The study of cost and benefit analysis on net cage nursing of *Penaeus monodon* fry in Nakhon Sri Thammarat.** Technical Paper No. 32/1994, Coastal Aquaculture Division, Department of Fisheries. 35 p.

Increasing aquatic product (net cage nursing of *P. monodon*) is an activity among many activities of the Small Scale Coastal Aquaculture and Fisheries Development Project under Thailand National Economics Plan. There are 2 main objectives of this study 1.) to analyse cost and benefit of the shrimp larval nursing and 2.) to study the visual and the understanding of the activity members. The locations of this study is Mu 3, Ban Khok-it, Tambol Pak-nakhon, Muang district and Mu 3, Ban Tasungbon, Tambol Tasala, Tasala district in Nakhon Sri Thammarat Province. The analysis of cost and benefit at Ban Khok-it is 75,577.50 and 10,856.38 baht per crop respectively. While the result at Ban Tasungbon is 41,072.50 and 47,828.84 Baht per crop respectively.

The member's visual to the project is found that mostly they are interested to involve in this project and they've already understood the technique in net cage nursing of *P. monodon*.

Keywords: Costs; Benefit; Analysis; Net cages; Nursing; *Penaeus monodon*

765 Matee Laipradith. 2002. **An economic analysis of Black tiger prawn (*Penaeus monodon* Fabricius) culture: a case study of Changwat Nakhon Sri Thammarat and Changwat Phangnga 1999/2000 crop year.** Master Thesis. Kasetsart University. 359 p.

The objective of the study was to estimate the Black Tiger Prawn production function, return to scale, technical and economic efficiency of input

use in Black Tiger Prawn production, cost and return of each farm size by type of previous land utilization in each study sites.

The study used primary data that were obtained from interviewing 40 farmers in Amphoe Pak Phanang and Amphoe Muang of Changwat Nakhon Sri Thammarat and 46 farmers in Amphoe Muang and Amphoe Takuatung of Changwat Phangnga. Total number of farmers in this study was 86 samples.

The results from translog production function model indicated that Black Tiger Prawn production in Changwat Nakhon Sri Thammarat had an increasing return to scale. Artificial feed and fuel could significantly explain the changes in output. Seed and labor should be reduced but artificial feed and fuel should be added. The result from cost and return analysis indicated that farmers who used former shrimp ponds and idle land lost and farmers whose farming area was mangrove gained the highest profit.

The results from translog production function model indicated that Black Tiger Prawn production in Changwat Phangnga had an increasing return to scale. Artificial feed and fuel could significantly explain the changes in output. Seed, artificial feed and labor should be reduced but fuel should be increased. The exception was small holding farmers in previously para-rubber plantation the farmers should reduce seed and artificial feed but increase fuel and labor. The result from cost and return analysis indicated that farmers whose farming areas had been mangrove, para-rubber plantation, former shrimp pond and paddy lost while farmers who used previously nipa area gained the highest profit.

Keywords: Economic analysis; Black tiger prawn; Production; Culture; Nakhon Sri Thammarat; Phangnga

766 Yongyuth Preedalumpabud and Kanit Chaikayam. 1994. **The coastal environment at Pakrawa coast before construction of sea outfall for shrimp culture project.** Technical Paper No. 15/1994. National Institute of Coastal Aquaculture, Songkhla. Department of Fisheries. 18 p.

Coastal environmental surveys were carried out during high and low tide at Ban Pakrawa, Songkhla where Pakrawa sea outfall project for shrimp culture will be constructed. The surveys have 3 transects with 15 stations ranged 100, 500, 1000, 1500, 2000 m. from shore. Velocity and direction at surface and bottom were determined in each station. Velocity were also measured around 13 hr. tidal cycle at mid-water. Water and soil were collected to analyse the degree of organic matters contamination on coastal water. The result showed that water current to the north was stronger than that to the south during the north east monsoon. Western wind plays important

role in seaward movement of coastal water which distributed and diluted pollutant to off-shore while eastern wind bring clean water from off-shore. Water quality survey revealed that opening of Pakrawa water-gate caused negative impact on coastal water by low pH and high total organic carbon and total ammonia within 100 m. from shore.

Keywords: Coastal environment; Construction; Sea outfall; Shrimp culture; Songkhla

767 Yongyuth Preedalampabud. 1996. **Estimation of the carrying capacity of shrimp farm areas at pare canal by mass balance techniques.** Technical Paper No.3/1996. National Institute of Coastal Aquaculture, Songkhla. Department of Fisheries. 13 p.

Shrimp farming has been over-developed in some canals cause accumulation of organic waste and finally, failed in production. The study aimed to estimate the carrying capacity of shrimp farm areas by mass balance technique and water quality standard in coastal aquaculture. Water quality, velocity and depth were hourly collected in 24 h. at the mouth of Pare canal to analyse total ammonia and calculated flow. Removal ratio was estimated by ammonia outflow and inflow. Maximum ammonia outflow was evaluated by removal ratio and maximum ammonia inflow. Finally, Carrying capacity of shrimp farm areas was determined by the maximum ammonia outflow and ammonia loading. Shrimp farm areas along the coast of Pare canal have been previously reported only 280 rai according to the results of this study the additional areas of 1333.9 rai can potentially be increased.

Keywords: Estimation; Carrying capacity; Shrimp farm; Pare canal; Mass balance; Pattani; Yaring

768 Yarin Masakul. 2000. **An analysis of revealed comparative advantage and constant market share model : a case of Thai canned seafood.** Master Thesis. Kasetsart University. 139 p.

The objectives of this study were to study the Revealed Comparative Advantage (RCA) was used to analyze the comparative advantage of export, and Constant Market Share (CMS) was also used to analyze factors on the change of export values of canned tuna, canned shrimps and canned crab in the United States, the European Union and Japan.

The RCA values of Thai canned tuna export in the United State during 1988-1991, 1992-1995, 1996-1997 and 1997-1998 were 5.0208, 2.1181, 1.0824 and 1.6195. The competitor exports were Philippines and Indonesia. In the European Union market, Thai RCA values were 7.0275, 3.7525,

2.1571 and 2.4199. The other exporters were Spain and Senegal. In Japan market showed that Thai RCA values were 0.0904, 0.1322, 0.1404 and 0.1190. The other exporters were Philippines and Indonesia. The RCA values of Thai canned shrimps in the United States during 1993-1994, 1995-1996, 1996-1997 and 1997-1998 were 1.7454, 1.9859, 2.8571 and 3.3077. The competitor export was Indonesia. In Japan market, Thai RCA values were 0.2052, 0.2631, 0.3082 and 0.2520. The other exporters were China and Indonesia. The RCA values of Thai canned crab in the United States during 1990-1992, 1993-1995, 1996-1997 and 1997-1998 were 0.6197, 0.4346, 0.7530 and 0.9512. The competing exporters were Mexico and Indonesia. In the European Union market during 1988-1991, 1992-1995, 1996-1997 and 1997-1998 showed that Thai RCA values were 6.9235, 3.3496, 3.6617 and 3.9637. The other exporters were Canada and Chile.

Factor affecting on the export value changes of canned tuna from Thailand, by using CMS. Comparing 1988-1991 to 1992-1995 showed that factor effecting to decrease export was competitive effect. Comparison of 1996-1997 and 1997-1998 showed that factor effecting to increase export was competitive effect. The results of export change of canned shrimps from Thailand during 1993-1994, compared to 1995-1996 showed that factor effecting to increase export was world market expansion effect, and 1996-1997 compared to 1997-1998 showed that factor effecting to increase export was competitive effect. Comparing 1988-1991 to 1992-1995 showed that distribution effect was major effect on Thai canned crab export changes. Compared 1996-1997 to 1997-1998 showed that factor effecting to increase export was competitive effect.

Keywords: Analysis; Comparision; Revealed Comparative Advantage; Constant Market Share Model; RCA; Exports; CMS; Export values; Canned seafood; EU; Japan; USA

769 Rapeepun Suwannatachote and Somporn Fuangchan. 1994. **Adjustment of rural community within Songkhla Lake Basin in response to changes in production Pattern.** Faculty of Management Sciences, Prince of Songkla University. 66 p.

The objectives of this study were to study the socio-economic and cultural settings, changes in land use pattern, changes of production pattern from paddy rice farming to prawn farming, as well as to assess the impacts of tiger prawn farming upon socio-economic and cultural settings of the local communities in Amphoe Ranot and Amphoe Singha Nakhon, Changwat Songkhla. The sample population employed in this study includes 249 tiger prawn farmers who reside in the prawn farms-densed area:

237 from Tambons Klong Daen, Thabon and Rawa in Amphoe Ranot; and 12 from Tambons Tambon and Sathing Moh in Amphoe Singha Nakon. The prawn farmers within these area can be divided into three categories: (1) farm workers; (2) individual farm owner, generally small-scale farmer; and (3) contract farmers generally associated with large cooperates.

The study involved documentary search, questionnaires interview employing questionnaires designed by the researchers, and a qualitative analysis. The latter included focal group discussion and direct observation. Data were analyzed by a computer and the results were presented as percentages and Chisquares. Focal group data were also analyzed.

The study revealed that most population in both Amphoes were agriculturists (paddy rice farmers). There was a tendency that families increasingly turned towards nuclear families. Family size in Amphoe Ranot averaged around 5.9; in Amphoe Singha Nakon, 6.8. Most people were Buddhists. Relations between inhabitants were of primary type.

In recent years, it was noted that more and more lands have been converted to prawn farms. In Amphoe Ranot, prawn farm area increased from 8,695 rais (1,390 hectares) in 1990 to 13,376 rais (2,140 hectares) in 1991; in Amphoe Singha Nakon, 429 rais (69 hectares) in 1992 to 629 rais (101 hectares) in 1993. It was found from the interview that, on the average, prawn farm owners owned two ponds, whose sizes averaged 2.7 rais (0.43 hectares). Thus, the average prawn farm owners earned a (gross) revenue of 353,750 - 466,950 ; and made profit of 53,750 - 166,950 Baht per rai per crop. A typical farm worker earned a monthly income of approximately 3,700 Baht.

The study showed that most prawn farmers were local residents. Most common reason for turning from original occupation to prawn farming was to earn higher income, which in turn improved quality of life and consequently enable them to fulfil their and their family members', satisfaction and needs. It was noted that simple life-styles were disappearing from the area. Prawn farming has prevented the farmers from enjoying their leisure time with their families. Primary relationship within the communities have noticeably faded out; more and more secondary relationship was observed.

Most questionnaire respondents contended that successful prawn farmers must be knowledgeable in prawn farming techniques. Nevertheless, there was no guarantee that one who chose to be prawn farmers would always be better off.

Regarding the right to use natural resources, the questionnaire respondents contended that the sea was the common property, hence one could pump

water for his/her uses at his/her discretion. Most respondents were not aware that messing up the beaches- by laying pipes, digging ponds and piling pond sediment on the beaches would affect the beauty of the beaches. Although all of them agreed that discharging prawn farm wastewater into canals would affect the water users, such practices have been observed. Most of them, however, contended that discharging untreated prawn farm wastewater into the sea would not deteriorate seawater quality.

All questionnaire respondents agreed that prawn farming yielded better income, as compared with rice farming. However, prawn farming demanded much more time and care than most other businesses; hence having less time for pleasure and community involvement.

Prawn farming accelerated uses of land and water resources, as well as raising land price. Quality of both fresh water and seawater continually deteriorates, since water resource has been used without suitable and sufficient care. Besides, most farmers were not aware of the need for environmental conservation; neither do they appreciate the beauty of the natural resources. Thus, deterioration of natural resources were not badly felt. Public environmental awareness campaign, as well as other proper remedial measures, is necessary and urgent before our mother nature is destroyed to the point of no return.

Keywords: Rural communities; Songkhla Lake; Production pattern; Rice fields; Paddy field; Farming; Shrimp farm; Songkhla

770 Manoch Roongratri and Anucha Songjitsawat. 1999. **Catching efficiency of the shrimp otter board trawl equipped with the Turtle Excluder Device (TED).** Technical Paper No. 70/1999, Eastern Marine Fisheries Development Center, Rayong. Department of Fisheries. 15 p.

Experiments on catching efficiency of the shrimp otter board trawler equipped with a turtle excluder device (TED) resulted in the escape of 1.244 kg/hr of economic faunas or 4.64% of total catch via the TED trawler should lose the income of 47.03 baht/hr. The escape could comprise 0.62 kg/hr of shrimps or 2.31% of total catch. This was equal to the loss of 43.64 baht/hr. Fishing income taken by the TED-equipped was nightly smaller than that of the non - TED. The TED trawler lost, in fact, only small amount of its catch. But the lost amount also contained high - priced shrimps, which could differentiate the fishing income. Statistically, marine shrimps caught by the TED trawler did not differ from that of the non - TED trawler and so that no difference in catching efficiency between the two boats was recognizable.

Keywords: Turtle Excluder Device; Catching; Efficiency; Shrimp otter board trawler; TED

771 Manoch Roongratri, Anucha Songjitsawat, Suthep Jualaong, Teerayut Srikum, Somdej Sookbunterng, Pornchai Kampaeng, Sayan Chanchuay and Prapart Binraman. 2000. **Impacts of the turtle excluder device (TED) on catching efficiency of the shrimp otter board trawl.** Technical Paper No. 6/2000, Eastern Marine Fisheries Development Center, Rayong. Department of Fisheries. 88 p.

Determination on of the Turtle Excluder Device (TED) on catching efficiency of shrimp otter board trawls was conducted by two fishing boats. One trawl was equipped the TED, while the other was not. Fishing operations of both were performed in parallel during nighttime in Trat Bay, Trat Province, during June to September 1998. To determine catch loss via TED- opening, an Appendix coded was applied to the TED- equipped net.

In general, species composition taken by the both trawls was similar. In average the non- TED could take 27.71 kg/hr, whereas the TED took only 18.40 kg/hr of total catch. This difference was statically significant. Concerning economic catch, the both trawls were similar in catchability. Namely, the non- TED caught 15.53 kg/hr and the TED 16.31 kg/hr. Main income of catch occurred by shrimp catch. Whereas the non- TED got 210.24 baht/hr from the shrimps, the TED could take only 165.02 baht/hr. The non- TED could earn about 21.51% rather than the TED. This made the non- TED succeed 257.15 baht/hr, but the non- TED 295.38 baht/hr. The non- TED could then obtain 12.82% of income rather than the TED did. Regarding to escapement of the TED- equipped, average of 7.38 kg/hr or about 27.80% of catch lost from net. This amount was equivalent to 87.63 baht/hr from 4.63 kg/hr of economic faunas including 0.62 kg/hr of shrimps (43.58 baht/hr). So that, the shrimp trawls may take only 72.20% of catch passing through net mouth or about 74.5% of income from economic faunas, less than they should obtain when there was no TED-used.

Statistically, the TED did not affect catching efficiency of the shrimp trawls except for the fishing income especially influenced by the shrimps. The loss of shrimp cost via TED-exit was considered unfair for the shrimp trawl occupation.

Keywords: Impact; Turtle Excluder Device; TED; Catching; Efficiency; Shrimp otter board trawler

772 Rewadee Panich. 2000. **An analysis of price and supply response of black tiger prawn in**

Thailand. Master Thesis. Kasetsart University. 125 p.

The main objectives of this study were study the existing situation of production and marketing of Black tiger prawn in Thailand, to study the supply response of Black tiger prawn to won price and inputs price and to analyze the price movement of Black Tiger Prawn.

An analysis of the price movement using Box-Jenkins method, with time series (quarterly) data from 1990 to 1998 disclosed that farm prices have been moving with a first order autoregressive [AR(1)] process.

Several supply response models using Restricted Least Squares, Estimate Generalized Least Squares and Non-linear Least Squares with time series (annual) data from 1979 to 1998. The 3 groups of equations were the area planted equation, the yield equation and the output equation. For all equations, the responses are dependent upon the current price of Black tiger prawn, the current price of shrimp seed, the current price of feed, the technology of production and the lagged values of the dependent variables (area planted, yield and output). The results conform to Nerlove's Partial Adjustment Model which describes that farmers can not adjust their output level as they desired due to resource constraints. The coefficient of adjustment as estimated were around 0.68 to 0.78.

The elasticity of black tiger prawn supply with respect to own price ranged from 1.3 to 1.6 for the short run and ranged from 1.9 to 2.1 for the long run. As for shrimp seed, the price elasticity ranged from 1.2 to 1.8 for the short run and ranged from 1.8 to 2.2 for the long run, For elasticity with respect to feed price the value ranged from 6.1 to 8.7 for the short run, and ranged from 9.0 to 11.1 for the long run. Estimation results disclose that the influential factors affecting changes in production were the feed price, the price of shrimp seed and the own price of Black tiger prawn, respectively.

Keywords: Analysis; Prices; Supply; Responses; Black tiger prawn; Production

773 Ruangyod Poonkaothong. 1998. **Development alternatives for former shrimp farming areas : a case study of the King's initiative project in Pak Pa Nang River Basin, Nakhon Si Thammarat Province.** Master Thesis. Mahidol University. 190 p.

The King's Initiative project at Pak Pa Nang, the area on which this study is based, has designed separate sea-water farming and fresh-water farming areas. However, a large number of shrimp farms are still in operation in the area designated as the fresh-water area. This study aims to explore three alternative development activities for the fresh-water

zone, (giant tiger prawn, catfish and nile), focusing on that were used for shrimp farming. The study is designed to investigate: 1) suitability of the shrimp farming area; 2) economic returns of the development alternative; 3) farmers' acceptance to each of those alternatives; 4) environmental impact which might occur from the development alternatives.

From the assessment of soil suitability, it was found that in general the land can still be used for other alternatives. However, since the project has just started, there are some limitations, namely, salinity in water and soil, which must be adjusted to a suitable level. Based on analysis of economic returns, raising giant tiger prawns is the best of the three alternatives. Catfish and nile are second and third respectively. From the survey of farmers' acceptance of the alternatives, raising giant tiger prawns is most attractive. Next the catfish and nile respectively. On potential for environmental impact of these options, wastewater from catfish ponds has the highest risk and nile farm second. Giant tiger prawn farming has the least potential of environmental impact.

In summary, giant tiger prawn farming appears to be the best alternative development in the fresh-water sea. It promises the highest return of all three. Farmers themselves show strongest interest and it has low potential of environmental impact. Catfish and nile farming are possible, through less preferable, alternatives. These alternatives can be useful for farmers when making adjustment under the project's development objectives.

Keywords: Shrimps; Farming; Shrimp farm; Pak Phanang River Basin; Giant tiger prawn; Catfish; Nile tilapia

774 in Thai

775 Worapoj Thanakobkij. 1995. **Domestic resource cost of canned shrimp and crab meat production in Thailand.** Master Thesis. Kasetsart University. 264 p.

The main objectives of this study are to study the cost and returns of canned shrimp and crabmeat in Thailand, both private and social cost : and to find domestic resource cost of canned shrimp and crabmeat in order to give policy recommendation in the promotion on this canning industry.

The results reveal that medium crabmeat cannery has the largest private and social net profits. Likely for shrimp, the medium-sized cannery has the largest private and social net profits. The results of domestic resource cost ratios reveal that crabmeat cannery has a lower domestic resource cost than shrimp cannery. Medium-sized crabmeat cannery has the lowest domestic resource

cost ratio. i.e. 0.51. following by the small and the large one. i.e. 0.62. 0.64 respectively. Medium-sized shrimp cannery has the lowest domestic resource cost ratio. i.e. 0.74 following by the large and the small one. i.e. 0.77. 0.81 respectively.

In conclusion, there should be a promotion on the crabmeat cannery rather than shrimp. The medium-sized cannery should be promoted as the first priority, following by the small and the large one.

Keywords: Domestic resources; Costs; Canned seafood; Production

776 Varagorn Lesuk. 2000. **The impacts of black tiger shrimp production on value added, employment and foreign exchange earnings.** Master Thesis. Chiang Mai University. 158 p.

The purpose of this study was to investigate the backward and forward linkage effects of the economic impacts that were affected by the black tiger shrimp production. These impacts were grouped to three major kinds. Firstly, the impacts on gross value added components. Secondly, the impacts on employment. And, thirdly, the impacts on net foreign exchange earnings by exports.

The 58-sector input-output table of Thailand, B.E. 2538, was the major source of secondary data exploited in the mathematical evaluation of matrix type process in this study. These backward and forward linkage effect evaluation processes were in conformity with P.N. Rasmussen (1968) methodology, and V. Bulmer-Thomas (1982) methodology respectively.

The black tiger shrimp production was actually separated into two parts, live or fresh shrimp production and preserved or prepared frozen shrimp production. This study had evaluations on the two of them separately.

For better understanding of readers in general, any kind of impact coefficients resulted from the aforesaid mathematical evaluations should be compared to the average impact coefficients of the same kind of all sectors in the whole economy. Then, they were classified into three ranges; unsatisfied, satisfied, and most satisfied. If an out-coming impact coefficients valued not far different from the said average, it meant that the economic potential of its kind (i.e.; employment) should be placed in 'satisfied class'. If an outgoing impact coefficient valued far above its said average, the economic potential of its kind should be placed in 'most satisfied class'. And if things happened in the opposite way, the economic potential should be placed in 'unsatisfied class'.

Finding of this study could be resumed as follows. First, in the input or production structure of this economy, live or fresh shrimp production had 'satisfied economical potential' to generate the income to people, the profit to entrepreneur, the

employment to people and the foreign exchange to the country. It has 'unsatisfied economic potential' to generate the tax-income to the government. Preserved or prepared frozen shrimp production had 'satisfied economic potential' to generate the income to people, the profit to entrepreneur and the foreign exchange to the country. It had 'unsatisfied economic potential' to generate the tax - income to the government and the employment to people. Second, in the output distribution or market structure of this economy, live of fresh shrimp production had 'satisfied economic potential' to generate the income to people and the profit to entrepreneur. It had 'most satisfied economic potential' to generate employment to people. But it had 'unsatisfied economic potential' to generate the tax-income to the government. Preserved or prepared frozen shrimp production had 'unsatisfied economic potential' to generate the income to people, the profit to entrepreneur, the employment to people and the tax-income to the government. However, when investigate in details of the input structure of live or fresh shrimp production, this production had quit high depreciation. It might mean that the equipment, machinery and building concerning in the production process had short working life. Anymore studies should be presented to overcome this problem. The way to prolong the working life would be an effective method to lessen the production cost and make the product more competitive. It would give the possibility of market expansion and production increase, and finally benefit the whole economy.

Keywords: Shrimps; Production; Black tiger shrimp; Value added; Employment; Foreign exchange earning

777 Waraporn Manatrakool. 2002. **Factors affecting the payment for irrigated water of farmers in the sea water irrigation for shrimp farming project : case of Kung Krabaen Bay, Amphoe Thamai, Changwat Chantaburi.** Master Thesis. Kasetsart University. 131 p.

The main objective of this research is to study factors affecting the payment for irrigated sea water of farmers in the sea water irrigation for farming project. The research has covered the social and economic status of the farmers including their opinions of participation of this sea water irrigation project. The logistic regression model is used to analyze raw data taken from random sampling technique and interviews of totally 80 farmers located inside and outside the project at Kung Krabaen Bay, Amphoe Thamai, Changwat Chantaburi.

The results from the estimated model show that, the factors which affect the farmers' payment

for irrigated sea water are follows: 1) Experience on shrimp farming. The more experiences on shrimp farming the farmers have, the less their willingness to pay for irrigated sea water. 2) Shrimp farming system. The farmers using closed system have less enthusiasm to pay for irrigated sea water as compared with those using other systems. 3) Quality of the irrigated sea water. As long as the farmers deem that they are continuously irrigated with good quality of the irrigated sea water, they tend to pay for it. 4) Age of farmers. The older farmers show higher reluctance to pay for irrigated sea water than the youngest farmers. All of such findings are found with the level of confidence at 99, 95, 95 and 90 percent respectively.

In order to educate and persuade those farmers to participate more actively in the management of the sea water irrigation project, the involved government agencies should have pointed out the advantage of their gathering as a group and the importance of paying for irrigated sea water. Responsible agencies should have also promoted and educated them the rules and regulations on the usage of irrigated sea water so that they understand better on the project, which should eventually help increase the effectiveness of the sea water irrigation for the shrimp farming project.

Keywords: Payment; Irrigated water; Farmers; Sea water Irrigation for Shrimp Farming Project; Kung Krabaen Bay; Chanthaburi

778 Wikeneth Werasuntorn. 1989. **An analysis of export market of Thai frozen shrimps.** Master Thesis. Kasetsart University. 94 p.

The frozen shrimp is one of fishery products that always generate high income to Thailand. Trend of both quatity and value are expected to increase in future. However, its export quantity and value are always fluctuated may be resulting from trade policy, economic situation, and other factors related to international trade. Therefore, this study aims to : 1) to describe the general feaures of export production and marketing of Thai frozen shrimps; 2) to analyze and compare the stabilities of export pricd, quantity of export and export earnings among those major import countries; and 3) to propose some policy and measure for increasing the export and stability of export of Thai shrimp.

The instability indexes were caculated by using the Macbean's method. The instability indexes of the export of Thai frozen shrimp to Japan with respect to value, quantity and price were 1.0973, 1.0167 and 0.5344 respectively as compared to 1.2291 , 0.9836 and 0.5196 respectively of those to The United States. In comparing the instability index of value, quantity and price, the results showed that the exports of Thai frozen shrimp to Japan and The United States

were not stable owing to the fluctuation of demand while the supply was constant and elastic. In the analysis of income variations of the export of the frozen shrimp to Japan resulted from the covariations of quantity and price, the variations of quantity and price were amounted to 76.46, 19.00 and 4.54 respectively and 63.27, 26.48 and 10.24 respectively for the United States.

The following recommendations can be drawn from the study as : 1) The shrimp for freezing product must be high in quality, i.e., fresh, clean, sanitary and constant in temperature and must be packed in standard package and properly labeled. 2) Due to non-uniformity in size and quality of raw material, frozen shrimp must be produced into different grades for market. 3) Keeping the market share of frozen shrimp constantly by future market contact and on time delivery.

Keywords: Analysis; Exports; Markets; Frozen shrimps; Prices; Quantity

779 Wichan Nuamkhayan. 1996. **Thailand's export of frozen shrimps under GATT agreement : a case study of Japanese and U.S. Markets.** Master Thesis. Kasetsart University. 116 p.

Frozen shrimps have been one of Thailand's major exports, earning a large amount of foreign exchange for the country each year. Japan and the U.S. are the major markets for world and Thai shrimps exports. Currently, Thai shrimps is number two behind Indonesia in the Japanese market, while being number one in the U.S. market. However, the two countries' imports of shrimps from Thailand have been growing at declining rate for the past few years. The important competitors with rapidly rising import market share in the two major markets are India and Vietnam. Apparently, Thai frozen shrimps have higher unit value than its competitors' in the important import markets.

Japan and the U.S. presently do not impose any import quota on frozen shrimps. However, Japan has an import tariff on frozen shrimps but at a very low rate, while the U.S. does not impose any tariff. Consequently, the tariff reduction under GATT agreement should not have any significant effect on the two countries' frozen shrimp imports. Furthermore, price is not a significant factor determining the Japanese and American frozen shrimps imports and consumption. The import and consumption depend on the product quality and reliability as well as the importing country's economic condition. At any rate, the GATT agreement has led to a transparent and non-discriminatory use of non-tariff barriers among importing countries. The competitive threats for Thai shrimps in both markets are the amount of

raw materials available for the frozen production in the future, and the agreement reached on more stringent quality inspection criteria and the impact of the industry on environment which the importing countries have imposed and are going to impose in the future. Consequently, Thai frozen shrimps producers should consider conserving the environment and/or relocating their factories to relatively more raw-material abundant and lower labour cost countries. Moreover, the product quality should be improved and more value should be added in order to be competitive.

Keywords: Exports; Frozen shrimps; GATT; Markets; Japan; USA

780 Withan Chumma. 1999. **An economic analysis of closed and open system intensive culture of black tiger shrimp (*Penaeus monodon*) in Thailand, crop year 1996/97.** Master Thesis. Kasetsart University. 154 p.

The main objectives of this study were to analyze cost - benefit of production and compare economic efficiency of input used between the closed and open system intensive culture of black tiger shrimp by employing Cobb-Douglas production function.

As for the cost-benefit analysis, the result has shown that on an average all of the closed system large farms have the greatest net return due to higher yield and price. The open system small farms receive the highest net return due to higher stocking density and proper care. The Cobb-Douglas production function analysis indicated that factors influencing productivity of these two systems were not significantly different, thus they were grouped together. The results showed that factors affecting black tiger shrimp yield were the number of fry, feed, other expenses, farm location and farm size. Holding the other factor constant, it was found that the farmer should be increase number of shrimp fry. Shrimp feed should be decreased in the Central, Eastern South and Western South while it should be increase in the East. Other expenses should be decreased in the Central and the eastern South while it should be increase in the East and Western South.

Keywords: Economic analysis; Closed system; Opened system; Intensive culture; Black tiger shrimp; Culture; *Penaeus monodon*

781 Winai Benheam. 1992. **Domestic resource cost of black tiger shrimp culture in Amphoe Pak Phanang, Changwat Nakhon Si Thammarat.** Master Thesis. Kasetsart University. 159 p.

The main objectives are to study the cost and returns of Black Tiger Shrimp Culture in Amphoe Pak Phanang by areas to compare domestic resource

cost, private and social costs and to make some recommendation for shrimp culture in coastal areas. The study relied on data collected from 94 shrimp farmers, randomly selected, and 6 cold storages who bought shrimp from Amphoe Pak Phanang.

The results show that Ban Laem Village had the largest private and social net profits i.e. 2.20 million baht and 1.02 million baht per farm annually, following by Bang Taeud, Kao Nang Doi, Bang Kong Khong, Sang Wiman and Bang Luk respectively. Bang Srichan Village loss both in term of private and social returns.

The results of domestic resource cost ratios showed that Ban Laem Village had the lowest domestic resource cost ratio, i.e. 0.33, following by Sang Wiman 0.52, Kao Nang Doi and Bang Kong Khong, 0.70 each, Bang Taeud 0.73, and Bang Luk 0.86, Bang Srichan had the largest domestic resource cost ratio being 3.59.

In conclusion, there should be a promotion on coastal shrimp culture in Ban Laem as the first priority, following by Sang Wiman, Kao Nang Doi, Bang Kong Khong, Bang Taeud, and Bang Luk in that order. These should not be any promotion for the culture in Bang Srichan.

Keywords: Domestic resources; Costs; Black tiger shrimp; Shrimp culture; Nakhon Sri Thammarat

782 Wirat Krasachat and Wichate Manerat. 1991. **A model for evaluating the effects of formal and informal barriers on trade of Thai frozen shrimp : a simulation analysis.** Master Thesis. King Mongkut's Institute of Technology Ladkrabang. 81 p.

Frozen shrimp is one of the important fishery products second only to canned seafood in term of export value. However, at present its export value and market share in world market tend to decline as the result of the problem of formal and informal barriers from both importing and exporting and exporting countries.

The major objective of this study was to describe the general situation of production, domestic and export markets of Thai frozen shrimp and also to analyse the effect of the barriers on supply, domestic demand per capita, export demand for Thai frozen shrimp and domestic wholesale price for Thai fresh shrimp. The time-series data from 1966 to 1987 was employed in this study.

Both ordinary least squares and two stage least squares methods were employed to estimate change in demand and supply of frozen shrimp, while simulation method was developed to analyse the effect of the barrier on trade of Thai frozen

shrimp and to forecast demand and supply of the frozen shrimp.

The study found that the elasticity of frozen shrimp product with respect to real domestic wholesale price was 0.582, while the elasticity of frozen shrimp production caused by last year production was 0.572. The elasticity of domestic demand per capita for frozen shrimp with respect to real domestic wholesale price and real income per capita were -0.102 and 2.200, respectively. The elasticity of frozen shrimp demand for export with respect to real export price was -0.354. And the elasticity of domestic wholesale price with respect to export price was 0.780

The study found that increasing in the barriers through increasing in export price by 20 percent would decrease the frozen shrimp production and domestic wholesale price by 8.500 and 45.663 percent on the average respectively. The domestic demand per capita and demand for export would be increased by 1.493 and 0.004 percent on the average, respectively.

The results of forecasting showed that the growth rate, covering the period of 1988-2000, of frozen shrimp production, domestic demand per capita, demand for export were at the average of 34,654.490 (ton), 0.34 (kg/capita) and 39,212.960 (tons) per year, respectively. The domestic wholesale price was 43.153 baht per kilogram on the average.

The overall study points to the fact that distributing export market, controlling quality of Thai frozen shrimp and helping in information are necessary to cope creatively with the problem of the barriers on Thai frozen shrimp trade.

Keywords: Models; Evaluation; Trade; Frozen shrimps

783 Wirat Krasachat. 1987. **An econometric model of Thai frozen shrimp : a simulation analysis.** Master Thesis. Kasetsart University. 152 p.

Frozen shrimp is one of the important fishery products second only to canned seafood in term of export value. However, at present its export value and market share in world market tend to decline as the result of the problem of price competition of frozen shrimp from other exporting countries.

The objectives of this study are : 1) to describe the general situation of production, domestic and export market of Thai frozen shrimp; 2) to derive and econometric model which consist of demand, supply and price determination for Thai frozen shrimp; 3) to analyse the effect change in exchange rate on supply, domestic demand, export demand and export price for Thai frozen shrimp; 4) to forecast supply, domestic demand, export demand and export price for Thai frozen shrimp. Two stage least squares method was employed to estimate change in demand

and supply of frozen shrimp, while simulation method was developed to analyse the effect of changes in exchange rate and to forecast demand and supply of frozen shrimp.

The study found that the elasticity of frozen shrimp production with respect to domestic wholesale price was 0.2801. while the elasticity of frozen shrimp production caused by last year production and time trend were 0.5245 and 0.8491, respectively. The elasticity of domestic demand for frozen shrimp with respect to domestic wholesale price and income per capita were -0.4529 and 2.0400, respectively. The elasticity of demand for frozen shrimp exported to Japan with respect to domestic wholesale price and exchange rate were -0.9889 and 1.3340, respectively. The elasticity of domestic wholesale price and exchange rate were -1.3765 and 7.2216, respectively. The study found that increasing in exchange rate by 20 percent would increase the frozen shrimp production, demand of export to Japan, demand of export to the United States, domestic wholesale price by 46.91, 35.73, 273.10 and 4.91 percent on the average, respectively. The domestic demand would be decreased by 2.38 percent on the average but the net social welfare would be increased 4.397 million bahts (in real term). The results of forecasting showed that after oil crisis situation the growth rate (covering the period of 1985-1994) of frozen shrimp production, domestic demand, demand of export to Japan and to the United States were at the average of 39,846.93, 8,735.20, 12,825.97 and 7,630.36 tons per year, respectively. The domestic wholesale price was 57.89 baht per kilogram on the average.

Keywords: Economics; Models; Frozen shrimps; Simulation analysis

784 Veera Boonragsa and Jumnong Chanasith. 1996. **Status of shrimp fisheries and resources in Phang-nga Bay, 1987-1992.** In Proceeding the Seminar on Fisheries 1996, Department of Fisheries, 18-20 September 1996, at Anon Meeting Hall and National Inland Fisheries Institute, Bang Khen. p.556-574.

Three major Fishing gears, namely, shrimp gill net, push net and set net are catch *Penaeus merguensis* as a target species where as dwarf trawl is mainly used to fish *Metapeneus spp.* All of these types of gears are found commonly and distribute all over Phang-Nga Bay. The main fishing areas are located in shallow waters, not exceed 20 m. deep within 3 kms from shore lines, including within fishing prohibited areas and marine park area. As a consequence, dwarf trawl and push net are unavoidable considered as illegal fishing types because of their operation with in

the prohibited areas. Fishermen are frequently arrested when they operated in these areas.

To take data during 1987-1992 into consideration, it is found that each small-scale fisherman in Phang-Nga Bay was possessed of more than one type of fishing gears. The fishing gear used is changed due to the target of species and occasion of high profit. In terms of resource utilization according to each type of gears, it is found that shrimp gill net is the rational fishing gear because the size of *Penaeus merguensis* is reasonable for market while shrimps caught by push net and set net are always very small resulting in low price. Furthermore, small pelagic crab and small sized of an economically important fish species are always encountered in the latter two gears. The dwarf trawl also catch *Metapeneus spp.* In small sized with low price, and other shrimp species, pelagic crabs and small sized economic fish species are always included in the trash fish composition. This is not wise utilization at all small-scale fisherman, dealing with four different types of gear in Phang-Nga Bay, earn quite low income and this makes their living hardly reach their need. As long as the resource deterioration circumstance keeps running their living seems to be getting worse and worse year by year. This is serious case that should be solved as fast as possible either in a way of fisheries management or another.

The four types of gears are definitely suitable for shallow water operation because of their limitation in deep water. Phang-Nga Bay is well fitted to these gears since its topography is mostly shallow and small islands scatter around the bay. To push introduce these four fishing gears operating in shallow water moved to deep-offshore area seems to be very difficult.

Therefore, to terminate these gears completely in the bay is extremely need to be considered. However, it needs a period of time for those fisherman to change their occupation and the state should take care until the fisherman are firmly standing on their legs with new job. In addition, to reduce the resource deterioration by pair-trawl and other board trawl must be regulated because the catch from their net always have an amount of small sized resources. These gears operate densely a bit further away from the bay.

Keywords: Status; Shrimp fisheries; Marine shrimps; Resources; Phang-nga Bay

785 Wudtichai Wungkhahart, Teerachai Reungprim and Theerapat Supasiripong. 2000. **Efficiency and benefit of trammel net with different mesh sizes of inner net in Phang-nga Bay.** Technical Paper No.8/2000, Andaman Sea Fisheries Development Center, Phuket. Department of Fisheries. 51 p.

Study on gear efficiency and income of trammel net in Phang-nga Bay deployed at the fishing ground

near Ko Nakya and Ko Yai. The experiment was carried out during May to August 1997. Completely randomized design was set at different 3 mesh sizes of inner net 37, 40 and 43 mm. Catches composition were 100 species with 57 species of fishes, 11 species of shrimps, 13 species of crabs, 6 species of stomatopods, 5 species of cephalopods, 5 species of mollusc and 3 species of others. Majority of the catches (41.75% of the total catch) was fish, while the target species (*Peneaus merguensis*) was caught at 24.46% of the total catches. There were non-significant differences among the catch rates and size of banana shrimp from those three mesh sizes of the inner net ($P>0.05$), but significant differences on the catch rates of *P. merguensis* ($P>0.05$) in mesh size of inner net 37 mm. which was lower than those of 40 and 43 mm. The results of income and profit analyses from three mesh sizes of inner net of trammel net such as : gross revenue, cash income, net income and net profit from the total catches were non-significant different ($P>0.05$), but significant different in the income from the catch of *P. merguensis* ($P>0.05$) in mesh size of inner net 37 mm. which was lower than those of 40 and 43 mm. The most suitable mesh size for the inner net of the banana prawn trammel net in Phang-nga bay is 43 mm. It should be promoted through extension to the fisherman, because it guarantees a good catch rate of banana prawn of suitable size and a good economic return.

Keywords: Trammel net; Inner net; Banana prawns; Fish; Efficiency; Catching; Benefits; *Peneaus merguensis*; Phang-nga bay

786 Wuttisan Kluaypanngam. 2000. **An analysis of revenue, cost, and net returns on giant tiger prawn culture in the rice field area : a case study in Bangkrood village, Banpo District, Chachoengsao Province.** Master Thesis. Krirk University. 75 p.

The objectives of the thesis were (1) to study the natural characteristics of this village, the social, and economic characteristics of Giant-Tiger Prawn feeders in Bang-grood Village, and (2) to analyze revenue, cost, and net returns on Giant-Tiger Prawn culture in this area.

The primary data were from interviewing, at random, 17 Giant-Tiger Prawn feeders in the area during 1999/2000 farming period. The data were then statistically economically analyzed to find out the revenue, cost and net returns of farming.

The study found that the farmers at Bang-grood fed their Giant-Tiger prawns by controlled farming but their procedure was not well managed. The unhealthy performance caused lower incomes and lower net returns as time

passed. The Giant-Tiger Prawn farming in this village lost money after three years of feeding due to yellow prawn disease caused by polluted water. The revenue was 28,848.27 baht per rai, the total cost was 24,116.96 baht per rai, the net return was 4,731.24 baht per rai and the breakeven point was 162.22 kilograms per rai.

Because of the losses sustained in this prawn-farming, it should let those who want to run Giant-Tiger Prawn farming know that they will finally lose unless they can find better farming technique.

Keywords: Analysis; Costs; Returns; Giant tiger prawn; Culture; Rice fields; Chachoengsao

787 Sorrayud Kidpod. 1993. **A study on fundamental problems for small and medium frozen-shrimp industries.** Master Thesis. King Mongkut's Institute of Technology North Bangkok. 85 p.

Thailand is one of the important countries which produce and export frozen shrimps. The production rate is about 125,000 metric tons per year, estimated 30,000 million Baht per year most and of which are small medium industries. Nowadays, although it is a well-grown business, there are still some problems and barriers in the frozen shrimps industry in the viewpoint of the entrepreneurs.

The 34 samples used in this research are the entrepreneurs of small and medium industries of frozen shrimps in the area of 3 provinces which are Samutprakarn, Samutsakorn and Samutsongkram. Data were collected questionnaires by using and analyzed by descriptive statistics.

The result of these appeared that problems and barriers of frozen shrimps industry in 5 aspects respectively. The first aspect is on Government sector in taxation Infrastructure and Regulations. The second one is on Raw material in Purchasing cost, the quality of shrimps and antibiotic in shrimps. The third one is on marketing in market environment, purchasing cost, market share and market conditions. The fourth one is on labouring in lack of technicians, job resignation and inadequate labour. The last one is on production quality control, by-product elimination, water supply and electricity.

Keywords: Problems; Frozen-shrimps; Industry; Shrimps; Exports

788 Siriphun Suchaikanaruck. 1991. **Study on the intensive culture of Giant tiger shrimp (*Penaeus monodon Fabricius*) to maximize profit.** Master Thesis. Kasetsart University. 116 p.

Data on factors affecting maximum profit of intensive culture of giant tiger shrimp (*Penaeus monodon Fabricius*) were collected from thirty ponds

in three provinces : Chanthaburi, Trat and Surat Thani, to analyze their correlations. Maximum profit was found to be highly significantly correlated with total cost. Thus, each factor comprising total cost was considered for its order of importance. The six major expense categories in terms of percentage of the total cost were, 1. total feed cost 50.23% 2. depreciation cost 13.99% 3. wages 10.36% 4. cost of shrimp seed 6.91% 5. electricity 6.78% and 6. maintenance 4.68%.

