UNIVERSITI PUTRA MALAYSIA

BIOLOGY AND POPULATION OF SERGESTID SHRIMPS (*ACETES* SPP.) (DECAPODA: SERGESTIDAE) FROM KLEBANG BESAR, MALACCA, MALAYSIA

S. M. NURUL AMIN

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By

S. M. NURUL AMIN

Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia, in Fulfilment of the Requirements for the Degree of Doctor of Philosophy

September 2008

DEDICATION

To the memory of my late father who is no longer to share with me at this moment

To my mother who always kept praying for me to achieve my goal

To my wife 'Roushon Ara' and son 'Md. Jahin Zawad' who have sacrificed so much for me during this study period

To my eldest brother Md. Zaherul Islam whom I tried to follow from my boyhood

and

To my respective teacher Professor Dr Mohammad Zafar for his contribution to develop my research career

Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfilment of the requirement for the degree of Doctor of Philosophy

BIOLOGY AND POPULATION OF SERGESTID SHRIMPS (*ACETES* SPP.) (DECAPODA: SERGESTIDAE) FROM KLEBANG BESAR, MALACCA, MALAYSIA

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September 2008

Chairperson: Associate Professor Aziz Arshad, PhD

Faculty: Science

Taxonomy, morphometric variation, population genetics, reproductive cycle, sex ratio, fecundity, feeding habits, seasonal abundance, growth, mortality, recruitment, yield-per-recruit and status of the stock of *Acetes* spp., locally known as 'udang geragau', from the coastal waters of Klebang Besar, Malacca, Peninsular Malaysia were examined during February 2005 to March 2007. Three species of sergestid shrimps viz *A. indicus, A. japonicus* and *A. intermedius* were identified from the study area. Among them, *A. intermedius* was recorded for the first time from Malaysia coast. All morphometric characters amongst the three species were significantly different ($P < 0.05$).

The Random Amplified Polymorphic DNA (RAPD) marker was used to study the population genetic variation of *A. japonicus* collected along the west coast of Peninsular Malaysia. A total of 90 samples of *Acetes japonicus*, comprised of 30 (15

males and 15 females) from Kedah, 30 (15 males and 15 females) from Perak and 30 (15 male and 15 females) from Malacca were used. The percentages of polymorphic bands of the three geographic populations investigated were varied from 57.77% to 87.77%. Genetic distances between populations and cluster analysis from UPGMA grouped the populations into two major clusters. The Perak and Malacca populations were in one cluster, while the Kedah population was clustered by itself indicating it was genetically different. The genetic distance was the highest for the Kedah and the Malacca populations while the lowest was for the Perak and the Malacca populations which probably has a closed ancestral relationship and are from the same species.

The sex ratio of *A. indicus* and *A. japonicus* in the coastal waters of Malacca was in favour of females in most months of the year. The analysis of the annual variation of gonadosomatic index (GSI) showed the continuously breeding of *A. indicus* and *A. japonicus* throughout the year. Size at first sexual maturity of female *A. indicus* was observed at 23 mm and that was > 17 mm of total length for female *A. japonicus.* There were no females with spent ovaries in the samples of both species. The estimated mean fecundity of *A. indicus* was 1666.28 (± 46.32) eggs. The mean monthly GSI for females *A. indicus* showed positive and significant ($P < 0.05$) correlation with conductivity ($r = 0.67$), salinity ($r = 0.65$) and TSS ($r = 0.59$)). No significant ($P > 0.05$) correlation was found between the mean monthly GSI and the remaining two variables (temperature and dissolved oxygen).

According the Simple Resultant Index (%Rs), the stomach contents of *A. indicus* were comprised of plant matters (22.85%), fine sand and mud (16.19%), crustacean appendages (19.03%), debris (15.46%), unidentified fragments (10.56%),

zooplankton (6.78%), phytoplankton (6.47%), algae (3.49%), shrimp nauplii (1.25%) and mollusc larvae (0.91%). Similarly, diet compositions of *A. japonicus* were made up of plant matters (31.82%), debris (20.06%), phytoplankton (18.45%), fine sand and mud (11.75%), appendages of decapods (6%), unidentified fragments (5.86%), algae (4.17%) and zooplankton (1.80%). These various compositions of food items proved that the two shrimps are bottom feeder omnivore.

