



**UNIVERSITI PUTRA MALAYSIA**

**BIOLOGY AND DISTRIBUTION OF PEN SHELL  
(BIVALVIA: PINNIDAE) IN SELECTED AREAS OF PENINSULAR  
MALAYSIA**

**MOHD HANAFI BIN IDRIS**

**FS 2009 23**



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DOCTOR OF PHILOSOPHY  
UNIVERSITI PUTRA MALAYSIA

2009



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**MOHD HANAFI BIN IDRIS**

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

**July 2009**



## DEDICATION

*I dedicated this work to my lovely wife, Mehpuzah Salim who has sacrificed so much for me to achieve my goal*

*To the memory of my late father and mother who are no longer to share with me for this moment*

*To my brothers and sisters*

*and*

*To all my friends who supported me all those past years that made me whom I am today is very much acknowledged*

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

**BIOLOGY AND DISTRIBUTION OF PEN SHELL (BIVALVIA: PINNIDAE) IN  
SELECTED AREAS OF PENINSULAR MALAYSIA**

By

**MOHD HANAFI BIN IDRIS**

**July 2008**

**Chairman : Associate Professor Aziz Bin Arshad, PhD**

**Faculty : Science**

A study on taxonomy, biology and ecology of pen shells were conducted in Merambong shoal off the south western state of Johor, Peninsular Malaysia. Several pen shells specimens were also acquired from other sites in Peninsular Malaysia to allow wider scope of sample collection. The study was conducted from August 2005 to April 2007. The site was chosen due to ample abundance of pen shells that live associatedly with the seagrass. A total of seven species have been recorded from the study areas comprising five species of *Pinna* and two species of *Atrina*. Ten internal and external morphological characteristics have been used for the taxonomic identification of pen shells. *Pinna* species showed that of the ten characteristics analyzed, four characteristics were highly significant ( $P < 0.01$ ) (WL, DPML, PAMPDNL and WS). Similar result of four morphometric characteristics showed a highly significant ( $P < 0.01$ ) between the characters of three closely related species, *Pinna bicolor*, *P. deltodes* and *P. atropurpurea*.

Adductor muscle tissue used for the isolation of DNA and RAPD successfully detected polymorphisms in the pen shells populations. The result showed 19 primers have produced various banding patterns and thus provided sufficient information for reliable discrimination of the analyzed samples. The results indicated that the primers used generated a total of 160 fragments with 70% to 100% of polymorphic fragments. The genetic distance among these seven species of pen shells was in the range of 0.0197 to 0.3190. The dendrograms constructed from RAPD markers data were able to reveal the relationships between the pen shells populations.

*Enhalus acoroides*, *Halophila ovalis*, *Halophila minor*, *Cymodocea serrulata* and *Thalassia hemprichii* were among the seagrasses associated with pen shells habitat in Merambong and Tanjung Adang shoals. However, pen shells can also be found in stony sand area of Merambong Island and live associated with zoanthid, *Zoanthus pulchellus*. The sediment types from four study areas were classified as sandy loam. Monthly *in situ* physico-chemical seawater parameters recorded showed no significant different ( $P > 0.05$ ) during the study period. Pen shell were recorded and classified into three classes of distribution i.e clumped, random and rare. Higher density was shown by *P. bicolor* in Merambong shoal (1) with the value of 0.83 ind/m<sup>2</sup> while *P. incurva* showed lower density with 0.03 ind/m<sup>2</sup> in Tanjung Adang shoal. *Pinna bicolor*, *P. deltodes* and *P. atropurpurea* were consistently found in these four study areas while, *P. deltodes* Menke and *P. incurva* Gmelin were both a new distribution record for Sungai Pulai seagrass beds. Merambong shoal population recorded higher diversity and richness as compared to the Tanjung

Adang shoal and Merambong Island, but the value of evenness was similar between Merambong shoal, Tanjung Adang shoal and Merambong Island. Five major phyla comprising 37 species of fouling organisms were recorded. Members from phylum Crustacea and Mollusca were higher in percentage of distribution when compared to the Annelida, Echinodermata and Chordata. Phylum Mollusca showed the highest diversity while phylum Annelida recorded the highest species richness. A symbiotic adult alpheid shrimp, *Synalpheus carinatus* was recorded inhabiting the mantle cavity of the pen shells.

