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BIOLOGY AND POPULATION DYNAMICS OF RAINBOW PRAWN, Parapenaeopsis sculptilis (HELLER, 1862), IN COASTAL WATERS OF TERONG, PERAK, MALAYSIA

ALSAYED, AMANI ABDULAZIZ A

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

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BIOLOGY AND POPULATION DYNAMICS OF RAINBOW PRAWN, *Parapenaeopsis sculptilis* (HELLER, 1862), IN COASTAL WATERS OF TERONG, PERAK, MALAYSIA

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Chairman: Professor Aziz Arshad, PhD

Faculty: Institute of Bioscience

Taxonomy, morphometry, food and feeding habits, reproduction and population parameters of *Parapenaeopsis sculptilis* Heller 1862 in the coastal waters of Terong, Perak, Peninsular Malaysia were studied between February 2012 and January 2013. A total of 120 specimens of *P. sculptilis* were used for morphometric studies and they were collected from four different locations *viz.* Perak, Penang, Port Dickson and Malacca. The morphometric characteristics investigated include the total length, standard length, carapace length, carapace height, rostral length, second pleon segment height, sixth pleon segment length, telson length, telson width, eye wide and eye length. The morphometric study is aimed to investigate on the possibility of differences in body morphometric characteristics amongst the different *P. sculptilis* populations in Peninsular Malaysia waters.The result showed that all morphometric characters of *P. sculptilis* from four different areas in the west coast of Peninsular Malaysia were significantly ($P < 0.05$) different at 5% level except for CL, CH, RL and TEW ($P > 0.50$) not significant at 5% level. Feeding process particularly feeding items is one of the important biological characteristics for species that has aquaculture potential. The observation of the stomach contents of 360 specimens from coastal waters of Terong Perak, found only 10.14% of empty stomachs of the *P. sculptilis* while 89.84% of the stomachs filled up with foods. The highest percentages of full stomachs, 3/4 full, 1/2 full and 1/4 full were found in January, June, May and March respectively. The diet compositions of *P. sculptilis* were grouped into nine different categories *viz.* phytoplankton, zooplankton, mollusca, fish scales, polychaetes, appendages of crustacean, detritus, sand and unidentified items. According to the Index of Relative Importance (%IRI), the main food items of *P. sculptilis* graded as first rank was molluscs (64.73%), and this was followed by appendages of crustacean (17.88%), zooplankton (7.49%), detritus (2.64%), sand (2.27 %), phytoplankton (2.20%), fish scales (1.84 %), unidentified items (1.19 %) and polychaetes (0.69%). The various

composition of food items proved that the *P. sculptilis* is an omnivorous bottom feeder. A study was also included to examine the sex ratio in the population of Terong coastal waters and the annual results for the ratio was found to be 1:3.4 (Males: Females). Consecutively, a study on the reproductive biology was carried out on 50 female individuals each month. Samples were examined monthly and the peak Gonadosomatic Index (GSI) of female *P. sculptilis* was very apparent during the months of April, August and October in the study area. The first sexual maturity of female was attained at a total length of 9.30 cm. The highest GSI value (5.89) was observed in April, where the females were a mature stage. The lowest GSI (0.63) was obtained in November, where the females were at an early active and immature phase. Relative condition factor (K_n) values ranged from 0.99 to 1.064 (1.013±0.005, mean ±SD). K_n values changes in various months: the highest peak was in March-April indicating the spawning period and small peaks indicated the cycle of gonadal development. A total of 3110 specimens of prawn were used for the works on the population dynamics of *P. sculptilis*. The estimated mean total lengths for males and females were 9.13(±0.83) and 11.96 (±2.2) cm. Length-weight relationship (LWR) parameters of both sexes was estimated at $W = 0.00027TL^{2.80}$. The estimated relative growth coefficient (b) was 2.80 for the both sexes which indicated that growth pattern of *P. sculptilis* was negative allometric in the investigated area. Monthly length–frequency data were analysed by using FiSAT (FAO ICLARM Stock Assessment Tools) software. The von Bertalanffy growth (VBGF) parameters were estimated as asymptotic length ($L\infty$) = 17.69 cm and growth coefficirent (K) = 2 yr^{-1}. The total mortality (Z), natural mortality (M) and fishing mortality (F) were found to be 6.71, 1.77 and 4.94 yr^{-1} respectively. The exploitation (E) rate was calculated as E = 0.74 which is higher than optimum level of exploitation (E= 0.50). It is revealed that the status of the stock of *P. sculptilis* is over exploited the in the coastal waters of Terong, Perak, Peninsular Malaysia.

