UNIVERSITI PUTRA MALAYSIA

BIOLOGICAL CHARACTERIZATION OF TWO Nemipterus spp. IN COASTAL WATERS OF BINTULU, SARAWAK, MALAYSIA

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FSPM 2016 10

BIOLOGICAL CHARACTERIZATION OF TWO *Nemipterus* spp. IN COASTAL WATERS OF BINTULU, SARAWAK, MALAYSIA

By

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

November 2016

Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfillment of the requirement for the degree of Master of Science

BIOLOGICAL CHARACTERIZATION OF TWO *Nemipterus* spp. IN COASTAL WATERS OF BINTULU, SARAWAK, MALAYSIA

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Threadfin bream of the genus *Nemipterus* is a demersal fish which is one of the valued food fishes in many parts of the world. This species is important economically and trawled in commercial quantities in the South China Sea. The study on *Nemipterus* in Malaysia especially in Sarawak is little. The present study was to observe the reproductive and feeding biology of *Nemipterus japonicus* and *Nemipterus peronii* at coastal area of Bintulu, Sarawak as well as its population dynamic. Monthly sampling was done within a period of 12 months from April 2013 until March 2014 at commercial fish landing site at Bintulu and Kuala Nyalau. Samples in various length sizes was purchased from fisherman and immediately kept in the ice chest and brought back to the laboratory in Department of Animal Science and Fisheries for further analysis.

The study of Length Weight Relationship showed that the growth of male and female of both *N. japonicus* and *N. peronii* is negative allometric growth. Both of the species tend to become thinner as they grow larger. Natural mortality (M) for *N. japonicus* was estimated at 1.63 yr^{-1} and fishing mortality (F) was found to be 1.34 yr^{-1}. The exploitation ratio (E) for *N. japonicus* is 0.45 which indicates the species is under exploitation of the resource. In case of *N. peronii*, natural mortality (M) was estimated at 1.74 yr^{-1} and fishing mortality (F) was 1.79 $yr^{-1.}$ Fishing mortality was higher than natural mortality which indicates that the species has been overfished. The exploitation rate of *N. peronii* is 0.51 which above the optimum level, it is advisable to maintain and reduce the fishing pressure on the stock.

For *N. japonicus*, the distribution of sexes were significantly in favor of males (χ^2 = 12.84; $P < 0.05$) while for *N. peronii*, there is no significant different in the distribution of sex ratio. Gonadosomatic Indices (GSI) values of males *N. japonicus* was ranged from 0.067 to 0.1861 in males and 0.336 to 4.994 in females. *N. japonicus* in coastal area of Bintulu showed two peaks of spawning season which are in August and March.

GSI values of males *N. peronii* was ranged from 0.0916 to 0.2168 and 0.5828 to 3.2127 in females. In females, spawning season extended within two peaks namely August and March. Based on histological observation, *N. japonicus* and *N. peronii* are continuous breeder as the spawning stage observed in all months with the highest percentage in March. For *N. japonicus*, the mean fecundity was estimated at 40826 while for *N. peronii*, the mean fecundity was estimated at 44813.

The study on stomach fullness between length classes, from small to large size group of *N. japonicus* found that this species is a moderate feeder to active feeder as it grows. For *N. peronii*, the species change it feeding habit from poor feeder to active feeder when it reaches the large size. The stomach fullness was varied with season. For *N. japonicus*, full stomach was observed in all months where the feeding activity was good in April, October and February. In case of *N. peronii*, the feeding activity was good in April and October. It was decreased furthermore from November to February (wet season) up to the lower percentage. Analyses of prey in the stomachs of *N. japonicus* and *N. peronii* identified 18 important items belonging to eight major groups: fish, crustacean, molluscs, echinoderm, foraminifera, polychaete, nematode and unidentified materials. Both occurrence and numerical method showed that crustacean especially crabs were the most preferable food by *N. japonicus* and *N. peronii*. This study revealed that *N. japonicus* and *N. peronii* are carnivorous and they change their feeding habits from shrimp to crabs and then after fish as it grows.