*Pinna bicolor* reaches sexual maturity at shell length of 170 mm. *Pinna bicolor* is dioecious and no hermaphrodite individual was found during the study period. Five stages of gonad development were observed and clearly been identified. *Pinna bicolor* showed a clear spent phase in the month of October 2006, December 2006 and March 2007 while the developing and spawning phases were observed throughout the whole study period. Monthly *in situ* physico-chemical parameters and rainfall recorded during the study did not significantly correlated with the reproductive activity of *P. bicolor* in Merambong Shoal. Pearson Correlation analysis also did not show any significant correlation between gonad index (GI) and physico-chemical parameters of seawater in Merambong shoal.

Growth rate in natural habitat has been found to be indeterminate and rapid when compared to *P. bicolor* in culture tank. For the length-weight relationships, the growth coefficient “*b*” was found to be significantly higher

than the isometric value (3.111) at 5% level and this is an indication of isometric growth in *P. bicolor* from Merambong shoal. The adductor muscle of *A. vexillum* was found the biggest in size when compared to other species.





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

**BIOLOGI DAN TABURAN SIPUT KIPAS (BIVALVIA: PINNIDAE) DI KAWASAN  
TERPILIH DI SEMENANJUNG MALAYSIA**

Oleh

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**Julai 2008**

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Kajian taksonomi, biologi dan ekologi siput kipas telah dijalankan di beting Merambong, bahagian barat laut negeri Johor, Semenanjung Malaysia. Spesimen siput kipas daripada lain-lain kawasan di Semenanjung Malaysia juga diambil bagi meluaskan lagi skop pengumpulan sampel. Kajian ini dijalankan bermula Ogos 2005 sehingga April 2007. Kawasan ini dipilih kerana kelimpahan siput kipas yang hidup bersama dengan rumput laut. Sebanyak tujuh spesies telah direkodkan di kawasan kajian yang terdiri daripada lima spesies *Pinna* dan dua spesies *Atrina*. Bagi mengenalpasti siput kipas, sepuluh ciri-ciri morfologi luaran dan dalaman telah digunakan. Empat daripada sepuluh ciri-ciri tersebut menunjukkan perbezaan sangat nyata ( $P < 0.01$ ) (WL, DPML, PAMPDNL dan WS) bagi spesies *Pinna*. Analisis ciri-ciri morfometrik juga mendapati empat ciri ini menunjukkan keputusan sangat nyata ( $P < 0.01$ ) di antara tiga species yang seakan sama seperti *Pinna bicolor*, *P. deltodes* dan *P. atropurpurea*.

Tisu otot pengatup yang digunakan bagi pengasingan DNA dan RAPD telah berjaya mengenalpasti polimorfik bagi populasi siput kipas. Keputusan mendapati 19 primer, telah menghasilkan corak ban yang pelbagai dan memberikan maklumat yang mencukupi untuk menjalankan analisis perbezaan. Keputusan mendapati primer yang telah digunakan menghasilkan sejumlah 160 sektor dengan 70% hingga 100% sektor polimorfik. Jarak genetik bagi tujuh spesis siput kipas adalah di antara 0.0197 hingga 0.3190. Pembentukan kelompok daripada data penanda RAPD memberikan petunjuk perhubungan di antara setiap populasi siput kipas.

*Enhalus acoroides*, *Halophila ovalis*, *Halophila minor*, *Cymodocea serrulata* dan *Thalassia hemprichii* merupakan rumput laut yang hidup bersama dengan siput kipas di beting Merambong dan beting Tanjung Adang. Walau bagaimanapun, siput kipas juga boleh dijumpai di kawasan pasir berbatu di Pulau Merambong yang hidup bersama zoanthid, *Zoanthus pulchellus*. Profil sedimen mendapati empat kawasan kajian diklasifikasikan sebagai pasir berlumpur. Parameter fizikal-kimia air laut telah direkodkan secara rawak pada setiap bulan dan tiada perbezaan nyata ( $P > 0.05$ ) didapati sepanjang kajian dijalankan. Siput kipas yang direkodkan diklasifikasikan kepada tiga bentuk taburan iaitu berkelompok, rawak dan jarang-jarang. Densiti tertinggi direkodkan oleh *P. bicolor* di beting Merambong (1) dengan nilai 0.83 ind/m<sup>2</sup> manakala *P. incurva* merekodkan densiti terendah iaitu 0.03 ind/m<sup>2</sup> di beting Tanjung Adang. *Pinna bicolor*, *P. deltodes* dan *Pinna atropurpurea* merupakan spesies yang sentiasa dijumpai di setiap kawasan kajian manakala, *P. deltodes* dan *P. incurva* merupakan taburan baru yang