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

BIOLOGI DAN POPULASI DINAMIK UDANG KULIT KERAS, *Parapenaeopsis sculptilis* (HELLER, 1862), DI PERAIRAN PANTAI TERONG, PERAK, MALAYSIA

Oleh

ALSAYED, AMANI ABDULAZIZ A

Disember 2015

Pengerusi: Profesor Aziz Arshad, PhD

Fakulti: institut biosains

Taksonomi, morfometri, makanan dan tabiat pemakanan, pembiakan dan parameter populasi *Parapenaeopsis sculptilis* Heller 1862 telah dikaji di antara Februari 2012 hingga Januari 2013 di kawasan perairan Terong, Perak, Semenanjung Malaysia. Sejumlah 120 spesimen *P. sculptilis* telah digunakan untuk kajian morfometrik dan ianya telah dikumpulkan dari empat lokasi yang berbeza iaitu Perak, Pulau Pinang, Port Dickson dan Melaka. Ciri morfometrik yang telah disiasat meliputi panjang keseluruhan, panjang piawai, panjang karapas, tinggi karapas, panjang rostrum, tinggi segmen kedua pleon, panjang segmen pleon keenam, panjang telson, lebar telson, lebar mata dan panjang mata. Kajian morfometrik adalah bertujuan untuk menyiasat mengenai kemungkinan perbezaan bererti dalam ciri morfometrik badan di kalangan populasi *P. sculptilis* yang berbeza di perairan Semenanjung Malaysia. Hasil kajian menunjukkan bahawa semua ciri morfometrik *P. sculptilis* dari empat kawasan yang berlainan di perairan pantai barat Semenanjung Malaysia telah berbeza dengan bererti ($P < 0.05$) pada paras 5%. Pemerhatian kandungan isi perut bagi 360 spesimen dari perairan pantai Perak, mendapati hanya 10.14% *P. sculptilis* adalah pada tahap perut kosong manakala 89.84% menunjukkan perut yang berisi makanan. Peratusan tertinggi adalah perut penuh, 3/4 penuh, 1/2 penuh dan 1/4 penuh dijumpai masing-masing pada bulan Januari, Jun, Mei dan Mac. Komposisi makanan *P. sculptilis* telah dikumpulkan ke dalam sembilan kategori iaitu fitoplankton, zooplankton, siput, sisik ikan, cacing, apendej bagi krustasea, detritus, pasir dan bahan yang tidak dikenali. Menurut Indeks Kepentingan Relatif (%IRI), bahan makanan utama *P. sculptilis* iaitu moluska telah digredkan sebagai tahap pertama (64.73%), ini diikuti dengan apendej krustasea (17.88%), zooplankton (7.49%), detritus (2.64%), pasir (2.27%), fitoplankton (2.20%), sisik ikan (1.84%), bahan yang tidak dikenali (1.19%) dan cacing (0.69%). Pelbagai