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

CIRI-CIRI BIOLOGI DUA *Nemipterus* spp. DI PERAIRAN BINTULU, SARAWAK, MALAYSIA

Oleh

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Kerisi daripada genus *Nemipterus* tergolong dalam kumpulan ikan demersal yang mempunyai nilai sebagai sumber makanan. Spesis ini penting dari segi ekonomi dan di tangkap dalam kuantiti yang komersal di Laut China Selatan. Setakat ini, kajian ke atas *Nemipterus* di Malaysia terutama di Sarawak adalah sangat kurang. Oleh itu, kajian ini dijalankan untuk melihat biologi pembiakan dan pemakanan *Nemipterus japonicus* dan *Nemipterus peronii* di perairan Bintulu, Sarawak di samping untuk melihat populasi dinamiknya. Persampelan telah di jalankan setiap bulan dalam jangka masa 12 bulan dari April 2013 sehingga Mac 2014 di pusat pendaratan ikan Bintulu dan di Kampung Kuala Nyalau. Sampel pelbagai saiz di beli daripada nelayan dan dibawa balik ke makmal di Jabatan Sains Haiwan dan Perikanan untuk di analasis.

Kajian ke atas hubungan panjang dan berat menunjukkan pertumbuhan ikan jantan dan betina bagi kedua-dua spesis *N. japonicus* and *N. peronii* adalah pertumbuhan alometrik negatif. Kedua-dua spesis cenderung untuk menjadi lebih kurus semasa membesar.. Kematian semula jadi (M) bagi *N. japonicus* dianggarkan pada 1.63 thn^{-1} dan kematian disebabkan penangkapan (F) didapati pada 1.34 thn^{-1}. Kadar eksploitasi (E) bagi *N. japonicus* ialah 0.45, menunjukkan ia adalah di bawah kadar ekploitasi sumber. Bagi *N. peronii*, kematian semula jadi (M) dianggarkan pada 1.74 thn^{-1} dan kematian disebabakan penangkapan adalah pada 1.79 thn^{-1}. Kadar exploitasi *N. peronii* pula ialah 0.51, melebihi aras optimum dan adalah di nasihatkan supaya mengekalkan dan mengurangkan tekanan penangkapan ke atas sumber yang sedia ada.

Hasil kajian mendapati bagi spesis *N. japonicus*, nisbah jantina sangat berbeza di dominasi oleh jantan ($\chi^2 = 12.84$; $P < 0.05$) manakala bagi *N. peronii*, tiada perbezaan nisbah jantina di lihat. *Gonadosomatic indices* (GSI) bagi *N. japonicus* jantan adalah di antara 0.067 hingga 0.1861 dan bagi betina adalah di antara 0.336 hingga 4.994. *N. japonicus* di perariran Bintulu menunjukkan dua kemuncak musim bertelur iaitu pada

Ogos dan Mac. Bagi jantan *N. peronii* pula, GSI adalah di antara 0.0916 hingga 0.2168 dan bagi betina adalah di antara 0.5828 hingga 3.2127. Kemuncak musim bertelur bagi betina *N. peronii* juga di dapati pada bulan Ogos dan Mac. Berdasarkan pemerhatian histologi, *N. japonicus* dan *N. peronii* merupakan pembiak berterusan di mana peringkat bertelur di lihat setiap bulan dengan peratusan tertinggi pada bulan Mac. Min fekunditi bagi *N. japonicus*, dianggarkan sebanyak 40826 manakala bagi *N. peronii*, min fekunditi dianggarkan sebanyak 44813.

N. japonicus, kepenuhan perut di antara kelas panjang yang berbeza, dari kecil ke besar, di dapati spesis ini tergolong dalam pemakan sederhana ke pemakan aktif. Bagi *N. peronii*, spesis ini mengubah tabiat pemakanan dari pemakan lemah ke pemakan aktif apabila ia mencapai saiz besar. Kepenuhan perut adalah berbagai pada setiap musim. Perut penuh *N. japonicus* di lihat setiap bulan dan aktiviti pemakanan adalah baik pada bulan April, Oktober dan Februari. Dalam kes *N. peronii*, aktiviti pemakanan adalah baik pada bulan April dan Oktober. Ia menurun pada bulan November sehingga Februari (musim hujan) sehingga peratusan terendah. Analisis mangsa dalam perut *N. japonicus* dan *N. peronii* mengenalpasti 18 jenis makanan tergolong dalam lapan kumpulan utama: ikan, krustasia, moluska, echinodermata, foraminifera, polychaeta, nematod dan lain-lain. Kedua-dua kaedah *occurrence* dan *numerical* mendapati krustasia terutama ketam adalah jenis makanan yang di gemari *N. japonicus* dan *N. peronii*. Kajian ini menunjukkan *N. japonicus* dan *N. peronii* adalah karnivor di mana tabiat pemakanan berubah daripada memakan udang dan ketam seterusnya ikan sepanjang ia membesar.

