UNIVERSITI PUTRA MALAYSIA

EDIBLE MOLLUSC (GASTROPOD AND BIVALVE) AT SELECTED DIVISIONS OF SARAWAK

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By

HADI BIN HAMLI

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

2013

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DEDICATION

DEDICATE THIS WRITING

TO MY BELOVED FAMILY,

THEY GAVE A LOT OF INSPIRATION

TO ME

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

EDIBLE MOLLUSC (GASTROPOD AND BIVALVE) AT SELECTED DIVISIONS OF SARAWAK

By

HADI BIN HAMLI

January 2013

Chairman: Mohd Hanafi Bin Idris, PhD

Faculty: Agriculture and Food Sciences (Bintulu)

Diversity of edible gastropod and bivalve was investigated at seven selected coastal division of Sarawak namely Kuching, Sibu, Mukah, Bintulu, Miri, Limbang and Lawas from July 2010 to January 2012. The most common and widely distributed species i.e., *Polymesoda* spp. was observed in details for morphology and genetic variation among different populations from different divisions.

A total of 41 edible species comprising 11 malacological family of gastropod with 21 species and 12 malacological family of bivalve with 20 species was recorded and identified. Bivalve from Corbiculidae (*Polymesoda erosa*, *P. expansa* and *P. bengalensis*) family was widely distributed in all divisions compared to other bivalve species. Whilst gastropod from Potamididae (*Cerithidea obtusa, C. quadrata, C. rizophorarum* and *Telescopium telescopium*) family was commonly recorded at six from seven divisions. Edible species of gastropod and bivalve was found higher in

Bintulu division (13 species for gastropod and 11 species for bivalve), while lower number of species was recorded from Sibu and Mukah divisions. Results on Jaccard's index showed high similarity for edible bivalves within Limbang versus Miri (0.75) and Limbang versus Lawas (0.75), while it was Sibu versus Mukah (0.50) for edible gastropod. This indicated species occurrence between two divisions is almost similar for higher similarity index while different species occurrence for lower similarity index.

A total of 15 morphometric characteristics (6 general and 9 additional characters) were used to differentiate three species of *Polymesoda* recorded from Sarawak. Significant differences (ANOVA, $p<0.05$) on 12 morphometric characteristics (SL; Shell Length, SW; Shell Width, SH; Shell Height, UL; Umbo Length, AL; Anterior Length, PL; Posterior Length, LPAS; Length of Posterior adductor scar to Anterior adductor Scar, LCT; Length of Cardinal Tooth, PVM; Palial line to Ventral Margin, AAAM; Anterior Adductor scar to Anterior Margin, PAPM; Posterior Adductor scar to Posterior adductor Margin and VPM; Ventral Posterior Margin) were found among three *Polymesoda* species collected from different divisions. Analysis showed that the proportion ratio for LCT/SL have had significant difference (ANOVA, $p<0.05$) between *P. bengalensis* and *P. expansa*, whilst VPM/SL significantly different (ANOVA, $p<0.05$) for *P. erosa* and *P. expansa* contrasted with *P. bengalensis*. However, the differences were not significant (ANOVA, $p>0.05$) between *P. erosa* and *bengalensis*, and *P. erosa* and *P. expansa* for LCT/SL and VPM/SL respectively.

Sixteen populations comprises of *P. erosa*, *P. expansa* and *P. bengalensis* recorded from different divisions were assessed (ANOVA) using morphometric characteristics to reveal differences among the species. Results showed significant differences ($p<0.05$) among populations of different divisions. Morphometric characteristic analysis on 16 populations of *Polymesoda* can be grouped based on cluster analysis which resulted in six groups at 98% similarity, namely Group 1 (*P. bengalensis* population from Limbang, Lawas, Miri, Bintulu and Kuching), Group 2 (*P. bengalensis* population from Sibu), Group 3 (*P. expansa* population from Miri and *P. erosa* population from Lawas and Miri), Group 4 (*P. erosa* population from Sibu, Mukah and Bintulu), Group 5 (*P. expansa* population from Limbang, Lawas and Bintulu) and Group 6 (*P. erosa* population from Limbang). These six groups of *Polymesoda* population were also supported by the results of Principal Component Analysis (PCA).

