BRACHYURAN CRAB DIVERSITY AND ABUNDANCE IN DIFFERENT AGED STANDS IN THE MATANG MANGROVE FOREST RESERVE, PERAK, MALAYSIA

SITI AMINAH IBRAHIM

FPAS 2019 15

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By

SITI AMINAH IBRAHIM

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

September 2019

DEDICATION

This work is dedicated to:

My beloved parents who are my first life teachers;
The Late (Allahyarham) Encik Ibrahim Abd Karim & Puan Maimunah Mohd Salleh for their endless prayers and unconditional support.

My great friends;
Rasdiana, Zulfa, Julalila, Maizatul, Salmah, Siti Balqis, Mastura, Hasyikin, Mazlia and Rhyma for your priceless love, time, laugh and endless support

and those who came around in my life and who supported me throughout this study.

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

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SITI AMINAH IBRAHIM

September 2019

Chairman : Professor Datin Faridah Hanum Ibrahim, PhD
Faculty : Forestry

The Matang Mangrove Forest Reserve (MMFR) has been sustainably managed since 1902, and is currently harvested mainly for charcoal production and for poles used in the construction industry. It is also rich in aquatic animals like fish, crabs, prawns (water bodies) and mudskippers, molluscs and crabs (intertidal shore). Crab abundance appears to be related to the diversity of the mangrove vegetation aged. It is hypothesized that crab abundance is low in the area of young vegetation stands compared to older vegetation stands in MMFR due to the difference in vegetation diversity and stand structures. Two species, *Rhizophora apiculata* and *Rhizophora mucronata* dominated the young aged stands due to the management practise of replantation. In the older aged stands, which was left for natural growth for more than 30 years, there are five (5) species recorded which are *R. apiculata, R. mucronata, Bruguiera parviflora, Excoecaria agallocha* and *B. gymnorhiza.* The objective of this study was to examine the composition, diversity and abundance of mangrove crabs in different aged forests stands in MMFR. 20 plots of size 10m X 10m each were set up distributed along four (4) transects at three (3) different aged stands. Each transect has five plots set up. Vegetation parameters such as tree species, diameter at breast height (DBH), height and the above ground biomass within each plot were measured. Buried pitfall traps were used to collect the crab samples. Five (5) pitfalls traps were buried in each plot sampling area and left overnight before collection. Eight (8) species of mangrove crabs, *Perisesarma eumolpe, Perisesarma onychophorum, Episesarma versicolor, Episesarma singaporiensis, Episesarma mederi, Uca rosea, Sarmatium crassum* and *Clistocoeloma merguiense,* of mangrove crabs were successfully collected and identified from a total of 215 individuals. The highest abundance of crabs was found in the young and middle-aged stands, which were below 30 years. The environmental conditions provided by the young and middle-aged stands may have influenced the crab diversity and abundance. Transect one (1) which was planted with *Rhizophora apiculata* aged below 20 years showed the highest composition of mangrove crabs in this study. This was followed by the middle-aged vegetation stands, aged more than 20 years but below 30 years, in Transect two (2) and three (3) planted

with *Rhizophora mucronata* and *Rhizophora apiculata*, respectively. These studies also successfully found mud-dweller crab, *Uca rosea* with four (4) individuals caught from transect one. This species is normally found near the riverbank of mangrove forest. The results strongly suggest that the forest management practices are able to facilitate and sustain the composition of mangrove crabs.