ACKNOWLEDGEMENT

With blessing from God almighty, I manage to complete my thesis. I take this opportunity to acknowledging all the important persons that contribute to succeed my master. I would like to express my deepest appreciation and most sincere gratitude to my supervisor Dr. Abu Hena Mustafa Kamal for the effort in guidance, comment advice and suggestion throughout the duration of this study. I also wish to thanks to other two members of my supervisory committee, namely Associate Professor Dr. Mohd. Hanafi Idris and Dr. Amy Halimah Rajaee for the useful comment and suggestion in supervising this thesis.

Thank you to my beloved father, Encik Tonie Madim; my mother, Puan Lona Mangkok; my sibling, Elton and Eliverster for their sacrifice and continuous support. Sincere thanks to En Kamis and his family who has help me during sampling in Kuala Nyalau Village. Thank you very much to the laboratory assistant for their assist in the laboratory to make the work possible. To all my friends Wendy Ferrina, Hasmidah, Suliana, Hadi and Hafizbillah, I would like to thank them for their help and sharing their idea. In this opportunity, I acknowledge the Department of Animal Science and Fishery, UPM Campus Bintulu Sarawak for providing facilities and Ministry of Higher Education, Malaysian Government for providing funds through Knowledge Transfer Programme (KTP). Thank you also to Universiti Putra Malaysia for the Scholarship (Graduate Research Fellowship) and Ministry of Higher Education Malaysia for the MyBrain15. Finally, I would like to thanks to anybody that indirectly contributed towards the successful of this research. Thank you so much and may God bless you.

This thesis was submitted to the Senate of Universiti Putra Malaysia and has been accepted as fulfillment of the requirement for the degree of Master of Science. The members of Supervisory Committee were as follows:

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LIST OF ABBREVIATIONS

BW	Body Weight
B/R	Biomass Per Recruit
ca	Cortical alveoli
CF	Condition Factor
ELEFAN	Electronic Length Frequency Analysis
GSI	Gonadosomatic Index
hyg	Hydrated yolk granule
LWR	Length Weight Relationship
mn	Migratory nucleus
nu	Nucleus
og	Oogonia
ow	Ovary wall
po	Primary oocyte
pof	Post ovulatory follicle
FL	Fork Length
SL	Standard Length
TL	Total Length
VBGF	von Bertalanffy Growth Function
VPA	Virtual Population Analysis
yg	Yolk granule
Y/R	Yield Per Recruit

CHAPTER 1

INTRODUCTION

1.1 Background

Fish is known as a cheap source of protein and plays an important role in the local livelihoods and economy (Abowei and Hart, 2008). Fish contribute a significant amount of animal protein to the diet of people worldwide (FAO, 2015). In Malaysia, the fisheries sector is important in contributing to the national Gross Domestic Product (GDP), source of employment, foreign exchange and protein sources (FAO, 2001). As demand for fish continue to increase, the task of managing and maintaining fisheries resources at sustainable level also become more challenging.

The threats of over-exploitation and the disruption of aquatic habitats have become serious problems in sustaining the fisheries resources (Abu Talib *et al*., 2003). Overfishing occurs when more fish are caught than the population can replace through natural reproduction (WWF, 2015). One of the main reasons fisheries can become overfished is that many different user group share the resources (FAO, 2015). Hence, it is fundamental to have basic biological data in order to conduct a reliable management system.

Threadfin bream of the genus *Nemipterus* is a demersal fish which is one of the valued food fishes in many parts of the world catches commercially by hook and line and bottom trawl (Russel, 1993). The distribution of this species widespread throughout the tropical and subtropical Indo-West Pacific region and identified with brightly coloured which inhabit shallow sand or mud bottoms. *Nemipterus* spp. are popular eating fishes and are marketed fresh, dry salted and dry smoked. Trash fish are made into fish balls, fish cakes, fish meal and surimi. *Nemipterus* spp. are important fish used for processing surimi for its selection criteria as a white flesh fish, low fat content, high protein content (Nair *et al*., 1988) and good gelling properties (Park, 2013). Surimi refers to minched fish flesh that has undergone the process of leaching and subsequent mixing with sugar and polyphosphate additive (Department of Fisheries Malaysia, 2015; Park, 2013; Singh and Balange, 2005).