The average monthly catch per unit effort (CPUE) of the estuarine push net (EPN) was estimated at 2.50 (± 3.42) kg/fisherman/hr. The total catch comprised of three major categories those were *Acetes* shrimps (90%), followed by fish juveniles (9%) and other shrimps (1%). The annual percent composition of *A. indicus*, *A. japonicas* and *A. intermedius* were found to be 57%, 41% and 2%, respectively. The peak catch was observed in the month of October to December. There was no significant correlation ($P > 0.05$) between monthly catches and environmental parameters (temperature, dissolved oxygen, salinity, conductivity and total suspended solid).

The length frequency distribution for *A. indicus* suggested that the population consisted of two dominant age group with mean values of 20.80 (± 0.07) mm and 29.85 (± 0.09) mm of the total length, respectively. And the population of *A. japonicus* consisted of maximum two age groups, with means of 15.18 (± 0.90) mm and 21.56 (± 1.03) mm of total length. The population of *A. intermedius* also consisted of maximum two age groups, with means of 19.18 (± 0.05) mm and 26.92 (± 0.06) mm of the total length. The positive allometric nature of growth for *A. indicus* was observed. However, isometric nature of growth was found in combined

sexes of *A. japonicus*. The positive allometric nature of growth was also observed in female and both sexes of *A. intermedius*. There were significant difference between males and females size-frequency distribution of *A. indicus* (Kolmogorov-Smirnov test: $d_{max} = 0.42$, $P < 0.05$), *A. japonicus* (Kolmogorov-Smirnov test: $d_{max} = 0.39$, $P < 0.05$) and *A. intermedius* (Kolmogorov-Smirnov test: $d_{max} = 0.40$, $P < 0.05$).

The growth, mortality, recruitment and relative yield per recruit of *Acetes* spp. were investigated based on monthly length-frequency data, using FiSAT software. Higher natural mortalities of male *A. indicus* and *A. japonicus* versus the fishing mortalities observed from the study indicated the unbalance position in the stock. Exploitation level (E) of female was higher than males in *A. japonicus* population. This study indicated two major recruitment events per year where two cohorts were produced per year for *A. indicus* and *A. japonicus* populations. The recruitment pattern of *A. intermedius* was continuous with one major cohort per year. Results from the analysis of the exploitation rate (E) based on the fishing mortality estimates, and from the relative yield-per-recruit (Y/R), indicate that the *Acetes japonicus* fishery is over exploited although *A. indicus* and *A. intermedius* fishery were slightly below the optimum level of exploitation. This implies that any further unrestrained increase in fishing effort might overshoot the level giving maximum sustainable yield, thus driving the stock down and leading to economic losses.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk ijazah Doktor Falsafah

BIOLOGI DAN POPULASI UDANG SERGESTID (*ACETES* SPP.) (DECAPODA: SERGESTIDAE) DARI KLEBANG BESAR, MALACCA, MALAYSIA

Oleh

S. M. NURUL AMIN

September 2008

Pengerusi: Professor Madya Aziz Arshad, PhD

Fakulti: Sains

Taksonomi, variasi morfometrik, genetik populasi, kitar pembiakan, kesuburan, tabiat pemakanan, kelimpahan mengikut musim, pertumbuhan, kadar kematian, pemulihan dan hasil perolehan bagi spesies *Acetes* spp., juga dikenali sebagai ”udang geragau”, telah dikaji di perairan Klebang Besar, Melaka, Semenanjung Malaysia dari Februari 2005 hingga Mac 2007. Sebanyak tiga spesies udang sergestid iaitu *A. indicus, A. japonicus* dan *A. intermedius* telah dikenal pasti di kawasan kajian. Antaranya *A. intermedius* direkodkan pertama kali di perairan Melaka. Semua ciri morfometrik antara ketiga-tiga spesies tersebut adalah berbeza secara bererti ($P < 0.05$).