By ranking statistically profit and the total cost of the ponds with maximum profit in each province at ninety-five percent confident interval, it revealed that Chanthaburi province was the third in profit and the eighty-fifth in the total cost ranking. The profit for Trat province was also the third in the ranking, but the total cost was the seventh-third. The number one ranking was Surat Thani in terms of profit and the fifty-seventh in total cost.

It could be seen from the statistical ranking the all three provinces bear high total cost. Therefore, in order to increase the profit, they should try to minimize their expenses by controlling the six cost categories mentioned above.

Keywords: Intensive culture; Giant tiger shrimp; Profits; Chanthaburi; Trat; Surat Thani

789 Sirisuk Suksawat. 2000. **Factors affecting farmers's practices in Black tiger shrimp raising, Pakpanang District, Nakhon Sri Thammarat Province.** Master Thesis. Kasetsart University. 112 p.

The objectives of the study were to determine 1) some socio-economic background of farmers; 2) knowledge level and practices in Black Tiger Shrimp raising; 3) the relation between some socio-economic background of farmers and their practices in Black Tiger Shrimp raising; 4) problems encountered and recommendations to improve Black Tiger Shrimp raising.

A total of 170 Black Tiger Shrimp farmers in Pakpanang District, Nakhon Sri Thammarat province served as samples. Data were gathered using interview schedule. They were analyzed and presented through percentages, means and standard deviation. Chi-square test was employed to test the hypothesis at .05 level of significance. The knowledge test was pre-tested using Kuder-Richardson-20 with 0.8227 reliability value.

The results revealed that the average age of Black Tiger Shrimp farmers was 33 years. Their highest level of educational attainment was Bachelor Degree while the lowest was primary education (Prathom IV). They had an average of 8 years of Black Tiger Shrimp raising experience. The average farm size was 1.60 rai and the average total income was 153,000 Baht. Neighbors or

fellow farmers were the main source of knowledge. The farmers had moderate level of knowledge and shrimp raising practices. Market price instability and Black Tiger Shrimp diseases were the major problems. Guaranteed price, marketing knowledge and the control for Black Tiger Shrimp diseases were the major farmer's needs. The factors affecting farmers' practices were income, experience at .05 significant level.

Keywords: Factors; Farmers; Black tiger shrimp; Culture; Nakhon Sri Thammarat

790 Somphop Sintuprapa. 2000. **The study of Price behavior with decision making in future price for the agricultural commodity exchange: case studies on Giant tiger prawn goods in Thailand.** Master Thesis. Kasetsart University. 175 p.

The Giant Tiger Prawn is an important exporting commodity, which brings a lot of income per year to Thailand. However, almost agriculturists received a few income from exporting this commodity. Thus, government has established the Agricultural Commodity Exchange to protect agriculturists from the risk.

The purposes of this thesis were to study the behavior of the Giant Tiger Prawn's price by using the stationary test, the cointegration relationship test and the causality test of price transmission of the Giant Tiger Prawn in domestic markets and international markets respectively.

The results of the study showed that the transmission of price in domestic markets and international markets moved as the trend of time that is, there was an increasing variance when the time went by. That meant there was a quality of non-stationary data. Nevertheless, the testing of cointegration relationship could not be used under the assumption of variable. Furthermore, the result of causality test showed that the price transmission of the Giant Tiger Prawn in domestic markets and international markets had a causal relationship at the same direction.

The above result showed that the testing of stationary quality was an important test for forecasting the future price. Which has an advantage for agriculturists to make a decision for investing in the Giant Tiger Prawn's market because every time series of the Giant Tiger Prawn's price could be adjusted to get stationary series in which they could be efficiently utilized in forecasting.

Keywords: Prices; Agricultural Commodities; Behavior; Future price; Goods; Giant tiger prawn

791 Sarigkawan Mongkhonsawat. 1997. **Revealed comparative advantage and the determinants of**

Thai frozen shrimp export supply to Japan. Master Thesis. Ramkhamhaeng University. 136 p.

Of all important Thai fisheries, frozen shrimp plays significant roles of value-added and export for Thai economy. This results in a great amount of foreign money inflow. Among frozen shrimp importers, Japan is on the top. The purpose of this research is therefore to study the revealed comparative advantages, the determinants of Thai frozen shrimp export supply to Japan and their complementarity index as well.

The descriptive study mainly concerned the production and export process of frozen shrimp, whereas the quantitative study concentrated on the revealed comparative advantage index (RCA), complementarity index as well as potential factors affecting the supply of both countries. The multiple regression analysis was then applied to find out the variables' relationship. The factors affecting supply bound to depend on multiplication of Thai and Japanese per capita income, complementarity index changes and transport cost come from time-series data annually from 2519–2538 collected by the government and private sectors.

The study of the revealed comparative advantage index pointed out that Thailand had an advantage over Japan through out the study period as the RCA output exceeds 1.

The complementarity index, on the contrary, was lower than 1. The trend gradually rising, implied that Thailand and Japan appeared to support each other more and more with frozen shrimp trade.

The study of factors affecting supply of both countries' frozen shrimp export could be summed up that the per capita incomes multiplication of Thailand and Japan, their complementarity indexes, and the transport cost were all 97% of perfection suitable for explaining the equation of export value changes. The per capita income of both countries closely related to their export value with 99% statistical significance; if the multiplication was \$ 1,000 more, the export value would similarly become \$ 0.85 thousand greater.

The complementarity indexes of Thai and Japanese frozen shrimp export conformed to their export value with 99% statistical significance; that is, an increase of \$ 1,000 complementarity index logically resulted in the increasing export value of \$ 1.08 thousand.

The transport cost reversely related to the export value with reliable 95% statistical significance; in other words, an increase of the transport cost led to the decreasing export value of \$ 0.15 thousand.

Keywords: Frozen shrimps; Exports; Factors; Supply; Revealed Comparative Advantage; RCA; Japan

792 Sitanon Jesdapipat and Piyawadee Chatchen. 1997. **"Exo-tax, shrimp farming and mangrove of Thailand.** In The Tenth National Seminar on Mangrove Ecology, 25-28 August 1997, JB Hotel Hat Yai, Songkhla. Bangkok: National Research Council of Thailand. IV-8 : 1-16.

Amidst the height of environmental awareness, especially of potential impacts of trade on the environment, Thailand has been "watched" and occasionally accused of trading off its valuable coastal mangrove for cheap shrimps. Such is a sign of both market and policy failures which have not been able to internalize environmental costs into product prices. This study discusses general trends of changes in mangrove areas of Thailand trying to attribute the extent of such a change due to shrimp farming and other developments during the past two decades. It also brings up policy issues and options that are at disposal for Thailand to better manage its mangrove and measures that may help safeguard this valuable resource. Specifically, the discussion centers on using market-based instruments such as eco-tax to fulfill the objectives. Eco-tax in the form of border tax adjustment (BTA) is discussed and modeled, using time-series cross sectional data, to test sensitivity of Thailand's shrimp supply response to an imposition of such a measure. It was found that export supply does respond to and imposition of import tax, thus causing a possible import substitution in the market for Thai exports. If eco-tax is not imposed uniformly Thailand's competitiveness will be adversely affected. The policy discussion that follows also include GATT/WTO rules and the current debate on BTA. It was indicated that should an eco-tax scheme be adopted and applied, Thailand will be better off imposing such other MBI.

Keywords: Shrimps; Farming; Eco-tax; Border Tax Adjustment; BTA; Market-based instruments; MBIs; Competitiveness

793 Siri Tookwinas. 1997. **Consideration on the utilization of mangrove forest by satellite imagery data.** Thai Fisheries Gazette. 50(2): 135- 142.

The shrimp farming has been blamed for mangrove forest destruction for a long time. This would cause the negative impact on the sustainable development for shrimp farming industry. However, in 1994 the satellite imagery data (Landsat TMs. 1993) were used to inventory the coastal land use pattern. The results shown that only 17.45% of total mangrove forest was used for shrimp farms which could separate into conservation zone 1.20%,

economic zone A 6.16% and economic zone B to 10%. As economic zone B is unproductive and upland mangrove area which can be leased by private along the Cabinet Mangrove Forest Resolution on 15 December 1987. Therefore, it can be concluded that only 7.36% of total area of productive mangrove forest has been used for shrimp farm sites.

Keywords: Utilization; Mangroves; Satellite imagery; Analysis

794 Siri Tookvinas, Khanidtha Jongpeepian and Pisit Sukreeyapongse. 1995. **"The view of local people on the impact of intensive marine shrimp farming to coastal resources and area development at Kung Krabaen Bay."** In The Ninth National Seminar on Mangrove Ecology, Mangrove conservation for Thai Society in the Next Decade. 6-9 September 1995, National Research Council of Thailand. p.II-03 :1-16.

From the interview survey of local people of 241 persons surrounding Kung Krabaen Bay, Chanthaburi province. Eastern Thailand on the impact of intensive marine shrimp farming on the coastal resources and coastal area development were conducted in 1994. The results shown that the nutrient in marine shrimp effluent could serve as the food for fish and shellfish. The price of land was increased very rapidly. And the shrimp farm has contributed the positive impact on tourism activity and labour employment. However, the effluent has caused pollution in coastal water area. And it also has had the negative impact on sea water intrusion in freshwater area and rice field. The statistical analysis was also applied to indicate the difference among the view of the people.

Keywords: Local people; Intensive culture; Farming; Coastal resources; Impact; Chanthaburi; Kung Krabaen Bay

795 Sukit Rattanavinitkul. 1993. **The costs analysis of intensive shrimp farm (*Penaeus monodon* Fabricius).** Technical Paper No.2/1993 Nakhorn Srithammarat Coastal Aquaculture Station, Coastal Aquaculture Division, Department of Fisheries. 22 p.

Study on the intensive culture of a tiger prawn (*Penaeus monodon* Fabricius) conducted in two ponds of two trials. The main thrust of the experiments was reduction cost of production involving the development of appropriate technologies in prawn culture. The sizes of ponds are four rai of two ponds.

The stocking rate is in the average of 50 pcs/sq.m (PL 18) of two ponds in the first trial.

Production per rai varies from 1,971 Kg. to 2,097 Kg. The cost of production per unit of prawn culture may be used as a rough indicator of farming efficiency, pond with a relatively low cost of production per unit of area are usually the one using inputs more efficiently. The cost of production (per rai) in the first trial ranges from 150,555 Baht and 157,096 Baht.

For the second trial of two ponds, the stocking rates are in the average of 59 pcs/sq.m. (PL 17) Production per rai range from 1,946 Kg. and 1,831 Kg. The cost of production (per rai) ranges from 166,372 and 169,400 Baht respectively.

At the prevailing average farm price, the estimated break-even production per rai are about 1,158 Kg. and 1,237 Kg. for the first trial. For the second trial, break-even values are 979 Kg. and 1,008 Kg. Generally, at the prevailing average farm price of a tiger prawn, ponds with production of 979 Kg. or more per rai are profitable.

Keywords: Costs; Analysis; Intensive culture; Farming; *Penaeus monodon*

796 Sunthorn Poolpipatana and Wathanachai Pongnang. 2000. **Geographical information systems (GIS) : application for management and administration of environmental deterioration due to black shrimp-culture business, sub-project 1, Pattern, behavior and using computer program for evaluation of contaminated toxic elements in soils related to black shrimp-culture in Chachoengsao Province.** National Research Council of Thailand, Bangkok. 77 p.

Black shrimp culture for business in Chachoengsao has currently expanded in areas and numbers of farming and finally caused on soil resources and water quality impact. As sightseeing many areas are abandoned due to the main problems of soil and water deterioration. The chemical study by collecting soil and water sample analysis from the ponds according to the history of culture periods between 1-5 years found that there were accumulated of various toxic substances. The most predominated form was exchangeable Al as accumulated in the high concentration of 527.04 ppm in the > 5 year aged ponds and only 368.85 ppm Al in the new aged ponds (1-3 year). The others were Fe and Mn accumulated in those ponds as the similar pattern of Al concentration but they had not shown an evidence in high concentration to toxic level when compared to Al pattern.

In addition to study as mentioned above the main forms of Al-speciation, the behavior and the activities of Al concentration could be observed also by using the main function of SOILSOLN Computer Program which is based on the chemical analysis of soil characteristics as input for running the program (pH, EC, %O.M., Exchangeable bases, Available P, SO_4^{-2} ,

Cl, Exchangeable Al, Fe and Mn concentration. The results showed that the > 5 year aged ponds had the highest concentration (as Al^{+3} activity, μmol). The new aged ponds (1-3 year) were amazingly in accumulated Al^{+3} speciation in higher and faster manner more than the forecast prediction. The latter pattern will show the strong evidence and could be the great identification revealed the main impact of toxic contamination to the black shrimp culture business of this area in the near future.

Keywords: Geographic Information Systems; GIS; Computer programs; Soil; Toxic elements; Shrimp culture; Chachoengsao

797 Sunthorn Poolpipatana and Wathanachai Pongnang. 2000. **Geographical information systems (GIS) : application for management and administration of environmental deterioration due to black shrimp-culture business, sub-project 2, Geographical information systems : the application for management and administration of black shrimp-culture areas in Chachoengsao Province.** National Research Council of Thailand, Bangkok. 73 p.

Geographical Information System: The Application for Management and Administration of Black Shrimp Culture Areas in Chachoengsao Province.

Black shrimp culture for business in Chachoengsao has currently expanded in numbers of area and farming, and those activities will be the great effects for changes in soils characteristics and water quality problems. The main resolution for these problems is emphasized and managed by introducing the GIS SPAN Program application to evaluate the deterioration level, and to classify into the results of soil and water properties (as obtained from the sub-project 1) incorporated into the prediction of land evaluation.

The main results showed that the total areas used for aquaculture in Chachoengsao were 220.51 sq. km. (137,818.8 Rai), and they could be separated into black shrimp culture areas only 85.89 sq. km. (53,681.3 Rai). As based on soil mapping analysis for the latter areas indicated that the soil series generally used for black shrimp culture business were clayey with higher of water holding capacity. The suitable soil series were Bangkok (Bk), Bangkokpong (Bg), Samut-prakarn (Sm), Chaam (Ca) and Chachoengsao (Cc), respectively.

When using chemical soil and water properties obtained from the sampling ponds in those areas as inputs for running the GIS Program and classified by based on the suitability class of FAO (1983), found that the main areas are Marginally Suitable

class (S3) and Non-Suitable class (N) as 83.78% (71.96 sq. km.) of total areas used for black shrimp culture business. The Highly Suitable (S1) and Moderately Suitable (S2) class found only 16.22% (13.93 sq. km.) of total areas for black shrimp culture, which are distributed only in the new-aged pond areas. In case of considering only the chemical properties (Cl and $S^{=}$ content) of water in ponds found that they give the similar pattern and not different in details. In addition, the land suitability for paddy rice could demonstrate the strong evidence that the S1 class is found in minimal as 1.53% of total black shrimp culture area, and the main areas will be classified as the S3 and N class, respectively, which cover 55.59% of total black shrimp culture area.

Based on the soil characteristics and water properties obtained from this study show that those have the strong influences on black shrimp culture areas. The suitability class for land evaluation could also give the confirmation that the main distribution of these areas (Class S1, S2, S3 and N, respectively) are related to the previous history of land use and the number of years using for the continuous black shrimp culture. Finally all these activities could be regulated the land, soil properties, water quality and environment to be the deterioration levels.

Keywords: Geographic Information Systems; GIS; Application; Management; Black tiger shrimp; Shrimp farm; Chachoengsao

798 Suriya Poosiri. 1997. **Impacts of prawn-raising on mangrove forests in Trang Province, Thailand.** Master Thesis. Maejo University. 134 p.

Due to the deterioration of mangrove forests and the promotion of prawn-raising in these forests, it is necessary to investigate impacts of prawn-raising on mangrove forests. Thus, this research was conducted to examine: 1) personal and economic characteristics of prawn-raising farmers in Trang province; 2) impacts of prawn-raising in mangrove forests on farmers' socio-economic features, environments and ecological system; and 3) problems and obstacles concerning prawn-raising in mangrove forests. The data were collected by interviewing 137 prawn-raising farmers selected by the multi-stage random sampling.

The research results revealed that most of the respondents were male, married, 39 years old on average, had an average of 4 household members, 2 of whom contributed to prawn-raising. The percentage of respondents owning land was 56.20. Their average land -holding was 21 rai, 9 of which was used for prawn-raising. Major incomes were obtained from prawn-raising and para rubber growing, at an average of 374,854 baht/year.

The analysis in which Siegel's Sign Test was used revealed that prawn-raising in mangrove forests had

impacts on the respondent's economy. For social impacts, the comparison of average scores in the past with the present by means of t-test showed that prawn-raising in mangrove forests had no impact on the respondents' group activities, training, participation in social activities but it had impacts on their contact with officers and information access.

It was found that prawn-raising had no overall impact on mangrove forests since no significant difference was found between the past and the present. However, when considering each aspect, the following impacts were found to increase: 1) the pond had long been used, causing water pollution and diseases in prawns; 2) prawn-raising areas were deteriorating; 3) quantities of organic matters were high, affecting young aquatic life; and 4) water was cloudy, affecting prawn-raising along the shore. The following impacts were found to decrease: 1) the release of sewage, wastes and oil into the water; 2) decreased quantities of phytoplankton and zooplankton; and 3) deterioration of trees in mangrove forests.

The problems and obstacles stated at a highest level by the farmers were 1) high prices of prawn breeds and antiseptics; 2) low prices of products; and 3) lack of sources of loans with low interest rates. The problem stated at a high level was cleanliness of the water for raising prawns. Other problems were stated at moderate level.

Keywords: Impact; Prawns; Culture; Mangroves; Trang

799 Supat Khongpuang. 2001. **Financial and social cost-benefit analyses of sea water irrigation project for marine shrimp culture : a case study of Kung Krabaen Bay, Chanthaburi Province.** Master Thesis. Kasetsart University. 145 p.

The Sea Water Irrigation Project was mainly constructed to solve the problem of water quality in shrimp culture, to improve farm production and to promote sustainable coastal resource use. The main objectives of this study were divided into three parts, cost-return analysis at farm level, financial cost-benefit analysis and social cost-benefit analysis at project level in order to reveal financial viability from the private consideration and economic viability from the social consideration.

The study found that result from cost-return analysis of shrimp farms with and without project is possibly considered a long-term investment. The net profit of both farm groups were 66,670 and 49,385 Baht/rai/crop respectively. Whereas, the financial cost-benefit analysis at 10% discount rate showed that the project would be feasible if it could be contributed by farmers at least 32.8% of

net profit. The social cost-benefit analysis taking into account some external costs using change in productivity of rice yield and opportunity cost of losing mangrove forest, revealed that the NPV BCR and IRR of this project were -69,380,224 Baht, 0.80 and 6.13% respectively. However, many other external costs as well as external benefits were not included in this study.

Theoretically, the study suggested here that the project invested by the private sector would possibly be feasible because an individual farm could afford to pay for the service charge of project. On the other hand, with an inclusion of some external costs, the project may turn to be infeasible expect the project would cover the larger services area.

Keywords: Financial analysis; Social analysis; Cost benefit; Marine shrimps; Shrimp culture; Sea Water Irrigation for Shrimp Farming Project; Kung Krabaen Bay

800 Supha Juntarakul. 1997. **An analysis of demand for and supply of Thai shrimps, prawns and lobsters.** Master Thesis. Ramkhamhaeng University. 160 p.

Shrimps, prawns and lobsters have been ones of the most important item in marine-products exports. The significance of shrimps exports in the overall trade figures were increased substantially. Shrimp production are classified into two types namely, marine shrimps and cultivated shrimps. In 1983, shrimp production were 127,584 tons and increase to 95,571 tons in 1993. The total production of shrimps were 1,950 tons and 225,514 tons in 1983 and 1993, respectively. Shrimp exports were 15,616 tons or 1,280.6 million Baht worth in 1977. The exports were increased to 212,867.7 tons or 75,958.6 million Baht in 1997. Obviously, the increase in shrimps exports were the result of an increase in shrimp production.

The objectives of the study consist of four parts. The first part concerned with the description of production process for both domestic and export market. The second one was the study of both domestic demand and demand for export. The third one was a forecast of domestic supply and demand as well as export demand. The last one was an analysis of change in exchange rate on export demand to Japan and the United States.

The study found that the elasticity of the world cultivated shrimp production with respect to the area of production was 2.3197 and to the world export price was 1.0611, respectively.

The elasticity of total shrimps production with respect to cultivated shrimps and quantity of exported shrimps were 0.2201 and 0.0231, respectively.

The elasticity of domestic demand for shrimps in year *t* with respect to both per capita income and

domestic demand in year to t-1 were 0.7622 and 0.7411, respectively.

The elasticity of export demand for shrimps to Japan and the United States with respect to change exchange rate were 2.4427 and 5.1529, respectively. The elasticity of export demand with respect to the quantity of shrimps production and per capita income of the United States were -2.8029 and 8.5403, respectively.

This study also found that an increase in exchange rate from 25.38 Baht/Dollar to 30 Baht/Dollar raised the export demand to both Japan and the United States by 83.83 and 156.46 percents, respectively. Finally, when the exchange rate was 38 Baht/Dollar the export demand for Japanese and the United States markets were increased to 179,479 tons and 864,775 tons, respectively.

Keywords: Analysis; Demand; Supply; Shrimps; Prawns; Lobsters

801 Surasak Inoudom. 2000. **An economic analysis of black tiger shrimp culture in mangrove area : a case study of Chanthaburi Province.** Master Thesis. Kasetsart University. 77 p.

The objective of this study is to study the optimum level of mangrove conversation for black tiger shrimp culture in Chanthaburi Province during a period of ten years from 1988 to 1997 by using optimal control theory.

The result of this study finds that the optimum level of mangrove conversation for black tiger shrimp culture in 1988-1997 are 10,942, 13,777, 15,835, 16,561, 42,985, 53,320, 57,824, 63,562, 61,797 and 52,293 rai respectively. They are lower than the actual culture areas which are 31,685, 32,020, 32,100, 41,898, 85,000, 88,046, 86,639, 87,000, 90,583 and 85,126 rai respectively. The actual area used for black tiger shrimp culture were higher than the optimum. The optimal social net benefit could not be realized. If the black tiger shrimp culture area has been at the optimum, there would have been a net present value of 32,887 million baht during the period of this study, while the existing level would have a social net present value of only 19,629 million baht.

The produce, production cost of black tiger shrimp culture and cost of mangrove conversation for black tiger shrimp culture at the optimum are lower than the existing levels. The mangrove area and total benefit of mangrove at the optimum are higher the existing levels.

Maintaining the mangrove area at the optimal level, not to convert them at such high rate, can lead to a greater a social net present value of 13,258 million baht.

Keywords: Economic analysis; Black tiger shrimp; Shrimp culture; Mangroves; Chanthaburi

802 Suwat Boonyuen. 2000. **Some effects of black tiger shrimp farming on soil properties and rice yield : case study in Supanburi Province.** Master Thesis. Mahidol Universtiy.132 p.

This research studied the effect of black tiger shrimp farming on the chemical properties of soil, on rice growing, and on rice yield and component yield of 2 varieties of rice, namely : Supanburi 1 and Hom Supanburi. Properties of Saraburi soil series from abandoned ponds (shrimp farming soil) and soil unaffected by black tiger shrimp farming (natural soil) were compared. Soil samples were collected at depth 0-30 centimeters. Samples were collected from natural soils, for rice farming and black tiger shrimp farming soil from shrimp ponds which had been cultured for 1, 2 and 3 years, with samples collected at 3 ponds of each age interval.

The results of this study indicate that some chemical properties of shrimp farming soils had been changed significantly ($P < 0.05$). In particular, electrical conductivity, sodium adsorption ratio and exchangeable sodium percentage, sodium, calcium and magnesium content were increased the longer the shrimp pond was used. The electrical conductivity showed a high value (more than 2 ds/m) after 1 year of shrimp farming. The exchangeable sodium percentage showed a high value (more than 15) after 1 year of shrimp farming. Sodium adsorption ratio, sodium, calcium and magnesium levels were increased in all three shrimp farming period intervals. Sulfate level increased more than in natural soil in all three period intervals. Phosphorus level decreased with longer periods of black tiger shrimp farming. The changes of rice yield, growth, and component yield indicated that these were significantly higher in natural soil than in shrimp farming soil at ($P < 0.05$). The changes of chemical properties, rice yield, growth and component yield were affected from salinity of black tiger shrimp farming soil and in turn affected rice growing and rice yield of Supanburi 1 variety more than Hom Supanburi variety.

Keywords: Black tiger shrimp; Soil properties; Rice yields; Freshwater area; Farming; Suphan Buri

803 Sangdao Thuthaworn. 2001. **An analysis of effecting factors on decision making on effluent water treatment of shrimp farmers in Chanthaburi Province.** Master Thesis. Kasetsart University. 113 p.

Shrimp farm in Chanthaburi, the environmental affected province either polluted water or soil, includes trespass deforestation of mangrove area from changing to be shrimp farms. However,

Chanthaburi still has efficiency shrimp production because having along seashore thus to search the way for sustainable shrimp farming should do. This study objectives are: (1) to analyze financial revenue from closed system shrimps farming both recycle and non-recycle (2) to analyze net revenue of Saline Water Irrigation Project and (3) to analyze effect factors on decision making on effluent water treatment of shrimp farmers.

This study which involve with revenue analysis use secondary data to study cost structure and revenue. Including use to analyze the project to consider the financial feasibility of Saline Water Irrigation Project. While the factor analysis, which effect to the water treatment decision, use primary data from 80 Chanthaburi Shrimp farmer's survey and Chi-square statistics testing is conducted.

From the study 3 objectives shows that (1) net average per rai of recycling water farm is higher than non-recycle water farm (2) a financial analysis at 12% discount rate shows that Saline Water Irrigations Projects is feasible considering Net Present Value (NPV), Benefit-Cost Ratio (BCR) and Internal Rate of Return (IRR) and (3) statistical testing shows that the factors which affected on shrimp farmers' decision to use "Treatment Operation" are : domicile, debt, cost, gross profit and knowledge on water treatment. For the unaffected factors are : education, number of family member, major occupation, ownership of land, knowledge of environmental situation and farm location.

Keywords: Analysis; Effects; Factors; Water; Treatment; Farmers; Shrimp culture; Chanthaburi

804 Sopon Havanon, David Clark and Mongkol Khaimook. 1997. **Survey of shrimp farmers attitude and opinions on mangrove forest and the sustainability of their industry.** In The Tenth National Seminar on Mangrove Ecology. 25-28 August 1997, JB Hotel, Hat Yai, Songkhla. National Research Council of Thailand. p. IV-5: 1-10.

The objective of the research was to study about attitude of the managers of shrimp farms towards mangrove and environment.

When we surveyed all of shrimp farm Managers, most are happy to co-ordinate with us because they want someone to listen to their needs. Usually the managers have a negative view to culture shrimp because they have had disease problems and problems with post larvae but questionnaire show that most shrimp farmers don't show about technique to treat post-larvae. And about mangroves they say the zonation of mangrove do not affect the way that they farm shrimp. But they think the Mangrove zonation are

very confusing. And they believe the Mangrove zonation are not designed to help shrimp farming however they feel that the Current government legislation is adequate to conserve Mangrove forest. Most say they would like to learn more about mangroves and they believe that mangroves are very valuable and should be save.

This research show that most shrimp farmers feel that more contact and co-ordination between Royal forest Department and Department of Fisheries is needed in order to develop a coherent functioning policy to make shrimp farming a sustainable industry.

Keywords: Attitude; Mangroves; Shrimp farm; Sustainable management; Farmers; Ranong

805 in Thai

806 Leamthai Poovanich. 1993. **Financial and social feasibility studies of coastal shrimp cultivation in Amphoe Pak Phanang, Changwat Nakhorn Si Thammarat.** Master Thesis. Kasetsart University. 176 p.

The main objective of this study is to analyze financial and social feasibility of intensive black tiger shrimp culture in order to guide for development planning of sustainable resources use in the coastal area.

Analysis of cost and return found in general that the intensive shrimp culture in Pak Phanang can be a long term occupation. Analysis of the profit function showed that the most significant variables of economic and social factors affecting a net profit are respectively the distance between shrimp pond and source of water and the education level of farmers.

The financial analysis revealed that the shrimp cultivation project in the coastal area is feasible. The social analysis which included the impact of externality cost such as mangrove forest value, decreasing rice production, and wasted water pond, on the other hand, has a rather low feasibility. This implied that planning for sustainable shrimp cultivation taking into account coastal resources and environmental impacts may not be easily possible in the overall studied area. However, considering in each specific location, degree of sustainable economic feasibility of shrimp farming are found varied significantly.

Keywords: Coast; Shrimps; Financial feasibility studies; Social feasibility studies; Pak Phanang; Nakhorn Sri Thammarat

807 Aphirak Poomklin. 1987. **A study on cost and return on investment of shrimp farming under natural culture and intensive culture for members of Samut Sakhon land settlement co-operative**

limited in 1984. Master Thesis. Chulalongkorn University. 130 p

The objective of this thesis is to study cost and return on investment of shrimp farming under natural culture and intensive culture for members of Samut Sakhon Land Settlement co-operative limited in 1984, including problems, related obstructions in such farming culture and possible recommendations to solve those problems. The study divides the farms into 3 sizes, 10-29 rais, 30-49 rais and 50-70 rais which will be called small scale, medium scale, and large scale, respectively. Shrimp farming under natural culture has also been divided into 2 groups, natural culture at sea-side and natural culture in land away from sea-side.

The result of the study showed that average cost per rai per year of all shrimp culture is in the same direction, the average cost per rai per year of shrimp farming in small scale farm is the highest, followed by those of medium scale and large scale respectively. But the medium scale farming gives the highest rate of return.

Problems and related obstructions in shrimp farming found in the study are as follows; polluted water, lack of baby shrimps, lack of funds and interest to improve shrimp culture and lack of good co-operation in selling products.

The proposed recommendations are firstly, the Government agencies should have a special measure to prevent industrial factories draining off waste water into rivers, or a sub-station for water inspection should be arranged. Secondly, the Department of Fisheries should expedite its works to produce adequate baby shrimps and promote private sector to invest in this project. Thirdly, the co-operative should plan to purchase shrimps from members to resell and transfer knowledges and understandings in modern shrimp culture and co-operative system to members.

Keywords: Investment; Costs; Returns; Shrimps; Farming; Natural culture; Intensive culture; Members

808 Ayut Nissapa, Somboon Charernjiratragul and Somsak Boromthananat. 2002. **Institutional and legal implications for integrated mangrove-shrimp farming-environmental planning and management in Laem Talumphuk, Pak Phanang District, Nakhon Si Thammarat Province.** Songklanakarin Journal of Social Sciences and Humanities. 8(1): 17-31

The objective of this study was to investigate responses of policies and plan implementation and enforcement of laws and regulations that resulted in existence and maintenance of Laem Talumphuk mangrove forest reserves in relation with shrimp

farming activities M-S-E or Mangrove forest-Shrimp farming-Environmental planning and management concept that integrated these seemingly conflicting components, was expected to provide a compromised solution for desirable institutional settings for an effective management of the common property resources such as mangrove forest. Goal-Oriented Project Planning (GOPP) technique was adapted for its use in data collection and analysis. The result of this research indicated that mangrove forest ownership and boundary were not clearly defined, which consequently changed the ownership pattern to become more privately owned. This had resulted in difficulties for the enforcement of laws and the implementation of the policies and plans of all concerned institutions. The ownership issue is crucial as it forms a basis for common property resource management plans that satisfy the needs of all stakeholders and the environment.

Keywords: Environmental management; Institution; Integration; Legal implication; Mangroves; Shrimp farm; Farming; Nakhon Si Thammarat; Pak Phanang

809 Orawan Teandee. 2001. **Mangrove forest conservation of tiger prawn culture in Klaeng District, Rayong Province.** Master Thesis. Chiangmai University. 154 p.

The objectives of this research aimed to study mangrove forest conservation of farmers, to analyze the relationship between independent factors and mangrove forest conservation of tiger prawn culture and finally, to explore problems and needs of tiger prawn farmers related to mangrove conservation. The population of this study were 116 tiger prawn farmers. Data were collected by using interview questionnaires and analyzed by using percentage, mean standard deviation, maximum, minimum, values, chi-square test and person's product moment correlation coefficient.

The results showed that most farmers had an average age of 44.2 years old. Most of them had primary education. The average income was 525,689.66 bath per annum. They received mangrove forest conservative information from television. The average agricultural labour was 2.69 per household. Their experience on prawn culture was 5.8 years in average. They borrowed some money from bank of Agriculture and Agricultural Cooperatives for their investment. Only 23.3 % of them had attend training course on mangrove forest conservation. Last year (2000) farmers did not increase any ponds.

On mangrove forest conservation aspect, it was found that most of tiger prawn farmers participated on mangrove forest conservation activity at low level with the average score of 1.53 Forest protection on mangrove forest conservation practices was also at low level with the average score of 1.49 but forest

plantation on mangrove forest conservation practices were at moderate level with the average score of 1.88.

For knowledge and understanding on mangrove forest conservation, it was found that tiger prawn farmers had knowledge and understanding practiced on mangrove forest conservation at high score and had good attitude towards mangrove forest conservation.

From hypothesis testing, it was found that the information dissemination, communication with agricultural and forestry officers, social position, borrowing some money among farmers and investor and training on mangrove forest conservation were related to participation in mangrove forest conservation with significantly difference (0.05). The contacts with agricultural and fishery officers were related to conservation in mangrove forest conservation at significantly difference (0.05).

From person product moment correlation coefficient analysis it was found that knowledge, understanding toward mangrove forest conservation of tiger prawn farmers were related to participation of farmers at low level ($r=-0.339$) and in opposite direction.

Problems encountered by tiger prawn farmers on mangrove forest conservation were farmers invasion, death of new planting mangrove forest, lack of information which disseminated by government agencies, forestry officers, contacted with only farmer leaders I about forest conservation.

Some suggestions were that government officials should pay more attention on their work. More training courses on mangrove forest conservation should be taken into account. In addition, tree species promoted for mangrove forest plantation project should be suitable to the specific areas.

Keywords: Mangroves; Conservation; Farmers; Culture; Black tiger prawn; Rayong

810 Ornwipa Limhemmakorn. 2000. **The determinants of Thailand's cultured giant tiger prawn supply.** Master Thesis. Ramkhamhaeng University. 157 p.

The culturing of giant tiger prawn has been a fast growing business in Thailand for several years. Main stimulating factor of this business is the attractive rate of return due to high price of prawn, especially its export price. Most of the culturing sites are located in coastal provinces of Central, Eastern, and Southern regions.

Giant tiger prawn farming started with extensive cultured system. Later, it was modified to semi- intensive and intensive cultured system. At

present, intensive culturing is widely accepted by most giant tiger prawn farmers. Advanced technology such as the using of treated recycled water help reducing the frequently need of bringing sea water into prawn farms so that the spread of germs which trigger prawn epidemics could be prevented.

Thailand has been the world's leader in advanced giant tiger prawn culturing technology for almost a decade. In 1981, Thailand produced only 24.9 tons of cultured giant tiger prawns with value of 2.94 million baht. The volume and value of cultured giant tiger prawns increased to 220,371.67 tons and 37,361.126 million baht respectively in 1996. In some year, however, the output declined because of production problems, such as rising farm cost and prawn epidemics.

Thailand is not only the leader in culturing technology, but also the world's leader in export of giant tiger prawns. In 1996, Thailand exported approximately 161,486 tons of frozen shrimp and prawn, worth 43,404 million baht. The importance of giant tiger prawn culturing, therefore, is clearly undeniable.

The objectives of this thesis are as follow :

- 1) To study the process of giant tiger prawn production
- 2) To investigate and analyze both domestic and international markets of Thailand's giant tiger prawns.
- 3) To investigate the factors determining supply of cultured giant tiger prawn in Thailand and their supply elasticities.
- 4) To study the problems of giant tiger prawn farming and measures to solve them.

The study found that current supply of cultured giant tiger prawn is positively related to its price in previous year and current number of farms, but negatively related to the occurrences of prawn epidemics. Elasticity of cultured giant tiger prawn supply with respect to its price in previous year, number of farms, and the occurrences of epidemics were 2.82, 5.09, and -1.53 respectively.

Keywords: Economics; Supply; Factors; Giant tiger prawn; Exports; Culture

811 Aranya Chatdech. 1994. **The economics of black tiger shrimp production in Chacherngsao, 1993/1994.** Master Thesis. Ramkhamhaeng University. 148 p.

Promotion of Black tiger shrimp farming has been one of the important government policies to increase fisheries product from 350 kilograms per rai in 1992 to 600 kilograms per rai in 1996 with purpose to decrease in marine catch and to earn the foreign currencies.

The objectives of this study are to study socioeconomic status of the shrimp farmers, to

determine cost and returns of farming, and to study and further difficulties and problems. The samples were collected 105 shrimp farms in Chacherngsao. The shrimp farms were classified into 2 sizes; small (size of pond : 1-10 rais, 58 samples) and large (size of pond:over 10 rais, 47 samples).

From analysis of Cobb-Douglas production function, it could be concluded that the changes in output of shrimp are greatly affected by feed cost, fry cost, labor and size of pond by 93.54% and being in the stage of increasing returns to scale with summation of input elasticity by 1.1386. Production of large farm could be affected by feed and electricity cost by 92.64% It was decreasing returns to scale with the sum of input elasticity by 0.9472.

The study of cost production function showed that the changes in shrimp farming cost of small and large farms could be explained by output by 82.71% and 86.79% respectively.

From the analysis of costs and returns of shrimp farming, the total cost per rai per crop were 72,187.85 and 59,567.20 baht for small and large respectively. The percentage of all fixed and variable costs were 30:70 for small farm and 24:76 for large farm. Production per rai per crop of small and large farm were 868.40 and 813.33 baht respectively. Then net profit of small farm was 55,779.57 baht/rai/crop and 60,423.37 baht/rai/crop for large size.

The study on increasing production or input for small farm showed that the marginal product of feed, fry, labor, electricity and size of pond were 0.02329, 0.01960, 0.18904, 0.01031 and 34.16108 respectively. In the large farm, the marginal products of all inputs were 0.2323, -0.00480, 0.23767, 0.09074 and 1.03696 respectively. In measuring the efficiency of each input uses by comparing the value of marginal product to the input prices, it was found that the values of marginal product of fry, labor and size of pond were higher than input prices in small size and in case of large farm size, the values of marginal product of feed, electricity were higher than input prices. This showed that the farmers of small farm should increase using in feed, fry, labor, electricity, size of pond and the large one should increase using in feed, labor, electricity and decrease fry and electricity in order to maximize profit of each input.

Keywords: Economics; Black tiger shrimp; Shrimps; Production; Chachoengsao

812 Amnuay Sangnoree. 1992. **Human capital affecting agricultural production : case study of nursing tiger prawn larvae.** King Mongkut's Agricultural Journal 10 (4): 33-45.

This study aims to construct econometric models and a path analysis model. The path analysis models give effect of human capital consisting of education and sex. The human capital plays an important role in adoption of technological innovation in agriculture, especially the feed for larvae, and agricultural production of tiger prawn larvae nursing farmer. Results in logit analysis of adoption models showed that the farmer education, sex and occupation status were significant. Thus, human capital of the nursing farmers affected on the adoption of feed for larvae. The results of the demand for larvae feed showed that the adoption was significant at 10 percent level and sign of the adoption was positive. In addition, results of the tiger larvae's production function showed that adoption of larvae feeds. Farm size and pond investment were also significant.

The results of the path analysis model showed that the causal effect of human capital, occupation status and adoption affected on production. The human capital and occupation status indirectly affected on the production but the production was directly affected by the adoption of feed for larvae.

Keywords: Human capital; Agricultural production; Nursing; Black tiger prawn; Larvae

813 Sutep Punprasit. 1991. **Return on shrimp cultivation in Samutsakhon Province.** Research Report. Dhurakijpundit University. 99 p.

The objective of this study aims at the evaluation of the rate of return on the investment for shrimp cultivation in Samutsakhon Province. In this area economic method and traditional method are cultivated.

According to the national statistics in 1985, 1016 household units engaged in shrimp cultivation. Traditional shrimp farmers whose farms closed to seaside were drawn to be samples of 30 units, whereas 30 units from shrimp farmers whose farms located far from seaside. And 42 economic shrimp farmers are chosen. Data was collected by structive interview and analysis with percentage ratio table and show value of factors quantities, cost, revenue of production. The optimum of shrimp farming project analysis by Net Present Value and Internal Rate of Return.

The results of the study are as followed; The shrimp production in Samutsakhon province was the highest. The majority of people engage in cultivation and fisheries respectively.

There are some problems which are concerned with economic activities in Samutsakhon. Firstly, the shortage of water in dry season. Secondly, trend of income from shrimp production has decreased. Thirdly, transportation system is disorganized. Fourthly, price of shrimp has decreased. Fifthly, the value of land is increased. Sixthly, the balance of

nature is destroyed by pollutions. Seventhly, the lack of sources for agricultural credit and eighty, problem on excess supply of shrimp.

The average of land tenure of farmers is about 29-70 rai in Samutsakhon area. It is also found that shrimp production isn't affected by the location of farms which are located at seaside or not. In stead, the production is varied by the size of land tenure and the method of cultivation. It is stated that economic method of cultivation gives higher production than traditional method of cultivation.

The findings show that new farmers hadn't better invest in shrimp cultivation since the value of NPV and IRR are very low. If the market price of shrimp has decreased to 76 - 72 baht farmers will become to a shut down point.

Keywords: Returns; Shrimps; Shrimp culture; Samut Sakhon

814 Jreeporn Ruangsri and Kidchakan Supamattaya. 1999. **DNA detection in suspected carriers of virus (SEMBV) by PCR (Polymerase Chain Reaction).** Songklanakarin J. Sci. Technol. 21(1): 41-51.

DNA fragments of white spot virus (Systemic Ectodermal and Mesodermal Baculovirus: SEMBV) were detected in various natural aquatic organisms by Polymerase Chain Reaction (PCR) technique. The suspected carriers (Shrimps, crabs, fish, benthic organisms and planktons) were collected from sources near shrimp farms (East coast and West coast in southern of Thailand) during October 1997 to September 1998. First step amplification of the DNA extracted from samples consistently yielded 643 basepairs PCR product as expected. Second step amplification PCR product containing SEMBV DNA yielded and expected 330 basepairs. Specific DNA fragments of SEMBV were detected in 6 species of wild shrimp (krill *Acetes* sp. and *Euphausia* sp., snapping shrimp *Alpheus euprosyne*, banana shrimp *Penaeus merguensis*, speckled shrimp *Metapenaeus monoceros* and dwarf prawn *Macrobrachium equidens*). It was also detected in 2 species of wild crab (merder'mangrove crab *Sesarma merderi* and hermit crab *Eupagurus bernberdus*) and 3 species of fish (mud skipper *Periophthalmus* sp., goby fish *Gnathogobius aliceae* and blue panchax *Aplocheilichthys panchax*). Gastropod (Family cerithidae), benthic polychaete and palnktons (copepods, rotifers, moinas, nauplius and *Oscillatoria*) were also positive for the SEMBV DNA fragments detection. These aquatic organisms were found to be reservoir hosts of SEMBV. Using both techniques demonstrated that the virus was found in carriers similar to SEMBV

in the cultured shrimp *Penaeus monodon* with white spot syndrome. The prevalence of SEMBV in different carriers in relation to seasonal cycle and localities is discussed in this paper.