komposisi makanan mengunjurkan yang *P. sculptilis* adalah jenis omnivor pemakan dasar. Kajian juga dijalankankan untuk meneliti nisbah jantina dalam populasi perairan pantai Terong dan keputusan tahunan bagi nisbah ditemui adalah 1: 3.4 (Jantan: Betina). Seterusnya, satu kajian mengenai biologi pembiakan telah dijalankan ke atas 50 individu betina bagi setiap bulan selama setahun. Sampel telah diperiksa setiap bulan dan puncak Indeks Gonadosomatik (GSI) *P. sculptilis* betina adalah sangat ketara pada bulan April, Ogos dan Oktober di kawasan kajian ini. Kematangan seks pertama bagi betina ialah apabila mencapai panjang keseluruhan 9.30 cm. Nilai GSI tertinggi (5.89) diperhatikan pada bulan April, di mana betina berada di peringkat matang. Nilai GSI paling rendah (0.63) telah diperolehi pada bulan November, di mana betina berada di fasa permulaan aktif dan tidak matang. Nilai Faktor Keadaan Relatif (K_n) adalah berjulat dari 0.99 ke 1.064 (1.013 ± 0.005, min ± SD). Nilai K_n berubah mengikut bulan di mana puncak tertinggi ialah pada Mac-April yang menunjukkan tempoh masa bertelur dan puncak kecil menunjukkan kitaran perkembangan gonad. Proses pemakanan terutamanya bahan makanan adalah salah satu ciri biologi yang penting untuk spesies yang berpotensi dalam akuakultur. Sejumlah 3110 spesimen udang telah digunakan untuk kajian populasi dinamik *P. sculptilis*. Anggaran purata jumlah panjang bagi jantan dan betina ialah 9.13 (± 0.83) dan 11.96 (± 2.2) cm. Parameter hubungan panjang-berat (LWR) kedua-dua jantina dianggarkan $W = 0.00027TL^{2.80}$. Anggaran pertumbuhan pekali relatif (b) ialah 2.80 bagi kedua-dua jantina telah menunjukkan bahawa corak pertumbuhan *P. sculptilis* adalah alometrik negatif di kawasan yang disiasat. Data panjang frekuensi bulanan telah dianalisis dengan menggunakan perisian FiSAT (FAO ICLARM Alat Penilaian Stok). Parameter pertumbuhan von Bertalanffy (VBGF) telah dianggarkan sebagai panjang asimptot ($L\infty$) = 17.69 dan pekali pertumbuhan (K) = 2 tahun^{-1}. Jumlah kematian (Z), kematian semula jadi (M) dan kematian tangkapan ikan (F) didapati masing-masing pada tahap 6.71, 1.77 dan 4.94 tahun^{-1}. Kadar eksploitasi (E) dikira sebagai E = 0.74 iaitu lebih tinggi daripada tahap eksploitasi optimum (E = 0.50). Ia mendedahkan bahawa status stok udang *P. sculptilis* telah mencapai tahap eksploitasi yang berlebihan di kawasan perairan pantai Terong, Perak, Semenanjung Malaysia.

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I certify that a Thesis Examination Ccommittee has met on 17th December 2015 to conduct the final examination of ALSAYED, AMANI ABDULAZIZ A on her Doctor of Philosophy thesis entitled " **Biology and Population Dynamics of Rainbow Prawn, *Parapenaeopsis sculptilis* (Heller, 1862), in the Coastal Waters of Terong, Perak, Malaysia**" in accordance with the Universities and University colleges Act 1971 and the Constitution of the Universiti Putra Malaysia [P.U.(A) 106] 15 March 1998.The Committee recommends that the student be awarded the Doctor of Philosophy.