Penanda (RAPD) telah digunakan untuk mengkaji populasi variasi genetik *A. japonicus* yang dikumpulkan di sepanjang persisiran pantai barat Semenanjung Malaysia. Sebanyak 90 ekor udang telah dikumpulkan dari Perak (30), Malacca (30) dan Kedah (30) telah digunakan. Peratus penanda polimorfik untuk ketiga-tiga

populasi yang dikaji adalah di antara 57.77% dan 87.77%. Jarak genetik antara populasi dan analisis kelompok dengan menggunakan UPGMA telah membahagikan semua populasi kepada dua kelompok besar. Populasi daripada negeri Perak dan Melaka digolongkan dalam satu kelompok manakala populasi daripada negeri Kedah dalam satu kelompok tunggal yang menggambarkan perbezaann secara genetik pada kedua-dua populasi ini. Populasi Melaka dan Kedah mempunyai jarak genetik yang paling tinggi manakala jarak genetik yang paling rendah dicatatkan pada populasi Perak dan Melaka, di mana ia borkemunglunan mempunyai hubungan leluhor yang rapat dan berasal dari spesis yang sama.

Nisbah seks bagi *A. indicus* dan *A. japonicus* di perairan Melaka menunjukkan dominasi betina dalam kebanyakan bulan di sepanjang tahun. Analisis variasi tahunan Indeks Gonadosomatik (GSI) menunjukkan bahawa pembiakan berlaku sepanjang tahun bagi *A. indicus* dan *A. japonicus. A. indicus* betina didapati mengalami fasa pematangan pertama pada jumlah panjang 23 mm manakala > 17 mm bagi *A. japonicus* betina. Tiada ovari yang tidak berfungsi (kosong) didapati pada betina dalam sampel kedua-dua spesies tersebut. Jangkaan min kesuburan bagi *A. indicus* ialah 1666.28 (± 46.32) telur. Min bulanan GSI bagi betina *A. indicus* menunjukkan korelasi positif ($P < 0.05$) dengan konduktiviti ($r = 0.67$), saliniti ($r = 0.65$) dan TSS ($r = 0.59$). Tiada korelasi secara bererti ($P > 0.05$) didapati antara min bulanan GSI dan dua parameter yang lain (suhu dan oksigen terlarut).

Merujuk kepada 'Simple Resultant Index' (%Rs), makanan dalam isiperut *A. indicus* dikelaskan kepada bahagian tumbuhan (22.85%), pasir dan lumpur (16.19%), apendej krustasea (19.03%), debris (15.46%), fragmen yang tidak dapat dikenal pasti

(10.56%), zooplankton (6.78%), fitoplankton (6.47%), alga (3.49%), naupli udang (1.25%) dan larva molaska (0.91%). Somontara komposisi makanan bagi *A. japonicus* pula juga digredkan kepada bahagian tumbuhan (31.82%), cebisan (20.06%), fitotoplankton (18.45%), pasir dan lumpur (11.75%), apendej decapoda (6%), fragman yang tidak dikenal pasti (5.86%), alga (4.17%) dan zooplankton (1.80%). Kepelbagaian komposisi makanan membuktikan bahawa kedua-dua udang tersebut merupakan pomakan omnivor di bahagian dasar laut.

Purata bulanan tangkapan per unit usaha (TPUU) bagi pukat tolak estuari (PTE) didapati mencatat nilai 2.50 (± 3.42) kg/nelayan/jam. Komposisi keseluruhan tangkapan terdiri daripada tiga talssa utama iaitu udang *Acetes* (90%), diikuti dengan juvenil ikan (9%) dan lain-lain udang (1%). Peratus komposisi tahunan bagi *A. indicus*, *A. japonicus* dan *A. intermedius* ada masing-masing pada 57%, 41% dan 2%. Tangkapan tertinggi diperolehi dari bulan Oktober hingga Disember. Tiada korelasi yang bererti ($P > 0.05$) antara tangkapan bulanan dan parameter persekitaran (suhu, oksigen terlarut, saliniti, konduktiviti dan jumlah pepejal terampai).