direkodkan di kawasan rumput laut di Sungai Pulai. Beting Merambong merekodkan kepelbagaian dan kelimpahan yang tertinggi jika dibandingkan dengan beting Tanjung Adang dan Pulau Merambong tetapi nilai kesamarataan di antara beting Merambong, beting Tanjung Adang dan Pulau Merambong didapati agak sama. Lima filum utama yang terdiri daripada 37 spesies organisma yang melekat pada cengkerang direkodkan. Filum Crustacea dan Mollusca merekodkan peratusan taburan tertinggi jika dibandingkan dengan Annelida, Echinodermata dan Chordata. Filum Mollusca menunjukkan diversiti tertinggi manakala filum Annelida merekodkan nilai kelimpahan tertinggi. Udang alpehid *Synalpheus carinatus* dewasa direkodkan mendiami bahagian rongga mantel siput kipas secara simbiosis.

*Pinna bicolor* mencapai tahap matang pada saiz cengkerang 170 mm. Jantina *P. bicolor* didapati berasingan dan tiada individu yang mempunyai jantan dan betina pada satu individu yang sama sepanjang kajian dijalankan. Lima peringkat perkembangan gonad diperhatikan dan telah dikenalpasti. *Pinna bicolor* menunjukkan fasa rehat pada bulan Oktober 2006, Disember 2006 dan Mac 2007 manakala fasa perkembangan dan pengeluaran telur diperhatikan sepanjang tempoh kajian. Parameter fizikal-kimia air laut dan taburan hujan di kawasan kajian direkodkan setiap bulan secara rawak tidak mempengaruhi aktiviti pembiakan *P. bicolor* di beting Merambong. Analisis Pearson Correlation juga didapati tiada perhubungan bererti di antara indek gonad (GI) dengan parameter fizikal-kimia air laut di beting Merambong.

Kadar tumbesaran *P. bicolor* di kawasan semulajadi didapati pantas dan tidak tetap jika dibandingkan dengan yang ditenak di dalam tangki. Bagi perhubungan panjang-berat, angkali tumbesaran “*b*” didapati sangat nyata berbanding nilai isometrik (3.111) pada kadar 5% dan ini merupakan penanda aras pertumbuhan isometrik *P. bicolor* di beting Merambong. Saiz otot pengatup *A. vexillum* merupakan yang terbesar dibandingkan dengan spesies yang lain.



## ACKNOWLEDGEMENTS

*In the Name of ALLAH, The Merciful Benefactor, The Merciful Redeemer.*  
Praise goes to ALLAH Almighty for I am blessed with strength and ardour to finally accomplish this thesis.

I would like to express my deepest gratitude to my supervisor Assoc. Prof. Dr. Aziz Arshad for his guidance, and assistance during this study. Also, my sincere thanks to my committee members Professor Dr. Japar Sidik Bujang, Professor Dr. Mazlan Abdul Ghaffar and Assoc. Prof. Dr. Siti Khalijah Daud for all the advices given towards the completion of my study.

I extend my thanks to Mr. Hidir, Mr. Shater, Mr. Perumal, Mr. Azmi, Jimmy, Dr. S. M. Nurul Amin, Dr. Said Al-Barwani, and Mrs. Zaharah, from Faculty of Science, Mr. Jasni and Dr. Khairumazmi from Faculty of Agriculture who assisted me in sample preparation and running my experiments.

Lastly, to my wife and family for their encouragement, supports, patience, understanding and faith on me.

I certify that a Thesis Examination Committee has met on July 16, 2009 to conduct the final examination of Mohd Hanafi Idris on his thesis entitled "Biology and Distribution of Pen Shells (Bivalvia:Pinnidae) in Selected Areas of Peninsular 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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