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Professor and Deputy Dean
School of Graduate Studies
Universiti Putra Malaysia

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This thesis was submitted to the Senate of Universiti Putra Malaysia and has been accepted as fulfilment of the requirements for the degree of Doctor of Philosophy. The members of Supervisory Committee were as follows:

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Universiti Putra Malaysia
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ANOVA	Analysis of variance
A	Condition factor
B	Growth coefficient of length-weight relationship
Cm	Centimeter
DOF	Department of Fisheries
E	Exploitation rate
E_{max}	Maximum allowable limit of exploitation
EPN	Estuarine Push Net
ELEFAN	Electronic Length Frequency Analysis
FiSAT	FAO ICLARM Stock Assessment Tools
FAO	Food and Agriculture Organization
g	Grams
GSI	Gonadosomatic index
IRI	Index of Relative Importance
K	Growth co-efficient of VBGF
K_n	Relative condition factor
$L\infty$	Asymptotic length
L_{max}	Predicted extreme length
LWR	Length-weight relationships
M	Natural mortality
mm	Millimetre
N	Sample size
r^2	Coefficient of determination
R_n	Response surface
SBN	Set Bag Net
SD	Standard deviation
Sp.	Species
t_{max}	Maximum life span
TL	Total length
TW	Total weight
UPM	Universiti Putra Malaysia
VBGF	von Bertalanffy growth function
Z	Total mortality
φ'	Growth performance index
^0C	Degree Celsius
%	Percentage
<	Less than
>	More than

CHAPTER 1

GENERAL INTRODUCTION

1.1 Background of the study

Prawns from the genus *Parapenaeopsis*, family of Penaeidae, are decapods and have a wide distribution, but the majority of species that comprise this genus are restricted to tropical and warm temperate shallow seas (Lee, 1972). Moreover, most occur throughout the Indo-Pacific region, from Persian Gulf Indian region and east coast of Africa to Japan and Australia while only a few species are found in Eastern Atlantic and Pacific America (Rao, 1969).

The most commonly studied species are from the Indian region and they include *P. uncta, P. cornntra maxillipedo, P. nana, P. acclivirostris, P. hardwickii, P. stylifera* and *P. sculptilis*. *Parapenaeopsis sculptilis* is unknown commercial species in Peninsular Malaysia and comprises about 27% of the total prawn catch in Malaysia. This species of shrimp is abundant in the western coast of Peninsular Malaysia. *Parapenaeopsis sculptilis* is known by the common name 'rainbow prawn' and is locally known as 'Udang Kulit Keras' in Peninsular Malaysia and are commercially important to many locals although it is sold as the at lower price than other top commercial species such as banana prawn (Ong and Weber, 1977; Bejie, 1985a, 1985b).

The commercial size of *P. sculptilis* range from 11-15 cm and a total length (TL) of 17 cm. Female *P. sculptilis* grow faster than males and the length of males at sexual maturity is 7.5 cm (Amin and Zafar, 2003). Moreover, *P. sculptilis* has a large body, but a comparatively small tail with a small yield (Dore and Frimodt, 1987).

On the west coast of Peninsular Malaysia, the straits of Malacca are very important areas for harvesting prawns in general and species of *P. sculptilis*, even though marine prawns are caught by a variety of fishing gears found at depths of 35-90 m (Lovett, 1981). The latest data information on annual landing of *P. sculptilis* in Malaysia was 3.526 tonnes during 2012 (DOF, 2013).

Parapenaeopsis is one of the most important fisheries in Malaysia although, since food is a main factor, it is critical to obtain information on their growth, abundance and migration, information on feeding habits and ecology to better understand the dynamics of this resource. It is known that *P. sculptilis* is a marine species that are mainly fished in shallow inshore waters where spawning adults are often found. The young live mainly in coastal mud flats or sand flats near to mangroves. Smaller individuals belonging to 0-1 year class contribute to the fishery of less saline areas and the larger sizes (I & II year's class) support the inshore fishery (Kirkegaard and Walker, 1970).

