



UNIVERSITI PUTRA MALAYSIA

***DISTRIBUTION, LARVAL ABUNDANCE, SPAWNING AND EARLY
DEVELOPMENT OF SADDLE OYSTER *Placuna ehippium*
(Philipsson, 1788) FROM MERAMBONG SHOAL***

NUR LEENA WONG WAI SIN

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DEVELOPMENT OF SADDLE OYSTER *Placuna ephippium* (Philipsson, 1788)
FROM MERAMBONG SHOAL**

By

NUR LEENA WONG WAI SIN

**Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia,
In Fulfilment of the Requirement for the Degree of Doctor of Philosophy**

October 2013

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

DISTRIBUTION, LARVAL ABUNDANCE, SPAWNING AND EARLY DEVELOPMENT OF SADDLE OYSTER *Placuna ehippium* (Philipsson, 1788) FROM MERAMBONG SHOAL

By

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October 2013

Chairperson: Professor Aziz bin Arshad, PhD

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Placuna ehippium (Placunidae) has not been previously studied in Malaysia although it has been known to the local coastal communities in Pulai River Estuary, Johor as *Senteng* and has been collected for food for generations. *Placuna ehippium* has sweet and succulent meat and adductor muscle. It is a delicacy among local shore communities. This species was selected in this study as it has high potential as new aquaculture product with its great taste and durability in high impact area. The distribution of this species and other epifaunal bivalve in Merambong Shoal seagrass bed has been studied, along with the diversity and coverage of marine macrophytes, the sediment texture profile of Merambong Shoal, and their correlations with bivalve distribution. Merambong Shoal seagrass bed sediments are loamy sand and sandy in texture. The abundance in density and distribution of 15 epifaunal bivalve species from 10 families have been estimated, and the coverage of 7 seagrass species and 1 genus of macroalgae on the shoal during low tide were calculated. *Placuna ehippium* has highest abundance in the southernmost shoal and none was found at the northern most station. *Anadara gubernaculum* was found dominant on the seagrass shoal and specimens found mostly on the more sheltered northern shoal. *Modiolus philippinarum* distributed only in southern shoal facing the incoming wave. Epifaunal bivalve abundance and macrophyte coverage were more heterogeneous in the southern shoal while more homogenous at the northern shoal. Spearman's rank correlation coefficient tested between epifaunal bivalve abundance and macrophyte coverage shows weak and non-significant results. Negative correlation was observed between the abundance of *Circe scripta* and *Ulva* spp. coverage ($P < 0.05$).

Temporal larval abundance of Placunidae and other bivalves were explored aiming to discover the natural spat fall season and explore the theory of seagrass meadow being a nursery for non-habitant bivalve larvae. The correlations between temporal bivalve larval abundance, environmental parameters and rainfall were investigated. Placunidae larvae were found from September 2007 to January 2008 but none was found in February 2008. The highest abundance of Placunidae was recorded in November 2007 with density 226 larvae m^{-3} . Major peak on total bivalve larval abundance was noticed between November 2007 and January 2008, while a low peak was observed in June 2007. Larvae of six bivalve families were identified by

umbonal shell morphology with Mytilidae larvae highest in abundance during November 2007 (7345 larvae m⁻³). No significant correlation was found between bivalve larvae abundance and seawater parameters like temperature, salinity, DO, pH and TSS. There are significant correlations between total larvae abundance and total rainfall within a week and two weeks prior to sample collection ($P < 0.01$).

Early development of *P. ehippium* was recorded and described. *Placuna ehippium* broodstocks were collected during low tide in Merambong Shoal seagrass bed. Thermal cycling procedure had successfully induced the spawning of this species. The average size of the spherical eggs before fertilisation was $57.65 \pm 5.97 \mu\text{m}$ in diameter and $90.91 \pm 2.04\%$ eggs were fertilised successfully. Embryos developed into straight-hinged larvae 22 hours after fertilisation. Umbo started to take shape from Day-2. Larval shells are inequivalve with right valve almost flat and left valve inflated. Larvae developed into pediveliger on Day-9 and started to form plantigrade on Day-11. Rapid decreases were observed in survival rate during settlement.