Keywords: Shrimps; White Spot Syndrome; SEMBV; DNA; *Penaeus monodon*; Virus carrier; PCR; Polymerase Chain Reaction; Prawns; Viruses; Systemic Ectodermal Mesodermal Baculovirus

815 Chainarong Wongteerasupaya, Siriporn Sriurairatana, Joan E.Vickers, Anutara Akrajarn, Vichai Boonsaeng, Sakol Panyim, Anchalee Tassanakajon, Boonsirm Withyachumnarnkul and T.W. Flegel. 1995. **Yellow-head virus of *Penaeus monodon* is an RNA virus.** In Shrimp Biotechnology In Thailand (BIOTEC Publication 2/2540). p. 55-60

Yellow-head virus (YHV) causes acute infections in *Penaeus monodon* that result in very high mortality. First reports of the virus suggested that the viral core consisted of DNA and that the virus should be classified as a granulosis-type baculovirus. However, 3 attempts at DNA extraction with high concentrations of purified virus (verified by transmission electron microscopy, TEM) gave only traces of DNA, which could not be visualized by ethidium bromide staining of agarose electrophoresis gels. Although selected recombinant clones derived from these pooled DNA traces did not hybridize with host shrimp DNA they also failed to react with YHV-infected tissue by the in situ DNA hybridization technique. Furthermore, negatively stained virions of YHV viewed by TEM were atypical for baculoviruses and viral assembly is cytoplasmic. Therefore, renewed attempts to extract nucleic acid from purified YHV preparations focused on RNA. Hemolymph was collected aseptically by syringe from 200 artificially YHV-infected, live shrimp in terminal stages of the disease. Purified virions were prepared by a program of centrifugation culminating in 22% to 45% Yrografin gradient ultracentrifugation. A band at the 30-37% interval of the gradient gave the cleanest preparation with the highest quantity of virions. By TEM these were enveloped, measured 150-170x40-50 nm and were surrounded by a fringe of knob-like projections approximately 11 nm. in length. Nucleic acid was extracted using guanidium thiocyanate and purified by CsCl gradient ultracentrifugation. High-molecular-weight nucleic acid was obtained which was degraded by RNase-A but not by DNase I. Based on morphology of negatively stained virions by TEM and on RNA content, YHV resembles rhabdoviruses or coronaviruses, rather than baculoviruses. This is an important discovery, since it necessitates cDNA preparation in the process to develop a nucleic-acid probe for YHV detection by the *in situ* of dot blot hybridization techniques.

Keywords: Prawns; Shrimps; *Penaeus monodon*; Yellow-head Virus; RNA Virus; Viruses; Baculovirus

816 Paiboon Pornmanee. 2001. **Amino acid sequence of hormone form eyestalk of tiger prawn *Penaeus monodon* using matrix-assisted laser desorption ionization mass spectrometry.** Master Thesis Chulalongkorn University. 68 p.

The amino acid sequencing of peptide using Post Source Decay Fragmentation in a MALDI-TOF mass spectrometer has been investigated. The method has been optimized for amino acid sequences were correctly determined. The method was applied to amino acid sequencing of an FMRFamide isolated from the eye stalks of *Macrobrachium rosenbergii* and a CHH peptide isolated from *Penaeus monodon*. It was found that the amino acid sequencing of both peptides were Ala-Pro-Ala-Leu-Arg-Leu-Arg-Phe and His-Glu-Glu-Tyr-Gln-Ala-His-Val-Gln-Thr-Val, respectively. The amino acid sequences of these two peptides were confirmed by Edman degradation method.

Keywords: Eyestalks; Amino acids; Hormones; Tiger prawn; *Penaeus monodon*

817 Sapon Onkong and Tanawut Klowklieng. 1996. **Monitoring of antibiotic residues of intensive tiger shrimp farms in Satul and Trang Provinces.** Technical Paper No. 23/1996. Satul Coastal Aquaculture Development Center. Department of Fisheries. 10 p.

The shrimp farms in Satul and Trang provinces were evaluated for antibiotic residues monitoring. Fifty-three farms of Satul and 29 farms of Trang were examined during January to September 1992. The farmers were interviewed about using of antibiotic in their shrimp farms and, samples of shrimp (more than 3 months in age) were periodically collected; 72 and 37 samples from samples from Satul and Trang. Micro bioassay were used for antibiotic residues testing in muscle of shrimp samples.

The results shown that antibiotics used of the farmer for shrimp culture in Satul and Trang was 66.04% (35 farms) and 62.07% (18 farms). Oxytetracycline was mainly used of both province. However, antibiotic residues were rather a few detected., 6.94% (5 samples) of Satul and 8.10% (3 samples) of Trang. Because of the majority using of antibiotics were widely used and highly detected in the area of Muang and Tung-wa district of Satul and Pa-lian district of Trang

Keywords: Antibiotic residues; Shrimp farm; Intensive culture; Satun; Trang

818 Sapon Onkong, Kuliwan Thinthara and Pensri Boontamchuy. 1997. **Effects on growth and muscular tissue residues of oxolinic acid in black tiger shrimp (*Penaeus monodon*).** Technical Paper No. 35/1997. Satul Coastal Aquaculture Development Center. Department of Fisheries. 12 p.

Growth and oxolinic acid (OA) residues in muscular tissue of 2 months old Black Tiger Shrimp *Penaeus monodon* at initial weight of 7.26 ± 0.27 – 7.82 ± 0.31 g were studied. Three groups (treatment) of shrimps were divided and fed with non-medicated feed and OA-medicated feed containing 1.0 and 3.0 g/kg of feed for 7 days. And then, the shrimp were fed on non-medicated feed from day 8 to throughout the experiment. The results showed that the average weight of non-medicated (control groups) shrimps were increased at 3.50 ± 0.26 g while those fed on OA 1.0 and 3.0 g/kg of feed were increased at 3.20 ± 0.20 and 2.98 ± 0.31 g, respectively. The average daily growth rate of shrimps fed with non-medicate, OA 1.0 and 1.0 and 3.0 g/kg of feed were 0.125 ± 0.02 , 0.117 ± 0.01 and 0.106 ± 0.01 g/day, respectively. They were no significant difference ($P > 0.05$) on growth of shrimps within 3 groups. No OA residues in muscular tissue was detected prior to the medication and in the control groups (non-medication) throughout the experiment, whereas those fed on OA medicated feed (1.0 and 3.0 g/kg of feed) were OA detected both during and after medication. The average maximum level of residues in muscular tissue of shrimps fed with 1.0 and 3.0 g OA/kg of feed were 1.372 ± 0.107 and 3.315 ± 0.360 ppm at the 5th and 6th day of the medication, respectively, and the drug was totally withdrawn from the muscular tissue of the shrimps at 7 and 10 days after the medication was stopped, respectively.

Keywords: Growth; Muscular Tissue Residues; Oxolinic acid; Black tiger shrimp

819 Mali Boonyaratpalin and Juadee Phongmaneerat. 1995. **Ascorbic acid derivative requirement of *Penaeus monodon*.** Phuket mar. biol. Cent. Res. Bull. 60: 65-73.

Two experiments were conducted to determine the Vitamin C requirements of juveniles of *P. monodon*. In experiment 1, practical diet supplemented with different level of ascorbyl phosphate-Mg at 0, 30, 60 and 100 mg/kg of feed, equivalent to 0, 12.6, 25.2 and 42 ppm ascorbic acid, respectively, were fed to *P. monodon* for 10 weeks in 200 l aquarium with a population of 20 shrimps per aquarium. Shrimp fed diet with zero level of ascorbyl phosphate-Mg showed deficiency signs of black spot,

erratic swimming, loss of appetite, incomplete molting, soft-shell, sluggishness, flipped gill cover and high mortality. Best growth result was obtained with ascorbyl phosphate-Mg level of 30 to 60 mg/kg. In experiment II, practical diets containing ascorbic acid-glucose at 0, 25, 50 and 100 mg/kg diet, which is equivalent to 0, 13, 26 and 52 mg ascorbic acid/kg diet, respectively were used. In shrimp fed diet without ascorbic acid glucose supplementation, mortality occurred in week 6 and total mortality recurred by the ninth week. The deficiency signs are soft shell, inactivity, opaque whitish muscle, big head with flipped gill cover, incomplete molting and total mortality. The ascorbic acid glucose required for normal growth and preventing deficiency signs was 25 ppm; 100 ppm was required for maximal feed efficiency.

Keywords: Ascorbic acid; Diets; *Penaeus monodon*

820 Patcharee Soonson, Chuchart Chairat and Salin Chairut. 2000. **Monitoring of oxolinic acid residue in preharvested tiger shrimp (*Penaeus monodon*) in Karbi Province.** Technical Paper No. 5/2000. Karbi Coastal Aquaculture Station. Department of Fisheries. 14 p.

Preharvest monitoring of Oxolinic acid residues in black tiger shrimp (*Penaeus monodon*) in Krabi province was conducted during October 1997 to September 1998. The information on using of antibiotic in shrimp farm was interviewed and recorded. Six hundred and thirty five shrimp sample were tested for the residual using HPLC method. The shrimp farmers commonly used antibiotic of 96 farms in 27.11% and mix the antibiotic drug into the pellet before feeding. An Oxolinic acid were widely used. At average, oxolinic acid 11.18% of 635 sample. The amount of oxolinic acid residue were about 0.01-0.05 µg/g 3.307, 5.039 and 2.834% of samples, respectively.

Keywords: Oxolinic acid; Oxytetracycline, Black tiger shrimp

821 อรษา สุตเธียรกุล, ศุภวิทย์ พึ่งจิตต์ตน, คล้ายอัปสร พงศ์พิพร, กนกรัตน์ ศิริพานิชกร, เนตรนภิส อีระวัลย์ชัย. 2544. การตรวจเชื้อ *Vibrio parahaemolyticus* และ ยีนฮีโมไลซินอย่างรวดเร็วในตัวอย่างกุ้งแช่แข็ง โดยวิธี **nested PCR**. รายงานการวิจัยฉบับสมบูรณ์ เสนอ สำนักงานคณะกรรมการวิจัยแห่งชาติ พุทธศักราช ๒๕๔๓. ๑๐๙ น.

Vibrio parahaemolyticus is accounted as a major cause of gastroenteritis outbreak by eating raw seafood. Since the seafood especially the frozen shrimp is one of the main products exported

from Thailand making millions and millions baht annually, therefore the food safety has to be considered carefully in international trade. In order to achieve this international level, the rapid detection of the causative agents in contaminated frozen seafood with high sensitive and specific method is required. Therefore, the nested PCR-based assay with two sets of primers for detection of lecithin dependent hemolysin gene (*ldh*) and hemolysin genes (*tdh* and *trh*) of *V. parahaemolyticus* was first developed and applied as direct detection in 103 frozen shrimp samples. The nested PCR assay developed produced a specific product size of 196, 215 and 172 bp and could detect the lowest genomic DNA of *ldh*, *tdh* and *trh* reference strains, at 1 fg (1.7 cells), 1 fg (4.6 cells), and 10 fg (34 cells), respectively. All known *V. parahaemolyticus* strains did give the specific DNA band of 196, 215, and 172 bp, while all 21 strains of other *Vibrio* spp. and enteric bacteria did not give any of these specific band of their corresponding genes, indicating 100% specificity of the assay. The assays were then applied as direct detection of the contaminated agent and its hemolysin genes in 103 frozen shrimp samples from a frozen food factory in Chachoengsao province collected during April to May, 1999. It was demonstrated that 79.6% (82/103) of frozen shrimp enrichment samples were contaminated with *V. parahaemolyticus* using the conventional method and 88.2% (91/103) were positive using the primary PCR by detection of *ldh* of *V. parahaemolyticus* in the enrichment samples with the significant difference ($P < 0.05$). Furthermore, the detection of *ldh* of *V. parahaemolyticus* directly from the samples by the nested PCR was 33.9% (35/103) which was significantly higher than that of the primary PCR (7.7%; 8/103) ($P < 0.001$). However, their hemolysin genes, *ldh* and *trh*, could not be detected directly from samples by primary PCR but could be detected by nested PCR (*tdh* 5.8% and *trh* 2.9%). Similarly, the detection rates of *tdh* and *trh* genes from enriched samples by primary PCR were 2.9% and 6.0%, respectively which were not significantly different from those detected directly from samples by nested PCR. In contrast, using the conventional method, only one sample was found to be positive for *V. parahaemolyticus* with the count of 10^2 CFU/g of food sample, which was acceptable according to the limit of *V. parahaemolyticus* based on the criteria of International Commission on Microbiological Specification for Food (ICMSF). However, if other criteria of microbiological quality standards (such as total viable count, coliform counts and *E. coli* counts) were considered, 37.9% (39/103) of the samples were unacceptable. This study showed the success of the development of the nested PCR assay for rapid detection (less than 8 h) of *V. parahaemolyticus* and their hemolysin genes as well as their application in frozen shrimp samples without a prior enrichment step. In addition, the nested PCR

could be used as a rapid screening method for direct detection of *ldh* of *V. parahaemolyticus* contaminated in frozen food with the high specificity and the positive predictive value of 85.7% and 91.4%, respectively.

Keywords: *Vibrio parahaemolyticus*; Nested PCR; Hemolysin gene; Frozen shrimps

822 Somprasong Kanthom and Siriporn Lauchai Chaiyakul. 1996. **Effect of chlorine powder (Ca(OCl)_2) on the mortality rate of tiger prawn (*Penaeus monodon*) larvae.** Technical Paper No. 6/1996. Chumporn Coastal Aquaculture Station. Prachuap Khiri Khan Coastal Aquaculture Development Center. Coastal Aquaculture Division. Department of Fisheries. 21 p.

The study of effect of chlorine powder on the mortality rate of tiger prawn and result as follow:

Zoea 3, 24 hr. LC_{50} = 4.46 mg/l and safety concentration = 0.45 mg/l

Mysis 3, 24 hr. LC_{50} = 2.71 mg/l and safety concentration = 0.27 mg/l

Postlarva 3, 24 hr. LC_{50} = 4.79 mg/l and safety concentration = 0.48 mg/l

Postlarva 10, 24 hr. LC_{50} = 2.88 mg/l and safety concentration = 0.29 mg/l

Postlarva 16, 24 hr. LC_{50} = 2.91 mg/l and safety concentration = 0.29 mg/l

Postlarva 22, 24 hr. LC_{50} = 4.86 mg/l and safety concentration = 0.49 mg/l

The study 24 hr. LC_{50} values are not always increase with growth stage.

Keywords: Chlorine powder; Mortality; Tiger prawn; *Penaeus monodon*

823 Jreeporn Ruangsri, and Kidchakan Supamattaya. 1999. **DNA detection in suspected carriers of virus (SEMBV) by PCR (Polymerase Chain Reaction).** Songklanakarin J. Sci. Technol. 21(1): 41-51.

DNA fragments of white spot virus (Systemic Ectodermal and Mesodermal Baculovirus: SEMBV) were detected in various natural aquatic organisms by Polymerase Chain Reaction (PCR) technique. The suspected carriers (shrimps, crab, fish, benthic organisms and planktons) were collected from sources near shrimp farms (East coast and West coast in southern of Thailand) during October 1997 to September 1998. First step amplification of the DNA extracted from samples consistently yielded 643 basepairs PCR product as expected. Second step amplification PCR product containing SEMBV DNA yielded and expected 330 basepairs. DNA fragments of SEMBV were detected in 6 species of wild shrimp (krill *Acetes* sp. And

Euphausia sp., snapping shrimp *Alpheus euprosyne*, banana shrimp *Penaeus merguensis*, speckled shrimp *Metapenaeus monoceros* and dwarf prawn *Macrobrachium equideus*). It was also detected in 2 species of wild crab (merder's mangrove crab *Sesarma merderi* and hermit crab *Eupagurus bernberdus*) and 3 species of fish (mud skipper *Periophthalmus* sp., goby fish *Gnathogobius aliciae* and blue panchax *Aplocheilichthys panchax*). Gastropod (Family Cerithidae), benthic polychaete and planktons (copepods, rotifers, moinas, nauplius and *Oscillatoria*) were also positive for the SEMBV DNA fragments detection. These aquatic organisms were found to be reservoir hosts of SEMBV. Using both techniques demonstrated that the virus was found in carriers similar to SEMBV in the cultured shrimp *Penaeus monodon* with white spot syndrome. The prevalence of SEMBV in different carriers in relation to seasonal cycle and localities is discussed in this paper.

Keywords: DNA; Viruses; SEMBV; PCR; Polymerase Chain Reaction

824 Roongthip Rojjananavin. 1996. **Degradation of povidone-iodine and its toxicity to *Vibrio* spp. and black tiger shrimp (*Penaeus monodon* Fabricius) larvae.** Master Thesis. Kasetsart University. 93 p.

The degradation of povidone-iodine at 5, 10 and 20 mg./l. in distilled water, 0.85% saline, 3% saline and 30 ppt sea water were investigated. The results revealed that it took 24, 21, 21, 12 hrs for 5 mg./l.; 33, 27, 27, 18 hrs for 10 mg./l. and 42, 36, 33, 24 hrs for 20 mg./l. to completely degrade, respectively. The shortest degrading time is in 30 ppt sea water and the longest is in distilled water. The influencing factors on the degradation of povidone-iodine are aeration, salinity, light and temperature. Efficacy study of povidone-iodine on 48 isolates of *Vibrio* spp. including *Vibrio parahaemolyticus*, *V. vulnificus*, *V. damsela*, *V. alginolyticus*, *V. fluvialis*, *V. cholerae* and *V. harveyi* indicated that all isolates of each species were killed within 30 minutes at the range of 1.5625-3.125, 12.5, 1.5625-3.125, 6.25-12.5, 1.5625-12.5, 1.5625-6.25 and 3.125-6.25 mg./l., respectively. Acute toxicity test of povidone-iodine on black tiger shrimp (*Penaeus monodon* Fabricius) postlarval stage 15 revealed the LC_{50} 24 hrs at 17.0 (15.125-19.108) mg./l. with slope function of 1.307 (1.216-1.405). Povidone-iodine had no significant impact on water qualities including dissolved oxygen, pH, total ammonia and nitrite.

Keywords: Povidone iodine; *Vibrio*; Acute toxicity; Black tiger shrimp; *Penaeus monodon*

825 Nuanchan Chansawang. 1994. **Effects of 17α -methyltestosterone and testosterone-propionate spermatogenesis of the giant tiger prawn (*Penaeus***

monodon, Fabricius). Master Thesis. Kasetsart University. 140 p.

Effects of exogenous male hormone, 17 α -methyltestosterone and testosterone propionate on spermatogenesis and microscopic structures of the male reproductive organs of the giant tiger prawn were investigated. Reproductive organs of male the giant tiger prawn is a paired structures, each consists of four distinctive portions lying from the ventral part of the hepatopancrease to the area underneath the skin medial to the base of the fifth walking leg. They are testes, vas deferens, duct and sperm sac. The testes has eight long and thin lobes spreading over the heart. These lobes contain a small tubules where the spermatogenesis takes place. Sperms are transported from the lobes through the vas deferens and duct to store in the sperm sac. Spermatogenesis found to take place from the stem cells in the spermatogenic zone. These cells undergo mitotic division giving rise numerous populations. Then, most of the cells keep going meiotic division giving four spermatid from one cell. The rest of the cells will be stored in the tubule for next cycle. 17 alpha -methyltestosterone and testosterone-propionate were injected subcutaneously at 0.1, 1.0 and 2.0 milligram/100 grams body weight of prawn every ten days for thirty days experiments. It was found 17 α -methyltestosterone at 1.0 milligram dose is able to maintain spermatogenesis significantly.

Keywords: Methyltestosterone; Testosterone propionate; Spermatogenesis; Giant tiger prawn; *Penaeus monodon*

826 Jatiya Rochanasiri. 1995. Efficacy of romet-30 against Vibriosis infection in black tiger shrimp (*Penaeus monodon* Fabricius). Master Thesis. Kasetsart University. 88 p.

The efficacy of Romet-30 against vibriosis infection in black tiger shrimp (*Penaeus monodon*) determined. The sensitivity of *Vibrio* spp. isolated from diseased shrimp was studied. The Minimal Inhibitory Concentration (MIC) of Romet-30 to twenty strains of bacteria was found to be between 0.5-2.0 ppt. Shrimp were fed with medicated (Romet-30) pellet feed at dose rates of 2 g./kg., 3.3 g/kg. of feed for five days prior to intramuscular injection with *V. parahaemolyticus* at the LD₅₀ level (3.6×10^6 cells). Survival rate was observed for seven days. Shrimp fed with a high dose of medicated feed had a higher survival rate (55%) than the low dose (30%) and control (25%). Histopathological changes in shrimp injected intramuscularly with the bacteria were studied. At 1 hour post injection, control and pre-medicated

groups showed a lower concentration haemocytes in damaged tissue than the non-medicated group. Twenty four hours post infection, the control group showed the smallest area and damage. The non-medicated group showed more extensively damaged tissue than pre-medicated shrimp. Seven days post injection, an affected area in the control was almost healed, whereas large damaged areas with dense haemocytes were found in the bacterial injected group and these healed more slowly than the medicated group.

Keywords: Vibriosis; Infections; *Vibrio*; Minimal Inhibitory Concentration

827 Somsak Suetorsak. 1994. Residues and effects on growth and disease of oxolinic acid in *Penaeus monodon* Fabricius. Master Thesis. Kasetsart University. 65 p.

Residues of Oxolinic acid in muscle of *Penaeus monodon* were studied after feeding oxolinic acid at levels of 0.5, 1.0, 5.0 and 10.0 g/kg of feed for 7 and 14 days. The higher concentration of oxolinic acid and longer the shrimp was fed, the higher amount of residues and the longer they were found in the shrimp tissue. For examples, at 0.5 g/kg for 7 days, the residue was detected until the twelfth day while at 10 g/kg for 7 days, the residue was detected until the twenty-seventh day.

Effects of oxolinic acid on growth of Post larvae 25 and 2 month old shrimps were non significant after feeding with oxolinic acid for six weeks and monitoring for twelve weeks.

After feeding with six different concentrations of oxolinic acid for 7 days and challenged with *Vibrio parahaemolyticus*, the survival rate of the shrimps fed with high levels of oxolinic acid (7 and 10 g/kg) were significantly higher than the low levels and the control ones.

Keywords: Residues; Oxolinic acids; *Penaeus monodon*; Disease

828 Woranat Anatsil. 2002. Study on efficiency of *Lactobacillus* on growth inhibition of *Vibrio* spp. and disease resistance of black tiger prawn (*Penaeus monodon* Fabricius) larva. Master Thesis. Kasetsart University. 84 p.

Study on efficiency of *Lactobacillus* spp. including *L. acidophilus*, *L. bulgaricus*, *L. casei*, *L. fermentum*, *L. plantarum* and *Lactobacillus* sp. on inhibiting the growth of pathogenic *Vibrio harveyi* and *V. parahaemolyticus* was conducted by using the whole cell and filtrate part. The result indicated that only the filtrate part of all *Lactobacillus* sp. was most effective against *V. harveyi* and *L. plantarum* against *V. parahaemolyticus*.

Study on the effect of *Lactobacillus plantarum* on the disease resistance of black tiger prawn (*Penaeus monodon* Fabricius) postlarva was studied. *L. plantarum* was applied by direct immersion of postlarva for 1, 2 and 4 hours and by immersion of *Artemia* in *L. plantarum* suspension before giving to postlarva for 3, 5 and 7 days. Both methods of application is not cause any negative side-effect to the postlarva. Disease resistance against *V. parahaemolyticus* by experimental immersion was compared. Application of *L. plantarum* in shrimp postlarva by immersion did not enhance immunity against the pathogen. However, the application by using *Artemia* as a carrier for 7 days did significantly enhance the disease resistance when compared to the control ($P < 0.05$).

Results from this study indicated the potential application of this lactic acid bacteria *Lactobacillus* spp. as means of probiotics concept for the control of harmful bacteria in shrimp by direct inhibiting activity and immunity enhancement. However, the crucial factor must be the method of application that can effectively introduce *Lactobacillus* into the digestive tract of the marine shrimp.

Keywords: *Lactobacillus*; *Vibrio*; Disease resistance; Black tiger shrimp

829 Paisarn Sithigorngul, Chatchadaporn Krungkasem, Weerawan Sithigorngul and Amorn Petsom. 2000. **Purification and characterization of neuropeptide hormones from eyestalk of the giant tiger prawn *Penaeus monodon*.** Research Report. The National Research Council of Thailand 86 p.

Purification and characterization of neuropeptide hormones from the eyestalk or sinus gland of *Penaeus monodon* were performed by using methanol-acetic acid extraction and RP-HPLC. We were able to isolate 3 families of neuropeptides: I. Seven novel peptide sequences range from 8-12 amino acids belong to FMRFamide family which can be divided into four subgroups according to the primary structure of the C-terminus (1) GDRNFRFamide (2) AYSNLNYLRFamide (3) AQPSMRLRFamide SQPSMRLRFamide SMPSLRLRFamide and DGRTPALRLRFamide (4) GYRKPPFNNGSIFamide II. Four novel peptide sequences range from 6-9 amino acids belong to NPY/PP superfamily: RARPRFamide YSQVSRPRFamide YAIAGRPRFamide and YSLRARPRFamide were identified. III. Six large peptides and one small peptide belong to CHH/MIH/GIH family were also isolated. N terminal sequence analyses of 37 to 55 residues of the large peptides revealed that they are similar to Pm-Spg I-V, Pm-CHH I, Pm-CHH II and Pem-

CMG. The small peptide consists of 11 residues is identical to the C terminus of Pm-Spg V peptide. This smaller form of CHH may have important roles due to its prevalence in high content at the hormone releasing site.

Keywords: Hormones; Eyestalks; Giant tiger prawn; Purification; Characterization; Neuropeptides

830 Asara Chaiyen. 1992. **Study on distribution of oxytetracycline in black tiger shrimp (*Penaeus monodon* Fabricius).** Master Thesis. Kasetsart University. 160 p.

In this study, the distribution of oxytetracycline in *Penaeus monodon* weighing 8, 15 and 20 g was examined after force-feeding at levels of 40, 60 and 80 g/kg respectively. Maximum oxytetracycline levels in the haemolymph were detected within 30 minutes. After 30 minutes, the concentration of oxytetracycline in the haemolymph began to decrease as levels in the hepatopancreas and muscle began to rise.

Over a short period, the residence of oxytetracycline residues in the three organs examined (haemolymph), hepatopancreas and muscle) were significantly different depending on the doses given. However, over a long period the residence times were not significantly different.

Concentrations of oxytetracycline in all three organs increased relative to the dose force-fed. Maximum levels were detected from the hepatopancreas.

The residence time of oxytetracycline in the hepatopancreas of larger shrimp (15 and 20 g) after force-feeding a dose of 80 mg/kg shrimp was 43 days, while in 8 g shrimp the residence time was only 9 days.

Keywords: Distribution; Oxytetracycline; Black tiger shrimp

831 Sumaitt Putchakarn. 1991. **Effects of the crude extracts of molting hormone (Ecdysteroid) from some plants in Thailand on the molt cycle of the giant tiger prawn: *Penaeus monodon* Fabricius.** Master Thesis. Mahidol University. 147 p.

The crude extracts of molting hormone which have been extracted from 8 selected plants were *Achyranthes aspera*, *Cyathula prostrata*, *Gomphrena celosioides*, *Trianthema portuacastrum*, *Sesuvium portulacastrum*, *Morus alba*, *Vitex pinnata*, *Vitex canescens* were tested for acute toxicity (96hr-LD50) with the giant tiger prawns, *Penaeus monodon* Fabricius and compared to β -ecdysone. The 96hr-LD50 of crude extracts were ranged from 0.347-3.7 mg/g body weight. The highest toxicity was the crude extract of *G. celosioides* and the lowest toxicity was

the crude extract of *M. alba*. The results show that the crude extracts had shown the same characteristic death as β -ecdysone. From the results of toxicity test, we used the toxicity curve of crude extracts for setting the concentration which were used in the molting experiments of *P. monodon*. The prawns were injected both in the intermolt and premolt stages of the molt cycle. The results show that the crude extracts and β -ecdysone could reduce the molt duration of *P. monodon* both in the intermolt and premolt stage by comparing to the control group. At the intermolt stage, the molt duration was shortened than the control by an average of 1.957 days (27.71%) at the lowest dosage (LD-0). The middle dosage (LD-25) shortened the molt duration by an average of 2.29 days (26.53%) and the highest dosage (LD-50) shortened the molt duration by an average of 2.7 days (313.5%). The best result for shortening the molt duration was the crude extract of *S. porulacastrum*. At the premolt stage, the molt duration was shortened than the control by an average of 0.57 days (14.72%) at the lowest dosage (LD-0). The middle dosage (LD-25) shortened the molt duration by an average of 0.943 days (24.63%) and the highest dosage (LD-50) shortened the molt duration by an average of 1.17 days (30.18%). The best result for shortening the molt duration was the crude extract of *M. alba*. The increased dosages caused a greater shortening the molt duration than the corresponding treatments both in the intermolt and premolt stages but there were no statistical significance. The high dosage caused slightly greater mortality rate than the low dosage both in the intermolt and premolt stage. By comparing to molting stage, the premolt stage had a greater mortality rate than the intermolt stage. The crude extracts did not repress the subsequent growth increment after molt that it was advantageous for aquaculture purposes of *P. monodon*.

Keywords: Molting hormones; Crude extract; Plants; Giant tiger prawn

832 Sasimanas Unajak, Nusra Sittidilokratna, Vichai Boonseang, Sakol Panyim and Sarawut Jitrapakdee. 2001. **Molecular cloning and expression of 65 Kda structural protein of yellow head virus.** In Abstracts and Proceeding, 27 th Congress on Science and Technology of Thailand, 16-18 October 2001, Lee Gardens Plaza Hotel, Hat Yai, Songkla, Thailand organized by The Science Society of Thailand under the Patronage of His Majesty the King, Faculty of Science, Prince of Songkla University. [CD-ROM, file://F:\STT\web\content\biochem\E040.html].

The yellow head virus (YHV) is a major infectious agent in penaeid shrimp. The YHV virions isolated from the infected shrimp contain 3 major structural proteins namely 116 kDa (p65) and 20 kDa (p20) in size respectively. P116 and p65 were the glycosylated structural component of the virus. Here we reported the complete nucleotide sequence and inferred amino acid sequence of p65 structural protein of the virus. Sequencing of the N-terminal of mature p65 allowed us to identify the precise coding region of p65 in the cDNA. The cDNA encodes a polypeptide of 565 amino acids with putative N- and O-link glycosylation site. The p65 is probably synthesized as a precursor protein, which undergoes N-terminal cleavage to yield mature protein. To confirm that open reading frame of p65 structural protein is coding for the putative structural component of YHV, we are currently transiently transfecting the cDNA encoding p65 in mammalian cell.

Keywords: Cloning; Protein; Yellow Head Virus

833 Siwaporn Longyant, Paisarn Sithigorngul, Weerawan Sithigorngul, Parin Chaivisuthangkura, Nittaya Thammapalerd and Piamsak Menasveta. 2001. **The effect of eyestalk extract on vitellogenin levels in the haemolymph of the giant tiger prawn *Penaeus monodon*.** In Abstracts and Proceeding, 27 th Congress on Science and Technology of Thailand, 16-18 October 2001, Lee Gardens Plaza Hotel, Hat Yai, Songkla, Thailand organized by The Science Society of Thailand under the Patronage of His Majesty the King, Faculty of Science, Prince of Songkla University. [CD-ROM, file://F:\STT\web\content\biochem\B036.html].

Competitive ELISA using combination of monoclonal antibodies specific to vitellogenin subunits was used to monitor the fluctuation of haemolymph vitellogenin levels in *Penaeus monodon* during ovarian development induced by bilateral eyestalk ablation and the effect of eyestalk extract injection in prawns with developing ovary. The haemolymph vitellogenin levels were undetectable in the prawn with ovary at the resting stage, elevated sharply when the ovary began to develop, maintained at high levels during developing into ripe stage, and finally fallen down to the low levels a day before spawning and at spent stage, the results from injection of eyestalk extract into prawn with developing ovary, revealed that haemolymph vitellogenin levels elevated sharply within 2 hr, reached the maximal levels and remained high during 4-10 hr, then slightly declined at 24 hr. This response directly depended on the amount of injected eyestalk extract and it was species specific. The application of eyestalk extract from *Metapenaeus affinis* demonstrated the same results but less effective whereas the eyestalk extract

from *Macrobrachium rosenbergii* did not cause any changes in haemolymph vitellogenin levels. Therefore, the assay is specific and may be used to determine the activity of the putative gonad inhibiting hormone by monitoring the alteration of vitellogenin levels.

Keywords: Eyestalk extracts; Ovaries; Eyestalks; Vitellogenin; Haemolymph; *Penaeus monodon*; Competitive ELISA

834 Wansika Kiatpathomchai, Anchalee Tassanakajon, Vichai Boonsaeng and Sakol Panyim. 2001. **A Non-stop single-tube nested PCR technique for grading the severity of white spot syndrome virus (WSSV) infections in *Penaeus monodon*.** In Abstracts and Proceeding, 27th Congress on Science and Technology of Thailand, 16-18 October 2001, Lee Gardens Plaza Hotel, Hat Yai, Songkla, Thailand organized by The Science Society of Thailand under the Patronage of His Majesty the King, Faculty of Science, Prince of Songkla University. [CD-ROM, file://F:\STT\web\content\biochem\E035.html].

A single-tube, non-stop nested PCR technique was developed for simultaneous detection and severity grading of white spot syndrome virus (WSSV) infections in the black tiger shrimp *Penaeus monodon*. The test employed 1 sense primer and 3 anti-sense primers that produced up to 3 PCR products (1,100 bp, 526 bp and 250 bp) depending upon the severity of infection. Specifically, heavy infections of WSSV produced all 3 fragments while moderate infections produced 2 (526 bp and 250 bp) and light infections produced 1 (250 bp). In addition, the technique employed internal control primers that yielded a shrimp characteristic fragment for non-infected samples and samples with a low quantity of viral target, in order to assure integrity and reproducibility of the PCR assays. The non-stop, one tube, nested PCR technique was simple and convenient and could detect as little as 5 fg WSSV DNA in crude extracts of postlarval samples or extracts of pleopods and haemolymph from larger shrimp.

Keywords: White Spot Syndrome Virus; WSSV; Nested PCR; Black tiger shrimp; *Penaeus monodon*; DNA

835 Paisarn Sithigorngul, Jirasak Pupuem, Chatchadaporn Krungkasem, Siwaporn Longyant, Nanthika Panchan, Weerawan Sithigorngul and Amorn Petsom. 2001. **Seven novel FMRFamide-like neuropeptide sequences from the eyestalk of the giant tiger prawn *Penaeus monodon*.** In

Abstracts and Proceeding, 27th Congress on Science and Technology of Thailand, 16-18 October 2001, Lee Gardens Plaza Hotel, Hat Yai, Songkla, Thailand organized by The Science Society of Thailand under the Patronage of His Majesty the King, Faculty of Science, Prince of Songkla University. [CD-ROM, file://F:\STT\web\content\biochem\B034.html].

Isolation of FLPs from 9,000 eyestalk was performed using methanol/acetic/water (90:1:9) extraction. After the extract was partially purified using C18 cartridges, it was further purified by 5-7 steps of RP-HPLC using 3 kinds of columns: C18, C8 and cyano and 3 solvent systems: acetonitrile/trifluoro acetic acid, acetonitrile/heptafluorobutyric acid and acetonitrile/triethyl ammonium acetate. Dot-ELISA using the combination of 3 monoclonal antibodies against FLPs was used to monitor FLRs in the fractions during purification processes. Seven new sequences of FLPs were identified which can be divide into 4 subgroups according to the primary structure of the C-terminus: 1. GDRNFLRFamide 2. AYSNLNYLRFamide 3. AQPSMRLRFamide, SQPSMRLRFamide, SMPSDLRLRFamide 4. GYRKPPFNGSIFamide. These evidences confirm the high complexity of this peptide family in which multiple forms of this peptide family are usually present in a single species.

Keywords: dot ELISA; Eyestalks; *Penaeus monodon*; Neuropeptides; Isolation

836 Nithawan Jarernporn, Cholticha Bantaokul, Nuchanart Tipmongkolsilp, Nonthon Lertworapreecha and Janenuj Wongtavatchai. 2003. **Antimicrobial susceptibility tests on *Vibrio* pathogens from black tiger shrimps *Penaeus monodon*.** Thai J. Med. 33(2): 72-78.

The standard, *in vitro*, minimal inhibitory concentrations (MICs) of 5 antimicrobial; chloramphenicol, ciprofloxacin, enrofloxacin and nalidixic acid were evaluated against vibrios isolated from diseased black tiger shrimps *Penaeus monodon*. One hundred and ninety-seven pathogenic vibrio isolates obtained from different shrimp culture areas in Thailand during March 2001-January 2002 were, *V. fluvialis* 50 isolates (25.38%), *V. damsela* 41 isolates (20.81%), *V. vulnificus* 39 isolates (19.80%), *V. parahaemolyticus* 28 isolates (14.21%), *V. cholerae* 25 isolates (12.69%), and *V. alginolyticus* 14 isolates (7.11%). MICs were examined for all the tested antimicrobials and the degree of susceptibility of shrimp vibrio pathogens to each product was analysed by determining their MICs. The investigation revealed that most of the tested isolates were susceptible to enrofloxacin, chloramphenicol, norfloxacin and ciprofloxacin. Less than 50% of the isolates were susceptible to nalidixic acid.

Keywords: Antimicrobial susceptibility; *Vibrio*; Black tiger shrimp; Minimal Inhibitory Concentration; MIC

837 Janenuj Wongtavatchai, Piya Subhachal, Wara Panichkriangkrai and Jirasak Tangtronpiroj. 2000. **Acetylcholinesterase activity as a biomarker for organophosphorus pesticides contamination in black tiger shrimp (*Penaeus monodon*)**. In Proceedings the Regional Conference on Consumer Safety and Residues in Animal Products July 26th-28th, 2000 at Faculty of Veterinary Medicine, Chiang Mai University. p.118-122.

Acetylcholinesterase (AChE) activity was measured in muscle tissue of black tiger shrimp (*Penaeus monodon*) using methodologies based on Ellman technique. AChE activities in different groups of shrimp were determined in response to organophosphorus pesticide, methylparathion, exposure. The exposure to a low concentration of methylparathion (3 ppb) resulted in a significant depression of AChE activity. AChE activity in 12 hr and 24 hr exposed shrimp declined to 78.0% and 48.82% of the control level. Whereas neither clinical abnormalities nor gill histopathological lesion were observed. The control suggests that measurement of AChE activity in cultured black tiger shrimp is a potential biomarker for a field contamination of organophosphorus pesticides, particularly when the contamination is not detectable by conventional chemical analysis

Keywords: Black tiger shrimp; Organophosphorus pesticide; Acetylcholinesterase

838 Sei-ichi Aiba. 2003. **Utilization of chitosan in industry: syntheses of organo- or water-soluble chitosan derivatives by chemical modification**. In The National Chitin-Chitosan Conference July 17-18, 2003 at Institute Building III. Chulalongkorn University. Organized by Center for Chitin-Chitosan Biomaterials (CCB), Chulalongkorn University and National Metal and Materials Technology Center (MTEC). p.8-11.

Toward further application of chitosan as functional materials, conversion of chitosan by chemical modifications to organo- or water-soluble derivatives was studied. Organo-soluble chitosan derivatives will be used in chemical plating on plastic surface as an adsorbent of palladium. Hydroxy groups were acylated by acyl chlorides in methanesulfonic acid. Some derivatives with long alkyl chains (DS=ca. 1 for O-acyl group) were soluble in THF, MEK, toluene, and CHCl₃. The adsorption property of the derivatives for palladium was studied (ca 0.004 mg/cm²). Water-

soluble derivatives are useful for biomedical materials such as hydrogel. We studied the Michael type reaction of chitosan with acrylic acid and esters. A variety of water-soluble derivatives with carboxyl, hydroxyalkyl ester, or oligoethylene glycol moiety in side chains were soluble in all pH range.

Keywords: Utilization; Chitosan; Adsorption

839 Monkol Sukwattanasinitt, Akamol Klaikherd, Siripatr Jayanta, Jariya Boonjawat and Sei-ichi Aiba. 2003. **Preparation of N-Acetyl-D glucosamine and chitooligosaccharide by enzymatic hydrolysis of chitin and chitosan with serum from Para rubber**. In The National Chitin-Chitosan Conference July 17-18, 2003 at Institute Building III. Chulalongkorn University. Organized by Center for Chitin-Chitosan Biomaterials (CCB), Chulalongkorn University and National Metal and Materials Technology Center (MTEC). p. 12-15.

Serum fraction of para rubber (*Hevea brasiliensis*) obtained from the process of concentrated latex preparation is known to contain an endo-chitinolytic enzyme, *Hevamine*. This work presents an investigation of a potential utilization of the serum for the production of N-acetyl-D glucosamine (GlcNAc) and N, N'-diacetylchitobiose ((GlcNAc)₂) from β-chitin. The optimum ratio of enzyme to chitin was found to be 0.22 mU/mg with optimum substrate concentration at 60 mg/mL. The optimum pH range was 2-4 and the optimum temperature was 45 °C where the reaction produced both (GlcNAc)₂ and (GlcNAc) with the product mole ratio ((GlcNAc)₂/GlcNAc) approximately 2:1. The hydrolysis of 300 mg of chitin yielded 39 mg of GlcNAc and 108 mg of (GlcNAc)₂ determined by HPLC within 8 days when 64 mU of the enzyme was used at the optimum condition.

Keywords: Chitosan; Chitin; Para rubber; Enzymes; Serum; *Hevamine*

840 Metha Rutnakompituk, Wanrudee Boonchu and Pranee Phinyocheep. 2003. **Preparation of siloxane-modified chitosan films**. In The National Chitin-Chitosan Conference July 17-18, 2003 at Institute Building III. Chulalongkorn University. Organized by Center for Chitin-Chitosan Biomaterials (CCB), Chulalongkorn University and National Metal and Materials Technology Center (MTEC). p. 16-19.

A novel method in preparation of polysiloxane-modified chitosan networks are discussed herein. Polysiloxanase in the chitosan-based polymers can serve as elastomeric crosslinkers. A series of the siloxane prepolymers with systematically varied molecular weights can be prepared via cationic ring-opening polymerization of

octamethylcyclotetrasiloxane (D₄). The siloxane prepolymers were then functionalized with epoxy groups at both terminals. The reaction progress was monitored by ¹H NMR to elucidate their chemical structures and molecular weights. Preliminary results suggest that only 10 wt% PDMS can significantly toughen the chitosan films.