These important commercial fisheries are being marketed fresh, frozen, peeled and cooked or canned, as well as being used as shrimp meal or shrimp paste in Malaysia and Singapore (Marsitah and Chong, 2002; Tham, 1968; Kubo, 1949). In Bangladesh, *P. sculptilis* are abundantly found in various estuaries and provides a lucrative fisheries industry (Kamal and Khan, 2009; Ahmad, 1957). Also, in Australia this species is of particular commercial value in the North of Cape Moreton, Queensland (Racek, 1959) as well as being a popular bait species on the Central Queensland coast (Grant, 1965). In addition, in the Pakistan coast and India this species often occurs in commercial catches off Bombay and the Ganges delta, respectively (Jones, 1967). There is also a small fishery in the northern east and west coasts of India (Kurian and Sebastian, 1976).

1.2 Statement of the problems

There are several accounts of *Parapenaeopsis* fisheries from West Malaysia or Malay Peninsula (Tham, 1968; Rao, 1969; Lee, 1972; Chong, 1984; Chong *et al*., 1994). All are very brief except those of Kirkegaard and Walker (1970), Holthuis (1980), and Marsitah and Chong (2002). However, most of these works focused on taxonomic diagnosis, and currently there is a lack of basic biological information, especially regarding the population biology, stock assessment and genetic structure of *P. sculptilis*.

Moreover, there is no report available regarding the feeding habits, spawning season and sex ratio of *P. sculptilis* in the Perak coastal waters, which are areas that local heavily harvest this prawn species. Such information is important for their potential aquaculture development as well as the formation of fisheries management policies. In terms of management, it is essential to evaluate their ecological role as well as the understanding its position in the food web structure in the ecosystem.

The population dynamics, such as asymptotic length ($L\infty$), growth co-efficient (K), fishing mortality (F), natural mortality (M), recruitment pattern and exploitation rate of *P. sculptilis* is also necessary to understand since, without such knowledge, it is impossible to undertake sound and effective management programs on *Parapenaeopsis* spp. Therefore, such information will help provide advice to the fishing industry, fishermen, fisheries managers as well as planners and policy makers on the optimum level of exploitation of *Parapenaeopsis* spp. fisheries and to provide possible management options. In view of the national importance of *Parapenaeopsis* spp., studies on their biology, genetic variation, population dynamics and stock assessment from the west coast of Peninsular Malaysia are very important.

Thus, if no attempt to properly manage the *Parapenaeopsis* fishery resource in the west coast of Peninsular Malaysia, then the abundance of these resources could be lost and livelihood of numerous fishermen will be adversely affected. Some studies have been carried out in terms of population dynamic of *Parapenaeopsis* spp. in other countries or areas (e.g. Bhimachar, 1963; Zafar *et al*., 1997; Amin and Zafar, 2003), despite it is a

commercial and exploited species, there is no detail study on biology and population of *Parapenaeopsis* spp. in Malaysia. Therefore this study is carried out to address this lack of biological and population characteristics information. For management purpose, it is necessary to understand some of the important biological characteristics and population parameters of *P. sculptilis* (i.e., spawning season, growth, mortality, recruitment, and exploitation). Some reports are available on food and feeding habits of *Parapenaeopsis* in other countries (Hall, 1962; Rajyalakshmi, 1966; Sukumaran and Rajan, 1986; Sarada, 2002), as stated there are limited information on feeding habits, reproductive and population dynamics of *Parapenaeopsis sculptilis* from Malaysia (Hall, 1962; Marsitah and Chong, 2002).

The present study was undertaken to examine the feeding habits, reproductive biology and population dynamics of *P. sculptilis* in the waters of Terong, Perak, Peninsular Malaysia.

1.3 Objectives of the study

The main objectives of research were:

1. To identify the morphometric variation *P. sculptilis* in several landing sites in the west coast of Peninsular Malaysia.

2. To investigate the food habits and annual temporal diet variation of *P. sculptilis*.

3. To determine the spawning season and sex ratio of *P. sculptilis* populations in the coastal waters of Terong, Perak.

4. To estimate the population parameters, such as asymptotic length ($L\infty$), growth coefficient (K), natural mortality (M), fishing mortality (F) and exploitation level (E) of *P. sculptilis* from Terong, Perak coastal waters.

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