UNIVERSITI PUTRA MALAYSIA

REPRODUCTIVE BIOLOGY, FEEDING HABITS AND POPULATION DYNAMICS OF Miyakella nepa (LATREILLE, 1828)

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By

ZAMRI BIN ZAINUDIN

Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia, in Fulfillment of the Requirements for the Degree of Master of Science

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DEDICATIONS

To the greatest father, Zainudin bin Sulong, and the best mother one could have, Che Mariah Bte Hj Abd Rahman, this one is for you. Thank you for the never ending prayers, perseverance, tender loving care, time and energy for helping me seeing my goal

To my brothers;
Dino
Zaidy
Zaid

And
To all my friends who supported and helped me all these years

Abstract of thesis was presented to the Senate of Universiti Putra Malaysia in fulfilment of the requirement for the Degree of Master of Science

REPRODUCTIVE BIOLOGY, FEEDING HABITS AND POPULATION DYNAMICS OF *Miyakella nepa* (LATREILLE, 1828)

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Chairman: **Prof. Aziz Bin Arshad, PhD**
Faculty: **Agriculture**

The reproductive biology, feeding habits, and population dynamics of *Miyakella nepa* (Latreille, 1828) was studied in the coastal waters of Pantai Remis, Perak from February 2012 to January 2013. A total of 951 specimens comprising 565 females and 386 males of *M. nepa* were examined. The results indicated that the overall male to female ratio of *M. nepa* was 1:1.46. About 30 *M. nepa* females were examined every month for their ovarian stages and gonadosomatic index (GSI). The peak GSI for female *M. nepa* were recorded during March-April, between June and September and November-December during the study period. The maximum GSI value of was 5.8 was observed in July 2012. It was found that *M. nepa* breed continuously throughout the year. The highest peak of the relative condition factor (Kn) for male and female *M. nepa* were both in February at 1.05 and 1.02, respectively. The size at first sexual maturity for female *M. nepa* was observed to be 100 mm in total length. The number of ova in females with mature ovaries was counted from 30 females and their mean fecundity was 425657.19 (± 18701.23) eggs. Bigger females have higher number of eggs. The identified prey items included seven major groups (decapod crustaceans, polychaetes, cephalopod molluscs, fish, gastropods and bivalves, eggs and unidentified items). Decapod crustaceans were the dominate prey items for *M. nepa* with an occurrence frequency and numerical abundance at 40.42 and 30.81 %, respectively. The occurrence frequency and numerical abundance were 19.28 and 27.35 % for polychaetes 9.69 and 6.18 % for cephalopod molluscs, 13.24 and 17.74% for fish, 4.90 and 4.58% for gastropods and bivalves, 0.28 and 3.16% for eggs and 3.85 and 1.85% for unidentified items, respectively. The maximum percentage and numerical abundance of each prey item changed at different months. *Miyakella nepa* was shown to be predatory carnivore, feeding mainly on the littoral zone communities. The mean total lengths for male and females were 122.89 (± 0.60) mm and 127.60 (± 061) mm, respectively indicating females were 4.71 mm longer compared to males. The estimated b value of *M. nepa* for both sexes in the present study (2.919) was similar to the isometric value (3). This indicates an isometric growth pattern of *M. nepa* in the coastal waters of Pantai Remis, Perak. For both sexes, fishing mortalities (F) was 2.84 compared to natural mortalities (M) of 0.62 indicating the balance position in the stock. The recruitment pattern for *M. nepa* was continuous with two major peaks per year. The exploitation rate (E) was 0.82 for combined sexes of *M. nepa*, and was higher than the E_{10} and E_{50} values of 0.79 and 0.43, respectively. Based on the fishing mortalities, and from the relative yield-per-recruit (Y/R), this indicates that *M. nepa* fishery is over

exploited in the coastal waters of Pantai Remis, Perak. A more detailed study on this particular species would improve fisheries activities and stock assessment of *M. nepa* in the coastal waters of Malaysia.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk Ijazah Master Sains

BIOLOGI PEMBIAKAN, TABIAT PEMAKANAN DAN DINAMIK POPULASI *Miyakella nepa* (LATREILLE, 1828)

