UNIVERSITI PUTRA MALAYSIA

THE EFFECTS OF CONTROLLED ENVIRONMENT AND DIETS ON BROODSTOCK MATURATION, SPAWNING, SPERMATOPHORE QUALITY AND JUVENILE PRODUCTION OF *Penaeus merguiensis* (de Man)

AKINFOLAJIMI OLUBUNMI

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MASTER OF SCIENCE
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By

AKINFOLAJIMI OLUBUNMI

Thesis submitted in Fulfillment of the Requirements for the degree of Masters of Science in the Faculty of Applied Science and Technology Universiti Putra Malaysia

February 1999

ACKNOWLEDGEMENT

I wish to express my profound gratitude to my Chairman of Supervisory Committee, Encik Aizam Zainal Abidin for his scholarly involvement, and counseling, financial and moral support throughout the duration of this work and also in the edition of the manuscript. He and his family have been a source of blessing and encouragement all the way. The helpful suggestions, constructive comments, help in data analysis and editorial guidance of other members of my Supervisory Committee, Dr Hj. Mohd. Kamil B. Abdul Rashid and Dr Siti Aishah Abdullah are gratefully acknowledged.

I appreciate immensely the assistance rendered by all the staff of the Marine Hatchery, Encik Yaakob Rasip, the late Encik Abd. Ghani Hamid (may his soul rest in peace), and Encik Mohd. Zain bin Yazid. I also extend my appreciation to all members of staff of the Faculty of Applied Science and Technology, Universiti Putra Malaysia Terengganu (UPMT) for their assistance in various ways during the period.

I would also like to thank Prof. Madya Dr Lokman Shamsudin for his help in allowing me the use of his laboratory for *Skeletonema* culture and assistance in the analysis of fatty acids.

Many thanks also go to the staff of the Third Country Training Program and the entire members of the UPMT postgraduate students' body for their friendship and advice.

I am also grateful to the Universiti Putra Malaysia Terengganu for offering me a conducive research and learning environment and for granting me through Encik Aizam Zainal Abidin by IRPA No 51029, a Graduate Assistantship. I am immensely grateful.

I am grateful to my able mother, Madam Olasibo Akinfolajimi, Mr Moboluwaji Akinfolajimi, Mrs Gbonjubola Folarin and Mrs. Valerie Ann Akinfolajimi for their financial assistance, encouragement and moral support during the period.

In the final analysis, I thank the Almighty God for all His blessings in my life and for granting me good health and the gift of life. To God be all the honour and aduration in Jesus name. Amen.

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SOME ASPECTS OF THE MATURATION AND ARTIFICIAL PROPAGATION OF *Penaeus merguiensis* (de Man)

By

AKINFOLAJIMI OLUBUNMI

December 1998

Chairman: Encik Aizam Zainal Abidin

Faculty: Faculty of Applied Science and Technology

Some aspects of the maturation and artificial propagation of *Penaeus merguiensis* were studied The percentage of naturally matured shrimps that were transported to the hatchery and spawned was 83 33% while the percentage of hatchery matured shrimps that spawned were 66 66%, 50 00%, 50 00% and 33 33% for broodstocks fed with squids (*Loligo* sp), polychaete (*Diopatra* sp), *Artemia* biomass and pellets diets, respectively

The lipid and fatty acid composition of some locally available maturation diets were also determined and compared Analytical results indicate that the total

lipid content (wet weight) of the diets was highest in *Loligo* sp (4.30%) followed by that of *Diopatra* sp. and enriched adult *Artemia* at 1.82 % and 1.15 % respectively. The lipid content of pellets was 6.0% (dry weight). Total fatty acid composition of the diets was highest for *Loligo* sp. (7519.74 µg/g) wet tissue, followed by the total fatty acid contents of *Diopatra* sp., enriched *Artemia* sp. and pellets at 5554.05 µg/g, 1075.38 µg/g and 636.62 µg/g wet tissue respectively.

Maturation diets have been reported to have certain polyunsaturated fatty acids, which can help trigger maturation. The total polyunsaturated fatty acid contents for *Loligo* sp., *Diopatra* sp., enriched adult *Artemia* and pellets were 5899.33 µg/g, 1726.81 µg/g, 326.14 µg/g and 12.57 µg/g constituting 78.46%, 31.09%, 30.33% and 1.98% of the total fatty acid composition respectively.