Keywords: Chitosan; Films; Crosslinking; Polymers

841 Wimolsiri Amornchai and Varawut Tangpasuthadol. 2003. **Surface modification of chitosan films by grafting with aldehyde derivatives of ethylene glycol.** In The National Chitin-Chitosan Conference July 17-18, 2003 at Institute Building III, Chulalongkorn University. Organized by Center for Chitin-Chitosan Biomaterials (CCB), Chulalongkorn University and National Metal and Materials Technology Center (MTEC). p. 20-22.

The structure of chitosan contains a large number of hydroxy and amino groups which can be modified by various chemical reactions. This research focused on the reactions between the amino groups of chitosan and aldehyde derivatives of monomethoxy triethylene glycol and monomethoxy poly (ethylene glycol) by using NaCNBH₃ as a reducing agent. The chemical modification was performed by immersing chitosan films in the aldehyde-methanol solutions. The presence of EG moiety attached on the films were determined by IR and NMR spectroscopy. The hydrophilicity of the modified film surface increased, as was revealed by air-water contact angle measurements. These films were subjected to protein adsorption study in order to assess their uses in biomedical applications. It was found that the adsorptivity of bovine serum albumin and lysozyme on the films were lower than the non-modified chitosan films.

Keywords: Chitosan; Films; Ethylene glycol; Proteins; Adsorption

842 Unchalee Intra and Khantong Soontarapa. 2003. **Ion exchange capacity of chitosan composite membrane.** In The National Chitin-Chitosan Conference July 17-18, 2003 at Institute Building III, Chulalongkorn University. Organized by Center for Chitin-Chitosan Biomaterials (CCB), Chulalongkorn University and National Metal and Materials Technology Center (MTEC). p. 23-25.

Chitosan with molecular weight and degree of deacetylation of 1.7×10^6 Dalton and 94%, respectively, was synthesized. Six types of chitosan membranes were prepared for testing of their ion

exchange capacities. They were uncrosslinked membrane, crosslinked membranes with sulfuric acid, composite membranes of both types by including lithium nitrate with and without ethylene carbonate plasticizer. The concentration of sulfuric acid solution of 2, 4 and 6% by weight and the amount of lithium nitrate of 5, 10, 20, 40, 50 and 100% of chitosan weight were varied in this study. The amount of ethylene carbonate was fixed at 40% of chitosan weight. It was found that the amount of lithium nitrate should not exceed 10% for uncrosslinked membrane. Otherwise the tensile strength was deteriorated while the ion exchange capacity was improved insignificantly. The optimum membrane with good tensile strength as well as good ion exchange capacity was composite membrane crosslinking in 45 sulfuric acid solution and including lithium nitrate by 50% of chitosan weight. Its tensile strength and ion exchange capacity were 101 MPa and 5.85 milliequivalent/gram, respectively, comparing to 88 MPa and 5.22 milliequivalent/gram of crosslinked membrane in 4% sulfuric acid solution.

Keywords: Chitosan; Sulfuric acid; Ions; Crosslinking

843 Wanida Janvikul, Boonlorn Thavornnyutikarn and Paweena Uppanap. 2003. **Wound dressing from carboxymethylchitosan hydrogels.** In The National Chitin-Chitosan Conference July 17-18, 2003 at Institute Building III, Chulalongkorn University. Organized by Center for Chitin-Chitosan Biomaterials (CCB), Chulalongkorn University and National Metal and Materials Technology Center (MTEC). p. 26-29.

Wound dressing materials were, in this study, directly prepared from chitin. Chitin extracted from squid pens was first carboxymethylated to carboxymethylchitosan (CM-chitosan) sodium salt. Sponge-like CM-chitosan pads fabricated by a freeze-dry process were subsequently subjected to a steam treatment. The resulting hydrogels were characterized by solid state ¹³C CP/MAS NMR and dynamic mechanical thermal analysis. The steam-included crosslinking of CM-chitosan sodium salt was found to involve the -NH₂ and -COONa groups, yielding amide linkages (-CONH-). The hydrogel pads instantly imbibed a great deal of water. The degree of swelling (DS) of the hydrogels was found to be up to 36, depending upon the harshness of steaming conditions used. The hydrogels appeared non-cytotoxic to L929 cells. These results make the hydrogels possible good wound dressing materials candidates.

Keywords: Chitin; Carboxymethylchitosan; Wound dressing; Hydrogels; Crosslinking; Steam

844 Vipavee P. Hoven, Chamaiporn Mutchapato, Yasuhiko Iwasaki and Tomomi Ito. 2003. **Blood compatibility of chitosan/poly (styrene sulfonate) assembled thin film.** In The National Chitin-Chitosan Conference July 17-18, 2003 at Institute Building III. Chulalongkorn University. Organized by Center for Chitin-Chitosan Biomaterials (CCB), Chulalongkorn University and National Metal and Materials Technology Center (MTEC). p.30-33.

Ultrathin polymer films were prepared by an alternate adsorption between negatively charged poly (styrene sulfonate) (PSS) and positively charged chitosan (CHI) on the amine-functionalized silicon substrate (Si-NH₂) at pH 4. The assembly process was monitored by ellipsometric measurements. The thickness of supported film is strongly dependent on the ionic strength of polymer solutions and the number of deposition. Zeta potential data supported the assumption that the assembled film is stratified and the charge is alternatively reversed after each deposition step. Due to the electrostatic interactions between positively charged CHI and negatively charged blood proteins, the surfaces having CHI as the top layer should promote protein adsorption and platelet adhesion, the early events of blood coagulation. And the opposite trend should be observed on the surfaces having PSS as the top layer. However, alternative responses of deposited films were only evidenced in the cases where the individual layer was sufficiently thick and the average roughness did not exceed a certain value.

Keywords: Chitosan; Film; Polymers; Blood; Polymers; Adsorption

845 Satit Puttipipatkachorn, Pagorn Tunsutthipanon and Jurairat Nunthanid. 2003. **Effect of chitosan on drug release from pellets.** In The National Chitin-Chitosan Conference July 17-18, 2003 at Institute Building III. Chulalongkorn University. Organized by Center for Chitin-Chitosan Biomaterials (CCB), Chulalongkorn University and National Metal and Materials Technology Center (MTEC). p.34-36.

Theophylline pellets were prepared by extrusion-spheronization, using chitosan in acid solution. Three different grades of chitosan including very low viscosity (VL), low viscosity (L) and high viscosity (H) grades, were used at the concentrations of 0.5, 1.0 and 1.5%w/w in acetic acid, malic acid or citric acid. Spherical pellets were obtained in all formulations. The release behavior of theophylline from the pellets was investigated in distilled water. Effects of type of granulating liquid (acid solution), type of chitosan, and chitosan concentration on drug release from

pellets were investigated. The pellets prepared by different acid solution showed comparable drug release rate. Chitosan of high viscosity grade provided the pellets of slower drug release rate. The drug release rate was decreased with increased chitosan concentration. The results demonstrated that chitosan could modify the drug release from pellets.

Keywords: Chitosan; Theophylline, Acid solution

846 Pornsak Sriamornsak, Jurairat Nunthanid and Satit Puttipipatkachorn. 2003. **Release of indomethacin from pectin-chitosan composite gel spheres.** In The National Chitin-Chitosan Conference July 17-18, 2003 at Institute Building III. Chulalongkorn University. Organized by Center for Chitin-Chitosan Biomaterials (CCB), Chulalongkorn University and National Metal and Materials Technology Center (MTEC). p.37-40.

Pectin-chitosan composite gel spheres were prepared by ionotropic gelation method. Pectin solution containing indomethacin, a model drug, was extruded into a mixture of chitosan and calcium chloride. The release behavior of indomethacin from composite gel spheres was investigated *in-vitro*. The influence of factors affecting release behavior, such as type of pectin, molecular weight of chitosan, cross-linking time and release medium, were discussed in this study. The release of indomethacin from gel spheres could be retarded by adding chitosan into gelation medium. The different type of pectin used demonstrated slightly different drug release profiles. The higher molecular weight of chitosan showed less indomethacin release than the lower one. The increased cross-linking time slowed the drug release from composite gel spheres. The release of indomethacin from composite gel spheres was also dependent on the release medium. The drug release was slower in Tris buffer where no phosphate ions which can induce the precipitation of calcium phosphate. The results suggested that the composite gel spheres of pectin and chitosan could be used as a controlled release drug delivery carrier.

Keywords: Pectin; Chitosan; Indomethacin; Gel; Crosslinking

847 Pomsila N., Warotamawit S., Suabgthook S., Krissnasuwan O. and Sang-In S. 2003. **A pilot study of using chitosan fibre as a drug delivery system for tetracycline hydrochloride.** In The National Chitin-Chitosan Conference July 17-18, 2003 at Institute Building III. Chulalongkorn University. Organized by Center for Chitin-Chitosan Biomaterials (CCB), Chulalongkorn University and National Metal and Materials Technology Center (MTEC). p.41-44.

Tetracyclin chitosan fibers were prepared by adding tetracycline hydrochloride in 3% w/v chitosan solution. The fibers were coagulated in wet spinning process. Then the fibers were dried, weighted and cut into 14 cm length. Tetracycline hydrochloride concentrations and the released profile of 34 fibers were determined. Tetracycline concentration was detected by UV-vis spectrophotometer. The result shows that the mean weight was 6.8 ± 0.7 mg. The mean concentration was 2.3 ± 0.6 mg% or 15.8 ± 5.3 ppm. Tetracycline hydrochloride was rapidly released from chitosan fiber matrix and reached the maximum concentration at 10 minutes. This result suggests that it is possible to use chitosan fiber as a vehicle to deliver tetracycline hydrochloride in a local drug delivery system.

Keywords: Chitosan fiber; Local drug delivery system; Tetracycline hydrochloride

848 Charurat Chaolerd and Khantong Soontarapa. 2003. **Removal of lead and mercury in wastewater from On-Nooch solid waste disposal site by chitosan flakes.** In The National Chitin-Chitosan Conference July 17-18, 2003 at Institute Building III. Chulalongkorn University. Organized by Center for Chitin-Chitosan Biomaterials (CCB), Chulalongkorn University and National Metal and Materials Technology Center (MTEC). p.45-47.

The chitosan flakes prepared from shrimp shells were used to remove lead and mercury in wastewater from On-Nooch solid waste disposal site. The chitosan yield based on dry shells and characteristics in terms of degree of deacetylation, average molecular weight and viscosity of 1% dope solution in 1% acetic acid were 31.46%, 90.1%, 1.8×10^5 Dalton and 54.6 centipoises, respectively. The lead and mercury concentrations in raw wastewater during the study period were 0.2-3.1 mg/g and 2.7-88.1 µg/l, respectively. The chitosan flakes were ground to 710-850 µm. The optimum condition was by adjusting the pH of wastewater to be 6, stirring 20 g/l of chitosan at 150 rpm for 3 hrs, and settling for 1 h. It was found that the removal efficiencies of lead and mercury were 95-98 and 95-98%, respectively.

Keywords: Chitosan; Prawn shells; Shrimp shell; Lead; Mercury; Wastewater

849 Chiraporn Songkroah, Paitip Thiravetyan and Woranan Nakbanpote. 2003. **Application of chitin for recovery of silver from photographic waste.** In The National Chitin-Chitosan Conference July 17-18, 2003 at Institute Building III. Chulalongkorn University. Organized by Center for Chitin-Chitosan Biomaterials (CCB),

Chulalongkorn University and National Metal and Materials Technology Center (MTEC). p.48-50.

Chitin obtained from shrimp shell (40% degree of deacetylation) was able to adsorb silver thiosulphate complexes, $[\text{Ag}(\text{S}_2\text{O}_3)_2]^{3-}$ at pH 2.0 without dissolution of chitin. The silver adsorption was completed within 5 minutes. However, the efficiency of chitin to adsorb silver-thiosulphate complexed reduced when increased particle size. The maximum adsorption capacity of chitin powder (0.1-0.5 mm) and chitin flake (0.5-1.0 mm) were 4.37 and 3.61 mg Ag/g, respectively. Silver adsorption decreased at higher concentration of thiosulphate ($\text{S}_2\text{O}_3^{2-}$) because silver-thiosulphate complexed will be more stable and resulted in more difficult to be adsorbed. The silver adsorbed onto chitin could be completely eluted to 100% by 3 M sodium-thiosulphate. The result implied that the mechanism of silver adsorption by chitin was chemisorption. In addition, chitin also adsorbed silver from photographic waste. Therefore, the potential to use chitin as a commercial adsorbent instead of resin for recovery of silver from photographic waste is feasible. This also increased the value of chitin and decreased heavy metal discharge.

Keywords: Chitin; Prawn shells; Shrimp shell; Silver; Adsorption; Thiosulphate; Photographic waste

850 บังอร ลีภักดีสกุล, ละเอียต เพ็งโสภะ และ ปิยะบุตร วาณิชพงษ์พันธุ์. 2003. **Treatment of wastewater from X-Ray film by chitosan porous bead.** In The National Chitin-Chitosan Conference July 17-18, 2003 at Institute Building III. Chulalongkorn University. Organized by Center for Chitin-Chitosan Biomaterials (CCB), Chulalongkorn University and National Metal and Materials Technology Center (MTEC). p.51-53.

This research studied on efficiency of silver adsorption from x-ray film by chitosan porous bead. Which was developed from 6% chitosan solution in 2% acetic acid solution and then bead forming by alkaline solution of potassium hydroxide with ethanol at ratio 1:1. Chitosan in this experiment was produced from shrimp shell with 75% of degree of deacetylation and molecular weight at 150,000 g/mole. The result was found that chitosan porous bead had efficiency of silver adsorption of 29.97, 30.04, 30.11, 30.12 gram of 92.38%, 92.74%, 92.78% at mass of chitosan porous bead 10, 20, 30 and 40 gram respectively.

Keywords: Chitin; Chitosan; Chitosan Porous Bead; Wastewater ; X-ray film waste; Silver; Prawn shell; Shrimp shell

851 นิรันดร์ สัพพวิญญู และ ปิยะบุตร วานิชพงษ์พันธุ์. 2003. **Zinc and cadmium removal by chitosan porous bead.** In The National Chitin-Chitosan Conference July 17-18, 2003 at Institute Building III. Chulalongkorn University. Organized by Center for Chitin-Chitosan Biomaterials (CCB), Chulalongkorn University and National Metal and Materials Technology Center (MTEC). p.54-56.

This research studied on efficiency of standard heavy metal (Zn and Cd) adsorption by using chitosan porous bead. Chitosan in this experiment was produced from local shrimp shell with degree of deacetylation 75% and molecular weight 150,000 g/mole. Chitosan porous bead was obtained from 4% chitosan solution in 2% acetic acid solution with dropping into alkaline solution of potassium hydroxide and ethanol at 1:1 ratio. The result was found that chitosan porous bead had efficiency of Cd adsorption (95.50%) over Zn adsorption (92.48%) at mass of chitosan porous bead 60 gram. Capacity ratio of Zn and Cd adsorption were 2.36 and 2.58 mg of heavy metal per gram of chitosan porous bead.

Keywords: Chitin; Chitosan; Chitosan Porous Bead; Zinc; Cadmium; Adsorption

852 ปิยะบุตร วานิชพงษ์พันธุ์ และ นิรันดร์ สัพพวิญญู. 2003. **Chitosan porous bead.** In The National Chitin-Chitosan Conference July 17-18, 2003 at Institute Building III. Chulalongkorn University. Organized by Center for Chitin-Chitosan Biomaterials (CCB), Chulalongkorn University and National Metal and Materials Technology Center (MTEC). p.57-59.

In this research used the commercial chitosan with degree of deacetylation 96 percent, moisture content 1 percent, ash content 1 percent, CaCO_3 content 0.08 percent and molecular weight 300,000 g/mole. Dropping 4 percent chitosan solution in 2 percent acetic acid into alkaline solution for development of chitosan porous bead. The obtained chitosan porous bead was spherical with white color like a glutinous pellet, soft, and sturdy. The surface area, porosity, density, moisture content and mean outside diameter of chitosan porous bead were 2,850 mm^2/mg , 0.159 cm^3/g , 0.1606 g/cm^3 , 97 percent and 3.43 mm, respectively.

Keywords: Chitosan; Chitosan Porous Bead

853 Patchra Limpanavech, Rath Pichyangkura, Chumpol Khunwasi, Supachitra Chachawan, Pongtharin Lotrakul, Peungwit Bunjongrat, Anchalee Chaidee and Thapana Akaracakpanya. 2003. **The effects of polymer type, concentration**

and %DD of biocatalyst modified chitosan on floral production of *Dendrobium* 'Eiskul'. In The National Chitin-Chitosan Conference July 17-18, 2003 at Institute Building III. Chulalongkorn University. Organized by Center for Chitin-Chitosan Biomaterials (CCB), Chulalongkorn University and National Metal and Materials Technology Center (MTEC). p.60-64.

The usage of chitin-chitosan for agriculture is one of the most important applications of this compound in Thailand. Many studies have demonstrated that the significant effects of chitin-chitosan on promoting plant growth and production could only be achieved when the chitosan polymer was modified into shorter chains by gamma ray irradiation or by partial chemical hydrolysis. The aim of this study was to determine the proper concentrations and molecule types of chitosan (oligomeric and polymeric forms with 70, 80 and 90% degree of deacetylation (%DD)) to increase the floral production of *Dendrobium* sp. 'Eiskul', one of Thailand's commercial cut-flower orchids. Four concentrations, 1, 10, 50 and 100 ppm of chitosan with different %DD and molecule types, were directly sprayed onto separate sets of tested plants once a week for 68 weeks. The data collection was conducted every week after the chitosan application. It was found that the 70% DD chitosan polymer and oligomer at the concentration of 1, 10 and 50 ppm, showed no significant effect on the inflorescence number (IN) and the number of flower per inflorescence (FPI). However, at 100 ppm the 70% DD chitosan oligomer increased IN while the polymeric form resulted in the significant increase in FPI. At all concentrations tested, the chitosan oligomer with 80% DD could significantly promote IN, but only at 10 ppm of this type could increase FPI. Both oligomeric and polymeric forms of the 90% DD chitosan did not significantly affect FPI, but at 10 and 50 ppm of the polymer and at 1 ppm of the oligomer, IN of the treated plants was increased. All orchid plants treated with chitosan seemed to produce flowers earlier than the controls. In conclusion, we demonstrated in this study that the biocatalyst-modified chitosan molecules were able to promote the floral production of *Dendrobium* sp. 'Eiskul' when the appropriate molecule types and concentrations were applied to the plants regularly.

Keywords: Chitin; Chitosan; Polymers; Orchids

854 ชนัสพร เกลี้ยงแก้ว, สุวลี จันทร์กระจำง และ พัลภา เสดตติลา. 2003. **A Study on the influences of chitosan upon the transplanting and growth of *Paphiopedilum bellatulum* x PAPH. anghong derived from tissue culture.** In The National Chitin-Chitosan Conference July 17-18, 2003 at Institute Building III. Chulalongkorn University. Organized by

Center for Chitin-Chitosan Biomaterials (CCB), Chulalongkorn University and National Metal and Materials Technology Center (MTEC). p.65-68.

The effects of Chitosan upon the transplant and growth of *Paphiopedilum bellatulum* x PAPH. *angthong* derived from tissue culture. It was investigated that the usage of Chitosan at 0,2.5, 5, 10, 20 and 40 ppm can stimulate *Paphiopedilum bellatulum* x PAPH. *angthong* to produced the root, new leaves and stimulate the growth of the leaves both width and length comparing with the controlling set particularly usage of chitosan at 10 ppm. After chitosan had been applied for 30 days, it could be able to increase the average length and width of the leaver up to the maximum for leaf-1, leaf-2, leaf-3 by the controlling set has the lowest average width and length. After the observation of each group of experiment. The group of controlling has attacked by worm and insect, withering leaves, the rim of leaves were bite and some plant are died due to they could not suffer from the surrounding conditon as good as the chitosan group.

Keywords: Chitosan; Orchids

855 วิมลรัตน์ ศรีจรัสสิน, อนุชนีย์ เลิศลัทธภรณ์, วัชรพงศ์ อริยเกรียงไกร และ วัชรเชื้อโชติ. 2003. **Production of rayon fibres mixed with chitosan**. In The National Chitin-Chitosan Conference July 17-18, 2003 at Institue Building III. Chulalongkorn University. Organized by Center for Chitin-Chitosan Biomaterials (CCB), Chulalongkorn University and National Metal and Materials Technology Center (MTEC). p.69-71.

The binary blend films of viscose rayon/ chitosan xanthate and the ternary blend films of viscose rayon/ chitosan xanthate/ N, O-dicarboymethyl chitosan were prepared at various ratios. The morphology of these films was investigated by Scanning electron microscope (SEM), Transmission electron microscope (TEM). The thermal property was examined by Differential scanning calorimetry (DSC) and antimicrobial activity against *Staphylococcus aureus* was assessed based on ATCC 147. It was found that the presence of N, O-dicarboymethyl chitosan in ternary blends can improve the compatibility of chitosan with viscose rayon. The morphology observations of the films showed that the distribution of chitosan particles is much smaller than those of binary blends. Antibacterial properties against *Staphylococcus aureus* of ternary blends are higher than binary blends. Fibre production and properties from the ternary blend has been investigated.

Keywords: Chitosan; Rayon; Films; Viscose Rayon

856 Fangangwanwong J., Tokura S. and Chirachanchai S. 2003. **Hydroxyapatite chitaneous gel and its physical properties**. In The National Chitin-Chitosan Conference July 17-18, 2003 at Institue Building III. Chulalongkorn University. Organized by Center for Chitin-Chitosan Biomaterials (CCB), Chulalongkorn University and National Metal and Materials Technology Center (MTEC). p.72-74.

A derivative of epoxy-chitosan gel for composite with hydroxyapatite is developed. The reaction of epoxy group with chitosan is focused at the hydroxyl group (C-3 and/or C-6) while the amino group is retained. Alternate soaking in calcium chloride an sodium hydrogen phosphate is applied for forming hydroxyapatite in epoxy-chitosan matrix. The chemical functionalization is clarified by FTIR, TGA and XRD. The gel strength is examined to evaluate the effect of hydrazine and hydroxyapatite.

Keywords: Chitosan; Crosslinking

857 Rangrong Yoksan, Michiya Matsusaki, Mitsuru Akashi and Suwabun Chirachanchai. 2003. **Controlled structure chitosan nanospheres**. In The National Chitin-Chitosan Conference July 17-18, 2003 at Institue Building III. Chulalongkorn University. Organized by Center for Chitin-Chitosan Biomaterials (CCB), Chulalongkorn University and National Metal and Materials Technology Center (MTEC). p.75-77.

The N-phthaloylchitosan grafted mPEG is prepared under the concept of controlling hydrophobic/ hydrophilicity on chitosan chain. The obtained derivative performs colloidal particles in water and some organic solvents. The colloidal particles show sphere in shape with the sizes in nanolevel as observed from SEM, TEM and DLS.

Keywords: Chitin; Chitosan

858 Krisana Siraleartmukul, Khatcharin Siritwong, Tawun Remsungnen and Supot Hannongbua. 2003. **Solvation structure of glucosamine in aqueous solution by Monte Carlo simulation basic properties for all application**. In The National Chitin-Chitosan Conference July 17-18, 2003 at Institue Building III. Chulalongkorn University. Organized by Center for Chitin-Chitosan Biomaterials (CCB), Chulalongkorn University and National Metal and Materials Technology Center (MTEC). p.78-83.

The solvation structure of glucosamine in aqueous solution has been investigated using Monte Carlo simulation at temperature of 298 K. The system contains 202 MCY water molecules plus one

glucosamine molecule in a periodic box length of 18.26 Å. A glucosamine-water potential function has been newly developed based on DZP *ab initio* calculation. The first solvation shell appears at 4.6 Å from the center of glucosamine with the coordination number of 7 water molecules, but only one of them forms hydrogen bond to ring-oxygen atom. Furthermore, mobility distribution and orientation of water molecules around glucosamine have been investigated in details.

Keywords: Chitosan; Chitin; Glucosamine molecules; Water molecules

859 Kyaw Nyein Aye and Willem F. Stevens. 2003. **Dry screening of shrimp shells for chitin production.** In The National Chitin-Chitosan Conference July 17-18, 2003 at Institute Building III. Chulalongkorn University. Organized by Center for Chitin-Chitosan Biomaterials (CCB), Chulalongkorn University and National Metal and Materials Technology Center (MTEC). p.83-85.

Pretreatment of shrimp shells was investigated to lower the costs and to improve the sustainability of chitin production. Physical pretreatment comprising of drying, grinding and sieving is attractive for the recovery of a dry powder rich in shrimp protein. The dry screening pretreatment procedure leads to cleaner technology for chitin production, to considerably lower costs, to useful by products and to less contaminated industrial effluent.

Keywords: Chitin; Shrimp shells; Prawn shell; Black tiger shrimps; *Penaeus monodon*; Shrimp waste products

860 Nitar Nwe, Suwalee Chandkrachang and Willem F. Stevens. 2003. **Influence of pH urea supplemented solid substrate fermentation for the production of fungal chitosan.** In The National Chitin-Chitosan Conference July 17-18, 2003 at Institute Building III. Chulalongkorn University. Organized by Center for Chitin-Chitosan Biomaterials (CCB), Chulalongkorn University and National Metal and Materials Technology Center (MTEC). p. 86-88.

The fungus, *Gongronella butleri* USDB 0201 was grown on sweet potato pieces supplied with mineral solutions containing urea adjusted to various pH. The fungal mycelia were harvested at the end log phase of the fermentation. A maximum yield of mycelia 40 g/kg of solid substrate was obtained. Chitosan was extracted from the mycelia. About 10 g/100 g mycelia was obtained from solid substrate fermentation medium supplied with 7.2 g urea/kg substrate adjusted to pH 3.5. The molecular

weight of chitosan slightly varied with different pH of solid substrate fermentation media.

Keywords: Chitin; Chitosan; Fungi

861 Wah Wah Thein Han, San Hein, Suwalee Chandkrachang and Willem F. Stevens. 2003. **In Vitro evaluation of a chitosan transdermal patch.** In The National Chitin-Chitosan Conference July 17-18, 2003 at Institute Building III. Chulalongkorn University. Organized by Center for Chitin-Chitosan Biomaterials (CCB), Chulalongkorn University and National Metal and Materials Technology Center (MTEC). p.89-91.

Chitosan membranes were prepared by the cast-drying method. A transdermal patch was developed using an agarose hydrogel as a drug reservoir and a chitosan membrane for rate control. The release of a drug this transdermal delivery system was analyzed *in vitro* using a Franz diffusion cell. The water-soluble drug, lidocaine hydrochloride was used as the model drug. Release profile of drug through different rate controlling chitosan membranes was compared with release through cellulose membrane. Drug release was more prolonged with the chitosan membranes and dependent on the degree of deacetylation (%DD).

Keywords: Chitosan; Rate controlling membrane; Drug delivery

862 Trang Si Trung, Chuen-How Ng and Willem F. Stevens. 2003. **Preparation of decrystallized chitosan from shrimp shell waste and its application in decolorization of textile wastewater.** In The National Chitin-Chitosan Conference July 17-18, 2003 at Institute Building III. Chulalongkorn University. Organized by Center for Chitin-Chitosan Biomaterials (CCB), Chulalongkorn University and National Metal and Materials Technology Center (MTEC). p.92-95.

Decrystallized chitosan was produced from shrimp shells with a low degree of crystallinity. Raw mixed dye wastewater from a textile factory was efficiently decolorized using decrystallized chitosan that appeared to be more efficient than using normal chitosan and activated carbon. Decolorization reached 90% within 10 min, and can be carried out over a pH range from 4.5 to 8.1. Decrystallized chitosan can be regenerated by 2 M H₂SO₄ and can be reused more than 10 times. It is an attractive candidate for the removal of dyes from textile wastewater.

Keywords: Shrimp shells; Prawn shells; Chitosan; Complex dye; Decolorization; Decrystallized chitosan; Adsorption

863 San Hein, Chuen-How Ng and Willem F. Stevens. 2003. **Assay for determination of insoluble chitinous materials in viscous chitosan solution.** In The National Chitin-Chitosan Conference July 17-18, 2003 at Institute Building III. Chulalongkorn University. Organized by Center for Chitin-Chitosan Biomaterials (CCB), Chulalongkorn University and National Metal and Materials Technology Center (MTEC). p.96-98.

Insoluble chitinous materials in highly viscous chitosan solutions can be quantified using the viscosity-lowering action of transglucosidase (EC 2.4.1.24). In chitosan, commonly produced by high temperature deacetylation (90 °C), between 70-90% of insoluble chitinous materials were recovered by the enzymatic method whereas only 25% recovery was achieved by the nitrous acid method. The insoluble material recovered after enzyme treatment had a higher degree of deacetylation and a lower degree of crystallization than that after nitrous acid treatment. The results are explained by difference in penetration by enzyme and nitrous acid into the insoluble particle.

Keywords: Chitosan; Chitin; Solution

864 ปิยะดา บุษผา. 2003. **Chitin production from rice-field crab shells.** In The National Chitin-Chitosan Conference July 17-18, 2003 at Institute Building III. Chulalongkorn University. Organized by Center for Chitin-Chitosan Biomaterials (CCB), Chulalongkorn University and National Metal and Materials Technology Center (MTEC). p. 100-103.

Rice field crabs are invertebrate living in rice field. They have convex, smooth and shine carapace. They are used as salted crabs and added in papaya salad. In the north of Thailand, fresh water crabs are used as fermented food called Nampoo. First, small crabs are ground and filtered. Then, filtrate is mixed with seasoning to improve flavour and heated until it becomes viscous. Nampoo is famous to add in the northern food such as bamboo salad, Nampoo chili sauce and bamboo curry. The process of Nampoo production has much crab shell waste. Chitin production from rice-field crab shells would be another choice of raw material to increase the value of local resource and to reduce environmental problems. In the experiment, the raw material was separated into 4 parts that are carapace, apron (abdominal covering on the bottom side of the crab), trunk (thorax and abdomen) and appendages. It was dried at 100 °C, 24 hours and ground. From experimental data, the percentages of chitin were compared. The percentages of chitin were 25.17, 25.67, 13.05 and 18.66 respectively. Protein content in chitin was reduced from 80-90% compared with raw materials.

It found that chitin from each part still had high calcium content that should be more investigated.

Keywords: Chitin; Wastes, Nampoo

865 Rangrong Yoksan, Siriratana Biramontri, Mitsuru Akashi and Suwabun Chirachanchai. 2003. **Stability of chitosan under γ -ray energy.** In The National Chitin-Chitosan Conference July 17-18, 2003 at Institute Building III. Chulalongkorn University. Organized by Center for Chitin-Chitosan Biomaterials (CCB), Chulalongkorn University and National Metal and Materials Technology Center (MTEC). p.104-106.

Chitosan irradiation with γ -ray under simple various conditions studied for practical production is focused. Molecular weight of chitosan was reduced approximately for 50% under γ -ray amount of 20 kGy in a simple condition of dry solid-state. The decrease in molecular weight was more significant up to 80% when aqueous solutions of radical initiators, i.e. $K_2S_2O_8$ and H_2O_2 , were involved. The backbone structure of irradiated product was maintained except the cases of chitosan irradiated in 2% aq. $K_2S_2O_8$ solution and 1% aq. acetic acid solution.

Keywords: Chitosan; Molecular weight; Solution

866 Phongying S. and Chirachanchai S. 2003. **Chitosan-REG: An approach for a self supramolecular derivative.** In The National Chitin-Chitosan Conference July 17-18, 2003 at Institute Building III. Chulalongkorn University. Organized by Center for Chitin-Chitosan Biomaterials (CCB), Chulalongkorn University and National Metal and Materials Technology Center (MTEC). p. 107-109.

A self supramolecular structured chitosan is designed by grafting polyethyleneglycol onto chitosan via carbonyldiimidazole coupling agent. The amino group of chitosan is protected by benzaldehyde through all preparation steps. The compound obtained is characterized by FT-IR, TGA and XRD. The inclusion property is qualitatively and quantitatively analyzed by UV spectrophotometer, using potassium picrate salt as a model ion.

Keywords: Chitosan

867 Tidarat Vijithuttagune and Varawut Tangpasuthadol. 2003. **Utilization of chitosan to enhance calcium absorption and hydroxyapatite formation of tyrosine-derived polycarbonates, a new class of biodegradable polymers.** In The National Chitin-Chitosan Conference July 17-18, 2003 at Institute Building III. Chulalongkorn University. Organized by Center for Chitin-Chitosan Biomaterials (CCB), Chulalongkorn University and

National Metal and Materials Technology Center (MTEC). p. 110-112.

Chitosan was used to blend with a new class of synthetic and biodegradable polymers, tyrosine-derived polycarbonates (TPC). TPCs contain carboxyl side group (-COOH), which might be able to interact with the amino groups (-NH₂) on chitosan. Electrostatic interaction between the COOH on TPC and NH₂ on chitosan was investigated by FT-IR analysis. Nevertheless, such interaction in the physical blend of the two polymers could not be indentified. A coupling agent, 1-ethyl-3-(3-dimethylaminopropyl) carbodiimide (EDCI) was therefore used to link the two functional groups by forming amide bonds between the two polymers during mixing in aqueous solution. Prepatation of chitosan-coated TPC films in the presence of EDCI was also introduced. It was found that EDCI was necessary to produce blends and chitosan-coated films without the separation of both polymers. The blends and the coated films exhibited similar properties as the chitosan homopolymer, i.e. the ability to absorb Ca²⁺ and to induce hydroxyapatite formation when immersed in a simulated body fluid buffer at pH 7.4.

Keywords: Chitosan; Polymers; Absorption; Films; Calcium; Coating; Polycarbonates; Solution; Utilization

868 Winita Punyodom, Ponlayuth Sooksamiti, Supharphorn Kasiwas, Somchai Lapanantnoppakhun and Kate Grudpan. 2003. **Development of some types of chitosan membranes for on-line separation and dilution.** In The National Chitin-Chitosan Conference July 17-18, 2003 at Institue Building III. Chulalongkorn University. Organized by Center for Chitin-Chitosan Biomaterials (CCB), Chulalongkorn University and National Metal and Materials Technology Center (MTEC). p. 113-116.

In this work, chitin and chitosan were prepared from various natural materials, namely: shrimp, cicada sloughs and rice-field Thai crab shells. Their chemical structure were characterized by IR, ¹H-NMR, ¹³C-NMR spectroscopy, XRD and elemental analysis. Chitosan membranes with different thicknesses (0.02-0.04 mm) were prepared by a film-casting method and were employed as dialysis membranes for on-line separation and dilution. Membrane thickness, water absorption capacity, tensile properties, surface structural morphology and porosity (SEM) were characterized and compared with a commercial cellulose acetate membrane. A simple analytical metod for the determination of Na⁺ and K⁺ in

electrolyte beverages using flow injection dialysis coupled with flame emission spectrometry (FID-FES) was developed. This study showed that natural chitosan membranes could be used as dialysis membrane for his purpose. Many advantages could be gained from the FID-FES system such as the speed and less complicated nature of the procedure.

Keywords: Chitin; Chitosan; Chitosan dialysis membrane; Prawn shells; Shrimp shells; Cicada sloughs; Dilution; Flow injection

869 Raghunath B. Shivappa and Pornlerd Chanratchakool. 1997. **Efficacy of probiotics and disinfectant in controlling luminescent bacteria in shrimp post larvae under normal and stressed conditions.** In สัมมนาวิชาการ “เทคโนโลยีชีวภาพกุ้ง” วันที่ 13 ธันวาคม 2540 ณ ห้องประชุม 101 อาคารสวทช. กรุงเทพฯ จัดโดย ศูนย์พันธุวิศวกรรมและเทคโนโลยีชีวภาพแห่งชาติ สำนักงานพัฒนาวิทยาศาสตร์และเทคโนโลยีแห่งชาติ. p.74-82.

The excessive and often indiscriminate use of antibiotics in the aquaculture industry has become ineffective and self defeating, with growing evidence of the development of resistant pathogens. Probiotics, immunoenhancers and vaccines are evolving as new management strategies to control bacterial diseases. A study was carried out to determine the efficacy of probiotics and the disinfectant, benzalkonium chloride (BKC) in controlling luminescent bacteria (*Vibrio harveyi*). The study aimed at exploring the possibilities to replace or minimize the use of antibiotics by using probiotics and/or disinfectants in shrimp hatcheries. The efficacy of BKC and probiotics was tested on *Penaeus monodon* with six treatments under normal an two stressed conditions. Shrimps were challenged with *V. harveyi* at a concentration of 5x10⁷ cfu/ml, probiotic suspension and BKC were added at a concentration of 10 ppm and 1 ppm respectively to control the pathogen in all the experiments. Survival was monitored over a period of 72 hours. Under normal conditions it was found that survival was significantly higher (P<0.05) in the probiotic treatments. Under temperature stress, probiotic was effective in controlling *V. harveyi* (P<0.05), but no significant effect was found under salinity stress. BKC treatments had no significant effect under all conditions. Fluctuations in environmental conditions were found to have a significant effect on the virulence of *V. harveyi*, which was higher with salinity stress than temperature stress.

Keywords: Probiotics; Disinfectants; Luminescent bacteria; Shrimps; Postlarvae; Stress

870 Preeyanat Vongchan, Watchara Kasinrerker and Prachya Kongtawelert. 2003. **Sulfated chitosan**

inhibits immunoglobulin production of human peripheral blood mononuclear cells. In The National Chitin-Chitosan Conference July 17-18, 2003 at Institute Building III. Chulalongkorn University. Organized by Center for Chitin-Chitosan Biomaterials (CCB), Chulalongkorn University and National Metal and Materials Technology Center (MTEC). p. 117-120.

The 3 isolated fractions of chitosan polysulfate (CPS) with different average molecular weight (P1, P2 and P3) with high potency in anticoagulant activity was synthesized in our laboratory. Its involvement in immunoglobulin production using pokeweed mitogen (PWM) as the stimulant was elucidated. The test condition was performed using PBMCs (5×10^5 cells/well) in the presence or absence of PWM (2.5 µg/mL) and various concentrations (0-8 µg/mL) of CPS in comparison to pentosan polysulfate (PPS) and heparin. The results showed that CPS and PPS could significantly inhibit PWM stimulated immunoglobulin production of PBMCs ($P < 0.01$). the inhibition effect was in dose dependent manner. This effect was not significantly observed in case of heparin. The decreasing in proliferation was not due to the toxicity of products as the dye exclusion assay showed >90% cell viability as was observed in cell cultured in the presence of PWM alone. Our results suggested that CPS could inhibit PWM induced immunoglobulin production of human PBMCs. This might be affected from both specific sequence of sulfation patterns and size of polymer chains. In addition, this is the first report of immunologic effect of CPS on human PBMCs.

Keywords: Chitosan polysulfate; Molecular weight; Immunoglobulin; Pokeweed mitogen; Pentosan polysulfate; Heparin

871 เรวดี มีสัจย์, หทัยรัตน์ ริมศิริ และ ธงชัย สุวรรณสินธุ์. 2003. **Development of skin care lotion with carboxymethyl-chitin.** In The National Chitin-Chitosan Conference July 17-18, 2003 at Institute Building III. Chulalongkorn University. Organized by Center for Chitin-Chitosan Biomaterials (CCB), Chulalongkorn University and National Metal and Materials Technology Center (MTEC). p.126-130.

The suitable process to produce carboxymethyl-chitin for utilization in skin care lotion was developed. The optimum formulation of skin care lotion with carboxymethyl-chitin was 0.5% carboxymethyl-chitin, 2.5% stearic acid, 1.0% glyceryl nonostearate, 1.0% acetyl alcohol, 6.0% olive oil, 1.6% isopropyl palmitate, 0.9% polyoxyethylene (40) stearate, 0.08% carbomer

(934), 5.0% glycerin, 1.0% triethanolamine, 0.5% apple fragrance, 0.55 lactic acid and 79.42% water. The color of skin care lotion with carboxymethyl-chitin was white and slightly yellow with $L^* a^* b^*$ value of 93.32, -0.84 and 3.85 respectively. The skin care lotion with carboxymethyl-chitin had pH 6.5 and viscosity 18,500 cP. No separation between water phase and oil phase was observed. The skin care lotion with carboxymethyl-chitin was evaluated by consumers (home use test) who are all female aged between 20-40 years old. Ninety one percent of consumers accepted the product and 40% would buy this product if it was available in the market.

Keywords: Chitin; Carboxymethylchitin; Skin lotion

872 Thawatchai Phaecamud. 2003. **Orodispersible tablet preparing using chitin as the excipient.** In The National Chitin-Chitosan Conference July 17-18, 2003 at Institute Building III. Chulalongkorn University. Organized by Center for Chitin-Chitosan Biomaterials (CCB), Chulalongkorn University and National Metal and Materials Technology Center (MTEC). p.131-134.

The orodispersible tablets or the rapidly disintegrating tablets have attracted a great deal of attention for the elderly patients who have difficulties swallowing tablet. In this study, the tablets were prepared by direct compression with the compression force of 1.5 tons and using the different materials as the tablet component. The physical properties of tablets containing chitin were compared with those of tablets containing chitosan, xylitol, microcrystalline celluloses, while bentonite and magnabite F. The xylitol tablets were rapidly dissolved and disintegrated within 7 ± 1 seconds, whereas, those of the others were longer than 30 minutes. However, the hardness of the xylitol tablet was very poor. Therefore, the tablets containing the mixture of xylitol and other materials were subsequently fabricated. An incorporation of the other excipients could enhance the hardness of the xylitol tablet. The wetting time of tablets containing chitin and xylitol at the ratio of 3:7 was shorter than that at the ratio of 2:8 and 1:9, respectively. Owing to the gel formation at higher concentration of the other disintegrant, ac-di-sol, it could not promote the disintegrating property of the tablets containing chitin and xylitol. The fast disintegration in the mouth of the prepared tablets indicated the possibility of chitin as the excipient for fabrication if the pharmaceutical orodispersible tablet.

Keywords: Chitin; Chitosan; Xylitol

873 Thawatchai Phaechamud Tamotsu Koizumi and Garnpimol C. Ritthidej. 2003. **New method to determine the dissolution time of chitosan film coated tablets under the influence of storage**

condition. In The National Chitin-Chitosan Conference July 17-18, 2003 at Institute Building III. Chulalongkorn University. Organized by Center for Chitin-Chitosan Biomaterials (CCB), Chulalongkorn University and National Metal and Materials Technology Center (MTEC). p.135-139.