Oleh

ZAMRI BIN ZAINUDIN

Julai 2015

Pengerusi: **Prof. Aziz Bin Arshad, PhD**
Fakulti: **Pertanian**

Biologi pembiakan, tabiat pemakanan, dan dinamik populasi *Miyakella nepa* (Latreille, 1828) dikaji di persisiran Pantai Remis, Perak dari Februari 2012 hingga Januari 2013. Sejumlah 951 spesimen dengan 565 betina dan 386 jantan *M. nepa* dikaji. Hasil ujikaji menunjukkan purata nisbah jantan betina *M. nepa* didapati dalam nisbah 1:1.46. Dalam 30 ekor betina *M. nepa* diperiksa setiap bulan untuk keadaan peringkat ovari serta anggaran indeks gonadosomatik. Nilai puncak untuk min indeks gonadosomatik (GSI) untuk *M. nepa* betina telah direkodkan semasa Mac-April, di antara Jun dan September dan November-Disember semasa tempoh kajian. Nilai maksimum untuk indeks gonadosomatik adalah 5.8 didapati dalam bulan Julai 2012. *Miyakella nepa* didapati membiak sepanjang tahun. Nilai tertinggi untuk faktor relatif keadaan (Kn) untuk *M. nepa* jantan adalah 1.05 pada bulan Februari dan 1.02 pada bulan Februari untuk betina. Saiz untuk kematangan seksual yang pertama untuk *M. nepa* betina di persisiran Pantai Remis, Perak didapati pada 100 mm untuk jumlah panjang badan. Jumlah ova di dalam betina dengan ovari matang dikira untuk 30 *M. nepa* betina. Min kesuburan untuk 30 *M. nepa* betina adalah 425657.19 (± 18701.23) biji telur. Udang lipan betina yang lebih besar mempunyai jumlah telur yang lebih banyak. Jenis mangsa dikenal pasti dengan tujuh kumpulan utama (dekapod krustasia, polichaeta, sephalopod molusk, ikan, gastropod dan bivalvia, telur dan sejumlah yang tidak dikenal pasti). Dekapod krustasia yang dijumpai di dalam perut *M. nepa* dikenal pasti sebagai mangsa utama di kalangan yang lain dengan kekerapan dan jumlah nilai, masing-masing bernilai 40.42 dan 30.81%. Mangsa lain dengan kekerapan dan jumlah nilai adalah polichaeta (19.28 %, 27.35 %), sephalopod molusk (9.69 %, 6.18 %), ikan (13.24 %, 17.74 %), gastropod dan bivalvia (4.90 %, 4.58 %), telur (0.28 %, 3.16 %) dan bahan yang tidak dikenal pasti (3.85 %, 1.85 %). Peratusan dan jumlah nilai maksimum untuk setiap mangsa adalah di dalam bulan yang berbeza. *Miyakella nepa* didapati sebagai pemangsa karnivor, dengan mangsa adalah terutamanya daripada komuniti zon pesisir. Min jumlah panjang badan adalah 122.89 (± 0.60) mm untuk jantan dan 127.60 (± 061) mm untuk betina. Min tahunan untuk jumlah panjang badan untuk betina adalah 4.71 mm lebih berbanding jantan. Nilai anggaran b untuk kedua-dua jantina *M. nepa* di dalam kajian (2.919) adalah hampir kepada nilai isomektrik (3). Ini menunjukkan pertumbuhan isometrik *M. nepa* di persisiran Pantai Remis, Perak. Untuk kedua-dua jantina, kematian perikanan (F) yang lebih tinggi (2.84) berbanding dengan kematian semulajadi (M) yang berjumlah 0.62 daripada kajian menunjukkan kedudukan stok berada dalam keseimbangan. Corak pengambilan untuk *M. nepa* adalah berterusan

dengan dua puncak utama setiap tahun. Hasil analisis kadar eksploitasi (E) berjumlah 0.82 untuk kedua-dua jantina *M. nepa*, lebih tinggi dari E_{10} dengan nilai 0.79 dan E_{50} yang bernilai 0.43. Berdasarkan anggaran kadar kematian perikanan, dan daripada hasil-setiap-pengambilan relatif (Y/R) menunjukkan yang perikanan *M. nepa* adalah diekploitasi dengan berlebihan di persisiran Pantai Remis, Perak. Kajian yang lebih terperinci ke atas spesis ini dapat membantu dalam mempertingkatkan aktiviti perikanan dan penilaian stok *M. nepa* di dalam perairan Malaysia.

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Also, thank you, *Miyakella nepa*. For thou art such a majestic creature, Masha Allah.