Genetic distance analysis through the 5S rDNA primer on *Polymesoda* species (*P. erosa*, *P. bengalensis* and *P. expansa*) revealed distinct banding patterns for 16 population samples from seven divisions (Limbang, Lawas, Miri, Bintulu, Mukah, Sibu and Kuching) of Sarawak. Band size for *P. erosa* and *P. bengalensis* were ranged from 100-1000 bp, while *P. expansa* 100-500 bp. Finding demonstrated that the most distant genetic was *P. bengalensis* from Bintulu (0.3365) while the close related genetic distance was *P. expansa* (Miri and Bintulu) and *P. bengalensis* (Sibu and Kuching) with 0.000 genetic distant. The results highlight the efficiency of 5S rDNA marker as identification tool which consent the identification of *Polymesoda* species.

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

MOLLUSKA BOLEH DIMAKAN (GASTROPODA DAN BIVALVIA) DI BAHAGIAN TERPILIH DI SARAWAK

Oleh

HADI BIN HAMLI

Januari 2013

Pengerusi: Mohd Hanafi Bin Idris, PhD

Fakulti: Sains Pertanian dan Makanan

Kepelbagaian siput gastropoda dan siput bivalvia yang boleh dimakan telah diselidik di tujuh bahagian pesisir pantai terpilih di Sarawak iaitu Kuching, Sibu, Mukah, Bintulu, Miri, Limbang dan Lawas dari Julai 2010 sehingga Januari 2012. Taburan spesis sebagai contoh, *Polymesoda* spp. adalah yang paling meluas dan umum telah diselidik terperinci untuk morfologi dan kepelbagaian genetik di antara populasi yang berbeza berdasarkan kawasan kajian.

Sejumlah 41 spesis yang terdiri 11 famili malakologi siput gastropoda dengan 21 spesis dan 12 famili malakologi siput bivalvia dengan 20 spesis telah direkodkan dan dikenal pasti. Bivalvia daripada Corbiculidae (*Polymesoda erosa, P. expansa* and *P. bengalensis*) mempunyai taburan yang meluas di mana terdapat pada semua kawasan kajian berbanding dengan spesis siput bivalvia yang lain. Manakala siput gastropoda dari famili Potamididae (*Cerithidia obtusa, C. quadrata, C. rizophorarum* and

Telescopium telescopium) telah direkod secara umum pada enam daripada tujuh bahagian. Spesis siput gastropoda dan bivalvia dijumpai paling banyak di bahagian Bintulu (13 spesis untuk siput gastropoda dan 11 spesis untuk siput bivalvia), manakala bilangan spesis terendah direkodkan adalah bahagian Sibu dan Mukah. Keputusan Indeks Jaccrad telah menunjukkan kesamaan tertinggi untuk siput bivalvia di antara Limbang lawan Miri (0.75) dan Limbang lawan Lawas (0.75), sementara Sibu lawan Mukah (0.50) untuk siput gastropoda yang boleh dimakan.

Sejumlah 15 ciri morfometrik (6 umum dan 9 ciri tambahan) telah digunakan untuk membezakan tiga spesis *Polymesoda* yang telah direkod daripada Sarawak. Terdapat perbezaan yang ketara (ANOVA, $p<0.05$) untuk 12 ciri morfometrik (SL; Panjang Cengkerang, SW; Lebar Cengkerang, SH; Tinggi Cengkerang, UL; Panjang Umbo, AL; Panjang Anterior, PL; Panjang Posterior, LPAS; Panjang parut aduktor Posterior ke parut aduktor anterior, LCT; Panjang Gigi Kardinal, PVM; Garis pallial ke hujung, AAAM; Parut aduktor Anterior ke hujung Anterior, PAPM; Parut aduktor Posterior ke hujung Posterior dan VPM; Hujung Posterior ventral) telah dikenalpasti antara tiga spesis *Polymesoda* yang dikumpul dari bahagian yang berbeza. Analisis menunjukkan kadar nisbah untuk LCT/SL adalah ketara berbeza (ANOVA, $p<0.05$) antara *P. bengalensis* dan *P. expansa* manakala VPM/SL ketara berbeza (ANOVA, $p<0.05$) untuk *P. erosa* dan *P. expansa* berbanding dengan *P. bengalensis.* Walau bagaimanapun, masing-masing tidak ada perbezaan ketara (ANOVA, $p>0.05$) antara *P. erosa* dan *P. bengalensis*, dan *P. erosa* dan *P. expansa* untuk LCT/SL dan VPM/SL.