Chitosan L, M and H (MW of 994,453.12, 1,046,197.21 and 1,449,978.86 and % deacetylation of 97.2, 76.4 and 79.6, respectively) were used as the tablet film former. Chitosan was dissolved in 1% acetic acid solution in amount to provide the viscosity of 125 mPas. The plasticizers were propylene glycol, PEG400 and triacetin in concentrations of 0, 10, 20 and 30%w/w of polymer. Propranolol hydrochloride was used as a model drug. The mean dissolution time of the coated tablets subtracted with that of the core tablet, ($MDT_{\text{coated-core}}$), would represent the film dissolution time. The chitosan film was changed to be insoluble after storage or exposure to the accelerated condition. After storage for 2 years, this effect was more prominent in chitosan M than chitosan L and H. This could correspondingly more retard the drug release from the coated tablets. Propylene glycol could promote good film formation. Therefore, the coated tablets containing this plasticizer after storage for 2 years had more MDT value than that of tablets coated with the film containing PEG400.

Keywords: Chitosan; Solution; Coating; Plasticizer; Storage; Films; Mean dissolution time

874 in Thai

875 Ittipol Jangchud, Pornravee Sumitra and Anuvat Jangchud. 2003. **Study of edible films from blends of chitosan and ester-modified starch.** In The National Chitin-Chitosan Conference July 17-18, 2003 at Institute Building III. Chulalongkorn University. Organized by Center for Chitin-Chitosan Biomaterials (CCB), Chulalongkorn University and National Metal and Materials Technology Center (MTEC). p. 143-145.

This research work was focused on preparation and property characterization of edible film made from chitosan (CHI) and ester-modified starch (ES). The film can be prepared by solution casting technique. Glycerol (0-15 %wt) was also used as a plasticizer. Several factors affecting film properties were studied including CHI/ES ration, % plasticizer loading, and degree of ester-substitution (DS) of the starch. It was found that the film at 50:50 (CHI/ES) blend ratio possessed optimum mechanical properties, i.e. tensile strength and modulus. As the ES ratio increased, % elongation at break, work done, and tear strength were

decreased; however, the water solubility was increased. The blend films also had lower vapor and oxygen permeabilities compared to those of the pure CHI film. It was shown that the film made from 0.020 DS starch had superior properties compared to that made from 0.060 DS. The film with 5% plasticizer had optimum overall properties.

Keywords: Chitosan; Films; Plasticizer; Polymers

876-878 in Thai

879 ปัทมา วิศาลนิตย์, ทศพร ทองเที่ยง, ปิยทัศน์ ทองไตรภพ และ ณรงค์ชัย พิพัฒน์ธนาวงศ์. 2003. **Effect of chitosan on quality of strawberry after harvest.** In The National Chitin-Chitosan Conference July 17-18, 2003 at Institute Building III. Chulalongkorn University. Organized by Center for Chitin-Chitosan Biomaterials (CCB), Chulalongkorn University and National Metal and Materials Technology Center (MTEC). p. 155-157.

The aim of this study was to investigate the effect of chitosan on the quality and fruit rot disease of strawberries in Nahaew, Lei area in 2003. The Prarajathan # 50 cultivar (maturity 75%) were used and dipped in chitosan at 60, 80 and 100 ppm for 2 minutes. After 5 days in the room temperature, found that, the berries coating with 100 ppm chitosan have high score of acceptable to consumer and have trended to fewer members of apparent disease and less disease virulent than another concentrations.

Keywords: Chitosan; Strawberry; Coating

880 สุวลี จันทรกระจำง, เพ็ญใจ สมพงษ์ชัยกุล, สมชาย ต่วนต่าย. 2003. **Effect of chitosan applying in multiculture crop plantation.** In The National Chitin-Chitosan Conference July 17-18, 2003 at Institute Building III. Chulalongkorn University. Organized by Center for Chitin-Chitosan Biomaterials (CCB), Chulalongkorn University and National Metal and Materials Technology Center (MTEC). p. 158-160.

The multiculture crop plantation of chilli, chinese cabbage, celery and bitter cucumber were set up in the same area. The planting area was divided into 5 sections for study the treatment of chitosan in 5 different doses ranging from 0, 3.75, 7.5, 11.25 and 15.0 ppm respectively. Any type of treatment during plantation was all the same except the spraying of chitosan in different doses on the plants during the period of culture. The measuring growth rate of chilli plants and the weight of chinese cabbage were recorded during the crop. It was found that the growth rate of chilli and the harvesting yield of the

chinese cabbage were significantly different among the dosed chitosan treatments.

Keywords: Chitosan; Chilli; Chinese cabbage; Celery; Cucumber

881 Sukeep Chaimanee, Suchon Tangtaweewipat and Boonlom Cheva-Isarakul. 2003. **The preliminary study of chitosan extraction and the supplement in broiler diets.** In The National Chitin-Chitosan Conference July 17-18, 2003 at Institue Building III. Chulalongkorn University. Organized by Center for Chitin-Chitosan Biomaterials (CCB), Chulalongkorn University and National Metal and Materials Technology Center (MTEC). p.161-164.

Chitin and chitosan from shrimp and crab shell in Chiang Mai were extracted with chemical process. The yields of these materials from shrimp shell were 43.3, 20.7% and crab shell 33.3, 16.0%, respectively. Chitosan from shrimp shell and crab contained 2.2 and 0.7% moisture. The other nutrients (on dry matter basis) were 6.8 and 4.9% protein, 0.05 and 0.14% lipid, 67.1 and 62.3% crude fiber and 1.2 and 20.5% ash, respectively. Broilers fed diet supplemented with commercial chitosan at 0.6% of the diet during 7-49 days of age had similar production performance and carcass quality to the control group. However, abdominal fat (1.26 vs 1.80% BW) and serum cholesterol decreased significantly (102.9 vs 130.5 mg/dl) when compared to the control.

Keywords: Chitin; Chitosan; Shrimp shells; Cholesterol; Abdominal fat; Broiler

882 วิมลรัตน์ ศรีจรัสสิน, จุฬารัตน์ เอี่ยมสมัย, พัชรินทร์ ขาดิกุล และ ภัทธราภรณ์ สิงห์สถิตย์. 2003. **Study on curcumin extraction from wastewater of essence factory by chitosan.** In The National Chitin-Chitosan Conference July 17-18, 2003 at Institue Building III. Chulalongkorn University. Organized by Center for Chitin-Chitosan Biomaterials (CCB), Chulalongkorn University and National Metal and Materials Technology Center (MTEC). p.165-167.

In essence factory, discharged water from the stream extraction process of turmeric gives the yellow substance that called curcumin. In this research, chitosan was used for curcumin adsorption to decrease water pollution from the factory. Effects of various parameters on the adsorption of curcumin on chitosan powder were investigated. It was found that the adsorption of curcumin was highly effective in acidic solutions at pH 3-4. The amounts of adsorbed dye increased with increasing adsorption time, amount of

chitosan and adsorption temperature. In addition, dyeing nylon and silk fabrics with curcumin-adsorbed chitosan was investigated. Colour fastness to washing and rubbing were examined. Antimicrobial activity against *Staphylococcus aureus* and *Escherichia coli* was assessed based on ATCC 147. The fabrics dyeing with curcumin-adsorbed chitosan increase the wash fastness. Abrasion resistance and antimicrobial ability were found effectively with both fabrics tested with curcumin alone and chitosan-adsorbed curcumin.

Keywords: Chitosan; Absorption; Tumeric

883 นัยนันท์ อริยกานนท์, กัญญาภรณ์ คมคาย และ วัจนา ประจมุข. 2003. **Comparison of the efficiency of aluminum sulphate, iron (III) chloride and chitosan in color removal of textile wastewater.** In The National Chitin-Chitosan Conference July 17-18, 2003 at Institue Building III. Chulalongkorn University. Organized by Center for Chitin-Chitosan Biomaterials (CCB), Chulalongkorn University and National Metal and Materials Technology Center (MTEC). p. 168-170.

This study investigated the ability of aluminumsulphate, iron (III) chloride and chitosan in color removal of textile wastewater by using Jar test technique. The result showed that the efficiency of aluminumsulphate, iron(III)chloride and chitosan for dye removal were 74.5%, 73.2% and 64.8 at optimum concentration 129.6 mg/l, 129.6 mg/l and 2,500 mg/l, respectively. In addition, it indicated that aluminumsulphate was more suitable for the reduction of disperse color than reactive color but iron (III) chloride and chitosan were more suitable for the reduction of reactive color than disperse color.

Keywords: Chitosan; Color; Absorption; Textile wastewater; Aluminumsulphate

884 สายรุ้ง เทพกรณ์, โยทะกา แก่นการณ์ และ จันทร์จรัส เสริมสาธณสวัสดิ์. 2003. **Chitosan used as a flocculation agent in wastewater of citric acid industry.** In The National Chitin-Chitosan Conference July 17-18, 2003 at Institue Building III. Chulalongkorn University. Organized by Center for Chitin-Chitosan Biomaterials (CCB), Chulalongkorn University and National Metal and Materials Technology Center (MTEC). p. 171-174.

The effect of chitosan on flocculation of wastewater from citric acid industry has been investigated. This study has focused on the effect of concentration, degree of deacetylation (%DD) of chitosan and pH of wastewater on the reduction of Chemical Oxygen Demand (COD) and suspended solid of wastewater. The results show that chitosan with degree of deacetylation of 70% and 90% can

improve the quality of wastewater at pH 5, 7 and 9 by reducing COD and suspended solid of wastewater. To compare the effect of degree of deacetylation, 90% DD is more effective than 70% DD.

Keywords: Chitosan; Prawn shells; Shrimp shells; Wastewater; Citric acid

885 Neerawan Khamnamtong, Sirawut Klinbunga, Anchalee Tassanakajon, Narongsak Puanglarp, and Piamsak Menasveta. 2002. **Isolation and characterization of sex-specific markers of black tiger shrimp (*Penaeus monodon*)**. In 28th Congress on Science and Technology of Thailand 24-26 October 2002, Queen Sirikit National Convention Center. p.434

Monosex culture is one of the potential techniques commonly used to increase the culture production of aquatic organisms when male and females exhibit different growth rates. In *Penaeus monodon*, females exhibit greater growth rate than do males at all stages of development. This promotes the possibility to increase culture efficiency of *P. monodon* through monosex farming. Accordingly, sex identification markers in *P. monodon* need to be developed. Bulked segregant analysis (BSA) and RAPD-PCR were used to isolate those markers. Bulked genomic DNA ($N = 10$). From broodstock sized males and females *P. monodon* were screened using 100 primers. Thirty primers yielded at least one RAPD band that disappeared in the opposite sex. Increasing the number of bulks ($N = 3 > 5$ and 10 for each sex) revealed that most of those RAPD bands fragments amplified from polymorphic loci among different individuals having the same sex. Seven fragments still exhibited sex-specific nature. In addition, three fragments showed different intensity between sexes. These RAPD markers are being cloned and characterised.

Keywords: Bulked Segregant Analysis; BSA; RAPD-PCR; Sex-specific markers; Shrimps; Black tiger shrimp; *Penaeus monodon*

886 Panuta Bunnag. 2000. **Computer assisted instruction for the identification of commercial shrimp species in Thailand**. Master Thesis. Mahidol University. 147 p.

There are aquaculture courses for students who are studying for a Certificate or a Bachelor degree in Fisheries. Shrimp identification is complex, difficult and rarely exact in this field. Computer Assisted Instruction for the identification of commercial shrimp species of Thailand is taught by both personnel and Computer Assisted Instruction

with multimedia. The latter utilized to motive and improved effective learning.

In this study the aim was to find models of shrimp identification by a computer assisted instruction program. Sampling groups were students of Chumphon Wittaya Ketara Udom Sak Fishing College, Chumphon Province. Certificate Students were divided into 2 groups, i.e., 35 experimental students used computer assisted instruction and 35 students were taught by a teacher. The technique of multiple choice test used to compare between the experimental and control group.

Results of the study found no difference between study by computer assisted instruction and study with a teacher at a level of significance of 0.05 (Z test = 0.4226). Computer Assisted Instruction is considered as effective as study with a teacher, and can be used with students in the college.

Keywords: Identification; Computer-assisted instruction; Shrimps; Commerce

887 Sirawut Klinbunga. 1999. **A rapid method for isolation of clonable quality mitochondrial DNA from the giant tiger shrimp (*Penaeus monodon*)**. In The 1st National Symposium on marine shrimps, 15-17 December 1999, B.P. Smila Hotel, Songkhla. National Center for Genetic Engineering and Biotechnology. p. 320 - 328.

Animal mitochondrial (mt) DNA is an ideal molecule for phylogenetic and systematic studies because it exhibits a rapid evolutionary rate without rearrangement within the genome. Nevertheless, isolation and purification of animal mtDNA requires ultracentrifugation which is time consuming and not cost-effective when dealing with a large number of specimens. Moreover, large amount of tissue is also required for that process. A rapid method based on differential centrifugation, preferential lysis of mitochondrial membrane and pheno-chloroform extraction was the developed to isolate the entire mtDNA from *Penaeus monodon*. mtDNA isolated from hepatopancreas and ovaries is heavily contaminated with genomic DNA. In contrast, mtDNA purified from pleopods of *P. monodon* is digestible by various restriction enzymes and is of clonable quality. It is also pure enough to be directly used to generate the labelled DNA probe for population genetic studies in this species.

Keyword: mtDNA; Isolation; Population genetics; Hybridization

888 Sirawut Klinbunga, Wanalux Wudthijinda, Anchalee Tassanakajon and Padermsak Jarayabhand. 1999. **Anomalous population structure patterns of the giant tiger shrimp (*Penaeus monodon*) in the east of peninsular Thailand: a possible**

consequence of farming activity and transplantation. In The 1st National Symposium on marine shrimps, 15-17 December 1999, B.P. Smila Hotel, Songkhla. National Center for Genetic Engineering and Biotechnology. p. 208 - 219.

Analysis of intraspecific population structure of the giant tiger shrimp (*Penaeus monodon*) collected from 5 geographic locales; Phangnga, Satun, and Trang from the west and Chumphon and Trat from the east of Peninsular Thailand. Using randomly amplified polymorphic DNA-polymerase chain reaction (RAPD-PCR) indicated that genetic population differentiation does exist in this species ($P < 0.0001$). Large genetic differences were observed between each of the Andaman Sea and Trat populations confirming genetic subdivision of *P. monodon* in Thailand.

A total of 88 genotypes from 3 polymorphic RAPD primers (UBC268, UBC273 and UBC299) were observed. The distribution pattern of RAPD genotypes of *P. monodon* from Chumphon was similar to that of Phangnga, Satun and Trang but difference from that of Trat. Within each region, the Andaman *P. monodon* is genetically homogeneous but significant geographic heterogeneity was found between Chumphon and Trat ($P < 0.0001$). Between region comparisons surprisingly revealed homogeneity between *P. monodon* from Chumphon and that of Phangnga, Satun and Trang while Trat is reproductively isolated from the remaining populations. This circumstance is unlikely to occur naturally and open the possibility that anomalous gene pool found in Chumphon may have been resulted from transplantation and farming activity of *P. monodon* in that area.

Keywords: Genetic diversity; Population differentiation; Gene pools; *Penaeus monodon*

889 Phuwadol Bangrak, Potchanapon Graidist, Siriporn Rattanahirunkul, Wilaiwan Chotigeat and Amornrat Phongdara. 2002. **Cloning and Expression of TCTP isolated from *Penaeus monodon* in *Escherichia coli*.** In Proceedings, The 4th National Symposium on Marine Shrimp, 18-19 November 2002, Rayong Resort, Rayong. National Center for Genetic Engineering and Biotechnology. p. 54-61.

We have cloned homologues of the mammalian translationally controlled tumor protein (TCTP) from the WSSV infected hemolymph of *Penaeus monodon*. TCTP genes from *P. monodon* was expressed in a T7 promoter vector as histidine tagged fusion proteins. The recombinant TCTP has a molecular mass of approximately 25 kDa with

the histidine tag. Sequence analyses showed that the putative protein has high similarity to *Drosophila* and *Anopheles* TCTP. Moreover, it is also similar to Fortilin, a novel nuclear antiapoptotic protein.

Keywords: *Penaeus monodon*, Fortilin, Antiapoptotic protein

890 Siriporn Pongsomboon, Anchalee Tassanakajon, Padermsak Jarayabhand, Sirawut Klinbunga and Vichai Boonsaeng. 1997. **Detection of genetic variation in populations of black tiger prawn *Penaeus monodon* by DNA fingerprint.** In Shrimp Biotechnology Meeting. National Center for Genetic Engineering and Biotechnology. p. 35-43.

Keywords: Genetic variation; Black tiger prawn; *Penaeus monodon*; DNA fingerprint; Andaman Sea; Satun; Trang; Medan; Gulf of Thailand; Chonburi; Primers; DNA Marker

891 Padermsak Jarayabhand, S. Uraiwan, Sirawut Klinbunga, Anchalee Tassanakajon, P. Srimukda, P. Pattanachan, R. Panakulchaiwit and Piamsak Menasveta. 1998. **Estimated heritabilities for early growth rate of the black tiger prawn, *Penaeus monodon*, Fabricius.** In : Felgel, T. (ed.), Proceedings to the Special Session on Advances in Shrimp Biotechnology, the Fifth Asian Fisheries Forum: International Conference on Fisheries and Food Security Beyond the Year 2000, 11-14 November 1998, Chiangmai. p. 67-70.

Heritabilities for growth of the black tiger prawn, *Penaeus monodon*, were estimated at the ages of 25 (PL₁₅) and 65 (PL₅₅) days by a full-sibs mating design. An artificial insemination technique (male:female=1:1) was used to create twenty-one full-sib families in three batches (i.e., batch no. 1 included 9 full-sibs, batch no. 2 included 5 full-sibs, and batch no. 3 included 7 full-sibs) over a one month period. Growth rates measured as total length at 25 days were significantly affected by batch, rearing conditions and full-sibs family. Effects from batch numbers and replicates were not significant with respect to growth rate at the age of 65 days, but the effect from full-sibs families was. At the age of 25 days, heritability for growth rate measured as total length was 0.153 ± 0.060 , whereas the heritabilities at the age of 65 days were 0.073 ± 0.037 for total length and 0.053 ± 0.029 for wet weight. Decline in the estimated heritabilities from 25 day to 65 days were partly due to a confounding of common environmental factors in full-sibs variance at the early stage of life which decreased as the animals got older. In any case, this experiment demonstrated a significant genetic component controlling growth rate in the species. Advantages and disadvantages of the method used in this experiment for heritability estimation are

discussed. It was concluded that further investigations with a better experiment design based on a full-sibs mating design were required to obtain better heritability estimates for growth rates of natural stocks of *P. monodon* meant that either total length or wet weight could be used to represent growth rate for a selective breeding program.

Keywords: Genetics; Black tiger prawn; *Penaeus monodon*; Growth; Heritability; Full-Sibs Mating Design

892 Sirawut Klinbunga, D. Siludjai, W. Wudthijinda, Anchalee Tassanakajon, Padermsak Jarayabhand and Piamsak Menasveta. 2001. **Genetic heterogeneity of the giant tiger shrimp (*Penaeus monodon*) in Thailand revealed by RAPD and mtDNA-RFLP analyses.** Mar. Biotechnol. 3:428-438.

Genetic diversity of the giant tiger shrimp (*Penaeus monodon*) collected from 5 areas, Chumphon and Trat (Gulf of Thailand), and Phangnga, Satun, and Trang (Andaman Sea), was examined by randomly amplified polymorphic DNA (RAPD) and mitochondrial DNA (16s ribosomal DNA and an intergenic COI-COII) polymorphism. A total of 53 polymorphic fragments from UBC299, UBC273, and UBC268 was consistently scored across all samples. From the respective primers 26, 32, and 30 genotypes were generated. A 260-bp RAPD fragment generated by the primer UBC268 was specifically observed in 95.8% of Trat *P. monodon*, suggesting that this RAPD could be used as a marker for comparing phenotypic performance of *P. monodon* from Trat and other geographic samples. In addition, 37 mtDNA composite haplotypes were observed from restriction analysis of the same *P. monodon* samples. High haplotype diversity (0.855) and nucleotide diversity (3.328%) of Thai *P. monodon* were observed. Population differentiation of *P. monodon* between the Andaman Sea and Gulf of Thailand was clearly illustrated by both techniques ($P < .0001$). Nevertheless, contradictory results on patterns of differentiation were observed between *P. monodon* within the Gulf of Thailand. Analysis of nuclear DNA polymorphism (RAPD) indicated a genetically significant difference between Chumphon and Trat ($P < .0001$), whereas mtDNA polymorphic did not show differentiation between these sample ($P = .0497$). Under the presumption of selective neutrality to these markers, biased female gene flow between Trat and Chumphon *P. monodon* may exist and be responsible for an anomalous differentiation pattern between these geographic samples.

Keywords: Population structure; *Penaeus monodon*; DNA marker; RAPD; mtDNA-RFLP; Stock enhancement; Giant tiger shrimp; Chumphon; Trat; Phangnga; Satun; Trang

893 Anchalee Tassanakajon, Siriporn Pongsomboon, Padermsak Jarayabhand, Sirawut Klinbunga and Vichai Boonsaeng. 1998. **Genetic structure in wild populations of the black tiger shrimp (*Penaeus monodon*) using randomly amplified polymorphic DNA analysis.** J. Mar. Biotechnol. 6(4):249-254.

Randomly amplified polymorphic DNA (RAPD) analysis was used to examine genetic variation in wild black tiger shrimp, *Penaeus monodon*. Specimens were collected from five geographically separated locations (Satun-Trang, Phangnga, and Medan in the Andaman Sea and Chumphon and Trad in the Gulf of Thailand). A total of 100 *P. monodon* individuals were investigated using seven arbitrarily selected primers. Fifty-eight (72.5%) of eighty reproducible RAPD fragments ranging in size from 200 to 2200 bp were polymorphic. The percentages of polymorphic bands of the five geographic populations investigated varied from 51.5 to 57.7%. The genetic distance between populations and UPGMA dendrograms indicated that the Medan population was genetically different from Thai *P. monodon* ($D_{ij} = 14.976\%$). Within Thailand, the Satun-Trang *P. monodon* was separated from the remaining geographic populations with a genetic distance of 2.632%. RAPD analysis in the present study yielded a total of 252 genotypes. A Monte Carlo analysis illustrated geographic heterogeneity in genotype frequencies within this species, suggesting that genetic population structure does exist in this taxon ($P < 0.001$ for all primers). Significant differences in genotype frequencies between Thai and Indonesian (Medan) *P. monodon* were observed ($P < 0.0001$). Within Thailand, the Andaman Sea *P. monodon* was significantly different from that of the Gulf of Thailand (P values between 0.0000 and 0.0387), indicating population differentiation between *P. monodon* from these two main fishery regions of Thailand.

Keywords: Genetic structure; Wild population; Black tiger shrimp; *Penaeus monodon*; Randomly Amplified Polymorphic

894 Anchalee Tassanakajon, Amornrat Tiptawonnukul, Premruethai Supungul, Vichien Rimphanitchayakit, Doug Cook, Padermsak Jarayabhand, Sirawut Klinbunga and Vichai Boonsaeng. 1998. **Isolation and characterization of microsatellite markers in the black tiger prawn, *Penaeus monodon*.** Mol. Mar. Biol. Biotechnol. 7(1): 55-61.

Isolation and characterization of microsatellite sequences from the genome of the black tiger prawn *Penaeus monodon* are described. Ninety-seven (GT)_n and 16 (CT)_n microsatellites were isolated from partial genomic libraries composed of 18,000 and 5250 clones, respectively. The genomic library screening indicated that (GT)_n microsatellites are more abundant than (CT)_n in *P. monodon* genome. The microsatellite sequences were classified into three categories, perfect, imperfect, and compound. The predominant categories found in *P. monodon* microsatellites are imperfect repeats for both (GT)_n and (CT)_n. Very long repeat arrays were found in *P. monodon* microsatellite clones, which resulted in difficulties in primer design. Two microsatellite loci, CUPmo 18 and CUPmo 386, were successfully amplified. The number of alleles of each locus was preliminarily determined. For the CUPmo 18 locus, Mendelian inheritance was tested by analysis of genotypic ratios in F1 offspring and their parents. The results of this study demonstrate the presence of highly polymorphic microsatellite markers in *P. monodon*. These markers will be useful in population studies and parental determination in *P. monodon*. However, the low abundance and difficulties in obtaining a large number of usable microsatellite loci indicated that these markers may not be appropriate for use in genome mapping of this species.

Keywords: Isolation; Black tiger prawn; Characterization; Microsatellite markers; *Penaeus monodon*

895 Premruethai Supungul, Pitak Sootanan, Sirawut Klinbunga, Wongpathom Kamonrat, Padermsak Jarayabhand and Anchalee Tassanakajon. 2000. **Microsatellite polymorphism and the population structure of the black tiger shrimp (*Penaeus monodon*) in Thailand.** Mar. Biotechnol. 2: 339-347.

Genetic variation and differentiation of Thai *Penaeus monodon* from five geographic locations (Chumphon, Trad, Phangnga, Satun, and Trang) were investigated using five microsatellite loci (CUPmo18, Di25, Di27, CSCUPmo1, and CSCUPmo2). The number of alleles across the five loci ranged from 19 to 30, and heterozygosities ranged from 0.49 to 0.95. The mean number of alleles and effective number of alleles per locus were 21.0 to 26.6 and 13.1 to 20.4, respectively. The average heterozygosity across all investigated samples was 0.78, indicating high genetic diversity in this species. Geographic heterogeneity analysis of the results from two of the loci, CUPmo18 and Di25, showed significant differences among the Gulf of Thailand (Trad and Chumphon) but not the

Andaman samples. Comparison between regions revealed significant heterogeneity of the Andaman and Trad *P. monodon* ($P < .001$), whereas those from Chumphon and the Andaman were genetically similar ($P < .05$). Significant genetic differentiation was consistently observed between the Andaman-Trad samples ($F_{st}=0.0101$, $P < .0001$) and the Chumphon-Trad samples ($F_{st}=0.0101$, $P < .0001$). On the basis of our analyses, the investigated samples from five geographic locations were allocated to three distinct populations composed of the Andaman Sea (A), Chumphon (B), and Trad (C).

Keywords: Microsatellite markers; Genetic variation; Black tiger shrimp; *Penaeus monodon*; Chumphon; Trad; Phangnga; Satun; Trang

896 Anchalee Tassanakajon, Premruethai Supungul, Padermsak Jarayabhand, Sirawut Klinbunga and Vichai Boonsaeng. 1997. **The application of microsatellite markers in the shrimp breeding program.** In Shrimp Biotechnology Meeting. National Center for Genetic Engineering and Biotechnology. p. 28-34.

Microsatellites are genomic sequences that consists of a mono-, di-, tri- or tetra-nucleotide motif repeated in multiple tandem copies. They are highly abundant and are dispersed throughout eukaryotic genomes. The repeat number of microsatellite has been demonstrated to be highly variable, providing an attractive source of genetic polymorphisms.

Microsatellite markers have great potential uses in aquaculture and fisheries biology. They exhibit several advantages over other genetic markers. Many microsatellites exhibit extremely high levels of allelic variation which make them especially attractive for species that show low level of variation with conventional markers such as allozymes, or mt DNA variations. Microsatellites are assayed using PCR, only minute amounts of tissue are required for analysis, permitting the non-destructive sampling of individuals.

In this study, microsatellite sequences in the black tiger prawn, *Penaeus monodon*, were isolated and characterized. Primers were designed for PCR amplification of the microsatellite loci. The genotyping based on microsatellite variations was performed to demonstrate the use of genetic markers to manage breeding programs of cultured species. A preliminary parental analysis using two of these microsatellite loci on families of the shrimp stocks showed Mendelian inheritance suggesting the potential utility of these markers to assist the shrimp selective breeding program.

Keywords: Microsatellite markers; Shrimps; Breeding; Genomes; Genetic polymorphism; Black tiger prawn; *Penaeus monodon*

897-899 in Thai

900 Thitima Naunboon. 2000. **Identification and characterization of population-specific marker of *Penaeus monodon* in Thailand.** Master Thesis. Chulalongkorn University. 102 p.

Randomly amplified polymorphic DNA (RAPD) analysis was used to identify a specific marker which could distinguish between the wild populations of *Penaeus monodon* from the Andaman Sea and the Gulf of Thailand. The eleven selected RAPD primers were screened. Two primers, OPB 08 and OPB15, showed a DNA band with size about 850 bp and 1,000 bp, respectively, which consistently appeared only in the sample from the Gulf of Thailand. By increasing the number of samples in each group using primer OPB 08 and OPB 15, these bands also appeared in the samples from the Andaman Sea. Therefore, the primer 428 which has been previously reported to provide a 950 bp specific to the population of the Andaman Sea was used in this study. The primer 428 appeared to identify a more variable region among the samples of Thai *P. monodon* from the Andaman Sea so a band with size about 950 bp which present in all of Satun, Trang, but absent in samples from Trad was used as a population-specific marker.

The 950 bp fragment was cloned and transformed into *E. coli*: XL1-Blue. Three different types of recombinant clones, A, B and C were obtained with the insert fragment size of 900, 950 bp which upon digestion with *Bam* HI providing two bands with size about 650 and 350 bp, respectively. To ensure that the insert fragment of the 3 clones were from the 950 bp RAPD marker, Southern blot hybridization was performed using the three insert fragments (900 bp, 650 bp and 350 bp) as DNA probes. A single specific band was appeared only in the samples from the Andaman Sea when using the 650 and 350 bp fragments while a positive band was found in all sample when using the 900 bp fragment. The insert fragment of the 3 clones were sequenced by using the ABI-PRISM automated sequencer and then aligned to other genes in the GenBank using BLAST program. Comparison of the 900 bp sequence showed similarity with the sequence of asparagine synthetase while the 650 and the 350 bp insert fragment were not significantly similar to any sequence in the GenBank. The specific primers were designed from the nucleotide sequences of the 350 bp fragment but could not distinguish the population of *P. monodon* from the Andaman Sea and the Gulf of Thailand.

Therefore, a method which can be to distinguish the two populations was to amplified the genomic DNA using primer 428, followed by

Southern blot hybridization with the 650 or 350 bp fragments. This method yielded a single band of 950 bp specific to the population of the Andaman Sea.

Keywords: *Penaeus monodon*; RAPD; Population-specific marker; Identification; Characterization; Satun; Trang; Andaman Sea; Gulf of Thailand

901 Siriporn Pongsomboon. 1996. **Detection of genetic variation in populations of black tiger prawn *Penaeus monodon* by DNA fingerprinting.** Master Thesis, Chulalongkorn University. 128 p.

Randomly amplified polymorphic DNA analysis (RAPD) was used to examine genetic variation of four geographically separated wild populations of *Penaeus monodon* from two regions: the Andaman Sea and the Gulf of Thailand. Samples from the Andaman Sea were collected from Satun-Trang and Medan (Indonesia) and samples from the Gulf of Thailand were collected from Chonburi (Angsila district) and Trad.

A total of 75 individuals were tested, which included 17, 28, 15 and 15 from Satun-Trang, Trad, Angsila and Medan respectively. A screen of 300 random decaoligonucleotide primers identified 7 primers, which were selected for the analysis of black tiger prawn DNA. A total of 80 reproducible RAPD fragments ranging in size from 200-2000 bp were scored and 62 fragments (77.5%) were polymorphic. The percentages of polymorphic bands were 57.7, 52.2, 45.6 and 53.4% for samples from Satun-Trang, Trad, Angsila and Medan respectively. The index of similarity within and between populations and genetic distances were performed based on the RAPD data. The values of genetic distance were used to construct dendrograms using arithmetic mean (UPGMA). The results of similarity index within population illustrated that the Angsila sample was the most similar among themselves. The results of similarity index between populations and UPGMA dendrograms showed that the Medan sample was significantly different from the 3 sample of Thai *P. monodon*. The results show that primer 428 detected a RAPD marker that was found only in samples from the Andaman Sea; Satun-Trang and Medan suggesting the use of this marker as a region-specific marker.

RAPD patterns among the 4 sample gave 214 genotypes. One hundred and sixty of these were population-specific genotypes and 10 were region-specific genotypes. Ninety-seven of these genotypes were represented by a single individual. In chi-square analysis of the genotypes show that Thai and Indonesian *P. monodon* were significant different for all primers ($P < 0.0001$) and Thai *P. monodon* from the Andaman Sea and the Gulf of Thailand were also different for primers 101, 268, 428, 457 and 459

($P=0.0049$, <0.0001 , <0.0001 , 0.0014 and 0.0156 respectively).

Keywords: Black tiger prawn; *Penaeus monodon*; RAPD; Genetic variation; DNA fingerprint; Andaman Sea; Gulf of Thailand; Satun; Trang; Medan; Chonburi; Trat

902 Anchalee Tassanakajon, Siraporn Pongsomboon, Vichien Rimphanichayakit, Padermsak Jarayabhand, and Vichai Boonsaeng. 1997. **Random amplified polymorphic DNA (RAPD) markers for determination of genetic variation in wild populations of the black tiger prawn (*Penaeus monodon*) in Thailand.** Molecular Marine Biology and Biotechnology 6(2): 110-115.

Random amplified polymorphic DNA (RAPD) analysis was used to amplify the genome of black tiger prawns (*Penaeus monodon*) to detect DNA markers and assess the utility of the RAPD method for investigating genetic variation in wild *P. monodon* in Thailand. A total of 200 ten-base primers were screened, and 84 primers yielded amplification products. Six positive primers that gave highly reproducible RAPD patterns were selected for the analysis of three geographically different samples of Thai *P. monodon*. A total of 70 reproducible RAPD fragments ranging in size from 200 to 2000 bp were scored, and 40 fragments (57%) were polymorphic. The RAPD analysis of broodstocks from three different locales, Satun-Trang, Trat, and Angsila, revealed different levels of genetic variability among the samples. The percentages of polymorphic bands were 48% and 45% in Satun-Trang and Trat, respectively, suggesting a high genetic variability of the two samples to be used in selective breeding programs. Only 25% polymorphic bands were found in the Angsila sample, indicating the lowest polymorphic level among the three samples examined. Primer 428 detected a RAPD marker that was found only in *P. monodon* originating from Satun-Trang, suggesting the potential use of this marker as a population specific marker in this species.

Keywords: Randomly Amplified Polymorphic; DNA; RAPD; DNA marker; Genetic variation; Genomes; Wild population; Primers; Black tiger prawn; *Penaeus monodon*

903 Sirawut Klinbunga, D.J. Penman, B.J. McAndrew, Padermsak Jarayabhand and Piamsak Menasveta. 1997. **Mitochondrial DNA diversity in giant tiger shrimp, *Penaeus monodon* and its application for selective breeding programmes.** In Shrimp Biotechnology Meeting. National Center

for Genetic Engineering and Biotechnology. p. 16-27.

Mitochondrial DNA restriction fragment length polymorphism (mtDNA-RFLP) was utilised for determination of genetic variation and population structure in *P. monodon* collected from Satun, Surat and Trat. Twenty-eight composite haplotypes were generated from fifty-two restriction profiles resulted from eleven restriction endonucleases used in the experiment. The genome size of entire *P. monodon* mitochondrial genome was estimated to be 15.913 ± 0.177 kb. The average haplotype diversity in *P. monodon* was 0.8641 ± 0.00007 whereas the average nucleotide diversity within populations was 2.5102%, 2.2168% and 1.9097% for the Satun, Trat and Surat populations, respectively. Based on the highest level of its genetic diversity, the Satun *P. monodon* was selected to be a founder population in our selective breeding programme.

Keywords: DNA; Diversity; Mitochondrial DNA; Giant tiger shrimp; *Penaeus monodon*; Breeding; Breeding programs; Satun; Surat Thani; Trat

904 Sirawut Klinbunga, David J. Penman, Brendan J. McAndrew, Anchalee Tassanakajon and Padermsak Jarayabhand. 1998. **Genetic variation, population differentiation and gene flow of the giant tiger shrimp (*Penaeus monodon*) inferred from mtDNA-RFLP data.** In : Felgel, T. (ed.), Proceedings to the Special Session on Advances in Shrimp Biotechnology, the Fifth Asian Fisheries Forum: International Conference on Fisheries and Food Security Beyond the Year 2000, 11-14 November 1998, Chiangmai. p. 51-59.

Genetic diversity, population differentiation, and gene flow level of *Penaeus monodon* were examined using restriction analysis of the entire mitochondrial DNA (mtDNA) of two hundred and six individuals collected from 10 geographic locales (Dungun, Kedah, Lamu, Lingayen, Medan, North Java, South Java, Satun, Surat and Trat) using 5 restriction endonucleases (*Bam* HI, *Sac* I, *Eco* RV, *Pvu* II and *Hind* III). Nineteen composite haplotypes generated from twenty-two restriction profiles were observed from all investigated individuals. The mitochondrial genome size of *P. monodon* was estimated to be 15.858 ± 0.138 . The average haplotype diversity of *P. monodon* mtDNA was 0.537 ± 0.006 . The average nucleotide diversity within and between samples were 3.341 ± 0.001 % and 4.676 ± 0.000 %, respectively, whereas the average nucleotide divergence between all pairs of samples was 1.335 ± 0.000 %. The overall gene flow level was 2.6 female migrants per generation whereas at the microgeographic level (within the Southeast Asian region), the level of gene flow was greater (4.8 female migrants). Based on analysis of geographic

heterogeneity, phylogenetic reconstruction and the variance of allele frequencies among samples, the wild *P. monodon* samples in the Southeast Asia could be allocated to 3 different stocks: A (Trat, Surat, Dungun, North and South Java from the east of the Malaysian peninsula), B (Kedah Medan and Satun from the Andaman Sea), and C (Lingayen from the Philippines). Additionally, *P. monodon* from Lamu (Kenya) should be recognized as a different stock from those of Southeast Asia.

Keywords : mtDNA-RFLP; Shrimps; Genetics; Population; *Penaeus monodon*; Gene flow

905 Burachai Sonthayanon, Chantana Wongsantichon, Chanikarn Boonchaay, Chutima Theparit, Apinunt Udomkit and Sakol Panyim. 1999. **Characterization of expressed sequence tags from black tiger shrimp's hemocytes.** The 1st National Symposium on marine shrimps. 15-17 December 1999. B.P. Smila Hotel, Songkhla. National Center for Genetic Engineering and Biotechnology. p. 65-73.

In an attempt to rapidly isolate the bulk of cDNA clones which code for proteins involved in intracellular signal transductions and other potentially useful functions of black tiger shrimp's phagocytic cells, lambda ZAPII-based cDNA libraries were prepared from poly(A)⁺ RNA of hemocytes. Several hundred random cDNA clones were isolated and their 5' end partial nucleotide sequence determined by automated procedure. A segment of each cDNA sequence was used to search online nucleotide and protein sequence databases by two BLAST programs, BLASTN and BLASTX. A number of the protein coding sequences not previously identified nor characterized in Penaeid shrimps could be identified, such as cDNA sequences for a *Ras* family protein, C-Serrate like protein, a protein kinase, a clathrin-associated protein, ubiquitin, antileukoproteinase, calreticulin. A number of cDNA clones for ribosomal proteins, structural proteins, and mitochondrial proteins were also identified. Analysis of random cDNA sequences from the second cDNA library was in progress. The study of the expressed sequence tags (EST) sequences from hemocytes should allow us to conduct rapid characterization of the shrimp DNA sequences, a number of which may be relevant to phagocytic cell stimulation, its differentiation, its mitotic control. The information may one day be applied to stimulate the shrimp's immune system.

Keywords: Black tiger shrimp; cDNA; Tag; Characterization; Hemocytes

906 Apinunt Udomkit, Sunthorn Chooluck, Burachai Sonthayanon and Sakol Panyim. 1999. **Molecular cloning of two cDNAs encoding neuropeptides in CHH/MIH/GIH family from *Penaeus monodon*.** In The 1st National Symposium on marine shrimps, 15-17 December 1999, B.P. Smila Hotel, Songkhla. National Center for Genetic Engineering and Biotechnology. p. 245-254.

Peptide hormones synthesized from the medulla terminalis X-organ (MTXO) of the crustacean eyestalks play important roles in controlling a number of physiological processes. Three related peptides originated from the MTXO make up a family of peptide hormones that seems to be unique in crustacean so far. The member of this family includes crustacean hyperglycemic hormone (CHH), molt-inhibiting hormone (MIH) and gonad-inhibiting hormone (GIH) that regulates blood glucose level, inhibits molting process and inhibit gonad maturation, respectively. The hormones in this CHH/MIH/GIH family share high degree of identity in their amino acid sequences. In this work, two different cDNAs from *Penaeus monodon*'s eyestalks have been cloned and characterized. These two cDNA clones (so called *Pem-CMG-I* and *Pem-CMG-II*) share up to 50% identity in their deduced amino acid sequence with the hormones in CHH/MIH/GIH family known from other crustaceans. *Pem-CMG-I* encodes a prepro-peptide of 128 amino acids in length, and the putative mature peptide contains 74 amino acid residues. The prepro-peptide encoded by *Pem-CMG-II* contains 127 amino acid residues, and its putative mature peptide is identical in length to that of *Pem-CMG-I*. The two peptides are only 43% identical in the signal peptide region whereas 95% of identity in their amino acid sequences is found in the mature peptide. This result suggests that the two peptides are encoded by two related genes in CHH/MIH/GIH family.

Keywords: cDNA; Neuropeptides; *Penaeus monodon*; Eyestalks; Medulla Terminalis X-Organ; MTOX

907 Chutima Theparit, Burachai Sonthayanon, Apinunt Udomkit and Sakol Panyim. 2000. **Members of shrimp signal transduction protein 14-3-3 identified from a RT-PCR DNA fragment of black tiger prawn.** In The 2nd National Symposium on marine shrimps, 23-25 November 2000, Royal Phuket City Hotel, Phuket. National Center for Genetic Engineering and Biotechnology. p.176-181.

Three cDNA clones containing nearly-identical 472 bp nucleotide sequences were accidentally found during a cloning attempt by RT-PCR for some transcription factors in black tiger prawn's hemocytes.

DNA sequence analysis revealed that the cDNA clones encoded at least two identical protein sequences which are similar to those of a family of conserved eukaryotic proteins called 14-3-3, which play important roles in a wide range of regulatory processes including signal transduction, apoptotic cell death, and cell cycle control (1). The truncated sequences of 153 deduced amino acid possessed a high degree amino acid identity of 78% and similarity of 84% compared to a 14-3-3 protein of *Drosophila melanogaster*, while they shared a 77% identity and 85% similarity with *Caenorhabditis elegans*'s. A significant level of sequence identity was also found among these putative *P. monodon* 14-3-3 proteins and 14-3-3-related proteins of a plant (*Arabidopsis thaliana*) and some mammalian organisms at about 71% identity and 82% similarity. The result shown that shrimp 14-3-3-related protein sequences are also highly conserved. In addition, our discovery of the 14-3-3-like protein sequences in black tiger prawn implied that a number of known mammalian regulatory processes including the Raf/Ras signal transduction pathway may have their similar counterparts in crustaceans as well.