Taburan frekuensi panjang bagi *A. indicus* mencadangkan bahawa populasi terdiri daripada dua kumpulan umur yang dominan dengan min 20.80 (± 0.07) mm dan 29.85 (± 0.09) mm jumlah panjang masing-masing. Populasi *A. japonicus* terdiri daripada maksimum dua kumpulan umur maksimum dengan 15.18 (± 0.90) mm dan 21.56 (± 1.03) mm pada min jumlah panjang. Populasi *A. intermedius* juga terdiri daripada dua kumpulan umur dengan 19.18 (± 0.05) mm dan 26.92 (± 0.06) mm min jumlah panjang. Pertumbuhan alomotrik positif didapati bagi *A. indicus* di perairan Melaka. Namun pertumbuhan isometrik didapati bagi gabungan seks *A. japonicus*.

Pertumbuhan alomotrik positif didapati bagi betina dan gabungan seks *A. intermedius.* Perbezaan bererti didapati bagi taburan saiz-frekuensi jantan dan betina *A. indicus* (Kolmogorov-Smirnov test: d_{max}= 0.42, P < 0.05), *A. japonicus* (Kolmogorov-Smirnov test: d_{max} = 0.39, P < 0.05) dan *A. intermedius* (Kolmogorov-Smirnov test: d_{max} = 0.40, P < 0.05).

Pertumbuhan, kadar kematian, pemulihan dan hasil perolehan relatif per pemulihan bagi spesis *Acetes* telah dikaji berdasarkan data frenkuensi panjang bulanan dengan menggunakan perisian FiSAT. Kadar kematian secara semula jadi bagi jantan *A. indicus* dan *A. japonicus* melawan kekerapan tangkapan yang diperhatikan dari kajian menunjukkan ketidakseimbangan pada stok. Aras eksploitasi (E) betina adalah lebih tinggi berbanding jantan bagi populasi *A. indicus* dan *A. japonicus.* Kajian ini menunjukkan dua proses pemulihan besar per tahun i.e., dua kohot dihasilkan per tahun bagi populasi *A. indicus* dan *A. japonicus.* Corak pemulihan *A. intermedius* adalah berterusan dengan satu kohot besar per tahun. Keputusan dari analisis kadar eksploitasi (E) berdasarkan jangkaan kekerapan tangkapan dan hasil relatif per pemulihan (Y/R), menandakan perikanan *Acetes* telah berada dalam tahap optimum berdasarkan prinsip $E_{0.1}$, dan mungkin menghampiri eksploitasi maksimum (MSY). Ini bermaksud sebarang peningkatan kekerapan usaha perikanan tanpa pengawalan boleh melampaui tahap hasil perolehan maksima, akan menjejaskan stok dan menyebabkan kerugian dari segi ekonomi.

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I certify that an Examination Committee has met on 4 September 2008 to conduct the final examination of S. M. Nurul Amin on his Doctor of Philosophy thesis entitled "Biology and Population of sergestid shrimps (*Acetes* spp.) (Decapoda: Sergestidae) from Klebang Besar, Malacca, Malaysia" in accordance with Universiti Pertanian Malaysia (Higher Degree) Act 1980 and Universiti Pertanian Malaysia (Higher Degree) Regulations 1981. The Committee recommends that the student be awarded the Doctor of Philosophy.

Members of the Examination Committee were as follow:

Ahmad Ismail, PhD
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This thesis submitted to the Senate of Universiti Putra Malaysia and has been accepted as fulfillment of the requirement for the degree of Doctor of Philosophy. The members of the Supervisory Committee are as follows:

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Date:

DECLARATION

I declare that the thesis is my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously, and is not concurrently, submitted for any other degree at Universiti Putra Malaysia or any other institution.

_____

S. M. NURUL AMIN

Date:

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