Enam belas populasi yang terdiri *P. erosa*, *P. expansa* dan *P. bengalensis* direkod dari bahagian berbeza telah dinilai (ANOVA) melalui ciri-ciri morfometrik bagi menunjukkan perbezaan antara spesis. Keputusan menunjukkan perbezaan ketara ($p<0.05$) antara populasi dari pelbagai bahagian. Analisis ciri morfometrik 16 populasi *Polymesoda* boleh dikumpulkan berdasarkan analisis kluster di mana menghasilkan enam kumpulan pada 98% kesamaan seperti Kumpulan 1 (Populasi *P. bengalensis* dari Limbang, Lawas, Miri, Bintulu dan Kuching), Kumpulan 2 (Populasi *P. bengalensis* dari Sibu), Kumpulan 3 (Populasi *P. expansa* dari Miri dan populasi *P. erosa* dari Lawas dan Miri), Kumpulan 4 (Populasi *P. erosa* dari Sibu, Mukah dan Bintulu), Kumpulan 5 (Populasi *P. expansa* dari Limbang, Lawas dan Bintulu) dan Kumpulan 6 (Populasi *P. erosa* dari Limbang). Enam kumpulan populasi *Polymesoda* ini juga disokong melalui analisis komponen utama (PCA).

Analisis jarak genetik melalui penanda 5S rDNA terhadap spesis *Polymesoda* (*P. erosa*, *P. bengalensis* dan *P. expansa*) menunjukkan corak jalur yang berbeza untuk 16 sampel populasi dari tujuh bahagian (Limbang, Lawas, Miri, Bintulu, Mukah, Sibu dan Kuching). Saiz jalur untuk *P. erosa* dan *P. bengalensis* pada julat 100-1000 bp, sementara *P. expansa* pada julat 100-500 bp. Penemuan menunjukkan jarak genetic yang jauh adalah dari Bintulu (0.3365) sementara jarak genetik terdekat ditunjukkan oleh *P. expansa* (Miri dan Bintulu) dan *P. bengalensis* (Sibu dan Kuching) dengan jarak genetik 0.000. *P. bengalensis* dari Bintulu merupakan populasi yang unik berbanding populasi lain dari spesis yang sama. Keputusan menunjukkan kecekapan penanda 5S rDNA sebagai alat pengenalpastian yang membantu pengecaman spesis *Polymesoda*.

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I certify that a Thesis Examination Committee has met on 10 January 2013 to conduct the final examination of Hadi Bin Hamli on his thesis entitled "Edible Mollusc (Gastropod and Bivalve) at Selected Divisions of Sarawak" 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 Science.

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DECLARATION

I declare that the thesis is my original work except for quotations and citation which has been duly acknowledged. I also declare that it has not been previously, and is not concurrently, submitted for any other degree at Universiti Putra Malaysia or at any other institution.