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

**TABURAN, KEHADIRAN LARVA, PEMBIAKAN DAN PERKEMBANGAN
AWAL TIRAM PELANA *Placuna ehippium* (Philipsson, 1788) DARI
BETING MERAMBONG**

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Placuna ehippium (Placunidae) belum pernah dikaji di Malaysia walaupun ia telah dikenali oleh komuniti pantai tempatan di Muara Sungai Pulai, Johor, sebagai Senteng dan telah dikutip sebagai makanan sejak dari beberapa generasi yang lepas. Taburan spesies ini dan siput dwicangkerang epifauna yang lain di Beting Merambong telah dikaji, bersama dengan diversiti dan taburan makrofit marin, profil tekstur sedimen di Beting Merambong, dan hubungan Antara unsur-unsur tersebut dengan taburan siput dwicangkerang. Beting Merambong mempunyai sedimen bertekstur pasir dan pasir berlumpur. Kebanyakan dan taburan 15 spesies siput dwicangkerang epifauna daripada 10 famili telah dianggarkan, dan liputan 7 spesies rumput laut dan 1 genus alga makro di beting semasa air surut telah dihitungkan. *Placuna ehippium* mempunyai density yang paling tinggi di kawasan hujung selatan beting tetapi tiada yang terdapat di bahagian hujung utara. *Anadara gubernaculum* merupakan spesies dominan dan kebanyakannya dijumpai di bahagian utara beting yang lebih terlindung. *Modiolus philippinarum* pula hanya terdapat di bahagian selatan beting menghadap impak ombak air pasang. Kebanyakan siput dwicangkerang epifauna dan liputan makrofit adalah lebih seragam di bahagian utara beting sementara lebih berkepelbagaian di bahagian selatan beting. Spearman's rank correlation coefficient yang diuji antara taburan dan kebanyakan siput dwicangkerang epifauna dan makrofit memperoleh keputusan yang lemah dan tidak ketara. Kolerasi negatif yang ketara dapat diperhatikan di antara kebanyakan *Circe scripta* dan liputan *Ulva* spp. ($P < 0.05$).

Kehadiran bertempoh larva Placunidae dan siput dwicangkerang yang lain telah dikaji dengan tujuan untuk mengesan musim pembiakan semulajadi dan menilai teori yang mengatakan bahawa kawasan rumput laut menjadi nurseri untuk larva siput dwicangkerang yang bukan penghuni. Kolerasi di antara kehadiran larva Placunidae bertempoh, parameter persekitaran dan jumlah hujan telah disiasat. Larva Placunidae boleh dijumpai dari bulan September 2007 ke Januari 2008 tetapi tidak didapati pada bulan Februari 2008. Rekod kehadiran larva Placunidae yang paling tinggi adalah bulan November 2007 dimana densitinya mencapai 226 larva m^{-3} . Puncak utama kebanyakan larva siput dwicangkerang dikesan di antara November

2007 dan Januari 2008, sementara puncak yang rendah dikesan pada Jun 2007. Larva daripada enam family siput dwicangkerang telah dikesan menurut morfologi cangkerang berumbo dan didapati larva Mytilidae mempunyai kebanyakan yang pali tinggi pada November 2007 (7345 larva m⁻³). Tiada kolerasi yang ketara dijumpai di antara jumlah hujan dan data parameter air laut seperti suhu, saliniti, DO, pH dan TSS. Korelasi adalah ketara di antara kebanyakan larva dan jumlah hujan dalam masa seminggu dan dua minggu sebelum penyampelan ($P < 0.01$).