Keywords: cDNA; Cloning; Black tiger prawn; Identification; Proteins; RT-PCR

908 Sirawut Klinbunga, David J. Penman and Brendan J. McAndrew. 1998. **A preliminary study of ribosomal DNA polymorphism in the tiger shrimp, *Penaus monodon*.** Journal of Marine Biotechnology. 6:186-188.

The preliminary study of rDNA polymorphisms in *P. monodon* showed that inter-and intraindividual polymorphisms of rDNA were clearly observed in this species. Individual-specific rDNA restriction patterns were observed when digested with BamHI and SacI. The intergenic spacers (IGS) region of *P. monodon* rDNA plays an important role in length heteroplasmy at both between and within individual levels in this species.

Keywords: rDNA; Ribosomal DNA; Tiger shrimp; *Penaeus monodon*

909 Poolsiri Prukkanone. 1999. **Purification of peptides from sinus gland of *Penaeus monodon*.** Master Thesis. Chulalongkorn University. 115 pp.

Isolation of peptides from sinus glands of *Penaeus monodon* was performed by dissecting out of sinus glands from the 1,000 eyestalks before extracting in methanol-acetic acid-water (90:1:9). The extract was partially purified using C18 cartridge and was further purified by 2 to 3 steps of

RP-HPLC using 3 types of columns i.e. C18, C8 and Cyano and 2 solvent systems i.e. acetonitrile / trifluoroacetic acid, acetonitrile / heptafluorobutyric acid. The chromatograms were detected at the absorbance of 215 nm. During each step of purification, the peptides were assayed by Dot-ELISA against 4 antibodies specific to different peptides : mouse anti-crustacean hyperglycemic hormone (CHH) antiserum, rabbit anti-human pancreatic polypeptide c-terminal hexapeptide (PP6) antiserum, rabbit anti β -pigment dispersing hormone (PDH) antiserum and combination of monoclonal antibodies made against FMRFamide (F-23), KNEFIRFamide (AF1-62) and KNEYRFamide (AF2-32). Ninety nine fractions of pure peptide were obtained from the twenty nine fractions of the first step of HPLC. The molecular weight of the peptide determined by MALDI-TOF mass spectrometry were ranging from 932.6 to 9103.1 daltons. Most of the peptides were different from previous peptides reported in *Penaeus monodon*, *Penaeus japonicus* and *Macrobrachium rosenbergii*. Therefore, almost all of the peptides obtained from this study are expected to be different sequences from those previously reported.

Keywords : Purification; Peptides; Sinus gland; *Penaeus monodon*: Eyestalks

910 Pipat Warukamkul. 1998. **Effect of salinity and protein levels on energy budget of juvenile black tiger shrimp *Penaeus monodon*.** Master Thesis. Chulalongkorn University. 101 p.

Effects of salinity and dietary protein on energy budget of juvenile *Penaeus monodon* (0.6–0.7 g ; 4.0–5.5 cm) using artificial diets were studied using 3x3 factorial design with 3 levels of salinity (10, 20 and 30 ppt) and 3 levels of dietary protein (25, 35 and 45%). Experiments were done in triplicates. Prior to the experiments, prawns were acclimatized for a month to the experiment conditions. No interaction between salinity and dietary protein was found. All 3 levels of salinity affected molting loss differently ($P < 0.05$). Molting loss was highest at 10 ppt and decrease as salinity increased. No effect of salinity on survival rate energy of consumption, growth, ammonia excretion, respiration and fecal loss. Effect of dietary protein on growth was found ($P < 0.05$) : the higher the dietary protein, the higher the energy for growth. No effects of dietary protein were found on energy of feed consumption, respiration, ammonia excretion, fecal loss and molting loss. Energy budget of juvenile in the suitable conditions (20 ppt with 35 ppt protein in the diet) could be explained as using energy for growth 15.39%, respiration 14.88%, ammonia excretion 0.98%, fecal loss 56.42%, molting loss 0.65% with 11.68% of energy was lost during feeding. In the low and high salinity (10 and

30 ppt) while receiving the same level of protein in the diet, juvenile prawn will lose more energy in ammonia excretion, respiration and fecal loss with less energy available for growth.

Keywords: Salinity; Dietary protein; *Penaeus monodon*; Juveniles; Energy budget

911 Amporn Wiwegweaw and Apinunt Udomkit. 2000. **Cloning and partial characterization of the 5'-flanking region hyperglycemic hormone-like genes of the black tiger prawn, *Penaeus monodon*.** In 28th Congress on Science and Technology of Thailand, 24-26 October 2002, Queen Sirikit National Convention Center. p. 366.

The crustacean CHH/MIH/GIH neuropeptide family, synthesized and secreted by neurosecretory cells in the X-organ-sinus gland complex, plays an important role in the regulation of growth and reproduction. In our laboratory, three cDNAs encoding CHH-like peptides of the black tiger prawn, *Penaeus monodon* (so called *Pem-CMGI-3*) have been previously identified and characterized. To study on the structural features of the 5'-flanking region of *Pem-CMGI-3* genes, we have cloned and partially characterized the upstream 5'-flanking region of these three genes. Sequence analysis revealed the presence of highly conserved putative TATA box, locating approximately 30 bp upstream of the predicted transcription start site. Additionally, several putative *cis*-acting elements corresponding to known transcription factor binding sites were also identified in the first 300-450 bp proximal region of the promoter. This information would lead to clearer understanding of the mechanism that regulates the expression of these genes at the molecular level.

Keywords: Cloning; CHH; 5'-flanking region; *Pem-CMGI-3*; Promoter; Black tiger prawn; *Penaeus monodon*

912 Nanthika Panchan, Pisarn Sithigorngul, Parin Chaivisuthangkura, Siwaporn Longyant, Weerawan Sithigorngul and Amorn Petsom. 2000. **Differential expression of CMG peptide and crustacean hypertglycemic hormones (CHH_s) in the eyestalk of the giant tiger prawn *Penaeus monodon*.** In 28th Congress of Science and technology of Thailand, 24-26 October 2002, Queen Sirikit National Convention Center. p. 383.

Mouse antiserum against C-terminal amide of Pem-CMG (a peptide in the family of CHH/MIH/GIH) penta-deca peptide (RPRQRNQYRAALQRLamide = CMG-15) was generated and used for localization of the peptide in tissue and extract of the eyestalk of *Penaeus*

monodon by means of immunohistochemistry and dot ELISA in comparison with anti-T+ antiserum (T+=YANAVQTV amide: the putative C-terminal amide octapeptide of crustacean hyperglycemic hormone (CHH) of *Macrobrachium rosenbergii*). The anti-CMG-15 antiserum did not show cross-reactivity to T+ peptide by dot-ELISA and vice versa for anti-T+ antiserum. In dot-ELISA of eyestalk extract of *P. monodon* after one step separation by RP-HPLC, anti-CMG-15 antiserum recognized different peptide fractions (F38-39) from those recognized by anti T+ antiserum (F19, 40-41 and 47-51). Most of the T+ immunoreactive fractions (except F19) show higher hyperglycemic activity than the CMG immunoreactive fractions. In immunohistochemical localization, anti-CMG antiserum recognized only 2-3 neurons in medulla terminalis X-organ complex (MTXO) with long processes terminated in the sinus gland. The CMG-immunoreactive neurons were clearly distinct from CHH containing neurons (34±4 cells) situated in the same area. This evidence confirms the existing of CMG peptide which may play distinct roles from CHHs in hormonal regulation in *P. monodon*.

Keywords: CMG; CHH; MIH; GIH; Dot ELISA; Immunohistochemistry; Giant tiger prawn; *Penaeus monodon*; Eyestalks

913 Kanchana Doungpunta, Narongsak Puanglarp and Piamsak Menasveta. 2000. **Determination of stress response in black tiger shrimp, *Penaeus monodon*, by detecting heat shock proteins and glucose level.** In 28th Congress of Science and Technology of Thailand, 24-26 October 2002, Queen Sirikit National Convention Center. p. 531.

When confronted immediate environmental changes, most animals suffer stress. A number of heat shock proteins (HSPs) are rapidly synthesized. These HSPs, highly conserved proteins found in diverse organisms from bacteria to mammals, are responsible for maintaining essential cellular proteins to function normally. They participate in a variety of cellular processes involving in folding or unfolding of proteins and translocation of proteins into organelles. The potential of HSPs as biomarkers for monitoring stress condition has been reported in many organisms. In this study, the heat induction of major HSPs (HSP 60 and HSP 70) in the haemocyte of black tiger shrimp, *P. monodon* was investigated. The experiments on thermal tolerance and HSP induction in shrimp were conducted. The result indicated that shrimps could tolerate the temperature below 35 °C for 2 h. The heat induction of HSPs (HSP 60 and HSP 70) was also detected. Only HSP 70 was identified in induced shrimp. There was no significant different on glucose level from the

haemolymph of the shrimps induced with the heat at 30 °C and 35 °C

Keywords: Heat shock protein; Black tiger shrimp; *Penaeus monodon*; Stress; Responses; Glucose

914 Pisarn Sithigorngul, Jirasak Papuem, Chatchadaporn Krungkasem, Siwaporn Longyant, Nanthika Panchan, Parin Chaivisuthangkura, Weerawan Sithigorngul and Amorn Petsom. 2000. **Four novel PYFs : The members of NPY/PP superfamily from the eyestalk of the giant tiger prawn *Penaeus monodon*.** In 28th Congress of Science and Technology of Thailand, 24-26 October 2002, Queen Sirikit National Convention Center. p. 382.

An immunocytochemical method was used for localization of pancreatic polypeptide (PP) immunoreactive substances in the eyestalk of *Penaeus monodon* using anti-C-terminal hexapeptide of PP (anti-PP6) antiserum. Approximately 200 neuronal cell bodies in the ganglia between medulla interna (MI) and medulla terminalis (MT) and surround MT in conjunction with the neuronal processes in medulla externa (ME), MI, MT and sinus gland were recognized. About half of the PP immunoreactive neurons were also recognized by combination of three monoclonal antibodies raised against FMRFamide-like peptides. Isolation of the PP immunoreactive substances from the eyestalk was performed using 7,500 eyestalks extracted in methanol/ acetic acid/water (90:1:9). After the extract was partially purified using C18 cartridges, it was further purified by 5-6 steps of RP-HPLC using 3 kinds of columns: C 18, C8 and cyano, and three solvent systems: acetonitrile (ACN)/trifluoro acetic acid, ACN/heptafluorobutyric acid and ACN/triethylammonium acetate. Dot-ELISA using the anti-PP6 antiserum was used to monitor PP-like substances in various fractions during the purification processes. Four new sequences of one hexapeptide and three nonapeptides: RARPRFamide, YSQVSRPRFamide, YAIAGRPRFamide and YSLRARPRFamide were identified and named as PYF1-4 due to their primary structures which are similar to the PYF found in squid. All new peptides share 4-7 common residues with the C-terminus of the PYF found in the squid *Loligo vulgaris* and the NPFs found in flat worms *Moiezia expansa* and *Atrioposthia triangulata*, in gastropods *Helix aspera*, *Lymnaea stagnalis*, *Aplysia californica*, and in insect *Drosophila melanogaster* and *Helicoverpa zea*. This finding suggests that multiple forms of NPFs exist in the nervous system of *P. monodon*. The NPY/PP superfamily as well

as the FMRFamide peptide family may be present throughout vertebrates and invertebrates

Keywords: Eyestalks; Immunohistochemistry; NPY; NPF; PP; PYF; *Penaeus monodon*; Neuropeptide; Purification

915 Chetsada Pothiratan, Sakol Panyim and Chalermpon Ongvarrasopone. 2000. **Molecular cloning of a cDNA encoding a putative octopamine/tyramine receptor in black tiger prawn (*Penaeus monodon*).** In 28th Congress of Science and Technology of Thailand, 24-26 October 2002, Queen Sirikit National Convention Center. p. 368.

Octopamine and tyramine are neurotransmitters that are only found in invertebrates. They mediate various behavioral and physiological effects such as learning, memory, ovarian muscle contraction, and osmoregulation by interacting with their receptors. Octopamine or tyramine receptor is a G-protein coupled receptor. Molecular cloning of this receptor will lead to an understanding of prawn physiology and controlling prawn reproduction in the future. In this study, a putative octopamine/tyramine receptor was cloned from brain and thoracic ganglia of *P. monodon* by using PCR techniques. Degenerate primers that corresponded to transmembrane domain (TM) III and VII were designed. 3' RACE (Rapid Amplification of a cDNA End) and Genome WalkerTM library kit were used to clone 3' and 5' end of this gene. An open reading frame of the cloned gene coding for a putative receptor contained 1329 nucleotides which encoded 443 amino acids. This putative receptor showed high sequence similarity to insect OA/tyrR that negatively coupled to adenylate cyclase ranging from 54-64%. Tissue distribution profiles of this receptor were investigated by using RT-PCR technique in wild broodstock prawn undergoing stage 3 ovarian maturation. This putative OA/TyrR was expressed in brain and thoracic ganglia and ventral nerve cord. It was also expressed in gill and ovary. The expression of this receptor in *P. monodon* differed from that in insects which were restricted only in central nervous system or head regions. This suggested that this putative OA/TyrR might have other unique functions in *P. monodon*.

Keywords: G-protein coupled receptor; Octopamine; Tyramine receptor; Neurotransmitter; Black tiger prawn; *Penaeus monodon*

916 in Thai

917 Wilairat Anurakolan. 2001. **Cloning and expression of genetic encoding antilipopoly saccharide factor from black tiger shrimp *Penaeus***

monodon. Master Thesis. Chulalongkorn University. 107 p.

Anti-lipopolysaccharide factor (Anti-LPS factor) is the major protein of crustacean immune system. In horseshoe crabs, this protein has an antibacterial effect on the growth of Gram-negative bacteria by binding and neutralizing material endotoxin, lipopolysaccharide (LPS). In the black tiger shrimp (*Penaeus monodon*), a cDNA encoding anti-LPS factor has been isolated from the hemocytes cDNA library. It contains an open reading frame of 372 bp coding for 123 as residues with a predicted molecular weight of 13.7 kDa. In this study, two versions of anti-LPS factor, full-length and NH₂-terminal truncated derivative, were cloned and expressed in insect cells by using baculovirus expression system to obtained large amount of recombinant proteins with similar in structure and biological activity to the naturally occurring protein. The DNA fragment of full-length and NH₂-terminal truncated derivative were cloned into transfer vector pBacPAK8) and co-transferred to baculovirus genome by homologous recombination inside the insect host cell (*Spodoptera frugiperda* Sf9 cells). Analysis of the recombinant proteins from infected cell lysate by SDS-PAGE revealed over expression, both of the full-length and NH₂-terminal truncated derivative. Protein bands of approximately 15 kDa were observed in the infected cells but not in uninfected cell lysate. The recombinant proteins have appropriate size corresponding to the full-length and N-terminal truncated derivative anti-LPS factor protein. The crude recombinant protein of both of the anti-LPS factors were tested for their antibacterial effect on the growth of bacteria by measuring bacterial growth rate of Gram-negative *Vibrio harveyi* 1526 and *Escherichia coli* DH5 α and Gram-positive *Staphylococcus aureus*. No significant antibacterial activity was found with crude recombinant proteins both of full-length and NH₂-terminal truncated, which may be due to the recombinant proteins formed insoluble inclusion bodies when they were over expressed. Thus, purified protein is required for further antibacterial activity test.

We examined the tissue expression of anti-LPS factor mRNA in normal shrimp by Northern blot and RT-PCR analysis. The result demonstrated that hemocytes were the main site of anti-LPS factor synthesis. from RT-PCR analysis, anti-LPS factor showed strong expression in hemocytes and significant amount of mRNA concentration were observed in heart, gills, intestine and lymphoid organ. No mRNA of anti-LPS factor was detected in hepatopancreas. In microbial challenge, anti-LPS factor was found increase in mRNA concentration level at 3 hours post injection and then return to initial level, indicated that anti-LPS

factor is stimulated in hemocytes at early stage of infection in response to bacterial challenge.

Keywords: Cloning; Anti-lipopolysaccharide factor; Horseshoe crabs; Black tiger shrimp; *Penaeus monodon*

918 Marine Biotechnology Research unit. 1992. **Pigmentation efficacy of bioquimex in giant tiger prawn.** Chulalongkorn University. Final Report Submitted to Bayer Thai Co. Ltd. 28 p.

In order to improve giant tiger prawn (*Penaeus monodon* Fabricius) discoloration resulting from successive feeding a commercial diet, the effect of two natural xanthophyll sources, i.e. saponified marigold and saponified peper (both are under the trade name of "Bioquimex") and the commercially available astaxanthin (carophyll pink) were comparatively studied. A commercial diet was divided into ten batches and were augmented with saponified marigold at the concentrations of 50, 100, 150, 200 mg xanthophyll/kg, saponified peper at the concentrations of 50, 100, 150, 200 mg xanthophyll/kg, carophyll pink at 50 mg astaxanthin/kg, and without adding (control), respectively. Each of the diets was fed to the prawns having the average weight of 11.5 g for two months. The growth performance showed no marked differences among the dietary treatments. The pigmentation in terms of xanthophyll, free astaxanthin and astaxanthin ester of the prawns fed the carotenoid augmented diets were progressively enhanced with time. Nevertheless, the rates of pigmentation were not the same. The diet augmented with saponified peper at the concentration of 150 mg xanthophyll/kg showed significantly highest rate of pigmentation. Astaxanthin showed a comparable performance with saponified marigold and saponified peper at the same concentration of carotenoids in the diets.

Keywords: Pigments; Bioquimex; Giant tiger prawn; *Penaeus monodon*; Xanthophylls; Astaxanthin

919 Chansawang Ngamphongsai. 2000. **Tryptic enzyme content in the larval stages of *Elminium modestus* Darwin, *Crangon crangon* Linnaeus and *Penaeus indicus* H. Milne Edwards.** The 2nd National Symposium on Marine Shrimps, 23-25 November 2000, Royal Phuket City Hotel, Phuket. National Center for Genetic Engineering and Biotechnology. p. 169-175.

The aim of this study is to investigate the trypsin activity of the larvae of *Elminium modestus*, *Crangon crangon* and *Penaeus indicus* in an attempt to validate the concept that herbivores show higher enzyme activity than carnivorous larvae. Tris-HCL

buffer solution and a substrate (1 mM TAME; N α -toluene-sulfonyl-L-arginine methyl ester) were used for trypsin analysis. Trypsin activity was measured on diode array spectrophotometer every 6th sec for 3 min at wave length 247 nm. The levels of specific trypsin activity of *E. modestus* larvae were high in NI-NII stages and reached a peak in NIII stage, then sharply decreased until the non-feeding cypris stages. The trypsin activity in newly hatched and 1-day-old of *C. crangon* was very low compare to that in *E. modestus* larvae. The trypsin activity for PZ1 and PZ2 *P. indicus* was higher than in *E. modestus*. The levels of specific trypsin activity of *E. modestus* in NI-NIII stages fit among the herbivorous category for crustacean larvae as do the trypsin levels for PZ1 and PZ2 *P. indicus* larvae. The trypsin levels declined as the larvae developed through NIV-NVI and metamorphosed to non-feeding cypris stages. This also fits overall pattern for crustacean larvae and falls into the omnivorous group. In contrast, early stages of *C. crangon* have low trypsin levels, and fit in the carnivorous group. Results confirm that feeding strategies of crustacean larvae may be predicted from their digestive enzyme complement and activity level. Thus feed development for new species of crustacean should be linked to knowledge of digestive physiology and trypsin levels.

Keywords: Energy; Trypsin; Larvae; *Elminium modestus*; *Crangon crangon*; *Penaeus indicus*

920 Narunchala Ruengjirachuporn, Sahdev Singh and Suthep Madarasm. 2000. **Development of a shrimp (*P. monodon*) growth model using image analysis.** In The 2nd National Symposium on Marine Shrimps. 23-25 November 2000, Royal Phuket City Hotel, Phuket. National Center for Genetic Engineering and Biotechnology. p. 63-66.

Intensive shrimp culture operations such as feeding, sorting, and drug treatment require accurate information about the number and representative size/weight of shrimp population in a culture system. Traditional shrimp sampling methods are invasive to the culture environment and prone to errors due to imprecision. Image-based measurement can potentially gain more accurate observations and save time with no harm to the culture environment. An image analysis based instrumentation system for observing shrimp population in an intensive culture environment was developed and named “**Shrimp Sizer**” The instrumentation system was used to develop a shrimp growth model by measuring the shrimp length and width in a non-intrusive manner. Image processing computer program used Blob Coloring and Generalized Hough Transform (GHT)

algorithm for 2D object detection. This algorithm can detect arbitrary objects taking into account various scales, and orientations objects. The growth model is based on the relationship between individual shrimp weight and those physical characteristics which can be captured by the image analysis technique. Using about 300 shrimps (*P. monodon*) of varying sizes the growth model was validated experimentally and statistically. The model considered individual shrimp weight as a function of orbit length, width, and/or orbit length and width. The results from the experiment confirm that there is strong relationship between individual shrimp weight and physical characteristics. For *P. monodon* shrimp regression equations of the form $Y = A(X)^B$ were obtained as shown below.

$$\text{Weight} = 7.2705 * (\text{Width})^{2.6337} \text{ with } R^2 = 0.9559$$

$$\text{Weight} = 0.0103 * (\text{Orbit length})^{2.8401} \text{ with } R^2 = 0.9538$$

$$\text{Orbit length} = 10.076 * (\text{Width})^{0.9037} \text{ with } R^2 = 0.9518$$

These growth models could predict shrimp weight quite well as the prediction errors in all cases were less than 5%.

Keywords: Image analysis; Growth; Blob coloring; Shrimps; *Penaeus monodon*; Shrimp sizer

921 Satit Kovitvadhi. 1992. **Taxonomic study on marine shrimp and mantis shrimp from the Eastern Coast of Thailand.** Research report, submitted to National research Council Thailand. 141 p.

Taxonomic study on marine shrimp and mantis shrimp in four provinces was carried out on the East Coast of Thailand in Chonburi, Rayong, Chanthaburi and Trat. A total 12 time of sampling collections in 10 fishery ports were taking from October 1990 to July 1992 and thirty-six species of marine shrimps and fourteen species of mantis shrimps were found as follows :

Eight genera and 35 species wer found in Family

Penaeidae Rafinesque, 1815:

1. *Atypopenaeus bicornis* Racek & Dall, 1965
2. *Metapenaeopsis barbeensis* Hall, 1962
3. *Metapenaeopsis lamellate* (De Haan, 1850)
4. *Metapenaeopsis mogiensis* (Rathbun)
5. *Metapenaeopsis stridulans* (Alcock)
6. *Metapenaeopsis toloensis* Hall, 1962
7. *Metapenaeus brevicornis* (H. Milne Edwards, 1837)
8. *Metapenaeus conjunctus* Rack & Dall, 1965
9. *Metapenaeus dobsoni* (Miers, 1878)
10. *Metapenaeus elegans* De Man, 1907
11. *Metapenaeus ensis* (De Haan, 1844)
12. *Metapenaeus intermedius* (Kishinouye, 1900)
13. *Metapenaeus lysianassa* (De Man, 1888)
14. *Metapenaeus monoceros* (Fabricius)

15. *Metapenaeus stebbingi* Nobili
16. *Metapenaeus tenuipes* Kubo, 1949
17. *Parapenaeopsis cornuta* (Koshinouye, 1900)
18. *Parapenaeopsis hardwickii* (Miers, 1878)
19. *Parapenaeopsis hungerfordii* (Alcock, 1905)
20. *Parapenaeopsis probata* Hall, 1962
21. *Penaeopsis eduardoi* Perez Farfante, 1977
22. *Penaeopsis rectacula* (Bate, 1881)
23. *Penaeus indicus* H. Milne Edwards, 1837
24. *Penaeus japonicus* Bate, 1888
25. *Panaeus latisulcatus* Kishinouye, 1896
26. *Panaeus logistylus* Kubo, 1943
27. *Penaeus merguensis* De Man, 1888
28. *Penaeus monodon* Fabricius, 1798
29. *Penaeus penicillatus* Alcock, 1905
30. *Penaeus Plebejus* Hess
31. *Penaeus semisulcatus* De Haan, 1844
32. *Trachypenaeus constrictus* (Stimpson)
33. *Trachypenaeus curvirostris* (Stimpson, 1860)
34. *Trachypenaeus fulvus* Dall, 1957
35. *Xiphopenaeus riveti* Bouvier

One genus and 1 species were found in Family Alpheidae

Alpheus eqphrosyne De Man, 1897

The mantis shrimp were found in 4 family, 8 genera and 14 species :

One genus and 1 species were found in Family

Lysiosquillidae Giesbrecht, 1910

Lysiosquilla siamensis Naiyanetr, 1980

One genus and 1 species were found in Family

Odontodactylidae Manning, 1980 :

Odontodactylus cultrifer (White, 1850)

Five genera and 11 species were found in Family Squillidae Latreille, 1803 :

1. *Anchisquilla fasciata* (De Haan, 1844)
2. *Carinosquilla carinata* (Serene, 1950)
3. *Carinosquilla multicarinata* (White, 1848)
4. *Clorida decorata* (Wood-Moson, 1875)
5. *Clorida latreillei* (Eyedoux & Souleyet, 1842)
6. *Clorida thailandica* Naiyanetr, 1982
7. *Cloridopsis scorpio* (Latreille, 1825)
8. *Oratosquilla gonypetes* (Kemp, 1911)
9. *Oratosquilla nepa* (Latreille, 1825)
10. *Oratosquilla quinqueidentata* (Brooks 1886)
11. *Oratosquilla woodmasoni* (Kemp, 1911)

One genus and 1 species were found in Family Harpiosquillidae Manning, 1980

Harpiosquilla harpex (De Hann, 1844)

Keywords : Taxonomy; Marine shrimps; Mantis shrimp; Coast; Chonburi; Rayong; Chanthaburi; Trat

922 Paulai Chantavongsa. 1992. **Growth and length-frequency distribution of giant tiger prawn (*Penaeus monodon*) in Phang-Nga Bay.** Technical Paper No. 11/1992. Andaman Sea Fisheries Development Center. Marine Fisheries Division, Department of Fisheries. 14 p.

Monthly length-frequency data of giant tiger prawn, *Penaeus monodon*, caught by trawlers, push nets and trammel nets which operated in the Phang-Nga Bay during 1988 and 1989 were pooled to obtain a length frequency distribution. The ELEFAN I program Bhattacharya method were used to estimate von Bertalanffy growth parameters K and Loo, from this length-frequency data. For male and female, growth parameters are K = 1.70/year and Loo = 64.50 mm, K = 1.55/year and Loo = 74.50 mm, respectively. Male and female recruited into the fishery at the minimum carapace length of 16 mm and 12 mm, respectively, during the period in March and June.

Keywords: Growth; Length; Giant tiger prawn; *Penaeus monodon*; Trawlers; Push net; Trammel net; Phang-nga Bay

923 Sirawut Klinbunga, D.J. Penman, B.J. McAndrew and Anchalee Tassanakajon. 1999. **Mitochondrial DNA diversity in three populations of the giant tiger shrimp *Penaeus monodon*.** Mar. Biotechnol. 1:113-121.

Mitochondrial DNA restriction fragment length polymorphism (mtDNA-RFLP) was utilized for determination of genetic variation and population structure in *Penaeus monodon* collected from Satun (the Andaman Sea) and Surat and Trat (the Gulf of Thailand). Twenty-eight composite haplotypes were generated from 52 restriction profiles of *P. monodon* mtDNA digested with 11 restriction endonucleases. The size of the entire *P. monodon* mitochondrial genome was estimated to be 15.913±0.177 kb. The average haplotype diversity in *P. monodon* was 0.864, whereas the mean nucleotide diversity within populations was 2.51%, 2.22%, and 1.91% for Satun, Trat and Surat, respectively. Geographic heterogeneity analysis indicated population differentiation between *P. monodon* from the Andaman Sea and *P. monodon* from the Gulf of Thailand ($p < .0001$). On the basis of the high genetic diversity level of *P. monodon* in Thailand, the Satun and Trat *P. monodon* populations from the west and east of the peninsula were selected to be founder stocks in our selective breeding program.

Keywords: Giant tiger prawn; *Penaeus monodon*; mtDNA-RFLP; Population structure; Genetic variation; DNA; Diversity; Selective breeding

924 Suchat Sawangareruks, Pensri Boonruang and Khordeeyoh Pornchai. 1999. **Distribution of banana prawns, *Penaeus merguensis* de Man 1888, at various stages in mangrove nursery ground, Kapur canal Province.** In The 1st National Symposium on Marine Shrimps, 15-17 December 1999. B.P. Smila Hotel, Songkhla. National Center for Genetic Engineering and Biotechnology. p. 229-244.

Banana prawns, *Penaeus merguensis*, were investigated monthly from January 1994 to January 1995. Postlarval stages were taken by 1 mm mesh size of Larval net and Bottom net. The greater stages were taken by a push net. This study area was the main nursery ground for banana prawns in Andaman Sea.

Postlarval stage of banana prawns found more abundance at canal mouth and known as one of the canal than inner part of the canal, Statistically *t*-test between pelagic and benthic postlarval stage shows a highly significant difference ($p < 0.01$) in density. Postlarval stage immigrated to nursery ground during early southwest monsoon (May to August) and early northeast monsoon (December to January). The other stages of banana prawns were found in high density in southwest monsoon (May to September). Carapace length (CL) as size distribution was mainly found between 9-15 mm CL while its mean size from station P-1, P-2 and P-3 ranged between 9.09-19.32, 10.32-21.05 and 11.92-18.68 mm CL, respectively. The mean biggest size of CL appeared at station P-3 (14.30 mm CL) whereas the mean smallest size of CL found at station P-2 (12.72 mm CL). The size distribution showed significant difference among 3 station ($p < 0.05$). Emigration of prawns in Kapur canal was found high density in southwest monsoon.

Keywords: Banana prawn; *Penaeus merguensis*; Mangrove; Recruitment; Immigration; Emigration; Kapur canal; Nursery ground; Andaman sea; Ranong

925 ประจวบ หล้าอุบล, สุวิทย์ วุฒิสุทธิเมธาวิ, บรรจง นิสภาณิชย์, อภิชาติ วรรณวิจิตร, ทิพา เจียวตั้ง, สมวงษ์ ตระกูลรุ่ง และธนาพงษ์ เมืองแมน. 2543. **Recurrent breeding of black tiger shrimp (*Penaeus monodon* Fabricius) and the development of molecular marker-assisted selection.** รายงานการวิจัยฉบับสมบูรณ์ ทุนอุดหนุนการวิจัยเพื่อพัฒนาเศรษฐกิจและสังคมด้วยวิทยาศาสตร์และเทคโนโลยี ประจำปี 2540-2543. เสนอต่อสำนักงานคณะกรรมการวิจัยแห่งชาติ.

Keywords: Breeding; Black tiger shrimp; *Penaeus monodon*; Microsatellite markers; Molecular markers; Domestication; Broodstocks; Selection

926 Padermsak Jarayabhand, Anchalee Tassanakajon, Supattra Uraiwan, Sirawut Klinbunga, Pichit Srimukda, Rungtawan Panakulchaiwit and Piamsak Menasveta. 2000. **Selective breeding programme in black tiger prawn, *Penaeus monodon*, Fabricius, Phase I: Population genetics and estimation of heritability for growth rate.** Research Report, BT-39-06 ATI-06-05 (181). 73 p.

Farming of the black tiger prawn (*Penaeus monodon* Fabricius, 1798) in Thailand has been rapidly developed and shown its success by producing the income of approximately 50,000 million baths annually. An intensive systems for cultivation of *P. monodon* used by Thai farmers integrate several disciplines including the use of appropriate nutritional feed for different shrimp stages, detection of diseases of larvae and broodstock used in farms and management of pond environments for primary prevention of diseases. Nevertheless, we still concern about production problems of *P. monodon* arising from spreading of serious diseases and seasonal inconsistency of good quality of *P. monodon* broodstock and larvae. These significantly contribute on sustainable farming activity of this species.

Our research project on "Selective Breeding Programme in Black Tiger Shrimp, *Penaeus monodon*, Fabricius phase I: Population Genetics and Estimation of Heritability for Growth Rates" was carried out based on the hypothesis that the highest efficiency of *P. monodon* production cannot be obtained unless the biological potential, particularly genetics of *P. monodon* is fully developed. Therefore, the objectives on the first phase of our selective breeding programme emphasised studies of genetic diversity and population genetic structure of *P. monodon* in Thailand and estimation of heritability for growth rates of *P. monodon*. Results obtained from these researches can be used as the basic data for aquaculture and fisheries management of this economically important species.

Studies on genetic diversity and population differentiation of *P. monodon* collected from main fisheries regions of Thailand indicated high genetic diversity level of Thai *P. monodon* and the existence of intraspecific genetic population structure (stock) between *P. monodon* from the gulf of Thailand and the Andaman Sea. Nevertheless, significant genetic differences were observed between *P. monodon* from Chumphon and Trat but not between Chumphon and each of the Andaman populations. This indicated a possible consequence of inappropriate fisheries management of broodstock and larvae of farmed *P. monodon*. A population-specific marker obtained

from amplification of *P. monodon* with the primer UBC268 was found in almost all specimens from Trat. This RAPD marker can be used to assist comparisons of the performance on economically important traits (e.g. growth and survival rate) between different *P. monodon* stocks. High levels of genetic diversity and differentiation in wild *P. monodon* populations in Thailand revealed by this study is useful to construct a selective breeding programme in this species appropriately.

Studies on estimation of heritability for growth rates of *P. monodon* were categorized to two different parts composing of development of microsatellite marker for family identification and selection, and construction of large full-sib family groups for heritability analysis. The use of DNA typing by microsatellites allow us to determine the family origins of progeny reared in the same communal tanks. These can be carried out by using only 3 microsatellite loci (CUPmo18, Di25 and Di27). The DNA extraction protocol was simplified from a standard phenol/chloroform extraction method to a more convenient method using Chelex100. This eliminated the tedious and time consuming step based on the standard method. As a result, microsatellite analysis can be directly applied for genetic analysis of a large number of specimens in our breeding programme.

Estimation of heritability using a full-sib model is more suitable than that using a half-sib model. The heritability for the growth rate of *P. monodon* at 145-150 days old (based on the body length) of the Gulf of Thailand and the Andaman Sea populations was approximately 0.20-0.24. This heritability level implied the possibility to eliminate the production efficiency of *P. monodon* through appropriate selective breeding programmes. The results from this study illustrated that efficiency of *P. monodon* production can be increased at 2.6% - 5.8% of the total length and 9.0% - 20.0% of the body weight per generation if selection of *P. monodon* was carried out appropriately.

The recommendations for an appropriate selective breeding programme of *P. monodon* are comparisons of growth rates (estimated from the total length or body weight) of *P. monodon* at the 120 days old stage as the selection trait. Data obtained should be collected and organised for easy use and must be updated regularly. The selective breeding programme of *P. monodon* for the next phase should incorporate strain comparison for the performance on important traits (e.g. growth and disease resistance) and generating hybrid progeny from different *P. monodon* stocks. The selection programme should be concurrently carried out to determine the response of *P. monodon* to desired selection both in farms and laboratory conditions.

Keywords: Selective breeding; Black tiger prawn; *Penaeus monodon*; Population genetics; Heritability; Growth; Broodstocks; Gulf of Thailand; Andaman Sea; Chumphon; Trat; RAPD; Microsatellite markers

927 Jintana Suwanjarat, Vanida Lim and Usavadee Decha. 2000. **Ovarian development in relation to body weight of juvenile black tiger prawn *Penaeus monodon*.** Songklanakarin J. Sci. Technol. 22 (suppl.): 725 – 733

The examination of ovarian development and ovarian stages in relation to body weight was carried out in the ovaries of the black tiger prawn *Penaeus monodon* with the body weight (BW) between 15 and 35 g. Histological sections were stained using haematoxylin and eosin, and Mallory trichrome stain. Ovaries of a 10 g to 15 g BW *Penaeus monodon* were in stage 2, or chromatin nucleolus stage. The ovary of 20 to 35 g BW was in stage 3, or perinucleolus stage, with the mean oocyte diameter measured 43.92 ± 7.75 μ m. There was no significant difference in the mean oocyte diameter between the ovaries in the C4 region of 15, 20 and 25 g BW *Penaeus monodon*, while the mean oocyte diameter of a 10 g BW *Penaeus monodon* was significantly smaller than those of the 15, 20, 25 and 30 g BW *Penaeus monodon*. In addition, the mean oocyte diameter of 15 to 25 g BW *Penaeus monodon* was significantly smaller than that of a 30 g BW *Penaeus monodon*. It was concluded that the ovarian developmental stage is related to the body weight. The female *Penaeus monodon* of 10 to 35 g BW consisted of stage 2 and 3 ovaries, and may not have reached the requirement for stage 4 in ovarian development with the body weight under 35 g.

Keywords: Black tiger prawn; *Penaeus monodon*; Ovarian development; Body weight; Juveniles

928 Jiraporn Kasornchandra, R. Khongpradit, Usanee Ekpanithanpong and Sitdhi Boonyaratpalin. 1997. **Progress in the development of shrimp cell cultures in Thailand.** In the Proceeding of the Biotech Forum on Shrimp Biotechnology, BIOTECH/NSTDA, Bangkok, Thailand. p. 132-136.

Primary shrimp cell cultures were developed from lymphoid organ, heart and ovaries of black tiger shrimp, *Penaeus monodon* in double-strength Leibovitz's L-15 medium supplemented with 15% fetal bovine serum, 1% glucose, 5 g/L NaCl, 10% shrimp meat extract and 0.01% cholesterol. The optimum conditions for primary culture *in vivo* were obtained in L-15 medium with an osmolality of approximately 700-740 mmol/kg, a temperature range of 25-28°C and incubation in a normal atmosphere. Both epithelial-like and fibroblastic-like cells were observed from those organs within 2 days

incubation. 80% confluent monolayers were obtained from lymphoid organ within 3-day period while cultures from other tissues required a 5-day period. Cultures were maintained for up to at least 43 days. Only cells from lymphoid organ can be subcultured and confluent monolayers were achieved within 10 days post-spilt. Health cultures of the lymphoid cells did not persist beyond the third passage. Application of these primary shrimp cell cultures for studying pathogenic viruses of shrimp *in vitro* will be discussed.

Keyword : Cell culture; Shrimps; Lymphoid organs; Heart; Ovaries; Black tiger prawn; *Penaeus monodon*

929 Amornrat Phongdara, Wilaiwan Chotigeat and AUSA Chandumpai. 1997. **Genotypic identification of banana prawn by using RAPD**. In Shrimp Biotechnology Meeting. National Center for Genetic Engineering and Biotechnology. p. 44-54.

Several lines of evidence have suggested a high potential for intensive farming of banana prawn in Thailand. However, farming experiences for the banana prawns show that they do not grow to marketable sizes and are susceptible to diseases. It was suggested that seed quality, i.e. broodstock selection may be the cause of this failure. Banana prawns are found in Thailand in fact included two species which are very similar in morphology and sometime ambiguous to interpret, namely, *P. merguensis* and *P. indicus*. Here, we use RAPD profile to differentiation and to study the genetic diversity of *P. merguensis* and *P. indicus* distributed in Thailand. After screening of 223 primers, there is one primer suitable for the species identify and the others for the study of genetic diversity.

Keywords: Genotypes; Identification; Banana prawn; *Penaeus merguensis*; *Penaeus indicus*; RAPD

930 Jesadawuth Sangkawanna. **An analysis of export potential of Thai frozen shrimp**. 1998. Independent Study, Master of Business Administration. King Mongkut's Institute of Technology Ladkrabang. 92 p.

The frozen shrimp is one of importance products that has made high income to Thailand. However, its export quantity and value have fluctuated, resulting from government policy, economic situation and other factors related to domestic production and international trade.

The main objectives of this study are to study the production and export situation of frozen shrimp, to analyze revealed comparative advantage (RCA)

and export expansion using the constant market share model (CMS) and to shed some recommendation to maintain its market share.

The analytical results indicate that there were the comparative advantages of Thai frozen shrimp and those of importance competitors such as India, Indonesia, Ecuador and Vietnam. The revealed comparative advantages of Thailand, Ecuador and Vietnam increased during the period of 1991-1993 and then decreased during the period of 1994-1996. The comparative advantage of Indonesia decreased while that of India improved continuously.

The analytical results indicate that there were the export expansion of Thai frozen shrimp during the periods of 1988-1990 and 1991-1993, due to the real competition, the world expansion and the interaction effects. The export values increased during the periods of 1991-1993 and 1994-1996, resulting from the world expansion, the distribution effect, the real competition and the interaction effect.

In order to maintain market share of Thai frozen shrimp, development of value added products, differentiation of product types from other competitors and increase in promotion and public relation as well as market distribution are recommended.

Keywords: Frozen shrimps; Exports; Analysis; RCA; Revealed Comparative Advantage

931 Thanin Sutthiwarotamgul. 1999. **Frozen fresh shrimp exporting situation to European union : case study exporter which located in Bangkok metropolitan area**. Independent Study, Master of Business Administration. King Mongkut's Institute of Technology Ladkrabang. 99 p.

European Union is one the most important market for Thailand exported market. Thailand has exported several goods to this community including frozen fresh shrimp. The export value, however, were inconsistency vary since European Union has imported this goods from various sources. Additionally, they have established many regulations to control the import content, thus, definitely affected to Thai exported. The objectives of this research were to study the frozen fresh shrimp production and exporting situation to European Union. Together with the details of all regulations developed by European Union which affected to Thai export value as well as the government and private sectors' contingency plan. The methods used in this study were related secondary information collecting and questionnaires by interviewing frozen fresh shrimp exporters 35 companies where their head office located in Bangkok metropolitan.

The result showed that the most exporters has the registered capital between 11-50 million Baht and manufacture frozen fresh shrimp as majority. Their

main export market were United States of America, Japan and European Union. The major competitors were the exporters in India, Ecuador and Indonesia. Main problems and constraints facing the exporters were (1) the termination of GSP for Thai exporters which effected to the substantial increasing in import duty (2) market penetration by competitors (3) no substituted market for current over supplies (4) lack of raw materials (5) safety standard of the import goods (6) new currency exchange regulation in Thailand. Exporters' countermeasures were (1) expanding the export markets (2) develop new products to a higher level of standards (3) manufacture new products to compensate frozen fresh shrimp. The most attitudes towards government solutions were suitable while expecting (1) the Thai government negotiation to acquire continued GSP with European Union (2) expand and penetrate new market (3) subsidy the premium duty paid to European Union (4) change and revise to the faster custom procedures

For the suggestion. Exporters should expand the market to compensate the European Union market. They should develop innovative production and manufacturing process, manufacture high value items, create value added to the products, increase competitive advantage and product differentiation over their competitors.