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HADI BIN HAMLI

Date: 10 January 2013

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LIST OF ABBREVIATIONS

ANOVA	Analysis of Variance
AL	Anterior length
AW	Aperture width
AAAM	Anterior adductor scar to anterior margin
AAPM	Anterior adductor scar to posterior margin
AW	Anterior adductor scar width
bp	Base pair
DNA	Deoxyribonucleic Acid
FAO	Food and Agriculture Organization
LCT	Length of cardinal tooth
LL	Ligament length
LPAS	Length of posterior adductor scar to anterior adductor scar
NA	Not available
ns	No significant difference
OP	Outer lip thickness
PAPM	Posterior adductor scar to posterior margin
PL	Posterior length
PCA	Principal Component Analysis
PCR	Polymerase Reaction Chain
PRIMER	Plymouth Routines In Multivariate Ecological Research
PVM	Pallial line to ventral margin
PW	Posterior adductor scar width

SAS	Statistical Analysis of Software
SH	Shell height
SL	Shell length
SW	Shell Weight
UL	Umbone
UPGMA	Unweighted Pair Group Method with Arithmetic averaging
VPM	Ventral posterior margin length
ha	Hectare
µL	Microliters
mL	Mililiters
ng	nanogram
mm	Millimeter

CHAPTER 1

GENERAL INTRODUCTION

1.1 Background Study

Mollusc provides an important source of protein for human besides fish. It is found in many part of the world such as marine, brackish, freshwater and terrestrial area including Southeast Asia. It is believed that seasonal pattern in the Southeast Asia, for instance monsoonal rainfall provide nutrients enriched environment for these filter feeder organisms which eventually help to increase the number of mollusc in this area (Vermeij,1978).

Bivalvia and gastropoda classes are belonging to phylum mollusca. Both of these classes comprise of 290 families (Okutani, 2000). They can be found distributed at the Western Central Pacific area (Poutiers, 1998). In Southeast Asia, about 1211 species of bivalves was reported and it is the highest diversity for bivalves compared to 29 regions around the world (Crame, 2000). Distribution of gastropod and bivalve in Malaysia can be located from east coast (Terenganu and Pahang), west coast (Melaka), south (Johor) of Peninsular Malaysia, Sabah and Sarawak (Idris *et al*., 2011; Yap and Edward 2010; Zaidi *et al*. 2010; Abdullah *et al*. 2007; Sallih, 2005; Supian and Ikhwanuddin 2002; Hashim, 1993).

In Peninsular Malaysia, gastropod is locally known as “Siput”, whereas it is known as “Tekoyong” in Sarawak. This bivalve is locally known as many names depends on species such as “lokan, kepah, ambal, kunau and kerang” in Sarawak.Variable names given by local people are referring to several species of edible mollusc. In term of scientific nomenclature only few studies were recorded regarding non edible and edible mollusc in Indo-Pacific such as, edible bivalve, (Nateewathana, 1995), morphology of Pinnidae (Scheltema, 1983), taxonomic of Pinnidae (Rosewater, 1961), review of *Polymesoda* (Morton, 1984), occurrence on Opistobranch from Hong Kong (Rudman and Darvell, 1990) and embryos of giant clam (Soria-Dengg and Ochavillo, 1990).

Bivalve and gastropod can be differentiated based on shell morphological characteristic. Gastropod could be identified based on one piece, hard and usually coiled shells (Wye, 2007). Whilst bivalve have shells with two hinged and also called as Pelecypoda because of the battle axe foot shape (Feinberg, 2003). These external characters were the basic work on taxonomic to distinguish mollusc species (Rosewater, 1961).

The morphological method can be used with other method to clarify species and distribution (Araujo *et al*., 1993). Other method is combination of morphological technique and supported with molecular genetics to asses mussel populations (Mass *et al*., 1999). The molecular work itself as the strong method for species identification. Moreover genetic diversity is more diverse than morphology diversity since genetic variation in natural population come from mutational, genetic

recombination and sexual reproduction (Nguyen *et al*., 2006). Besides that marine mollusc has gene flow ability which tend to be more homogenous in term of genetic even for large geographic area (Donrung *et al*., 2011).

Gastropoda and bivalvia classes are the largest and abundance mollusca phylum throughout the world. Furthermore, mollusc from the marine habitat received more attention because of their aesthetic and gastronomic appeals (Subba Rao, 1993). Mollusc diversity, abundance and diversity are related to physico-chemical parameters, climatic condition and soil of the habitat area. This habitat area condition and characters were reported as strong factor influenced mollusc diversity and behaviour (Armitage and Fong, 2004; Chapperon and Seuront, 2011).