Placuna ehippium telah diuji dengan beberapa cara pembiakan untuk menentukan protocol pembiakan yang berkesan bagi spesies ini. Spesies ini mempunyai isi dan otot aduktor yang manis dan berair. Ia merupakan makanan istimewa di antara komuniti pantai tempatan. Ia mempunyai potensi yang tinggi sebagai produk akuakultur yang baru dengan rasanya yang sedap dan daya ketahanannya di kawasan impak tinggi. Induk *Placuna ehippium* telah dikutip semasa air surut dari kawasan rumput laut Beting Merambong. Prosedur kitaran haba telah berjaya menyebabkan peneluran terhadap spesies ini. Purata saiz telur yang berbentuk sfera adalah berdiameter $57.65 \pm 5.97 \mu\text{m}$ dan $90.91 \pm 2.04\%$ telur telah berjaya disenyawakan. Embrio berkembang menjadi larva berengsel lurus dalam masa 22 jam selepas persenyawaan. Umbo mula terbentuk dari hari kedua. Cangkerang larva adalah tidak seimbang dengan cangkerang kanan yang leper dan cangkerang kiri lebih kembung. Larva berkembang menjadi pediveliger pada hari kesembilan dan mula membentuk plantigrade pada hari kesebelas. Kadar kehidupan didapati menurun secara mendadak semasa penempatan ke dasar.

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LIST OF ABBREVIATIONS

cm	=	centimeter
°C	=	degree Celsius
ppt	=	parts per thousand
TSS	=	Total suspended solids
gL ⁻¹	=	grams per Litter
km	=	kilometer
DO	=	Dissolved oxygen
Cells mL ⁻¹	=	cells per milliliter
µm	=	micrometer
mgL ⁻¹	=	milligram per litter
m	=	meter
knot	=	nautical mile per hour
mL	=	milliliter
M	=	molar
UV	=	Ultra-violet
L	=	litter
ha	=	hectare
m ³	=	cubic meter
mm	=	millimeter
ppm	=	parts per million

CHAPTER 1

INTRODUCTION

1.1 Background of the Study

Placuna ehippium is normally found laying flat on the sediment in Merambong Shoal and has been collected by the local coastal communities as food. Fishermen normally collect this species for self consume and rarely put up for trade. It has a single abductor muscle with bright orange gonad similar to those found in scallop. However, unlike *Placuna placenta*, the commercially exploited window-pane shell, little is known about this species and there is no previous study on this species in Malaysia. The natural reproduction cycle and biology of this species still remains unexplored.

The seagrass bed of Merambong was described as a sub-tidal shoal which is important in biodiversity, a traditional fishing ground supporting the local coastal population, a collecting site for gastropods and bivalves, a nursery ground for invertebrates and vertebrates, and a feeding ground for dugong and birds (Japar Sidik *et al.*, 2006). It has been providing major food and income for generations of fishermen in Pulai River estuary. About 70-76 species of fish in 41 families have been observed in this site and the adjacent mangrove areas (Sasekumar *et al.*, 1989), and 35 species of commercial importance (Arshad *et al.*, 2001). This valuable ecosystem has major market and non-market economic values in fisheries, raw materials research, shoreline protection, carbon sequestration and as an important contributor in biodiversity (MPP-EAS, 1999). It also play an important ecological role with the long seagrass blades in controlling water quality and reduces water turbidity as seagrass leaf canopies are able to reduce particle resuspension (Terrados and Duarte, 2000). Other than that, with only as many as 14 seagrass species in Tropical Indo-Pacific, a region where seagrass diversity is the highest in the world (Short *et al.*, 2007), Tanjung Adang-Merambong is one of sites with highest seagrass diversity where 10 species were recorded in this site while only 12 species were recorded throughout Malaysian waters (Japar Sidik *et al.*, 2006).