A study was carried out to evaluate the effects of different rearing conditions on the growth and survival of juvenile *Penaeus merguiensis* in circular and rectangular tanks. Postlarvae *P. merguinesis* with initial weight of 5.0 mg were reared under varied rearing conditions by utilising trash-fish and commercial pellets, trash-fish and commercial *Spirulina*, and trash-fish and *Skeletonema* as treatment A, B, and C respectively. The specific growth rates of the different treatments were 14.53, 10.89 and 12 .16 while; the survival rates were 96.92%, 44.39% and 89.55% respectively. There was no significant difference ($p< 0.05$) in the specific growth rate and survival rate for juveniles fed trash-fish and commercial pellets and the juveniles fed trash-fish and *Skeletonema*. The specific

growth rate and survival rate of juveniles fed trash-fish and *Spirulina* were found to be significantly lower than in the other two treatments.

In another experiment, postlarvae *P. merguiensis* with an initial weight of about 3.5 mg/ postlarva (PL) were reared under two different densities, 1200 and 2400 respectively. All the tanks were fed with trash-fish and commercial pellets. The specific growth rates were 15.34 and 11.82 while the survival rates were 84.50% and 90.57% respectively. However, there was no significant difference ($p<0.05$) between the values obtained

A comparison of the performance of circular and rectangular tanks in terms of growth and survival of juveniles stocked at a density of 1200 per liter shows that juveniles reared in circular tanks had lower specific growth rate than those reared in rectangular tanks. There was a higher survival rate than for juveniles reared in rectangular tanks. However, these differences are not statistically significant ($p <0.05$). A more uniform growth was observed for juveniles reared in raceways (C. V = 32.84%) than juveniles reared in circular tanks (C.V = 34.31%).

Abstrak tesi dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi syarat untuk mendapatkan Ijazah Master Sains.

BEBERAPA ASPEK KAJIAN KE ATAS KEMATANGAN DAN PENINGKATAN HASILAN SECARA ARTIFISIAL *Penaeus merguiensis* (de Man)

Oleh

AKINFOLAJIMI OLUBUNMI

Disember 1998

Pengurusi: Encik Aizam Zainal Abidin

Fakulti: Fakulti Sains Gunaan dan Teknologi

Kajian terhadap beberapa aspek kematangan dan pengkulturan secara artifisial ke atas *Penaeus merguensis* telah dijalankan. Peratus peneluran udang yang matang secara semulajadi yang dipindahkan ke hatcheri ialah 83.33%. Peratus penetasan udang yang matang dalam pemeliharaan di hatcheri yang diberi makan sotong (*Loligo* sp.), polychaete (*Dioptra* sp.), *Artemia* dan pelet ialah 66.66%, 50.00%, 50.00% dan 33.33% mengikut diet masing-masing.

Penentuan keatas komposisi lipid dan asid lemak pada diet tempatan untuk peningkatan kematangan serta perbandingan ke atas diet-diet ini juga telah dijalankan. Keputusan analitikal ke atas kandungan lipid (berat basah) dalam diet adalah tertinggi pada *Loligo* sp. (4.30%), diikuti oleh *Dioptera* sp. (1.8%) dan

Artemia (1 15%) Kandungan lipid (berat kering) dalam setiap diet adalah 6 0% Jumlah komposisi asid lemak adalah tertinggi dalam *Loligo* sp (7519 74 µg/g) tisu basah diikuti dengan *Dioptra* sp (5554 05 µg/g), *Artemia* sp (1075 38µg/g) dan pellet (636 62 µg/g)

Diet bagi kematangan telah dilaporkan mempunyai asid lemak tak tepu yang dapat menggalakan kematangan Jumlah asid lemak tak tepu di dalam *Loligo* sp (5899 33µg/g), *Dioptra* sp (1726 81µg/g), *Artemia* sp (326 14µg/g) dan pelet (12 57µg/g) merangkumi 78 46%, 31 09% 30 33% dan 1 98% daripada jumlah keseluruhan komposisi asid lemak mengikut diet masing-masing

Satu kajian telah dijalankan untuk menilai kesan perbezaan keadaan ternakan ke atas tumbesaran dan kemandirian juvenil *Penaeus merguiensis* di dalam tangki bulat dan tangki raceway *Penaeus merguiensis* pada peringkat larva dengan berat 0 005g telah diternak di dalam pelbagai keadaan menggunakan ikan baja dan pelet komersil, ikan baja didalam medium *Spirulina* dan ikan baja di dalam medium *Skeletonema* Kadar tumbesaran spesifik bagi pemberian makanan yang berbeza adalah 14 53, 10 89 dan 12 16 manakala kemandirian yang diperolehi adalah 96 92%, 44 39% dan 89 55% mengikut diet masing-masing Analisis menunjukkan tiada perbezaan ($p<0$ 05) pada kadar tumbesaran spesifik dan kemandirian juvenil yang diberi ikan baja dan pellet komersil dengan juvenil yang diberi ikan baja di dalam medium *Skeletonema.* Kadar tumbesaran spesifik

dan kemandirian juvenil yang diberi ikan baja dalam medium *Spirulina* di dapati lebih rendah berbanding dengan dua rawatan lain.