Keywords: Frozen shrimps; Exports; EU

932 Pornchai Chulertmongkol. 1999. **Factors affecting Japan import demand for Thai fresh frozen shrimps.** Independent Study, Master of Business Administration. Kasetsart University. 75 p.

Fresh frozen shrimps have been one of Thailand's major exports, earning a large amount of foreign exchange for the country each year. Japan is the major markets for the world and Thai shrimps exports.

The objectives of this study were to analyze factors affecting Japan import demand for Thai fresh frozen shrimps, to find the demand price and Gross Domestic Product elasticities and to forecast the quantities of Japan import demand for Thai fresh frozen shrimps during 1999 to 2003.

The study was done by collecting the secondary data from public sectors and private sectors. Time-series data from 1982 to 1996 was employed in the analysis by SPSS (Statistical for Social Scientists) The data analysis was done by qualitative method and quantitative method.

The results of this study were that the major significant factor affecting Japan import demand for Thai fresh frozen shrimps was the fresh frozen shrimps f.o.b. export price to Japan deflated by Japan consumer price index and the minor

significant factor affecting Japan import demand for Thai fresh frozen shrimps was Japan Gross Domestic Product deflated by Japan consumer price index. The elasticities of Thai fresh frozen shrimps f.o.b. export price to Japan, Thai fresh frozen cuttlefish export price to Japan and Japan Gross Domestic Product deflated by Japan consumer price index were - 2.17, 0.83 and 4.82 respectively. The forecasting of Thai fresh frozen shrimps export to Japan would increase in the diminishing rate during 1999 to 2003. The average quantity export and the growing rate of Thai fresh frozen shrimps to Japan were 89,398.07 tons and 4.65 in percentage respectively.

The results of this study concluded that the Japan import demand for Thai fresh frozen shrimps depend on demand for fresh frozen shrimps in Japan, product price and product quality. Therefore public sectors and private sectors should fine the strategies to reduce cost. Moreover, the product quality be improved and more value should be added in order to be competitive in the world market.

Keywords: Factors; Imports; Demand; Frozen shrimps

933 Worawut Koysombut. 1999. **An analysis of export demand for Thai frozen shrimps to Singapore.** Independent Study, Master of Business Administration. Kasetsart University. 104 p.

Frozen shrimp is the agro-industry product which earns a lot of money for country. At present, however, shrimp exports to the main market such as USA and EU have faced with trade barrier, therefore, the new market like Singapore that has increasing imports frozen shrimp from Thailand became a promising export market.

The objectives of the study are to analyze the factors affecting demand for frozen shrimp exported from Thailand to Singapore, to analyze the change of Thai frozen shrimp market share in Singapore and to make suggestion for further development of frozen shrimp export to Singapore.

The analysis of export demand for Thai frozen shrimp to Singapore concluded that quantity demanded responses to the per capita gross domestic product which has the higher elasticity of +2.88, while quantity demanded responses to the export price of frozen shrimp and the export price of frozen squid are comparatively lesser with elasticity of - 1.33 and -0.60, respectively. The analysis of Thai frozen shrimp market share change concluded that imports from Thailand and Myanmar increase was due to the advantage of the market expansion, while imports from China and Vietnam increase was due to their competitive advantage in the market. However, the decrease of imports from Oceania and Malaysia was caused by their competitive disadvantage in the market.

As the result of this study suggested that Thai frozen shrimp should deduct export price and adapt appropriate export plan in line with the economic situation in Singapore in order to boost and enlarge the value and volume of export. Increasing competitive advantage in the market by decreasing production cost for pricing benefit and maintaining or increasing comparative advantage which was due to the market expansion by developing value added product.

Keywords: Demand; Exports; Analysis; Frozen shrimps

934 Surapart Luesukprasert. 2000. **Enhancement for productivity of frozen shrimp in the seafood industry.** Industrial Research Project, Master of Engineering. King Mongkut's University of Technology Thonburi. 119 p.

The purpose of this study is to improve the processing rate for frozen seafood industry. The processing line of frozen fresh water shrimp, especially a weighing and laying process, was chosen as a sample line for improvement. After analyzing the production system and process of this line by recording the processing line at each step for production one block of frozen fresh water shrimp, it was found that there was an idle delay time during processing which will affect to product's quality. In addition, the unbalance line lead to the bottle necks or build up of raw materials on the conveyors. Therefore, the principals of work study, standard time, and line balancing were adopted to improve the production system by increasing the production rate and line efficiency. From these improvements, balance delay, the use of required worker, and work – in – process inventory were reduced. This was beneficial to product quality in which product deterioration results from microorganism. Furthermore, the bottle necks were improved by a line balancing to enhance work efficiency. The standard time of each step was set up and used for daily production planning. This research has shown that the production rate was increased by 25.05 percent and labour cost was reduced by 16.13 percent. Finally, this study can be applied to the other products having a similar production processes, like fresh water shrimp ones.

Keywords: Productivity; Frozen shrimps; Seafood industry

935 Siri Tookwinas, Rangsichai Tabkaew and Prapansak Srisapoom. 1997. **An intensive marine shrimp culture in freshwater area (Suphanburi province): the preliminary investigation on**

impact assessment. Thai Fisheries Gazette 50(2): 153-164.

The preliminary investigation on impact assessment of an intensive marine shrimp farm in freshwater area has been conducted. The water and soil samples from the culture pond, freshwater canal in front of shrimp ponds and paddy field 20 m. distance from culture ponds were collected for water quality and soil quality analysis. The electrical conductivities (ECs) were higher on the second crop. And the ECs in paddy field were higher than 2 mmho/cm in the second crop which should have the effect on agriculture area. Therefore, the model for impact assessment which is purposed to minimized the salt ion intrusion from an intensive marine shrimp farms will be presented.

The paper presented at the Asian Shrimp Culture Council Meeting at Fortune Blue Wave Hotel, Bangkok on March 15, 1997.

Keywords: Marine shrimps; Intensive culture; Freshwater area; Suphan Buri

936 Sorawit Powtongsook. 1998. **Environmental studies in intensive prawn culture in Thailand.** Thai J. of Aqua. Sci 4(1-2): 1-19.

In Thailand, research on environmental impact from the intensive prawn farming has been conducted along with a rapid expansion of prawn industry since 1987. This review is a summary of selected research articles concerning environmental studies in prawn cultivation ponds. Several topics, *i.e.*, environmental impact from prawn farming on water and sediment quality, microbial studies, distribution of salt, water treatment and the development recirculating systems in prawn culture are discussed.

Keywords: Construction; Shrimp ponds; Treatment; Pollution loading

937 Suda Tandavanitj and Chantana Kaowtapee. 2000. **PCR technique for detection of WSSV in black tiger shrimp (*Penaeus monodon*) and other crustaceans known as carrier in Andaman coast.** Technical Paper No. 13/2000, Andaman Marine Shrimp Research and Development Center, Phuket. Department of Fisheries. 9 p.

A total of 864 shrimp broodstocks and 3478 post larvae were collected from hatcheries in Phuket and nearby province from October 1997 to December 1998 and detected for the presence of SEMBV using either one- or two step PCR assay. The one-step PCR assay showed 4.83% and 8.45% of positive results on post larvae and broodstocks, respectively, however, there were no significant difference ($P \geq 0.05$). The maximum positive results on post larvae and the

broodstocks were 28.80% in December 1996 and September, respectively. Three species of shrimp (*Penaeus merguensis*, *Metapenaeus ensis* and *Acetes* sp.) three species of crab (*Scylla serrata*, *Portunus pelagicus* and *Sesarma* spp.) and one species of mollusc, *Cerathium nodulosum* were collected from shrimp ponds, reservoirs, canals showed positive results. Two species of polychaetes (*Perinereis* sp. and *Diopatra* sp.) using as feed for the broodstocks were tested. *Perinereis* sp. were found to be positive for SEMBV.

Keywords: PCR; Detection; White Spot Disease; Black tiger shrimp; *Penaeus monodon*; Crustaceans; Andaman coast

938 P. Sansanayuth, A. Phadungchep, S. Ngammontha, S. Ngangam, P. Sukasem, H. Hoshino and M. S. Tabucanon. 1996. **Shrimp pond effluent: Pollution problems and treatment by constructed wetlands.** Wat. Sci. Tech. 34(11): 93-98.

An Intensive shrimp culture in Thailand has rapidly expanded especially along the coast during the last decade. Excessive feed basically given during the culture causes water and sediment in the pond to contain organic matter and nutrients in high concentration. After harvesting, discharging sediment is prohibited; however, pond water is mostly discharged directly to natural water resources without any effective treatment. The nutrient load discharged from shrimp ponds can form significant source of nutrients causing pollution and eutrophication in littoral areas of Thailand. The possibility of a subsurface-flow constructed wetlands application for treating shrimp pond effluent containing high salinity was studied. An experimental-scaled model planted with *Acrostichum aureum* (mangrove fern) in gravel was studied by comparison with one containing only gravel. The results showed that models can reduce suspended solids, biochemical oxygen demands, total organic carbon, total nitrogen (T-N) and total phosphorous (T-P) up to 84%, 91%, 46%, 48% and 31%, respectively. Higher removal efficiencies for TOC, T-N and T-P of the planted model compared with the gravel model were clearly found.

Keywords: Nutrients; Shrimp ponds; Effluents; Treatment

939 Benjamas Chuntapa, Sorawit Powtongsook and Piamsak Menasveta. 2003. **Water quality control using *Spirulina platensis* in shrimp culture tanks.** Aquaculture 220: 355-366.

A cyanobacterium (*Spirulina platensis*) was co-cultured with black tiger shrimp (*Penaeus*

monodon) for water quality control. We evaluated the effects of: (1) three *S. platensis* trial conditions on inorganic nitrogen concentrations at one shrimp density (*S. platensis* trial conditions included: absent, nonharvested and semicontinuous harvesting) and (2) two shrimp densities on inorganic nitrogen concentrations, with and without *S. platensis*. Semicontinuous harvesting of *S. platensis* at one shrimp density resulted in significantly reduced ($P<0.05$) inorganic nitrogen concentrations (NH_4 , NO_2 and NO_3). With *S. platensis* absent, ammonium and nitrite concentrations ranged from 0.5 to 0.6 mg l^{-1} , while nitrate concentrations ranged from 16 to 18 mg l^{-1} by day 44. With nonharvested *S. platensis*, considerable variability occurred with nitrogen concentrations. Semi-continuous harvest of *S. platensis* reduced nitrate to 4 mg l^{-1} , while ammonium and nitrite ranged from 0.0 to 0.15 mg l^{-1} , respectively. The factorial evaluation of shrimp density versus presence and absence of *S. platensis* resulted in greatly reduced nitrogenous compounds with *S. platensis* present regardless of shrimp density, and only moderately increased nitrogen with greater shrimp density. Without *S. platensis*, all nitrogen compounds were substantially elevated and shrimp survived was significantly reduced at high shrimp density.

Keywords: Water quality; *Spirulina platensis*; Shrimp culture; Cement tank

940 in Thai

941 Wimon Hemachandra. 1995. **Bacterial studies in the gulf of Thailand.** In Proceeding of NRCT-JSPS Joint Seminar on Marine Science, December 2-3, 1993, Songkhla. Bangkok: Department of Marine Science, Chulalongkorn University. p. 212-215.

Research on bacteria in the Gulf of Thailand has been focused on the contaminations from land and river run of that were used for indication of enteric disease and water pollution. At present the studies generally concentrate on pathogenic bacteria, food poisonings and paralytic shellfish poisonings. The studies on marine bacteria with direct effects on the environment are still limited.

Keywords: Bacteria; Gulf of Thailand; Water pollution

942 Piamsak Menasveta, Tanya Panritdam, Pakitsin Sihanonth, Sorawit Powtongsook, Benjamas Chuntapa and Phillip Lee. 2001. **Design and function of a closed, recirculating seawater system with denitrification for the culture of black tiger shrimp broodstock.** Aquacultural Engineering 25: 35-49.

A closed, recirculating seawater system with a denitrification process was designed for the culture of black tiger shrimp broodstock. The system comprised a circular rearing tank (9 m³ volume), a nitrifying biofilter (6 m³ volume) and denitrification process. The denitrification process comprised a deoxygenation column, a bacterial substrate column (143 L volume) and a re-aeration column connected to the biofilter. The experimental period was 81 weeks, consisting of 3 sequential trials using different substrates, bacterial inoculates and carbon sources: Trial 1- porous plastic balls for substrate, mangrove soil for inoculant and ethanol for the carbon source; Trial 2- crushed oyster shell for substrate, a strain of laboratory cultured bacteria for inoculant and ethanol for the carbon source; and Trial 3- crushed oyster shell for the substrate, no inoculant and methanol for the carbon source. The nitrifying biofilter controlled ammonium-N and nitrite-N within acceptable ranges (<0.5 and < 0.2 mg L⁻¹, respectively). The nitrate-N however, became elevated gradually during trial 1 (<50 mg L⁻¹). During trial 2, modification of bacterial substrate and the inoculation with denitrifying bacteria reduced nitrate-N in the denitrification column and the rearing tank (P<0.05) changing the carbon source to methanol and increasing the hydraulic residence time in trial 3 resulted in a significant reduction (P<0.05) in nitrate-N (from >160 to <25 mgL⁻¹) without the need for bacterial inoculation.

Keywords: Closed recirculating system; Shrimp culture; Denitrification; Black tiger shrimp; Broodstocks

943 Pipop Prabnarong, Prawit Towatana and Somsak Maneepong. 1994. **The impacts of shrimp culture on some chemical properties of soil in Amphoe Ranot, Songkhla.** Songklanakarin J. Sci. Technol. 16 (4): 425-436.

The expansion of shrimp farming, tiger prawn, into rice growing areas has adverse impacts on socioeconomic aspects and natural resources of the areas, particularly soil resources. Therefore, it is necessary to investigate the impacts of shrimp farming on the chemical properties of the soils. Three sites of Bangkok soil series (Bk) were selected from different locations at Amphoe Ranot, Sanot, Songkhla, namely a paddy field, new ponds (one-year old shrimp ponds), and old ponds (three-year old shrimp ponds). Soil samples were collected at the depth of 0-10, 10-20, 20-30, 30-40 and 40-50 cm from the bottom of the ponds respectively, and then analyzed for pH, electrical conductivity, organic matter, Na, K and S after they had been air-dried and sieved.

Statistical analysis comparisons among the same depth of the soil samples obtained from the paddy field, new ponds and old ponds revealed that pH levels of the shrimp pond soils decreased with cultivation time. Organic acid from the decomposition of organic matter and sea water employed in the shrimp ponds were probably responsible for the decline in the soil pH. The electrical conductivities of the shrimp pond soils.

Keywords: Soil properties; Shrimp farm; Songkhla

944 Prawit Towatana and Pipop Prabnarong. 1996. **Accumulation and mobility of ions from sea water in shrimp pond soil profiles and their impacts on environment and soil resource in Amphoe Ranote, Songkhla.** Songklanakarin J. Sci. Technol. (1): 113-127.

The study on accumulation and mobility of sea water ions in shrimp pond soil profiles was conducted by collecting soil samples from Tambol Phakgrae, Amphoe Ranote, Songkhla. All of the samples were Bangkok soil series and came from one-year old ponds (new ponds), three-year old ponds (old ponds) and the nearby paddy fields at the depth of 0-10, 10-20, 20-30, 30-40 and 40-50 cm from ponds' bottom, equal to 100-110, 110-120, 120-130, 130-140 and 140-150 cm from ground level. The investigated parameters included the amounts of Ca, Mg, Mn, Zn, Cu and microelements available in sea water ie. Hg, Sn, As, Cr, Sb, Cd, Pb, Ni, Ag, Cs and Ba. The results revealed that Ca was leached away at the depth interval of 100-130 cm from ground level and accumulated beyond depth of 140 cm by sea water, while Mg was leached away from the whole study profiles. Mn and Cu were neither leached away nor accumulated in the profiles. However, the accumulation of Zn at the depth of 100-120 cm was observed and its amount declined with depth. None of microelements was found accumulated in the profiles, except that minor amounts of Ba and Ni were detected at the ponds' bottom. The accumulated elements found in this study has no sufficient amounts to have adverse impacts on environmental integrity and soil resource.

Three zones could be designated on the basis of chemical reactions and ion mobility characteristics in the profiles. Firstly, leaching zone (100-120 cm), where the high concentration of Na⁺ in sea water substituted for exchangeable Ca²⁺ at the surface of clay minerals and organic matter as in the reaction. $2\text{Na}^+_{(\text{aq.})} + \text{Ca}^{2+}_{(\text{exch.})} \rightarrow \text{Ca}^{2+}_{(\text{aq.})} + 2\text{Na}^+_{(\text{exch.})}$. This resulted in the gain of Na but depletion of Ca in the profiles. Secondly, transition zone (120-140 cm) has neither Ca accumulation nor Ca depletion the leachate contained less Na⁺ and more Ca²⁺ than that of the leaching zone, resulting in decreasing influence of the aforementioned reaction. Finally, accumulation

zone, (140-150 cm) possessed the leachate with high Ca content and low amount of Na resulting in triggering the following reaction. $\text{Ca}^{2+}_{(\text{aq.})} + 2\text{Na}^{+}_{(\text{exch.})} \rightarrow 2\text{Na}^{+}_{(\text{aq.})} + \text{Ca}^{2+}_{(\text{exch.})}$. Based on this chemical signature, two major stages of Ca and Na mobility in the soil profiles were reconstructed as follows:

1. The initial stage took place at the beginning of shrimp culture. In this stage Na^{+} substituted for exchangeable Ca^{2+} in all the three zones since Na with monovalence travelled faster than divalent ions (Ca^{2+}) causing the gain of Na in the whole profiles.

2. The mature stage occurred when the pond had been used for some time. Thus, Ca^{2+} in solution arrived at the accumulation zone and substituted for exchangeable Na^{+} resulting in Ca accumulation in this zone.

Keywords: Accumulation; Mobility; Ions; Sea water; Shrimp ponds; Soil; Songkhla

945 Waleerat Musikasung, Somchai Vibunpant, Vichan Chusuwan and Kingkan Sudjai. 1994. **Study on water quality of shrimp farm effluence at Ranod, Songkhla province.** In Proceedings the Seminar on Fisheries 1994 Department of Fisheries, 19-21 September 1994 DOF Meeting Hall National Inland Fisheries Institute. p.224-229.

Study on coastal water quality from shrimp farm effluence in the nearshore area of Huasai district, Nakornsrithammaraj province to Ranod district, Songkhla province. The annual oceanography characteristic; chemical and physical parameters were conducted to highlight the environment during the period of before and after setting up of shrimp farm effluence managing system at Pakrava. Water sampling were taken during March 1993-May 1994 prior to determine salinity, temperature, transparency, pH, dissolved oxygen, biochemical oxygen demand, total suspended solid, nitrate, nitrite, ammonia, phosphate and water depth variations. The results show the ranges to be: salinity 0-35 ppt, temperature 26.0-32.9°C, transparency 0-370 cm, pH 6.60-8.78, dissolved oxygen 0.60-10.80 mg/l, biochemical oxygen demand 0.02-6.695 mg/l, total suspended solid 7.20-386.20 mg/l nitrate 0-0.1352 mg/l, nitrite 0-0.0900 mg/l ammonia 0-2.5034 mg/l, phosphate 0-0.6161 mg/l and water depth 0.40-12.50 m.

Keywords : Water quality; Shrimp farm; Songkhla; Effluents

946 Mali Boonyaratpalin, Wootiporn Phromkunthong and Kidchakan Supamataya. 1988. **Substitution of soybean meal for fish meal in**

***Penaeus monodon* feed.** Songklanakarin J. Sci. Technol. 10: 45-50.

Feeding experiments with *Penaeus monodon* were performed in 200 glass aquaria fitted with a closed recirculating system, *P. merguensis* with weight range from 0.035-0.043 g were reared by using 8 diet formulae (40% crude protein, 10% crude fat) containing varying levels of soybean meal (25, 35, 45, 55%). Each treatment comprises 4 replications. After a rearing period of 2 months it showed that diet formula 3 with 45% soybean meal gave the best growth. FCR and survival rate, but there were no significant differences among these treatments.

Keywords: Fish meal; Soybean meal; *Penaeus merguensis*; Feed

947 Chalee Paibulkichakul, Somkiat Piyatiratitivorakul, Prasat Kittakoop, Voranop Viyakarn, Arlo W. Fast and Piamsak Menasveta. 1998. **Optimal dietary levels of lecithin and cholesterol for black tiger prawn *Penaeus monodon* larvae and postlarvae.** Aquaculture 167: 273-281.

The effect of lecithin and cholesterol on growth and survival of larval and postlarval *Penaeus monodon* was evaluated using semi-purified diets containing four levels of lecithin (0.0, 0.5 and 1.0%). Three early stages (zoea, mysis and postlarval) of *P. monodon* were fed the experimental diets. Growth and survival of shrimp fed diets containing 1.0 and 1.5% lecithin were not significantly different ($P>0.05$) but these groups had significantly greater growth and survival than those fed 0.0 and 0.5% lecithin diets. Shrimp fed diets containing 1.0% cholesterol had significantly greater ($P<0.05$) growth and survival than that of shrimp fed diets containing 0.0 and 0.5 % cholesterol. There was no interaction between lecithin and cholesterol on growth and survival of *P. monodon*. During a low salinity stress test, PL-15 shrimp fed diets containing 1.0% cholesterol had significantly greater ($P<0.05$) tolerance to low salinity exposure.

Keywords: Lecithin; Cholesterol; Larval feeds; Larvae; Postlarvae; *Penaeus monodon*; Black tiger prawn

948 in Thai

949 Chalee Paibulkichakul, Somkiat Piyatiratitivorakul and Piamsak Menasveta. 2001. **Effect of fish oil enrichment on maturation performance of pond-reared black tiger prawn *Penaeus monodon* broodstock.** In the 28th Congress on Science and Technology of Thailand. p. 436.

In order to study the influence of fish oil on spawning rate, amount of spermatozoa and fatty acid composition of *P. monodon*, two groups of eyestalk ablated spawner were fed pelleted diets for a period of 120 days. The pelleted diet differed only in their lipid concentration: 3 and 8% fish oil of total diet. Shrimp fed low dietary fish oil showed significantly lower number of eggs ($P < 0.05$) than the other group. No significant difference was found in weight gain of spawner. Shrimp fed diet containing 8% fish oil had significantly higher docosahexaenoic acid concentration in ovary and hepatopancreas ($P < 0.05$) than the other group.

Keywords: Broodstocks; *Penaeus monodon*; Fish oil; Maturation

950 in Thai

951 Putth Songsangjinda, Chatchaval Intramontree and Lakana La-ongsiriwong. 2000. **Oxygen consumption in marine shrimp ponds of different production.** Technical Paper No. 4/2000. Marine Shrimp Research and Development Center, Songkhla. Department of Fisheries. 13 p.

Dissolved oxygen is one of most important water quality parameters essential for shrimp growth. Oxygen is consumed by three major respiration components in shrimp pond; water, sediment and shrimp respiration. The present study is aimed to measure the variation of oxygen consumption by these three components and to calculate the oxygen available for good growth in 2 marine shrimp (*Penaeus monodon*) ponds, which have different biomass.

During the study period, dissolved oxygen (DO) and temperature have been continuously measured every 15 min overnight. Whole pond respiration (WPR) was calculated from the slope at the saturation point of the second degree polynomial curve of the overnight DO variation. Water respiration (WR) was measured using dark bottles that were simultaneously incubated overnight. Shrimp respiration (SHR) was estimated from the oxygen consumption equation of the study species based on a measured weight and estimated number of shrimps living in the ponds. Sediment respiration (SR) was estimated to be equal to WPR-WR-SHR. The available oxygen was determined as total oxygen mass overnight that was higher than 4 mg l^{-1} .

Results of the present study showed that WPR varied from $179 - 1,186 \text{ mg O}_2 \text{ m}^{-2} \text{ h}^{-1}$ and increased with grow-out period. The average SP, WP and SHR were 45, 45 and 10% WRP, respectively. WPR in the ponds of which grow-out period less than 100 days were not significant

difference ($p > 0.05$), while WPR in those of grow-out period more than 100 days showed a significant difference due to different shrimp biomass (640 and $399 \text{ g fresh wt m}^{-2}$). WPR showed good correlation with water temperature (wtemp), shrimp biomass (biom) and cumulative feed (cfpm) expressing as the equation; $\text{WPR} = -1343.3 + 50.7 \text{wtemp} + 3.2 \text{biom} - 1.1 \text{cfpm}$ ($r^2 = 0.08$, $p < 0.05$). The available oxygen calculated from after midnight until dawn in the pond of less shrimp biomass was about $2,025 \text{ mg O}_2 \text{ m}^{-2}$ which was significantly higher than the available oxygen in the pond of high shrimp biomass ($683 \text{ mg O}_2 \text{ m}^{-2}$).

The present study indicates an importance of WR and SR as the factors influencing the variation of oxygen consumption in marine shrimp ponds of different production. The available oxygen especially from after midnight to dawn in the high production pond is occasionally low leading to the oxygen depletion and reduce of shrimp growth. This understanding is able to apply for the management of DO in marine shrimp pond for the good growth and production.

Keywords: Oxygen consumption; Marine shrimps; Shrimp ponds; Production

952 Kidchakan Supamattaya, Suprb Kiattapetew and Rodolf Hoffmann. 2000. **The immune system in black tiger shrimp, *Penaeus monodon* Fabricius III. Electron microscopic studies on hemocytes of black shrimp (*Penaeus monodon* Fabricius).** Songklanakarin J. Sci. Technol. 22 (Suppl.): 589-596.

Hemocytes of black tiger shrimp (*Penaeus monodon*) were studied under electron microscopy. Three types of hemocytes were described: hyaline cell, semigranular hemocyte and large granular hemocyte. Hyaline cells were discoid, spindle or crescent shaped approximately $6.8-13.9 \mu\text{m} \times 6.4-8.3 \mu\text{m}$. Cells contained a large nucleus with scanty cytoplasm. Semigranular hemocytes were approximately $9.0-14.2 \mu\text{m} \times 4.2-6.8 \mu\text{m}$, with small granules $0.5-1.0 \mu\text{m}$ in the cytoplasm. Pseudopodia were formed with a few microvilli on the surface of the cell. Large granular hemocytes were approximately $12.2-14.6 \mu\text{m} \times 7.2-7.8 \mu\text{m}$ and contained abundant $1.0-1.5 \mu\text{m}$ dense granules in the cytoplasm. Pseudopodia were formed with numerous microvilli. Hemocyte culture showed that there were more semigranular and large granular hemocytes than hyaline cells spread and adhering on glass slides. Virus infected hemocytes revealed decreased pseudopodia, decreased dense granules and karyorrhexis.

Keywords: Immune; Black tiger shrimp; *Penaeus monodon*; Electron Microscopy; Hemocytes

953 Kidchakan Supamattaya, Ussanee Ekpanithanpong, Yoshiaki Itami and Jiraporn Kasornchandra. 2000. **The immune system in black tiger shrimp, *Penaeus monodon* Fabricius: I. Techniques on immunological assessment and blood component in black tiger shrimp, *Penaeus monodon* Fabricius.** Songklanakarin J. Sci. Technol. 22 (Suppl.): 567-580.

The objectives of these studies were to develop appropriate techniques as standard method for studies of blood component and immune function in black tiger shrimp (*Penaeus monodon* Fabricius). The studies comprise a study on techniques for collection and separation of hemocytes, application of continuous gradient centrifugation techniques for separation of hemocytes, immunological function of hemocytes and serum i.e. phagocytic activity, clearance ability of bacteria, bactericidal and virucidal activity in the serum, prophenoloxidase activating system, superoxide production of hemocytes and copper content in serum. The application of techniques in immunological and blood parameters studies in black tiger shrimp are also discussed.

Keywords: Immune; Black tiger shrimp; *Penaeus monodon*; Blood

954 Mali Boonyaratpalin, Kidchakan Supamattaya and Choosak Borisuth. 2000. **The immune system in black tiger shrimp, *Penaeus monodon* Fabricius: VIII. Effects of astaxanthin on blood parameters, immune system and disease resistance in black tiger shrimp (*Penaeus monodon* Fabricius).** Songklanakarin J. Sci. Technol. 22 (Suppl.): 633-639.

Effects of astaxanthin supplemented in the feeds on growth, survival and weight increment in black tiger shrimp (*Penaeus monodon* Fabricius) were studied. The results showed that there were no effects on growth or on survival. However, an increase in the hemocyte count and in the clearance ability of shrimp body against bacteria were noted but no effects on phenoloxidase activity were detected. The supplementation of astaxanthin in the feeds improves the resistance against bacterial infection and the pigmentation of shrimp.

Keywords: Immune; Black tiger shrimp; *Penaeus monodon*; Astaxanthin; Blood; Disease resistance

955 Mali Boonyaratpalin, Kidchakan Supamattaya, Juadee Pongmaneerat, Sitdhi Boonyaratpalin and Yasuhiko Toride. 2000. **Immunostimulant and vaccination in black tiger shrimp. *Penaeus monodon* Fabricius : IV The stimulatory effect of high and low molecule peptidoglycan (PG) on**

immune responses in black tiger shrimp, *Penaeus monodon* Fabricius. Songklanakarin J. Sci. Technol. 22 (Suppl.): 689-696

High and low molecule peptidoglycan (hm-PG and lm-PG) extracted from *Bifidobacterium thermophilum* were mixed in shrimp feed at the levels of 0 and 0.1% for hm-PG and 0.0085% for lm-PG. Shrimps were fed with peptidoglycan (PG) supplemented diets for five weeks. Superoxide anion production from hemocyte of shrimp fed PG supplemented diet was higher than that of the control shrimp. Phenoloxidase activity in the cytoplasmic granules of hemocyte of shrimps fed test and control was determined, but showed no significant differences.

The results on clearance ability of shrimp against bacteria in the hemolymph showed that the shrimps fed PG supplemented diets were able to eliminate 90% of bacteria whereas the control shrimps could eliminate only 50%. Moreover, shrimps fed with PG supplemented diets were more resistant to *Vibrio harveyi* infection than the control group with the survival rates of 61, 70 and 10% for shrimp that fed hm-PG, lm-PG supplemented diets and control diet, respectively. The results on superoxide anion production from the shrimp hemocyte and resistance to bacterial infection revealed that lm-PG was a better immunostimulant than hm-PG.

Keywords: Peptidoglycan; Vaccination; Black tiger shrimp; *Penaeus monodon*; Immune

956 Sapon Onkong, Amonrat Sermwatanakul and Chutima Tantikitti. 2000. **Residues of oxytetracycline in black tiger shrimp (*Penaeus monodon*) reared in cement tank and earthen pond.** Songklanakarin J. Sci. Technol. 22 (Suppl.), 717-724.

The objective of this experiment was to investigate residual concentration of oxytetracycline (OTC) in different tissues of black tiger shrimp subsequent to treatment with the antibiotic. Three-month-old shrimps weighing 17.54 ± 0.5 g were cultured in $1.2 \times 2.8 \times 0.6$ m³ cement tanks or in 0.25 hectare earthen ponds. Three cement tanks each containing 30 shrimps per square meter and two earthen ponds each containing 35 shrimps per square meter were used. Shrimps were fed commercial diet sprayed with OTC (86.4% active ingredient) 5 g/kg of diet at the daily feeding rate of 3% of body weight for seven days. The shrimps were then sampled every day for a period of 28 days for the determination of residues of OTC in integument, hepatopancreas, and muscles. These determinations were made using high performance liquid chromatography. For both rearing conditions, the OTC concentration in the hepatopancreas during the medication period was 2 to

3 fold higher compared with the other tissues. The OTC concentration in hepatopancreas decreased from approximately 19 to 2 ppm within 7 days after withdrawal and the tissue was free of any detectable residue at 17 and 14 days after withdrawal in the cement tanks and earthen ponds, respectively. Since the dietary concentration of OTC used in this experiment is the same as that used in commercial farming, a withdrawal period of 21 days appears to be adequate in terms of public health concerns related to residual levels of this antibiotic in the shrimp tissues meant for human consumption.

Keywords: Black tiger shrimp; Oxytetracycline; Residues; Cement tank; Earthen pond

957 Sawitri Silakes and Kidchakarn Supamattaya. 2000. **Immunostimulant and vaccination in black tiger shrimp, *Penaeus monodon* Fabricius: II. Production of vaccine from *Vibrio harveyi* and its application in black tiger shrimp (*Penaeus monodon* Fabricius).** Songklanakarin J. Sci. Technol. 22 (Suppl.): 663-676.

The luminescent bacterium *Vibrio harveyi* was isolated from infected black tiger shrimp and identified biochemically. The bacterium was incubated at room temperature for 24 hours in Tryptic Soy Broth. The cells were then killed by ultrasonic homogenization. The sterility of the vaccine was confirmed. The vaccine was then lyophilized and preserved in dried form.

The vaccine was administered to the black tiger shrimp using two methods; oral and immersion. Oral administration was with the dry vaccine mixed with feed at 0, 0.1, 0.5 and 1% of the total weight of the feed. The immersion solution was prepared by diluting 2.5% vaccine solution to 1 : 250 (vaccine : seawater). Shrimp were immersed in the dilute solution for five hours. The treatment was repeated 14 days after the first immersion. Blood was collected from black tiger shrimp at 10, 20 and 30 days post vaccination. It was analyzed for phenoloxidase activity, superoxide anion production, bacterial clearance from haemolymph and disease resistance against *V. harveyi*.

These methods produced positive results in clearing bacteria from the haemolymph, and in disease resistance against *V. harveyi*. The overall survival (RPS) was less than 60%, leading to the conclusion that vaccine administered by either oral or immersion methods has a low protection factor for black tiger shrimp. In the oral trial, there was no significant difference among the 0.1, 0.5 and 1% vaccine added to the feed.

Keywords: Immunostimulant; Vaccination; *Vibrio harveyi*; *Penaeus monodon*; Shrimps; Vaccines

958 Sunthorn Chooluck, Thiranan Wongsombat, Apinunt Udomkit, Burachai sonthayanon and Sakol Panyim. 2000. **Expression of Pem-CMG1, an eyestalk neuropeptide of *Penaeus monodon* in *Escherichia coli*.** In the 2nd National Symposium on Marine Shrimp, 23-25 November 2000. p.56-62.

A number of physiological processes in crustacean are regulated by a family of neuropeptides that are synthesized from eyestalks. Member of this neuropeptide family includes crustacean hyperglycemic hormone (CHH), a hormone that regulates sugar metabolism, molt-inhibiting hormone (MIH) that triggers inhibition of molting and gonad-inhibiting hormone (GIH) that controls gonad maturation. The hormones in this family of several crustaceans have highly similar structure. Based on the conserved amino acid sequences of these hormones, a cDNA encoding a peptide related to this family, so-called Pem-CMG1 was successfully cloned from *Penaeus monodon*. In this work, the Pem-CMG1 cDNA was subcloned into expression vector, pET3a, and the expression of Pem-CMG1 cDNA was induced to occur at high level in *Escherichia coli* by IPTG. The recombinant peptide was expressed as an insoluble fraction that formed inclusion in *E. coli* cells. The sequence of five amino acid residues at the N-terminus of the expressed peptide was determined and revealed identical amino acid sequence as expected from the nucleotide sequence of Pem-CMG1 cDNA. More than 50% of the inclusion protein could be solubilized in 6 M urea. The soluble Pem-CMG1 peptide was purified with one round of reversed-phase HPLC. Most contaminated proteins were removed by this purification step. The purified Pem-CMG1 peptide could be used in further characterization step such as an assay for its biological function.

Keywords: Expression; Pem-CMG; Eyestalks; *Penaeus monodon*; *Escherichia coli*

959 Phudhi Chauyuchwong, Paisarn Sithigorngul, Weerawan Sithigorngul, Parine Chaivisuthangkura and Piamsak Menasveta. 1999. **Development of a monoclonal antibodies: Establishing an immunological-basis for specific diagnosis of viral infection in *Penaeus monodon*.** In the 1st National Symposium on Marine Shrimp, 15-17 December 1999, B.P. Smila Hotel, Songkhla. National Center for Genetic Engineering and Biotechnology. p.74-84.

Two monoclonal antibodies specific for viral antigens were produced from a mouse immunized with *Penaeus monodon* gill extract prepared from infected shrimp. One clone designated SEM-3-2B showed a stronger immunoreactivity by dot-blot assay to gill extract prepared from infected shrimp

than did the other clone, designated SEM-219. Both antibodies bound with native and SDS treated viral antigens. Immunocytochemical studies of infected gills revealed viral immunoreactivities in epithelial cell cytoplasm and in haemocytes. No antibody binding was observed in gills from non-infected shrimp. Our preliminary work with immunocytochemistry using SEM-3-2B antibody with tissues from asymptomatic shrimp revealed viral immunoreactivity in a few cells of gill muscles, ovaries, hepatopancreas and lymphoid organs. This suggested that this antibody can be used to identify mild viral infections in shrimp and therefore provides a promising and effective tool for routine viral diagnosis.

Keywords: Monoclonal antibody; Diagnosis; Infections; *Penaeus monodon*

960 Premruethai Supungul, Sirawut Klinbunga, Rath Pichyangkura, Sarawut Jitrapakdee, Ikuo Hirono, Takashi Aoki, and Anchalee Tassanakajon. 2002. **Identification of immune-Related Genes in Hemocytes of Black Tiger Shrimp (*Penaeus monodon*)**. Mar. Biotechnol. 4: 487-494.

An expressed sequence tag (EST) library was constructed from hemocytes of the black tiger shrimp (*Penaeus monodon*) to identify genes associated with immunity in this economically important species. The number of complementary DNA clones in the constructed library was approximately 4×10^5 . Of these, 615 clones having inserts larger than 500 bp were unidirectionally sequenced and analyzed by homology searches against data in GenBank. Significant homology to known genes was found in 314 (51%) of the 615 clones, but the remaining 301 sequences (49%) did not match any sequence in GenBank. Approximately 35% of the matched ESTs were significantly identified by the BLASTN and BLASTX programs, while 65% were recognized only by the BLASTX program. Of the 615 clones, 55 (8.9%) were identified as putative immune-related genes. The isolated genes were composed of those coding for enzymes and proteins in the clotting system and the prophenoloxidase-activating system, antioxidative enzymes, antimicrobial peptides, and serine proteinase inhibitors. Three full-length ESTs encoding antimicrobial peptides (antilipopolysaccharide and penaeidin homologues) and a heat shock protein (cpn10 homologue) are reported.

Keywords: Identification; Immune; Genes; Black tiger shrimp; *Penaeus monodon*

961 Lila Ruangpan, Rangsichai Tabkaew and Koolvara Sangrungruang. 1995. **Bacterial flora of**

ponds with different stocking densities of black tiger shrimp, *Penaeus monodon*. In Diseases in Asian Aquaculture II. M. Shariff, J.R. Arthur & Subasinghe (eds.), Fish Health Section, Asian Fisheries Society, Manila. p. 141-149.

A survey of aerobic and facultatively anaerobic bacterial flora in the rearing water of shrimp ponds in Chanthaburi Province was carried out during November 1989 to April 1990. A black tiger shrimp (*Penaeus monodon*) farm selected for this study comprised of two ponds stocked at 30/m² and another two ponds with densities of 45/m². The total bacterial and *Vibrio* counts ranged, respectively, from 10³ to 10⁴ and 10² to 10³ CFU/mL in the ponds stocked with low density, whereas 10⁴ to 10⁵ and 10³ to 10⁴ CFU/mL were found in the ponds stocked with high density. *Pseudomonas* dominated the bacterial flora throughout the rearing period. Based on 42 biochemical tests, the isolated vibrios were identified as *V. damsela*, *V. alginolyticus*, *V. parahaemolyticus*, *V. harveyi*, *V. fluvialis*, *V. cholerae* (non-01), and *Vibrio* spp. Other bacteria were classified as *Aeromonas*, *Moraxella*, *Pseudomonas*, *Flavobacterium*, *Plesiomonas*, and *Acinetobacter*.

Keywords: Ponds; Stocking density; Bacterial flora; Black tiger shrimp; *Penaeus monodon*

962 Kreeson Packthongsuk, Chaivat Kittigul, Amornrat Angajchariya and Apichai Prachasuparp. 2001 **Purification and Protein Characterization of Yellow-head virus for Preliminary Monoclonal antibody Production**. In The 39th Kasetsart University Annual Conference, 5-7 February 2001. p. 284-289.

Purification of yellow head virus (YHV) of black tiger shrimp was performed by ultracentrifugation using 25-45% continuous sucrose gradient. Characterization of virus protein was performed by 10-15% gel SDS-PAGE. There are four major virus proteins molecular weights of 22, 67, 112 and 135 kDa. By Western Blot (WB) analysis, all of the four virus proteins reacted with polyclonal antibody from mice immunized with purified YHV. The protein band with molecular weight of 135 kDa showed prominent reaction with antibody in WB analysis when compare to the others, indicating that it is highly immunogenic. Seven hybridoma clones secreting monoclonal antibodies to YHV were obtained from cell fusion between mouse myeloma cells and spleen cells of mice immunized with purified YHV. These monoclonal antibodies are in the process of characterization. Utilization of monoclonal antibody for development of immunoassay of YHV will be performed further.

Keywords: Purification; Proteins; Yellow Head Virus; YHV; Monoclonal antibody

963 Pornlerd Chanratchakool, Chalor Limsuwan, Supranee Chinabut, Niti Chuchird and Seri Donkaewbua. 1997. **Studies on pathogenicity and prevention of white spot disease in black tiger shrimp (*Penaeus monodon* Fabricius).** Research report 1997, BT-39-06API-30-12. National Center for Genetic Engineering and Biotechnology (BIOTEC). 26 p.

White Spot disease, caused by White Spot Baculovirus, has proved to be one of the major diseases of black tiger shrimp. The disease has caused severe losses over wide areas. The virus can be detected in all stages of the shrimp life cycle and this study looked at the possibility of reducing the incidence of the disease using formalin as a treatment during the culture process. The effect of such treatment on water quality, survival rate and production was also investigated.

The effect of formalin bath treatment at concentrations of 100, 150 and 200 ppm for up to 90 minutes on the survival of shrimp post larvae 12-15 after transportation was studied. No significant reduction in survival rate was observed up to 1 day post treatment. A similar result was observed on the treatment of infected larvae. Formalin at concentrations of 100 and 150 ppm can be used to bathe larvae for 30-60 minute without any significant reduction of survival rate. Stressful conditions during the treatment period caused some mortality and weakness of the larvae. More virus was found within the weak larvae which were subsequently separated from the population that was stocked. Chances of disease outbreak can therefore be reduced by elimination of infected larvae from the population using formalin treatment. However, some infected larvae remain in the population after treatment and can act as source of virus. Infected larvae can survive until the pond conditions deteriorate, mainly due to seasonal changes. During periods of fluctuation an outbreak can occur when infected dead shrimp are eaten by others; evidence from field studies confirmed this observation. Many ponds stocked with White-Spot virus free post larvae (checked using PCR), and using formalin treatment to eliminate the weak larvae before stocking, suffered from White Spot diseases. Most of the affected ponds were found to be infected during the period of heavy rain in October and November. Results from transmission experiments also suggested that transmission by the oral route was more significant than the water-borne route.