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

KEPELBAGAIAN DAN KELIMPAHAN KETAM BRAKURA DI HUTAN BERBEZA UMUR POKOK, HUTAN SIMPAN PAYA BAKAU MATANG, PERAK, MALAYSIA

Oleh

SITI AMINAH IBRAHIM

September 2019

Pengerusi : Profesor Datin Faridah Hanum Ibrahim, PhD
Fakulti : Perhutanan

Hutan Paya Bakau Matang (MMFR) diuruskan secara mampan sejak 1902, dan diusahakan terutamanya untuk penghasilan arang dan tiang yang digunakan oleh industri pembinaan. Ia juga kaya dengan haiwan akuatik seperti ikan, ketam, udang(kawasan berair), ikan belacak, moluska dan ketam (dikawasan pasang surut air). Kehadiran bilangan ketam yang tinggi dikaitkan dengan kepelbagaian usia pokok bakau. Hipotesis menjangkakan bahawa kehadiran ketam adalah rendah di kawasan bakau muda berbanding kawasan bakau yang berusia di MMFR disebabkan perbezaan kepelbagaian strucktur dan usia tumbuhan bakau. Dua spesies yang mendominasi kawasan bakau muda ialah *Rhizophora apiculata* dan *Rhizophora mucronata*. Di kawasan bakau berusia, yang dibiarkan tumbuh secara semulajadi melebihi 30 tahun, terdapat lima (5) spesies tumbuhan bakau telah direkodkan iaitu *R. apiculata, R. mucronata, Bruguiera parviflora, Excoecaria agallocha* and *B. gymnorhiz.* Objektif kajian ini adalah untuk mengkaji komposisi; kepelbagaian dan kelimpahan ketam paya bakau di hutan bakau berlainan usia di MMFR. 20 plot dengan saiz 10m X 10m dipasang di empat (4) transek di tiga hutan berlainan usia. Setiap transek mempunyai lima plot. Parameter tumbuhan seperti 'Diameter Breast Height (DBH)', ketinggian pokok, dan 'Aboveground Biomass' di dalam setiap plot diukur. Perangkap tanam digunakan untuk mengutip sampel ketam. Sebanyak lima (5) perangkap tanam ditanam di setiap plot dan dibiarkan sepanjang malam sebelum dikutip. Hasil kajian mendapati, lapan (8) spesies ketam bakau telah berjaya dikutip dan dikenalpasti iaitu; *Perisesarma eumolpe, Perisesarma onychophorum, Episesarma versicolor, Episesarma singaporiensis, Episesarma mederi, Uca rosea, Sarmatium crassum* dan *Clistocoeloma merguiense* dengan jumlah 215 ekor kesemuanya. Kelimpahan ketam tertinggi didapati daripada kawasan bakau pertengahan usia dibawah 30 tahun. Faktor sekitaran yang terdapat di kawasan bakau muda dan pertengahan usia adalah mempengaruhi taburan dan bilangan ketam bakau. Transek satu (1) yang ditanam dengan spesies bakau *Rhizophora apiculata* yang berusia kurang dari 20 tahun mempunyai komposisi ketam bakau tertinggi dalam kajian ini. Ini diikuti dengan bakau pertengahan usia yang berusia lebih 20 tahun dan kurang dari 30 tahun di Transek dua (2) dan tiga (3), yang

masing-masing ditanam dengan *Rhizophora mucronata* dan *Rhizophora apiculata*. Kajian ini juga berjaya menemui ketam lumpur, *Uca rosea* sebanyak empat (4) individu dari transek satu (1). Spesies ini biasanya hanya ditemui dikawasan lumpur terbuka, ditebing sungai dikawasan hutan paya bakau. Keputusan kajian ini menyokong amalan pengurusan hutan yang berupaya membantu dan mengekalkan komposisi ketam bakau.

ACKNOWLEDGEMENTS

My endless thank you to all my teachers who are close to my heart; Prof. Datin Dr. Faridah Hanum Ibrahim, for her nagging, financial support and forever-motherly advice, Prof. Dr Ainuddin Nuruddin, for his great advice and laughter, Dr Mohamad Roslan, for his statistical advice and Prof. Dr. Sasekumar for his patience throughout the identification work, endless advice, kindness and jokes.

I also wish to express my appreciation and gratitude to the Director and staff of Perak State Forestry Department, staff of Kuala Sepetang and Kuala Trong District Office, Centre for Marine & Coastal Studies (CEMACS) of Universiti Sains Malaysia, Prof. Dr. Peter Ng. Kee Lin of National University of Singapore and Prof. Dr. Farid Dahdouh-Guebas, Vrije Universiteit Brussel for the fruitful advice and assistance throughout the research work.