Di dalam eksperimen yang lain, postlarva *Penaeus merguiensis* dengan berat awal 0.0035g diternak di dalam dua kepadatan yang berbeza iaitu pada kepadatan 1200 dan 2400. Kesemua raceway telah diberi makan ikan baja dan pelet komersil. Kadar tumbesaran spesifik yang diperolehi adalah 15.34 dan 11.82 manakala kemandirian yang diperolehi ialah 84.50% dan 90.57% mengikut kepadatan masing- masing. Walaubagaimanapun, kajian menunjukkan tidak terdapat perbezaan ($p<0.05$) di antara kedua-dua nilai yang diperolehi.

Perbandingan prestasi diantara tangki bulat dan tangki raceway dari segi tumbesaran dan kemandirian juvenil yang diternak pada kadar 1200/l menunjukkan bahawa juvenil yang diternak di dalam tangki bulat mempunyai kadar tumbesaran spesifik yang rendah berbanding dengan juvenil yang diternak dalam tangki raceway. Terdapat peratus kemandirian yang tinggi pada juvenil yang diternak dalam tangki raceway. Walaubagaimanapun, tidak terdapat perbezaan ($p<0.05$) pada keputusan kajian. Terdapat tumbesaran yang sekata pada juvenil yang diternak dalam tangki raceway (C.V. = 32.84%) berbanding dengan juvenil yang diternak dalam tangki bulat (C.V. = 34.31%)

CHAPTER I

INTRODUCTION

The world cultured shrimp production in the year 1995 was 712,000 MT live weight (INFOFISH, 1996). Asian countries contributed about 78% or 558,000 MT of this total. Among the Asian nations, Thailand, Indonesia, China and India were the leading producers contributing 39.4, 14.3, 12.5 and 10.8 % respectively of the total Asia production and 30.9, 11.24, 9.83 and 8.43 % of the total world shrimp production respectively.

Bangladesh, Malaysia, Philippines and Vietnam also produced world class crops of farm-raised shrimps. Bangladesh and Vietnam produced 9.0 and 5.4% of the total Asian production respectively while, Malaysia and other shrimp producing countries jointly contributed 46,000 MT consisting 8.2% of the total Asian production and 6.46% of world farm-raised shrimps. The Food and Agriculture Organization of the United Nations lists 343 shrimp species that are actually or potentially important for commercialisation. Of these, 110 species belong to the family Penaeidae (Holthuis,1980 cited in Bailey-Brock and Moss, 1992) and of the 17 species that are cultured commercially in the world (Csavas, 1994), *Penaeus monodon* constituted the most commercial species of culture constituting 57% of total production in 1997 (Lucien-Brun, 1997).

Penaeus merguiensis is the second-most important species cultured in most Southeast Asian countries with the percentage contribution to the cultured shrimp production in Indonesia, Thailand, Vietnam, Bangladesh and the Philippines being 28,000 MT (20%), 11,000 MT (10%), 6,016 MT (20%), 5,000 MT (20%), 1,500 MT (5%) respectively (Rosenberry, 1991).

In Malaysia, the principal shrimp species cultured is *P. monodon* constituting 5789.46 MT (98.82%) of total shrimp production in 1994 followed by *P. merguiensis* at 69.28 MT (1.18%) for the same period.

There is a steady expansion in the international market due to the rapid increase in world wide shrimp culture and the strong growing demand for shrimps because of its nutritive demand as a source of protein. Japan and the United States of America and Western Europe dominate the world market for Asian shrimps however, because of its comparative geographic advantage, Japan is the leading importer of Asian shrimps including Malaysian farm-raised shrimps (INFOFISH, 1996; Ling, 1996). There is also a growing domestic consumption in Malaysia. Ang (1996) citing Westlund (1995) noted that the per capita fish consumption by Malaysians is estimated to be between 26.8 and 32.0 kg as compared to the average in Southeast Asia of 23, 25, and 28 kg for 1990, 2000 and 2010 respectively

Apart from its nutritional benefits, shrimps are also known to have health benefits because it helps in the reduction of risk of coronary heart disease due to its ω-3 fatty acid contents. Higuera-Ciapara (1996) reported that shrimps contain an average of 0.50 g of ω-3 fatty acid per 100g muscle and therefore a good source of eicosapentanoic acid (20: 5ω-3) and docosahexanoic acid (22: 6ω-3). There is also an indication that the cholesterol content of shrimps does not lead to an increase in the blood lipid or serum cholesterol in humans (Nettleton, 1995 cited in Higuera-Ciapatra (1996).