1.2 Statement of Problems

Despite the undeniable richness and importance of Merambong seagrass ecosystem, due to rapid and heavy development activities in the surrounding area, and with the increasing number of people utilizing the coast and adjacent waters, this ecosystem is currently under serious threats (Japar Sidik *et al.*, 2006). It has also been exposed to inevitable threats due to the nearby commercial shipping port, Pelabuhan Tanjung Pelepas, at the river mouth of Pulai River. Across the border, land reclamation has been active in Tuas – Jurong area since late 1990's until 2011 may have resulted in sedimentation and burial of seagrass bed (Japar Sidik *et al.*, 2006). Sedimentation and suspended sediments are major human impacts on tropical seagrass beds (Short *et al.*, 2007). Changes of seagrass landscapes have been observed by the local fishing community but were not documented. Edible mollusc with aquaculture potential such as *P. ehippium* is facing the threat of losing habitat which could be a lost to the local aquaculture industry if they are being wiped out before any research has been done on their association with other species in this ecosystem. There are urgent

needs to document the landscape, distribution and abundance of both marine fauna and macrophytes of Merambong seagrass bed, and bivalve larvae which took shelter in this seagrass ecosystem during their planktonic stage.

In local scale, epifaunal molluscs made up part of the daily protein source and household income for the Pulai River estuary shore communities, while in larger scale, marine molluscs are delicacies in seafood restaurants throughout Malaysia but the local markets still mainly rely on wild stocks or imports. Mollusc culture is relatively less established in Malaysia compares to other Southeast Asia countries with Annual Fisheries Statistics 2009 (Anon., 2009) documenting only 3 types of mollusc cultured in Malaysia for the local food market: *P. viridis* (green-lipped mussel), *Anadara granosa* (blood cockle) and *Crassostrea* spp. (edible oysters). There is a need in search for new potential culture species in order to expand Malaysia mollusc culture industry. High priority should be given to species that grow rapidly, tasty, not cannibalistic, hardy, and inexpensive to culture when looking for new potential culture species (Mann, 1984) such as *P. ehippium*.

Many marine bivalve culture farms started their culture by collecting bivalve seeds from the wild. The practice of seed collecting can benefits small scale local farmer while providing sustainable seafood source to the local community either for self-consumption or trade. However, bivalve spawning and spatfall seasons are never documented in Pulai River estuary areas. It is essential to find out the spawning season of marine bivalve in the respective area to facilitate effective seed collection.

1.3 Significance of the Study

The study on the spawning and early development of *Placuna ehippium* (Philipsson, 1788), a local delicacy with sweet succulent meat and adductor muscle opens the possibilities of discovering and promoting new aquaculture species while provide sustainable product and reduce the dependence on wild harvesting.

The study will help fill in the knowledge gap on *P. ehippium* in Malaysia, and Merambong seagrass ecosystem within the unique environment in Pulai River estuary. Distribution and diversity of marine macrophytes and epifaunal bivalves will provide insights on how sediment profile and environment shape the landscape of this seagrass bed while providing baseline data for future investigation on the changes of this ecosystem. The research output will promote better understanding on the interactions and correlations between marine macrophytes and epifaunal bivalves. Temporal bivalve larvae abundance study will acknowledge the nursery status of seagrass meadow for residence and non-residence bivalve larvae. At the same time, it could provide valuable information on the best timing on setting up spat collectors in the area. This is essential in helping local fishermen starting up small scale mollusc culture farms by collecting spats during spawning season.

1.4 Objectives

Thus, the objectives of this research were to:

- a. estimate the abundance and distribution of *Placuna ehippium*, other epifaunal bivalves and marine macrophytes coverage in Merambong Shoal seagrass bed.
- b. explore the correlation between *P. ehippium*, epifaunal bivalves, marine macrophytes coverage and sediment profile in Merambong Shoal.
- c. determine temporal abundance and diversity for the larvae Placunidae and other bivalves in Merambong Shoal seagrass ecosystem.
- d. establish induce spawning and culture protocol for potential aquaculture species *P. ehippium*.
- e. observe the early development and life cycle of *P. ehippium* for aquaculture purposes.



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