I certify that a Thesis Examination Committee has met on September 2019 to conduct the final examination of Siti Aminah Ibrahim on her thesis entitled **"**Brachyuran Crab Diversity And Abundance In Different Aged Stands Of Matang Mangrove Forest Reserve, 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 Master of Science.

Members of the Thesis Examination Committee were as follows:

Mohd Zaki Hamzah, PhD
Associate Professor
Faculty of Forestry
Universiti Putra Malaysia
(Chairman)

Mohamad Azani Alias, PhD
Associate Professor
Faculty of Forestry
Universiti Putra Malaysia
(Internal Examiner)

Dr. Asyraf, PhD
Associate Professor
Schoolof Life Sciences
Universiti Sains Malaysia
(External Examiner)

RUSLI HAJI ABDULLAH, PhD
Professor and Deputy Dean
Deputy Dean
School of Graduates Studies
Universiti Putra Malaysia

Date:

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

Faridah Hanum Ibrahim, PhD
Professor
Faculty of Forestry
Universiti Putra Malaysia
(Chairman)

Ainuddin Nuruddin, PhD
Dean, Professor
Faculty of Forestry
Universiti Putra Malaysia
(Member)

Mohamad Roslan Bin Mohamad Kasim, PhD
Senior Lecturer
Faculty of Forestry
Universiti Putra Malaysia
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Signature : _____
Name of Member of
Supervisory Committee : Prof Ainuddin Nuruddin

Signature : _____
Name of Member of
Supervisory Committee : Dr. Mohamad Roslan Mohamad Kasim

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LIST OF ABBREVIATIONS

ANOVA	Analysis of variance
cm	Centimeter
mm	Millimeter
MMFR	Matang Mangrove Forest Reserved

CHAPTER 1

INTRODUCTION

1.1 Study Background

Mangrove forests are known as hot, muddy and dirty. It is a habitat of many species of specialized flora and fauna, and the vegetation stands make noteworthy contribution towards the coastal environment (Alongi, 2009; Duke et al., 2007; Hogarth, 1999; Macnae, 1968). Due to its ability to survive in saline water, mangrove poles are used for scaffolding construction in soft substrates. Mangrove wood is also converted to charcoal for cooking purposes. A mangrove forest acts as a buffer between the land and the sea, thus protects the coasts against extreme high tides and tsunami.

A mangrove is home to many plants, animals, and human. The flora of the mangrove forest is well adapted to the muddy soil, periodic tidal and saline habitat and known as halophytes, the salt tolerant species (Omar, 2012). Mangroves are also strategic place for breeding of organisms, as a nursery and feeding areas for molluscs, crustaceans, fish, birds, tigers, crocodiles, monkeys and honeybees. Mangrove productivity of the vegetation stands is very important due to its direct impact on the food chain and food web of the forest. Therefore, high productivity of stands may provide wider range of habitats that could support large number of organisms (Omar, 2012).

Mangrove forests are distributed widely in sheltered shores in the tropics and subtropics between the latitudes 22 ^{o} N and 22 ^{o} S (Alongi, 2009; Hogarth, 1999; Macnae, 1968). There are 112 countries in the world with mangrove forests. The total size of mangrove forest in the world is approximately 10 million ha (Bunt, 1992). According to Kathiresan and Bingham (2001), 41.4 % of the world mangrove forests occur in Southeast Asia. Indonesia has the largest area of mangrove forests contributing 23.5% of the world's total mangrove forest. The total area of mangrove forest in Malaysia is 566,856 ha (Latiff, 2012 and Sasekumar et al., 1994).

According to Japar et al. (1994), there are 104 species of mangrove plants; of this 38 species are exclusive to Malaysia. Sabah state has the largest area of mangrove forest with 340,689 ha, followed by Sarawak 126, 400 ha (Latiff, 2012; Berry, 1972). Most of the states in Malaysia have mangrove forest and this includes Johor, Kedah, Perlis, Negeri Sembilan, Pahang, Pulau Pinang, Selangor, Kelantan, Terengganu, Melaka and Perak. The managed Matang mangrove forest reserve in Perak is the largest mangrove area in Peninsular Malaysia (Latiff, 2012; Omar, 2012). Matang mangroves was gazetted and declared as a forest reserve in 1902 and the first working plan to manage the 40,000 ha mangrove forest was published in 1904. Since then, Matang Mangrove Forest Reserve (MMFR) has come under sustainable management.