I would also like to take this opportunity, to humbly apologize for any inconvenience and burdens that I have caused before, during, and after the project.

APPROVAL

I certify that an examination committee has met on 8 July 2015 to conduct the final examination of Zamri bin Zainudin on his Master of Science thesis entitled "Reproductive Biology, Feeding Habits and Population Dynamics of *Miyakella nepa* (Latreille, 1828)" in accordance with Universities and University Colleges Act 1971 and the Constitution of the Universiti Putra Malaysia [P.U.(A) 106] 15 March 1988. The committee recommends that the student be awarded the Master of Science.

Members of the examination committee are as follows:

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This thesis submitted to the Senate of Universiti Putra Malaysia has been accepted as fulfilment of the requirements for the Degree of Master of Science. The members of Supervisory Committee are as follows:

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Declaration by graduate student

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LIST OF ABBREVIATIONS

AS	Abdominal somite
b	Growth coefficient of length-weight relationship
DOF	Department of Fisheries (Malaysia)
et al.	And others
E	Exploitation rate
E_{max}	Maximum allowable limit of exploitation
ELEFAN	Electronic Length Frequency Analysis
FiSAT	FAO ICLARM Stock Assessment Tools
FAO	Food and Agriculture Organization
g	gram
GSI	Gonadosomatic index
GW	Total weight of ovary
GWs	Sample weight of ovary
IM	Intermediate carinae
K	Growth co-efficient of VBGF
Kn	Relative condition factor
L_∞	Asymptotic length
L_{max}	Predicted extreme length
Lc	Length at first capture
LT	Lateral carinae
m	meter
mg	milligram
mm	millimeter
M	Natural mortality
MD	Median carinae
MG	Marginal carinae
ML	Mid length
MXP	Maxilliped
N	Sample size
PLP	Pleopod
PRP	Pereopod
r^2	Coefficient of determination
R_n	Response surface
sp.	species
SM	Submedian carinae
t_{max}	Maximum life span
TL	Total length
TS	Thoracic somite
TW	Total weight
UPM	Universiti Putra Malaysia
VBGF	von Bertalanffy growth function
Z	Total mortality
φ'	Growth performance index
±	Plus-minus
%	Percentage
<	Less than
>	More than

CHAPTER 1

GENERAL INTRODUCTION

1.1 Background

Mantis shrimp is a crustacean just like other shrimps and crabs, but not technically a natantian shrimp in terms of its morphology. It retains the characteristics of both aquatic shrimp and mantis. The common name mantis shrimp derives from its method of capturing prey using folded raptorial appendage that resembles the foreleg of a praying mantis (Cronin *et al*., 2006). Locally, mantis shrimp is known as 'udang lipan' or 'udang kertak', depending on location in the country. Although stomatopods belong to the Malacostracan as crabs and shrimps, they form their own subclass Hoplocarida, which contains the single order Stomatopoda. Information on stomatopods are quite established worldwide but very scanty as in the case of Malaysian species. One notable carcinologist specializing in mantis shrimp was Raymond Brandon Manning (1934-2000). A total of 306 species, 153 genera, 5 subfamilies, 19 families, and 3 superfamilies were mentioned in his written or co-written publication papers, with the collections covering 90% of the known species (Clark and Schram, 2009; Lemaitre and Reed, 2000).

The total existing species is believed to be around 450 species (Patek and Caldwell, 2006). Like other stomatopod, *Miyakella nepa* has body that is elongated, dorso-ventrally flattened and shows body that is shrimp-like or lobster-like crustaceans. According to Manning (1978), all mantis shrimps are typically characterized by large moveable eyes, short carapace, three pairs of walking legs or periopods, five pairs of swimming legs or pleopods and a long flattened tail section. Body size can vary according to species although stomatopods may range in size from 1-2 cm to more than 30 cm in the case of some deeper-water lysiosquillids.