With the growing demand for shrimp in international and domestic markets and the plateauing of ocean harvests (Jory, 1995 and Ling, et al., 1996) the onus now falls on aquaculture to make up the shortfall in shrimp supply. It is estimated that by the year 2000, the total output of farm-raised shrimps in Malaysia would be about 21000 MT (Kuperan, 1988). However, there are problems in the realization of this noble objective.

Information on the best nursery conditions for postlarvae production and juvenile rearing are lacking (Har, 1988) and inspite of the advantages of nursery practices (Wyban and Sweeny, 1991) many farms still stock small postlarvae (Singh and Kamaruddin, 1998).

In Malaysia and indeed, in most Southeast Asia countries, there is an over-dependence of the shrimp industries on the supply of broodstocks from the wild.

This constitutes a constraint to the growth of the shrimp industry because any change in the global weather and environmental condition such as the annual monsoon, pollution and environmental degradation or even overfishing could cause chronic shortages in the broodstock supply (Jory, 1995). This may be associated with the following;

- There is pressure on wild broodstocks thereby increasing the cost of gravid females. It also leads to conflict with capture fisheries.
- Because of the seasonality in the abundance of wild broodstock populations, planning of postlarvae production is also seasonal.
- Dependence on wild broodstock could lead to the introduction of serious disease-causing pathogens from the wild.
- When there is dependence on wild broodstocks, genetic improvement of broodstocks is impossible.

The predominance of the black tiger shrimp (*P. monodon*) is one other problem with the cultured shrimp industry. Csavas (1994) noted that however good the tiger shrimp might be, their predominance goes against consumer preferences. Therefore, there is the need to provide an alternative species to satisfy consumers in terms of size and taste.

Despite the predominance in the production of the black tiger shrimp, some preferred species such as *P. japonicus, P. merguiensis and P. chinensis* command significantly higher prices (Csavas, 1994). This view agrees with that of

Menasveta (1992) who noted that the US market prefers the white shrimp rather the dark or striped shrimps and therefore advised an increase in the production of *P. merguiensis* in order to corner more markets in the US .

P. merguiensis has good culture characteristics. It is tolerant to low water quality and can feed lower down the aquatic food chain and can make maximum use of naturally occurring pond organisms with minimal exogenous supplementary feed inputs (Tacon, 1993) and the yield range between 200 – 5850 kg/ ha/crop.

Therefore, this study aims to increase the propagation of *P. merguiensis* by investigating the best rearing conditions for juvenile production, investigation of locally available live foods as penaeid shrimp maturation diets and the possibility of inducing maturation and spawning of adult *P. merguiensis* under captive conditions. In order to achieve these objectives, the following experiments were performed;

- The effects of stocking density on the growth and survival of *P.merguiensis* larvae;
- Experiments on the effects of rearing *P. merguiensis* larvae and juveniles under different rearing conditions;
- Determination of the lipid and the fatty acid composition of certain live foods available locally as shrimp maturation diets;

- Determination of the spermatophore quality of male *P. merguensis* kept in captivity for a prolonged period.
- Experiments to induce maturation and spawning of *P. merguensis* in captivity using different diets with different ablation techniques.

CHAPTER II

LITERATURE REVIEW

Classification and Taxonomy

Penaeid shrimps belong to the largest phylum in the Animal Kingdom, Arthropoda. They are characterized by the possession of jointed appendages and an exoskeleton that is periodically moulted (Bailey-Brock and Moss, 1992). Penaeid species are different from other decapods in that they hatch into a nauplius stage, and their females deposit or broadcast their eggs instead of carrying them until they hatch. They also possess toothed rostrum.

Penaeus merguiensis can be distinguished from other penaeid shrimps by the possession of a creamy white body and a high and more or less triangular rostrum. The rostrum is short and almost straight. Their adrostral carina does not reach up to the epigastric tooth. The adrostral carina on the rostrum does not reach up to the epigastric tooth and the gastro-orbital carina on the cephalothorax is short, occupying only the middle 1/3 of the distance between the hepatic spine and the orbital angle.