In spite of the distribution of mangrove vegetation are usually determined by sea level and fluctuations of the sea (Omar, 2012), in Matang mangrove, the distribution of

vegetation is taken care by the management practise of replantation which has been planned and managed well (Ariffin and Nik Mohd Shah, 2013; Muda and Nik Mohd Shah, 2003; Gan, 1995; Abu, 1981). The working plan of MMFR for the years 2010 to 2019 reported MMFR as occupying 40, 228ha or 0.75% of total land area in Peninsular Malaysia. Although it is located along the west coast of Peninsular Malaysia across many districts of Perak, MMFR is mostly located in Matang district, therefore it is commonly known as Matang mangroves.

Under the management practise of MMFR, the forest has been divided into Productive area (74.8%), Unproductive area (1.0%), Restrictive Productive area (6.8%) and Protective area (17.4%). Under protective areas, there are several types of functional classes including the Virgin Jungle Reserve (VJR), which was left unmanaged for natural growth. In the management plan prepared every 10years, managed forests will go through thinning and replantation cycles.

Thinning practise is known to be a good method in ensuring less competition between trees and these results in sufficient nutrient uptake by each vegetation stand and producing a high quality of charcoal and poles from the forest (Ferreira et al., 2015; Goessens et al., 2014). There are three (3) cycles of replantation currently taking place in the productive area. The first thinning is done using 'one-stick' method for every 15 years after planting and the second thinning is done at 20 years after planting using the same method. When the plantation reaches 30 years, the compartment will be clear-felled for charcoal (Ariffin and Nik Mohd Shah, 2013; Muda and Nik Mohd Shah, 2003; Gan, 1995; Abu, 1981).

The charcoal production from Matang mangroves fulfils local demand as well as for overseas export. Most of the charcoal from Matang is exported to Japan, 80% representing 23,000 tonnes in 2010 (Ariffin et al., 2013). Other countries that buy charcoal from Matang are Singapore and Hong Kong (Ariffin et al., 2013) and Matang continues successfully producing it under the management of State Government of Perak (Ariffin and Nik Mohd Shah, 2013; Muda and Nik Mohd Shah, 2003; Gan, 1995; Abu, 1981). Goessens et al. (2014) studied the success of replantation in Matang under many successive cycles of management and suggested to shorten the time of thinning. The thinning practise could assist to ensure the quality of forest production in MMFR, with the community also directly and indirectly contributing to this healthy production of mangroves.

Mangrove ecosystems are formed by many members of mangrove community including snails, worms, bivalves, insects, spiders, snakes, monkeys, crabs, and many more. (Alongi, 2009; Hogarth, 1999; Berry, 1972; Sasekumar, 1974). They form a complex community link closely related and contributed to the vegetation stands through daily activities and as a part of the food chain and food web within the ecosystem (Cannicci et al., 2008; Hogarth, 1999; Sasekumar et al., 1994). Gastropods and crustaceans are the major invertebrates found living on the soil surface of mangrove floor (Cannicci et al., 2008). Mangrove crabs are part of the mangrove crustaceans that play an important role in nutrient cycling within the mangrove ecosystem.

Crabs are members of kingdom of Animalia, phylum Arthropoda, subphylum of Crustacea, class Malacostraca and order Decapoda. They successfully dominated many estuarine habitats, where salinity and temperature fluctuate daily (Ng et al., 2008). They not only existed in the marine environment, but able to survive in the mud substrates in the tidal zone worldwide (Hogarth, 1999). Crabs are the most abundant macrofauna on the mangrove shore (Geist et al., 2012; Ravichandran et al., 2011).