Using formalin at concentrations of 25 and 45 ppm as bath treatment after exposing shrimp to virus solution and co-habitation was not effective.

The formalin concentration was too low to eliminate the virus both in the water and in the dead shrimp. However, formalin application in the pond at 30 ppm stressed the animals, especially weak or infected shrimp, due to oxygen and pH reduction. These stressed shrimp will come to the pond surface and can be removed before they die in the pond and further spread infection. Once the disease carrier is eliminated, the possibility of severe outbreak is reduced. Due to the effects of formalin on water quality and plankton, water parameters need to be closely monitored. Water exchange can be performed after treatment to improve conditions in the pond.

Keywords: Black tiger shrimp; *Penaeus monodon*; Prevention; White Spot Disease; Pathogenesis

964-965 in Thai

966 นนทวิทย์ อารีย์ชน. 1990. การใช้ Povidone Iodine ในการกำจัดเชื้อ *Aeromonas hydrophila* และ *Vibrio harveyi*. Thai Fisheries Gazette 43 (3):199-203.

Povidone Iodine, (PI), an organic-iodine complex, was used as a disinfectant of two common pathogenic bacteria of aquatic animals, *Aeromonas hydrophila* and *Vibrio harveyi*. This iodophor was very effective as a bactericide of these two gram negative bacteria. *A. hydrophila* (1.9×10^7 cells/ml.) were completely disinfected within 30 minutes with 3 ppm of PI (active ingredient) while *V. harveyi* (4.5×10^6 cells/ml) were completely disinfected with 2 ppm. Unsterilized seawater (30 ppt) with 10^5 cells/ml of *V. harveyi* could be disinfected by 1 ppm povidone iodine (active ingredient) within 30 minutes. Povidone iodine has been found to have good bactericidal activity in this study.

Keywords: Povidone iodine; *Aeromonas hydrophila*; *Vibrio harveyi*; Bacteria; Aquatic animal

967 Piyarat Chansiripornchai, Warin Tanasomwang, Malinee Kitkumthorn and Janenuj Wongtavatchai. 2002. **Comparative toxicity between cypermethrin and deltamethrin in black tiger shrimp (*Penaeus monodon*) and tilapia (*Oreochromis niloticus*) by measurement of cholinesterase activity.** In การประชุมวิชาการทางสัตวแพทย์และการเลี้ยงสัตว์ ครั้งที่ 28 วันที่ 9-11 ตุลาคม 2545 ณ โรงแรมอิมพีเรียล ควีนส์ปาร์ค ถนนสุขุมวิท กรุงเทพมหานคร. [CD-ROM]

Toxicity of cypermethrin (CM) and deltamethrin (DM) in black tiger shrimp (*Penaeus monodon*) and tilapia (*Oreochromis niloticus*) was compared by measuring the inhibition of cholinesterase activity (ChE) in muscle tissue of shrimp and fish serum. The exposure of 0.1 ppb CM of DM for 5 days effectively

reduced ChE activity in shrimp muscle. This indicated the sensitivity of shrimp, a member of the same phylum as target species of insecticides, to both CM and DM. Whereas the toxicity study in a non-target animal species, fresh water fish tilapia, suggested that CM was more toxic than DM. The significant decline in serum ChE activity ($p < 0.05$) was observed within a shorter period in tilapia exposed to CM than those exposed to DM. The study demonstrated efficiency of both CM and DM in the inhibition of ChE in target animal species. DM appeared to be less toxic than CM when the effect on ChE inhibition in a non-target species, tilapia, was concerned.

Keywords: Toxicity; Cypermethrin; Deltamethrin; *Penaeus monodon*; Black tiger shrimp; *Oreochromis niloticus*; Cholinesterase

968 Pradit Chonchuenchob. 1998. **Diseases of eye-ablated jumbo tiger prawn.** Technical Paper No. 34/1988, Satul Brackishwater Fisheries Station. Department of Fisheries. 10 p.

Unilateral eyestalk ablation of Jumbo Tiger Prawn (*Penaeus monodon*) resulted in ovarian development of 22 female prawns, but only five of them were spawned. Cannibalism, serious injury suffered from ablation, protozoan infestation (*Zoothamnium* sp. and *Acineta* sp.) bacteria (Filamentous bacteria and *Vibrio* sp.) and diatom (*Nitzschia* sp.) were occurred and led to the average mortality rate of 58.67%

Keywords: Jumbo tiger prawn; Diseases; Eyestalk ablation

969 Pornlerd Chanratchakool, Chalor Limsuwan and Jaree Polchana. 1998. **The use of formalin to prevent White Spot Baculovirus outbreaks in black tiger shrimp, *Penaeus monodon* (Fabricius).** In Proceedings of the 36th Kasetsart University Annual Conference, 3-5 February 1998. [Online]. Available: <http://kucon.lib.ku.ac.th/Agris/th/index.html>.

Mass mortality due to White Spot Baculovirus (WSBV) infection has proved to be one of the biggest problems in the culture of tiger shrimp, *Penaeus monodon*. Outbreak of this disease has resulted in serious economic losses over wide areas within a short period of time. This is possibly due to the transmission of the pathogen by water and potential carriers, especially shrimp post larvae. Avoiding stocking with infected post larvae is one simple technique to prevent an outbreak. Bath treatment using formalin at 100, 150 and 200 parts per million (ppm) for 30, 60 and 90 minutes can separate weak and infected post

larvae from the population. This method does not effect the survival rate of healthy post larvae. Field trials were conducted during the high risk period in November by treating the post larvae with 100 ppm formalin, for 30 minutes prior to separating out the healthy post larvae for stocking into 3 nursery ponds each with a stocking density of 500,000 pl/1,600 m². Juvenile shrimp were transferred to 7 others grow-out ponds 35 days post stocking. Health monitoring for WSBV infection was carried out using PCR technique every 10 days. Formalin treatment at 30 ppm was used if the results from the PCR testing were positive. After 110-150 days, shrimp were harvested, the survival rate was 60-90% and the shrimp had an average size of between 14 and 24 gm.

Keywords: Formalin; White Spot Baculovirus; Black tiger shrimp; WSBV

970 Ranue Juntarawimoon and Panas Tumkiratiwong. 2001. **Effect of trifluralin on changes of biochemical substance and some important enzymes in hemolymph black tiger prawns (*Penaeus monodon*).** In The 39th Kasetsart University Annual Conference, 5-7 February 2001. p. 18-24.

This research was conducted to investigate the effect of various levels of trifluralin concentration on some of biochemical substance and enzymes in hemolymph of black tiger prawns aged 4 months, of which 96 black tiger prawns were allocated into 4 groups; 0, 0.015, 0.03 and 0.06 ppm, each group contains 24 animals and designed according to completely randomized design. The hemolymph was collected prior to trifluralin administration in 4 groups and 15 hours post-administration of trifluralin. It was found that blood urea nitrogen tended to be increased in all 4 groups and there was no significant difference between control group and all remainder groups both 0 and 15 hours of trifluralin administration ($P > 0.05$). Whereas the activity (unit per liter) of aspartate transaminase, alanine transaminase, alkaline phosphatase, gamma glutamyl transaminase and lactate dehydrogenase was not significantly different between control and treatment groups ($P > 0.05$) both 0 and 15 hours but there was significant difference in alkaline phosphatase between control group and treatment groups at 15 hours post administration ($P < 0.05$). It was concluded that the activity of all enzymes investigated in hemolymph of black tiger prawns are highly varied distribution.

Keywords: Trifluralin; Enzymes; Hemolymph; Black tiger prawn; *Penaeus monodon*

971 Ussanee Ekpanithanpong and Sitdhi Boonyaratpalin. 1997. **Efficacy of calcium hypochlorite as a disinfectant against yellow-head virus disease in Tiger prawn, *Penaeus monodon*.**

Technical Paper No. 13/1997, National Institute of Coastal Aquaculture, Songkhla. Department of Fisheries. 8 p.

Virucidal activity of chlorine was determined against yellow-head baculovirus (YHD). Chlorine was added into virus suspension at concentrations of 20, 30, 50, 100 mg/L for 1, 3, 6, 24 hours of exposure time and 300 500 mg/L for 1, 5, 10, 30 minutes of exposure time. Viral infectivity after chlorine treatment was performed by injecting those solution into healthy shrimp. The result indicated the viral activity was reduced by chlorine at 20 mg/L for 24 hours. The static bioassay of chlorine was used to estimate the acute toxicity of chlorine to *P. monodon* (10-30 cm). The median lethal of chlorine was 56.82 mg/L at 96 hours. The use of chlorine as YHD disinfectant was also suggested.

Keywords: Calcium hypochlorite; Disinfectants; Yellow Head Virus; YHV; *Penaeus monodon*

972 Kanokphan Srimanobhas. 1993. **Microbiological method for detection of antibiotic residue (oxytetracycline) in frozen black tiger shrimp.** Fish Inspection and Quality Control Sub-Division Fishery Technological Development Division. Department of Fisheries. 11 p.

Detections of antibiotic residue (Oxytetracycline) in frozen black tiger shrimp (*Penaeus monodon*) for export by microbiological method were undertaken during 1991-1993. A total of 6, 2 and 32 samples contained oxytetracycline and representing 170.5, 34 and 835.7 tons of export product respectively. The detection of oxytetracycline in frozen shrimp show that there are still improper used of oxytetracycline in aquaculture. So farmer should carefull use of antibiotic and shrimp raw material should be examine before processing.

Keywords: Antibiotic residues; Oxytetracycline; Frozen shrimps; Black tiger shrimp

973 Supatra Srichairat. 1995. **Determination of cholinesterase activity in tiger shrimp and giant perch.** The Thai Journal of Veterinary Medicine 25(3):194-206.

The conventional colorimetric method of cholinesterase activity determination in blood and tissues of mammals was applied to investigate the enzyme activity in muscle and nervous cell of aquatic animals which are economically important, such as, tiger shrimp (*Penaeus monodon* Fabricus) and giant perch (*Lates calcarifer*). Decreased

enzyme activity in aquatic animals may indicate the contamination of insecticide in water resources. This study demonstrated that the method was suitable for detecting toxicity of organo-phosphate insecticide due to its convenience, simplicity and no sophisticated or expensive instruments needed. Moreover, the samples can be kept frozen for 2 weeks before analysing with less than 1% declining of enzyme activity.

Keywords: Determination; Cholinesterase; Black tiger shrimp; Enzymes; *Lates calcarifer*

974 Sataporn Direkbusarakom, Sompom Rungkomneradwong, Angkana Herunsalee and Lila Ruangpan. 1996. **Screening of Thai traditional herbs against shrimp pathogenic bacteria.** Technical Paper No. 7/1996, National Institute of Coastal Aquaculture, Songkhla. Department of Fisheries. 7 p.

Sixteen kinds of Thai traditional herbs; *Ocimum sanctum* white and red strains, *Cassia alata*, *Tinospora cordifolia*, *Eclipta alba*, *Tinospora crispa*, *Psidium guajava*, *Clinacanthus nutans*, *Andrographis paniculata*, *Momordica charantina*, *Phyllanthus reticulatus*, *Phyllanthus pulcher*, *Phyllanthus acidus* and 3 strains of *Phyllanthus* spp. Including *P. amarus*, *P. debelis*, and *P. urinaria* were tested for their antibacterial efficacy against 10 strains of *Vibrio* spp. isolated from diseased shrimp using plate dilution method (Tragen 1983).

Eleven species of the tested herbs showed antibacterial activities, however only two species of them (*P. guajava* and *M. charantina*) showed the highest effective against *Vibrio* spp. Minimal inhibitory concentration of *P. guajava* was found at 0.625 mg/ml while the *M. charantian* was 1.25 mg/ml. Further studies were considerably carried on in various aspects of these two herbs in order to apply in the large scale of the experimentation.

Keywords: Herbs; Shrimps; Bacteria; Diseases; Black tiger shrimp

975 Kanika Kanjanachatee. 1991. **Depletion of oxytetracycline in fresh and salt water.** Master Thesis. Kasetsart University. 80 p.

The study indicated that 25 and 45 part per million (ppm) of oxytetracycline were required to inhibit the growth of *Aeromonas hydrophila* (10^7 CFU/ml) and *Vibrio* sp. (10^9 CFU/ml) respectively. Rate of depletion of oxytetracycline with concentration of 25, 50, 75 and 100 ppm in fresh and salt water were determined. At 25 ppm, oxytetracycline completely depleted in fresh and salt water within 9 and 12 days respectively. Comparison between clear zone of same concentration of

oxytetracycline indicated smaller diameter in salt water than in fresh water which might be due to different composition of these two waters. Cation and with other elements in salt water might bind and form large complex with oxytetracycline and made it more difficult to diffuse through the bacterial membrane and reduced the size of the clear zone.

Studies on the influence of salinity, temperature and sunlight on the depletion rate of oxytetracycline were investigated. With salinity of 10, 20, 30 and 40 ppt, oxytetracycline at a concentration of 45 ppm completely depleted within 15, 19, 27 and 30 days respectively. Sunlight exposure increased the depletion rate of oxytetracycline. In fresh water, oxytetracycline exposed to sunlight from morning to evening depleted from 24.12 ppm to 5.77 ppm while unexposed oxytetracycline depleted slightly from 24.34 ppm to 22.77 ppm within the period of 24 hours. These different depletion rates were highly significant. In salt water, sunlight had less influence on depletion rate than in fresh water in which exposed oxytetracycline depleted from 43.96 to 26.20 ppm while unexposed oxytetracycline depleted from 44.34 to 42.11 ppm. These differences were statistically significant. High temperature sped up the depletion rate of oxytetracycline. At 50, 40, 30 and 20°C, oxytetracycline in fresh water (25 ppm) and salt water (45 ppm) depleted completely within 1, 3, 8, 20 and 8, 16, 29 and 50 days respectively.

When oxytetracycline was used along with the culture of fresh water fish and marine shrimp, depletion rate were not significantly affected when compared with the non cultured one.

Keywords: Oxytetracycline; *Vibrio*; *Aeromonas hydrophila*; Salinity; Temperature

976 in Thai

977 ลีลา เรืองแป้น, สถาพร ตีเรกบุษราคม และ เขาวนิตย์ ดนยตล. 2543. ประสิทธิภาพและผลข้างเคียงของการใช้ พญาขอ (*Clinacanthus nutans*) ป้องกันโรคไวรัสในกุ้งกุลาดำ. ใน การประชุมวิชาการกุ้งทะเลแห่งชาติครั้งที่ 2 “การยกระดับกุ้งไทยด้วยงานวิจัยและพัฒนา” วันที่ 23-25 พฤศจิกายน 2543 โรงแรมรอยัล ภูเก็ต ซิตี้ จ. ภูเก็ต. ศูนย์พันธุ์วิศวกรรมและเทคโนโลยีชีวภาพแห่งชาติ. น. 119-127.

The experiment on using *Clinacanthus nutans* for control the Yellow Head Baculovirus (YHV) and Systemic Ectodermal and Mesodermal Baculovirus (SEMBV) which cause mass mortality to black tiger prawn (*Penaeus monodon*) was carried out to achieve the efficacy and side effect

as well as the environmental impact to prawn culture after using this medicated herb.

The efficacy of the herb was constant in the different level of seawater salinitites range from 10-30 ppt, which could eliminate 100, 78.3, 78.3, 66.7, 63.3 and 50% of YHV and 80, 75, 63.7, 60, 53.3 and 50% of SEMBV in day 1 to day 7 after 1 µg/ml of herb extract was dissolved in seawater. The optimal concentration for mixing with pellet feed was 0.1 g/kg which could be control the diseases caused by SMBV and YHV at the highest rate 37.93 and 94.4% after prawn received the herb continuously for 14 and 28 days, respectively. No side effect in terms of growth rate, immune system, tissue organs and intestinal bacterial flora after the prawn received herb extract at the optimal concentration or even 10 times higher level. It was suggested that further investigations were needed to prove the herb's efficacy for control the epidermic of viral diseases by elimination the virus in prawn broodstock and postlarvae before release to the grow-out pond.

Keywords: *Clinacanthus nutans*; Viruses; Black tiger prawn; *Penaeus monodon*; Herbs

978 ชัชวาล อินทมนตรีย์, พุทธ ส่องแสงจินดา และลักขณา ละอองศิริวงศ์. 2545. ผลกระทบของการเกิดสภาวะขาดออกซิเจนต่อคุณภาพสิ่งแวดล้อม และการเติบโตของกุ้งกุลาดำในบ่อเลี้ยงแบบหนาแน่น. ใน การประชุมวิชาการกุ้งทะเลแห่งชาติครั้งที่ 4 “เทคโนโลยีเพื่อกุ้งไทย กุ้งคุณภาพระดับโลก” 18-19 พฤศจิกายน 2545 ศูนย์ประชุมริมน้ำทะเล ระยองรีสอร์ท จังหวัดระยอง. ศูนย์พันธุ์วิศวกรรมและเทคโนโลยีชีวภาพแห่งชาติ. น. 175-185.

An anaerobic condition in shrimp pond usually finds in the intensive cultivation system, which producing the toxic substrants i.e. hydrogen sulfide, methane by the anaerobic decomposition. The objective of the present work is to study the effect of anaerobic condition on water and sediment qualities and shrimp (*P. monodon*) growth in intensive cultivation. The pond size of out 0.5 rai, was used for collection water and bottom sediment including shrimp growth through 150 days of culture period. The water and bottom sediment quality were measured every 2 weeks intervals until shrimp harvest. Concentration of water quality was in suitable level and increased over the time. (TAN, Nitrite, TN and Chlorophyll a: 0.032-0.949 mgN/l, 0.001-0.065 mgN/l, 0.761-5.564 mgN/l, 12-268 µg/l, respectively) The dissolved oxygen ion was more than 70% saturation. In the surface layer of sediment, occurred anaerobic condition from 30 days of culture period which oxidation-reduction potential was negative (-122 to -313 mV). The shrimp growth retardation was detected during 100-114 days of culture period which total ammonia-nitrogen,

hydrogen sulfide, organic matter and sediment oxygen demand in the sediment ranged in highest values. (72-73 mgN/l, 1,078-1,275 mgS²/kg, 34-26% and 364-532 mgO₂/kg dry soil/hr respectively). When shrimp was partially harvest the shrimp growth recovers to be normal and sediment quality improved making oxidation-reduction potential increase. The results from the present study indicate that organic matter has importunate on sediment bottom qualities which changed sediment oxygen demand and oxidation-reduction potential, stimulating anaerobic condition and producing hydrogen sulfide and ammonia-nitrogen. Such worse anaerobic condition was cared by anaerobe bacteria and finally affected to the retardation of shrimp growth.

Keywords: Bottom sediment; Dissolve Oxygen; DO; Bacteria

979 เอกสิทธิ์ จีระเร็นศักดิ์, วิวัฒน์ เรืองเลิศปัญญากุล และ Timothy William Flegel. 2545. แบบจำลองคณิตศาสตร์ของออกซิเจนในบ่อเลี้ยงกุ้ง. ในการประชุมวิชาการกุ้งทะเลแห่งชาติ ครั้งที่ 4 "เทคโนโลยีเพื่อกุ้งไทย กุ้งคุณภาพระดับโลก" 18-19 พฤศจิกายน 2545 ศูนย์ประชุมริมทะเล ระยองรีสอร์ท จังหวัดระยอง. ศูนย์พันธุ์วิศวกรรมและเทคโนโลยีชีวภาพแห่งชาติ. น. 198-207.

Aeration is the most usual way to provide oxygen in shrimp pond. Knowing oxygen dynamics in the shrimp leads to better and more efficient aeration. Sequentially, mathematical model is one of the effective way for study the oxygen dynamics in the pond.

Measured dissolved oxygen (DO) data at 3 different depths showed that the pond bottom had the lowest DO level. Since photosynthesis occurs mainly at the water surface while degradation of organic matters occurs at the pond bottom. This prompted us to develop the mathematical model by dividing the shrimp pond into 3 region according to the depth. The DO levels are functions of light intensity, temperature, air-water oxygen transfer, pond respiration and biodegradation.

The simulation results agreed well with the measurement for the whole crop. There were two tuning parameters P_{max} and K used in the model. The maximum photosynthesis rate, P_{max} depended upon chlorophyll-a and nutrients, while the aeration intensity, K represented the operation condition of the aeration of pond which varied with the time of the day and the cultivation day as well. The photosynthesis in the pond was also found to be more temperature dependent than expected.

Measurement and simulation showed that oxygen stratification occurred in the pond, especially after the 2nd month. Therefore, mixing

the water vertically is very important for sufficient oxygen providing. Since the photosynthesis is temperature dependent, more aeration is required in the cooler day to compensate reduction of oxygen provided by photosynthesis.

Keywords: Aeration; Shrimp ponds; Dissolve Oxygen; DO; Oxygen dynamics

980 ชวิน อรรถสาสน์, วิวัฒน์ เรืองเลิศปัญญากุล และ ปิยะบุตร วานิชพงษ์พันธุ์. 2545. การบำบัดน้ำทิ้งจากการเลี้ยงกุ้งด้วยกระบวนการทางชีวภาพ. การประชุมวิชาการกุ้งทะเลแห่งชาติ ครั้งที่ 4 "เทคโนโลยีเพื่อกุ้งไทย กุ้งคุณภาพระดับโลก" 18-19 พฤศจิกายน 2545 ศูนย์ประชุมริมทะเล ระยองรีสอร์ท จังหวัดระยอง. ศูนย์พันธุ์วิศวกรรมและเทคโนโลยีชีวภาพแห่งชาติ. น. 188-197.

Since Thailand become the leading country for marine shrimp production in 1991, the shrimp farming in Thailand has rapidly expanded. These intensive shrimp farms require amounts of high protein feed, consequentially, the uneaten feed and excreted waste create number of water quality problems. One of the easiest and most popular way to maintain the water quality is to exchange the water which leads to pollution of the natural water reservoir and environments. Many researches found that the effluent can be treated cost-effectively and environment-friendly by using biological method. Oysters and mussels were reported to be able to reduce the suspended solid in the effluent, while seaweed can effectively uptake ammonia.

This research focuses on integrating shrimp farm with cultivation of other organism which can be sold or linked into a food chain to minimize the effluent and pollutants from the farm. The integrated shrimp farm is consisted of sedimentation pond, fish, mussel, and seaweed cultivation pond. Selection of each species depend not only on the pollutants degradation rate but also on the market value and practicability of that species. Seaweed and macroalgae was tested for ammonia, nitrite, nitrate, and COD degradation or uptake rate. It was found that the specific uptake rate of ammonia of coontail and duckweed was 0.04 mg-NH₃N/g-wet weight/h although with while different stocking density (2.5 and 0.8 g-wet weight/L, respectively).

Keywords: Shrimp farm; Water quality; Treatment; Shrimp culture

981 Piamsak Menasveta, Jaruk Choosuwan, Somkiat Piyatiratitivorakul, Arlo W. Fast and Thierry Latscha. 1991. Effect of dietary astaxanthin on gonadal maturation and spawning of giant tiger prawn (*Penaeus monodon*). Technical Report No. 5/1991,

Sichang Marine Science Research and training Station, Chulalongkorn University. 15 p.

Two groups of large (>88 g), pond-reared giant tiger prawns (*Penaeus monodon*) were fed maturation diets with and without the carotenoid astaxanthin added during 80 day trials. Significant increases ($P<0.05$) occurred in total carotenoid and astaxanthin fraction concentrations in the hepatopancreases of both treatment groups, while those prawns fed astaxanthin fortified diet had significantly greater concentrations than prawns fed astaxanthin fortified diet had significantly greater concentrations than prawns fed non-fortified diet. Both prawn treatment groups had significant increases in total carotenoid and astaxanthin fraction concentrations in their ovaries during the trials, but they were not significantly different from each other. Number of maturation and spawning events were about the same for the two treatments. Total egg and total protozoa productions were greater from prawns fed astaxanthin fortified diet, which reflects greater broodstock survival for this group. Mean eggs per female, percent fertilization, and percent metamorphosis to protozoa were not significantly different. Prawns fed astaxanthin added diet had significantly greater egg diameter. There was no increase in maturation or spawning frequency of non-ablated prawns fed the astaxanthin added diet. Only one non-ablated prawn matured and spawned (4 times) from both feed groups combined.

Keywords: Astaxanthin; Gonadal maturation; Spawning; Giant tiger prawn

982 Sunun Siriraksophon and Chalermraj Wantawin. 2000. **Bacteria community in water body and sediments from closed system intensive shrimp culturing using fixed film nitrification for *in situ* water treatment.** In The 2nd National Symposium on marine shrimps, 23-25 October 2000, Royal Phuket City Hotel, Phuket. National Center for Genetic Engineering and Biotechnology. p. 86-92.

This work aims to present the bacterial community in water body and sediments from closed system shrimp culturing using fixed film nitrification for *in situ* water treatment. Bacteriological monitoring was performed by analyze total bacteria count (TBC) and total vibrio bacteria count (TVC) in three rectangular concrete culturing tanks. Two culturing tanks were installed with fibrous carrier with fixed film nitrification by the ratio of fiber surface area/tank surface area of 4.59 and 8.75, respectively. One of culturing tank was kept as control with no biofilm installation. The density of shrimp in tanks was 47 shrimp/m².

Comparatively, TBC and TVC in the tank with more fibrous carrier showed less number of bacteria in water body than in the other two tanks. The Installation of fixed film nitrification in culturing tank could affect the type of bacteria in bottom sediment due to the different color observed. The colors of dark gray, dark brown and reddish brown were seen in the bottom sediment from culturing tanks with no fibrous carrier to more fibrous carrier, sequentially. The TBC in sediments collected during day 66 to day 94 of culturing period obtained in the range of 1×10^5 – 1×10^7 CFU/ml. Gram stain of those bacteria isolated from sediments demonstrated the predominant of endospore-forming, gram-positive, rod-shaped bacteria. The diversity of cultivable microorganisms obtained from three tanks was perceived and 16s rRNA identification technique would provide further information of certain microbial community in the culturing system.

Keywords: Bacteria; Sediment; Closed system; Intensive culture; Shrimp culture

983 Sirirat Rengpipat, Aroon Tunyanun, Somkiat Piyatiratitivorakul, Piamsak Menasaveta. 2000.

Supplement of *Bacillus* S 11 for black tiger shrimp *Penaeus monodon* culture in earthen ponds. In The 2nd National Symposium on marine shrimps, 23-25 October 2000, Royal Phuket City Hotel, Phuket. National Center for Genetic Engineering and Biotechnology. p. 49-54.

Bacillus S11 (BS 11), a bacterial probiont, was used as feed supplement for black tiger shrimp culture in earthen ponds. Two preliminary trials were performed at the small scale size, at ~0.66 rai, in the first experiment after feeding shrimp for 40 days weight and length of shrimp from culturing with probiotic feed were more than those of the shrimp with regular feed. Shrimp fed in separated kra-chungs in the same pond of the second experiment were performed. The same results were repeatedly shown that weight and length of shrimp fed probiotic feed were significantly different from those of the control with regular diet at $P<0.0001$. Also more survival of probiotic-fed shrimp (76.5%) was more than that of the control group (65%). In addition, we expanded shrimp culturing up to a bigger pond, a sized of 2.5 rai per pond for 2 ponds under general care, after 82 days of low intensive culture (~ a hundred thousand shrimp per pond) ~ 1.7 tonnes of shrimp with different sizes were obtained. No effect of a probiont on water quality was observed in all experiments.

Keywords: Supplement; Black tiger shrimp; *Penaeus monodon*; Shrimp culture; Earthen pond

984 Kidchakan Supamattaya, Jreeporn Raungsri, Suprada Kiriratnikom and Naraid Suanyuk. 2000. **The immune system in black tiger shrimp, *Penaeus monodon* Fabricius: VII. Immune system in black tiger shrimp, (*Penaeus monodon* Fabricius): based on sex, size and molting cycles.** Songklanakarin J. Sci. Technol. 22 (Suppl.): 623-632.

Comparative studies were carried out on blood composition and immune system in black tiger shrimp of both sexes, with various body weight ranges and different stages of molting cycle. The shrimp samples were collected from farms in Amphoe Ranot, Songkhla province, and Amphoe Langu, Satun province. Parts of the samples were also obtained from glass tanks maintained at the Aquatic Animal Health Research Center (AAHRC). The total hemocyte count and phenoloxidase activity of the samples from Ranot and those maintained at the AAHRC did not differ with respect to the various stages of molting cycle. The samples from Ranot showed total hemocyte count and phenoloxidase activity during pre-molting period (D-stage), molting period (C-stage) and post-molting period (A- and B-stages) of 5.76 ± 1.53 , 5.05 ± 1.52 , $4.95 \pm 1.02 \times 10^4$ cell/mm³ and 393.53 ± 104.31 , 368.54 ± 113.38 , 374.56 ± 368.54 unit/min/mg protein respectively, whereas the samples from the AAHRC had gave the values 1.56 ± 0.90 , 1.60 ± 1.48 , $1.36 \pm 1.10 \times 10^4$ cell/mm³ and 66.78 ± 47.36 , 89.32 ± 41.12 , 101.82 ± 49.03 unit/min/mg protein, respectively. The samples collected from Langu showed higher total hemocyte counts during D-stage and became lower during A- and B-stage with 7.59 ± 2.30 and $5.56 \pm 0.90 \times 10^4$ cell/mm³, respectively. Phenoloxidase activity had a peak during C-stage and declined during D-stage with a minimum during A and B-stage with 299.23 ± 91.68 , 293.64 ± 74.09 and 280.97 ± 65.96 unit/min/mg protein respectively. However, the total hemocyte count and PO activity as well as blood sugar level did not depend on the sex and size. Additionally, the serum protein from samples collected from different sources showed from Ranot possessed higher serum protein (13.42 ± 1.30 g%) during D-stage which were higher than for other stages having serum protein levels 12.02 ± 0.70 - 12.67 ± 1.42 g%. the samples from Ranot and the AAHRC showed no difference in serum protein levels during stages of molting cycle. Measurement of serum pH showed no difference statistically with values 7.31 ± 0.11 - 7.79 ± 0.10 for the samples collected from all three sources during various stages of molting cycle. It is noted, however, that female samples collected from Ranot had higher serum pH than the males from the same source.

Keywords: Immune; Moulting; Sex; Size; Black tiger shrimp; *Penaeus monodon*

985 Jintana Darachai, Somkiat Piyatiratitivorakul, Prasat Kittakoop, Charoen Nitithamyong and Piamsak Menasveta. 1998. **Effects of astaxanthin on larval growth and survival of the giant tiger prawn, *Penaeus monodon*.** In: Felgel, T. (ed.), Advances in Shrimp Biotechnology. National Center for Genetic Engineer and Biotechnology, Bangkok. p. 117-121.

The aim of this study was to evaluate effects of natural and synthetic astaxanthins on growth, survival and low salinity resistance of *Penaeus monodon* larvae. Four diets: algal astaxanthin-added diet (AAD), synthetic astaxanthin-added diet (SAD), non astaxanthin supplemented diet (NAD) and natural food (NF) were prepared to feed three *P. monodon* larval stages (zoea, mysis and postlarvae). The results indicated that zoea fed AAD, NF and NAD survived significantly better than zoea fed SAD. For the mysis stage, larvae fed NF and AAD had better survival rates than those fed NAD and SAD. After 15 days of rearing the postlarval stage to PL-15, AAD showed the best survival rate and it was significantly higher than that of PL-15 that had been fed NF. PL-15 fed AAD and NF were significantly longer than those fed SAD and NAD ($P < 0.05$). In low salinity challenge tests, the postlarvae fed AAD showed higher tolerance than postlarvae fed other diets.

Keywords: Astaxanthin; *Penaeus monodon*; Growth; Giant tiger prawn

986 Piamsak Menasveta, Porcham Aranyakanonda, Sompop Rungsupa and Nudol Moree. 1989. **Maturation and larviculture of Penaeid prawns in closed recirculating seawater systems.** Technical Report 2/1989, Sichang Marine Science Research and training Station, Chulalongkorn University. 14 p.

The maturation and larviculture of giant tiger prawns (*Penaeus monodon* Fabricius) and banana prawns (*P. merguensis* de Man) were studied in two types of closed recirculating seawater systems (closed systems), and in a seawater system with daily water exchange (open system). One closed system consisted of a 6 m³ rectangular tank with filters at both ends of the tank. The second closed system of a new design consisted of a 30 m³ circular tank with a filter at the center of the tank. *Penaeus monodon* maturation in these culture systems was comparable. Although egg production rates in the open system was higher than for the closed system, nauplii production rates were similar. With *P. merguensis*, the open system gave greater production of post larvae (P₂₀), although the water quality in the closed systems was much better than with open system.

Keywords: Maturation; Larviculture; Penaeid; Prawns; Closed recirculating water system

987 Suwit Wuthisuthimethavee, Prajuab Lumubol, Apichart Vanavichit and Somvong Tragoonrung. 2003. **Development of microsatellite markers in black tiger shrimp (*Penaeus monodon* Fabricius).** Aquaculture. 224 (2003): 39-50.

Microsatellites or Simple Sequence Repeats (SSRs) represent an abundant source for genetic markers in eukaryotic genomes. Nine synthesized repeat sequences labeled with biotin were used to create an enriched microsatellite library [(AG)₁₀, (TG)₁₀, (GAA)₁₀, (GAC)₁₀, (CAT)₁₀, (TAC)₁₀, (GACA)₈, and (TCAG)₈] for *Penaeus monodon*. From a total of 2417 clones, only 406 clones (16.8%) were positive after colony hybridization against the nine repeat sequences. Those clones with insert sizes ranging from 300 to 1000 bp were isolated and characterized. The most abundant repeat sequences in the *P. monodon* genome are (AG)_n and (CAT)_n making up to 22% and 21%, respectively. A total of 102 from the 129 primer pairs (designed for 129 clones) were able to amplify *P. monodon* DNA. According to the sequences of the 102 clones, 27 loci, 17 loci, 4 loci and 54 loci were dinucleotide, trinucleotide, tetranucleotide and compound repeat sequences, respectively. Thirty microsatellite primer pairs were used to screen wild *P. monodon* germplasm and the result revealed PIC values ranged from 0.4275 to 0.9264. Therefore, this set of microsatellite primers would provide a useful tool in *P. monodon* breeding programs.

Keywords: Microsatellite markers; *Penaeus monodon*; Alleles

988 Somchai Wangvibulkit. 1997. **Using filtrants for water quality improvement in black tiger shrimp (*Penaeus monodon*) pond.** Research report 1996-1997. Department of Fisheries Science, Faculty of Agricultural Technology, King Mongkut's Institute of Technology Ladkrabang. 10 p.

Study on quality of water filtered by using different filtrants as treatments; fine sand, coarse sand, brick, charcoal, small coral, middle coral, coconut-husk, gunny-bag and mixed filtrants was investigated. Each treatment consisted of 3 replications. The results were found that temperature, pH, alkalinity, total ammonia-nitrogen, nitrite-nitrogen and nitrate-nitrogen were 29.5±0.2°C, 8.50±0.06, 364±3 ppm, 40.047±1.112 ppm, 0.140±0.007 ppm and 0.107±0.004 ppm respectively at flow rate 2.0±0.2 litres/hour. They were non-significant (P>0.05). Besides

orthophosphate and density of plankton were significant (P<0.05); coconut-husk increased orthophosphate 0.670±0.191 ppm and fine sand decreased density of plankton by 66.7±13.1%. Quality of water filtered by mixed filtrants in black tiger shrimp ponds was similar to water analyzed in the laboratory. Mixed filtrants increased orthophosphate 0.473±0.049 ppm but decreased density of plankton by 35.34±2.18% at flow rate 8.5±0.6 litres/minute.

Keywords: Filtrants; Water quality; Black tiger prawn; Shrimp ponds

989 Nikhom La-ongsiriwong, Youngyut Predalumbaburt, Thongpetch Sunbuka and Sukanda Maitreekaew. 2003. **Partitioning of different forms of nitrogen and phosphorus in intensive shrimp culture areas, Songkhla Province.** In the 41st Kasetsart University Annual Conference 3-7 February 2003. p. 467 - 474.

Partitioning and concentration of nitrogen and phosphorus compounds in water column were monthly measured over the period of October 1998 to September 1999 in Songkhla province received tiger shrimp farming effluents. The result showed mostly nitrogen forms at Khlong Pakwava-Thakheng were clearly higher than other, except organic nitrogen. While concentration of most forms of phosphorus were found the highest at area of amphoe Sathing Phra, Songkhla lake, except orthophosphate which was found the highest at Ban Khu Tao. Nitrate and total ammonia is the main species of DIN, which is slightly different proportion in each area. Although its proportion is more than 90% of DIN but it is contributed to 10-20% of total nitrogen. For phosphorus, we found that the major form of TDP is DOP which is contributed to 68-93% of TDP, while PP is the main component of phosphorus in most areas which is slightly higher than TDP. This study indicates that it should be more emphasized on particulate and organic form of nitrogen and phosphorus because it is the major component of nitrogen and phosphorus in water column.

Keywords: Nitrogen; Intensive culture; Songkhla

990 Thongchai Nitiratsuwan and Ajcharawadee Anumarnpysan. 2001. **Factors and its relation to *Vibrio* sp. content in black tiger prawn pond (*Penaeus monodon*) around Trang Province 1998-2000.** In the 41st Kasetsart University Annual Conference, 3-7 February 2003. p. 145-152.

Vibrio sp. content in shrimp pond and hepatopancreas was collected from shrimp information service center (Charone Porkapan Group), Trang province. Some basic water quality parameters

and *Vibrio* sp. data was collected between June 1998 to June 2000. The parameter that found relation to total *Vibrio* sp. (in water) are salinity and shrimp age. Those parameters also found significant difference ($P<0.01$) compared with time (month) so the *Vibrio* sp. content are vary monthly. *Vibrio* sp. in shrimp's hepatopancreas is related to the content in water. The farmer should carefully plan for shrimp release period to avoid *Vibrio* sp. infection.

Keywords: Factors; *Vibrio*; Shrimp ponds; Black tiger prawn; Trang

991 Visanu Boonyawiwat, Theerapol Sirinarumitr, Preeda Lertwatcharasarakul, Orawan Boodee, Thinnawat Srisook and Worawidh Whajjwalkul. 2000. **Development of *in situ* hybridization for the detection of white spot disease from *Penaeus monodon* in modified-Davidson's fixed paraffin-embedded sections.** In The 38th Kasetsart University Annual Conference 1-4 February 2000. p. 125.[on line] Available: <http://kucon.lib.ku.ac.th/Agris th/index.html>

The 200 bp. PCR product from specific primer set (SMBV1 and SMBV4) for Systemic Ectodermal and mesodermal baculovirus (SEMBV) was ligated to plasmid vector (PCR II) and used to transform *E. coli*. This clone was used to prepare digoxigenin-labeled DNA probe using PCR technique for the detection of SEMBV in shrimp tissue by an *in situ* hybridization assay. Probe readily distinguished SEMBV-infected from uninfected shrimp tissues and did not react to shrimp tissues infected with Monodon baculovirus. Positive cells were localized to the stomach, integument, gill, heart, midgut and lymphoid organ.

Keywords: *In situ* hybridization; Detection; White Spot Disease; *Penaeus monodon*

992 Benjamas Chuntapa, Sorawit Powtongsook and Piamsak Menasveta. 2001. **Control of water quality in high density prawn culture by integrating with the microalga, *Spirulina platensis*.** In Abstracts and Proceeding, 27 th Congress on Science and Technology of Thailand, 16-18 October 2001, Lee Gardens Plaza Hotel, Hat Yai, Songkla, Thailand organized by The Science Society of Thailand under the Patronage of His Majesty the King, Faculty of Science, Prince of Songkla University. [CD-ROM, file://F:\STT\web\content\environ\B007.html]

Cultivation of juvenile prawn (*Penaeus monodon*) with semi-continuous harvesting of microalga *Spirulina platensis* (Cyanophyta) illustrated an excellent possibility of water quality control by an integrating culture system. The results indicated that ammonium, nitrite and nitrate

nitrogen concentration in prawn aquariums with *Spirulina* in both high or low prawn density (80 or 40 prawns/m² respectively) were significant lower than those culture without *Spirulina*. At the end of the experiment, there is no statistical difference in growth rate of prawn in all treatments, but prawn culture with *Spirulina* had significantly higher survival rate than without *Spirulina* ($P<0.05$).

Keywords: Water quality; Prawn culture; Microalgae; *Spirulina platensis*

993 วิจิตรา ลีละตุกกุล และ สมหมาย เชี่ยววาริสังจะ. 1998. **Preliminary studies of the application of the potential microorganisms for water treatment and disease control in shrimp farming.** รายงานการวิจัยฉบับสมบูรณ์ทุนอุดหนุนการวิจัยจากเงินรายได้ของมหาวิทยาลัยสงขลานครินทร์ ประเภทกำหนดหัวข้อ ประจำปี 2541. 31 p.

A preliminary study on the application of *Bacillus subtilis* (BS) for treating water and luminous diseases caused by *Vibrio harveyi*. Bacteria were cultured in conditions corresponding to black tiger shrimp farms, including high salinity and high pH. Five strains of BS-D04, D05, D06, D07 and D18 grew well in the culture medium, which contained NaCl at 5-30 ppt, with a pH 7.8 at 37°C. Some still survived at 50-75 ppt. Culture inhibition of *V. harveyi* on agar plate was demonstrated by all 5 BS strains tested. BS-D18 gave the highest inhibition of *V. harveyi* on an agar plate test and in the tube, mixing both cultures at 10³ cfu/ml at the beginning. Effectiveness of the ABS-D04, D07 and D18 strains were further studied by precipitating culture filtrate of the BS with hydrochloric acid and reneutralized to pH 7.0. The two-fold-diluted HCl precipitated culture filtrate solutions were mixed with melted agar and *V. harveyi* cultures at a concentration 10⁶ cfu/ml were plated on agar. ON the 1:4 dilution plates complete inhibition of *V. harveyi* was detected. In another trial the antibacterial substances were partially purified from the culture filtrate of BS-D18 and their activity tested. A concentration of 1 mg/ml was shown to control growth of *V. harveyi*. On the aspect of controlling of water quality, BS-D18 was selected and used at the concentration of 10³ cfu/ml mixed with waste water obtained from the shrimp farm. The amount of total ammonia nitrogens (TAN), nitrite, nitrate, and pH changes during 34 days were monitored. However, no significant differences ($P>0.05$) between data obtained from the treated water with BS and the control samples was found. It was concluded that BS had no use in improving water quality on the shrimp farm, but there was a potential for the control of *V. harveyi*, which is a significant bacterium causing luminous disease in shrimp.

Keywords: Microorganisms; Disease control; Shrimp farm

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