As a benthic invertebrate, stomatopods live in burrows or spaces under rocks or coral which they excavate themselves. Stomatopods of the 'spearer' type often inhibit burrows while those of 'smasher' group can often be found in hard substrates. The special body characteristics such as short carapace and having flexible body has enable them to turn around inside the burrow easily. Stomatopods are predatory benthic marine crustaceans primarily occurring in variety of tropical littoral and sublittoral habitats (Cheroske *et al*., 2009; Dingle and Caldwell, 1978). They would normally lie in wait in these burrows for passing prey, fishes or crustaceans. Mantis shrimps are often found dwelling in the shallow sandy sediments. Greatest diversity of species is in the tropics and they more or less found in abundance in the sediments of coral lagoons. However, the habitat can never be specific, it goes with the species and the feeding and reproductive requirements. As many as five genera are found in a habitat of one tidepool (Reaka, 1976). Few species also inhabit the deep sea. The special difference in size forms could be translated in the survival of the species. This is because larger stomatopods are capable of tackling much larger animals in defence of themselves or during prey capture.

In a natural habitat, mantis shrimp dig burrows with several openings in a soft substrate, and is a nocturnal hunter, making it quite difficult to spot. Smashers have

enlarged and extremely tough elbows, and they use this appendage to smash crabs and other hard-shelled prey while spearers lack this tough elbows, they have an alternative formidable weapons of barbed fingers. When handling the prey, they can even pierce them an upward thrust and tearing apart with specialized mouth parts. The spearers are usually larger and less aggressive than the 'smashers', and they tend to build their burrows in soft materials like mud and sand. The smashers live mainly in hard materials such as corals rubbles and calcified rocks and in the feeding process, they will often paralyzed their prey first before dragging it back to their burrows. They can be of a 'homey' character, spend most of their time in their burrows or habitats, only leaving to find foods or to migrate to a new home.

A review by Chu *et al.* (1997) reveals stomatopods attribute up to 13 % of the total trawl catch and more than 20 % of the crustacean catch by weight (Chu *et al.*, 1996). As opposed to Malaysia, mantis shrimp is commercially valuable and caught for consumption, such as *Oratosquilla oratoria* in Japan (Kodama *et al*., 2004; Ohtomi *et al.*, 2005), *Squilla mantis* in the Mediterranean (Musa and Wei, 2008), as well as several other countries such as Spain, Italy, Egypt and Morocco (Abelló and Martin, 1993). It fetched quite high price in India for substitute as feed, consumption or manure (James and Thirumilu, 1993; Sukumaran, 1987) as opposed with the condition here which they are priced lower compared to other shrimps in the market. Stomatopods have the potential as an alternative source of food that is high in protein. Jose *et al.* (2014) also showed that *M. nepa* muscle's collagen has great potential as a new source of materials for nutraceutical industries, food and biomedical materials. Moreover, the high content of polyunsaturated *n*-3 fatty acids in the crustaceans positively affect the neurodevelopment in infants, controlling fat glycemic, learning process and visual function (Burr, 1989; Goodstine *et al*., 2003).

Stomatopods are widely-used as an effective way to measure the health of coral reefs. Their presence or absence in coral reef area allows scientists to gauge the environmental health of the habitat. Steger and Caldwell (1993) found that stomatopods abundance, diversity and recruitment are very negatively correlated with sediment concentrations with high concentrations of petroleum hydrocarbons, heavy metals, sewage, and agrochemical runoff contaminations. The exoskeleton can be processed to a product called chitosan. It is a pharmaceutical product to absorb excess body fat. On another note, chitosan harvested from *M. nepa* could also be used in removing heavy metals from water (Zynudheen *et al*., 2009).

1.2 Statement of problem

The stomatopod fauna has received relatively little research attention in the country. To date, nothing is known on the fishery and biology of mantis shrimps in Malaysia. Although stomatopods are now commercial species, the status has never been discussed, and the biological aspects such as reproduction and feeding are never researched. There is no aquaculture activity for mantis shrimp in Malaysia, due to inavailability of hatchery-produced postlarvae. Fishing presently are done with trawl net and as it gains on popularity, mantis shrimp will more subjected to overfishing problem. The main objective of this study is to explore the diversity, distribution and abundance of mantis shrimps in a fishing area of Perak coastal waters particularly in Pantai Remis. Some aspects of stomatopods biology such as feeding habit and

reproductive season are still in need of information. For instance, the full range of morphological variation among localized populations is also unknown. In addition, population parameters are also poorly understood.

1.3 Objectives

Thus this study was established to address the following objectives:

- To determine reproductive cycle and spawning season, sex ratio and fecundity of mantis shrimp
- To investigate the feeding habits and seasonal variation of diet composition of mantis shrimp
- To estimate the population parameters and stock assessment of mantis shrimp

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