This survival is due to its morphology and anatomy that helps in burrowing, swimming, walking and climbing (Pestana et al., 2017; Kathiresan et al., 2016; Smith et al., 1991; Warner, 1977; Schmitt, 1973). Mangrove crabs possess 3 pairs of walking legs in contrast to the common swimming crabs from the genera *Portunus* and *Scylla* that have only swimming legs attached to the body (Ng et al., 2008; Warner, 1977 ; Schmitt, 1973). Male mangrove crab has one tubular monopods or two tubular gonopod and penis whereas the females have either paired spermathecae or vulvae on thoracic sternum (Ng et al., 2008; Warner, 1977; Schmitt, 1973).

Distributions of crabs in the mangrove forest are generally related to their feeding biology and daily activities (Geist et al., 2012). This is supported by a few studies such as Smith (1992) and Ashton (2002). According to Robertson et al. (2002), large proportion of leaf litter are either hidden in the burrow or consumed by the crabs. Those leaf litters in the burrow could serve as a nutrient retention mechanism. Crabs are also a predator of plant propagules. The propagules species preference can be attributed according to the difference in tannin and nutrition contents (Clarke and Kerrigan, 2002). In the natural growth forest, the propagule predators could help in reducing the competition between mangrove vegetation for nutrient to grow (Cannicci et al., 2008).

Mangrove crabs are known as the best engineer to the mangrove ecosystem by consuming mangrove fresh leaves, propagules and detritus, digging a burrow underneath mangrove roots hence enhancing the aeration between the soil and the mangrove vegetation roots and consume large benthic algae (Ashton, 2002). They could also alter the particle size of food source distributed on the forest floor for other feeders as a secondary consumer (Kathiresan et al., 2016; Nedervelde et al., 2015; MacKenzie and Cormier, 2012; Luo et al., 2010; Alongi, 2009; Cannicci et al., 2008 Ashton et al., 2003; Sasekumar, 1974). They could be found walking, running, crawling, hiding among leaves and twigs during the daytime at the lower tide of water flux (Pestana et al., 2017; Sasekumar et al., 1998; Sasekumar et al., 1994; Alongi and Sasekumar 1992; Smith et al., 1991).

1.2 Problem Statement

According to the study done by Cannicci et al. (2008), replantation management was well practiced but less attention was paid to other ecological members of mangrove such as crabs. The management plan of MMFR emphasises its socio-economy, ecotourism and education. Recent studies (Ferreira et al., 2015; Goessens et al., 2014) indicated that there is a decrease in forest stands (quality of wood) due to unknown factors. The decrease in the quality of forest stands requires intensive studies to find out what are the important factors that could help to bring back the quality of the vegetation stands (Ferreira et al., 2015; Rahman, 2015; Goessens et al., 2014). Many earlier studies only focussed on forest stands as it has economic value.

The mangrove crab community, diversity and abundance in Malaysia are still poorly studied and understood. In the current Working Plan of MMFR, there are species of crabs recorded (Ariffin and Nik Mohd Shah, 2013). There is also limitation to this study as many subfamilies are still poorly defined and there are still many grapsoids and ocypodoids still awaiting formal naming, revising, and discovery (Ng et al., 2008). There is insufficient information on the association between distribution and abundance of crabs in different aged mangrove forest stands in the MMFR. It remains unclear how forest stands could have influence on the distribution or abundance of crabs and vice—versa.

To achieve a healthy stand of mangrove forest, the ecological factors prevailing in the forest have to be studied such as the abundance and distribution of crabs including the structure of the forest with the selection of the species under the management practise as well as the different vegetation age stand structure. Crabs in the forest are mutually important for health and survival of both the crabs and forest stand.

Therefore, the study of the crab diversity, abundance and its relationship to the different aged mangrove stands could contribute knowledge on forest management in managing the forest towards an ecologically functional mangrove forest.

1.3 Objectives

The general objective of this study was to examine the composition, diversity and abundance of mangrove crab in different age forest stands in the MMFR. The following specific objectives are as follows:

1 To compare the diversity and abundance of mangrove crabs in different age stands of Matang Mangrove Forest Reserve.
2 To examine the association between crab composition with different aged stand of Matang Mangrove Forest Reserve

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