Threadfin bream is one of the demersal fish groups landed in substantial amounts. The greater portion of the landings has always come from trawlers, followed by portable traps, drift/gill nets and hook and line (FAO, 2009). Updated and adequate information on its biology and population dynamic are helpful generally for the fishery management. Biological information can be obtained from analysis of length and weight of fish (Le Cren, 1951). Length–weight relationships help to determine the somatic growth of the fish whether isometric or allometric (Ricker, 1975). The relationships also allow the estimation of the fish condition (Goncalves *et al*., 1996). Furthermore, knowledge of various population parameters such as asymptotic length

($L\infty$) and growth coefficient (K), mortalities (natural and fishing) rate and exploitation level (E) are important for efficient planning and management of fisheries resources (Amin *et al.*, 2009). The main purpose of studies on fish population dynamics is to provide the understanding on the optimum exploitation of aquatic living resources so that it should be properly managed to sustain it benefit for future generation.

Studies on fish reproductive biology allow quantifying the breeding prospect of individual fish such as by fecundity, size during maturity period, the spawning actions and seasonal reproductive duration period (Zamidi *et al*., 2012). Furthermore, knowledge of the sex ratio, state of maturity and the fecundity of individual fish in a population are important in population dynamics and its productivity studies. Most of the studies on spawning season of fish are based on maturation on intraovarian eggs and ova diameter measurements (Hunter *et al*., 1992; Rao and Rao, 1991; Dan, 1977). Spawning season between fish species are varies with some fishes exhibiting one or two spawning seasons a year (Cushing, 1990).

The knowledge of food and feeding habits of fish are important in understanding its biology and useful in order to assess it role in the ecosystem (Bachok *et al*., 2004). The feeding habit study conducted to determine the different food types and the most frequently consumed prey by the fish. Feeding is usually part of the daily routine and sometimes rate of feeding has a bearing on the spawning of the fish (Rao *et al*., 1998; Kadwage, 1967). Fish diets and feeding habits also provides the basis information on trophic interactions in aquatic food webs. Diets of fish represent an integration of many important ecological components that includes behavior, condition, habitat use and interaction. Therefore, could evaluate the ecological role of the species as well as the understanding of its position in the food web structure and tropic linkage in the coastal waters of South China Sea.

The survey on the status of demersal fishery resources of Malaysia in four areas of Malaysian water (west and east coast of Peninsular Malaysia, and waters off the coast of Sarawak and off the west coast of Sabah since 1970 has been conducted by Abu Talib *et al.* (2003) and reported that the level of exploitation vary among the four areas and with depth, but most show over-exploitation. In the latest data, Department of fisheries in year 2012 reported the total of landing of marine fish in Sarawak is 141,102 tonnes and the highest catch is by trawls net with 71,053 tonnes. Nemipterids occupying the second position after Scianidae (6,751 tonnes) with total landing are 4,163 tonnes with the highest catch was on February (409 tonnes) and the lowest was on January (275 tonnes).

Information on the aspects of biology and population dynamic of *Nemipterus* are available at Mediterranean Sea (El Haweet, 2013), Gulf of Suez (Amine, 2012), Cochin (Joshi, 2010), Northern of Persian Gulf (Kerdgari *et al*., 2009), South Western Taiwan (Wu *et al*., 2008), off Visakhapatnam (Rajkumar *et al*., 2003), Jizan area (Bakhsh, 1996) and Madras (Vivekanandan and James, 1986),

Species of *Nemipterus* are also caught commercially in Bintulu coast with multispecies catch in one trawl but the research on biology and population dynamic of *N. japonicus* and *N. peronii* are scare. Therefore, this research is undertaken to provide the current information about the biology (reproductive and feeding) and population dynamics of *N. japonicus* and *N. peronii* at Bintulu coastal waters, South China Sea. The result of this study would be useful for future development of these two commercially important fish.

1.2 Objectives

i. To estimate the population parameters such as growth, mortality and exploitation rate of *Nemipterus japonicus* and *Nemipterus peronii* in the coastal area of Bintulu Sarawak South China Sea.

ii. To determine the sexual cycle, sex ratio and fecundity of *N. japonicus* and *N. peronii.*

iii. To investigate the stomach contents and variation of diet composition in *N. japonicus* and *N. peronii*.

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