Different species is significantly depends on habitat types for instance high proportion of mud suitable for *Anadara granosa* and *Gafiarium tumidum* (Baron and Clavier, 1992; Broom, 1985). Habitat located at tropical water with sandy shallow and sandy reef flats are inhabit by Strombide and *Lambis* respectively (Ramadoss, 2010). Furthermore other gastropod and bivalve species can inhabit wide range habitat from mangrove, freshwater, seagrass bed, intertidal, coral reef and even most extreme habitat such as acidic, high temperature and high sulphide substance.

In Malaysia *Anadara granosa* is found abundantly at the West coast of Peninsular Malaysia due to their suitable habitat with extensive tidal mudflats. Another species that easily can be found is *Perna viridis* which spread to Western coast of Peninsular Malaysia especially Melaka (Sallih, 2005) and this species is native at Malaysian coast (Vakily, 1989). Razor clam (*Solen* spp.) that belongs to Solenidae family can be found at Kuching, Sarawak has high market demand since it found seasonally (Hassan and Hung, 2006).

1.2 Problem Statement

Little information was recorded regarding non edible and edible mollusc in Malaysia which included gastropod diversity around Malaysia (Abu Hena *et al*., 2004), nursery habitat (Zaidi *et al.*, 2010) and source of edible marine food in Sabah (Hashim, 1993). Lack number of documented mollusc from Malaysia may directly relate on number of habitat preference.

In Sarawak, molluscs inhabit in wetland together with other flora and fauna to form tangible ecosystem that support each other. Commonly in Sarawak, large number of gastropod and bivalve species which derived from wetland is consumed by local people. These molluscs provide essential protein in daily diet of the local communities and some species play important role for fishery economy of the state. The increasing of development activity at Sarawak may expose the major wetland destruction, damages due to pollution, changes of habitat characteristics and condition. Major changes on wetland habitat will affect on the biodiversity including

mollusc population which lastly lead toward the extinction of certain species. Besides, pollutants derived from sawmills, wood chip and sago factories may destroy the natural habitat of mollusc and other biodiversity (Davy and Graham, 1982). Over exploitation on edible mollusc by local people could also gradually contribute to species depletion.

To fill the gap of lack of information on edible mollusc diversity, present study was intended to collect information regarding diversity, distribution and morphology of edible mollusc from Sarawak. This study also includes some of their habitat characteristic. The most and widely distributed species was investigated for morphometric characteristics that could differentiate among the similar species. Genetic distance of this species population also was investigated if have had any differences among them.

Documentation of this edible mollusc could have scientific importance as a record that can be used as ready reference in future research activities toward aquaculture development, conservation and proper management of this natural resource in Sarawak.

1.3 Objectives

Objectives of the study are:

1. To investigate the diversity, distribution and morphology of edible mollusc at selected divisions of Sarawak.

2. To examine the morphometric characteristics of the most common bivalve, *Polymesoda* spp. from the coastal area of Sarawak.

3. To investigate the genetic diversity and variation of the *Polymesoda* spp. of the study areas.

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LIST OF PUBLICATIONS

1. Hamli, H., Idris, M. H., Abu Hena, M. K. and Wong, S. K. (2012). Taxonomic Study of Edible Bivalve from Selected Division of Sarawak, Malaysia. ***International Journal of Zoological Research*****, ISSN, 1811-9778, v(8): 52-58.**

2. Hamli, H., Idris, M. H., Abu Hena, M. K. and Wong, S. K. (2012). Diversity of Edible Mollusc (Gastropoda and Bivalvia) at Selected Division of, Sarawak. ***International Journal on Advanced Science Engineering Information Technology*****, ISSN, 2088-5334, v(2): 5-7**

3. Hamli, H., Idris, M. H., Abu Hena, M. K., Wong, S. K. and Arshad, A. (2013) Checklist and Habitat description of edible gastropods from Sarawak, Malaysia. ***Journal of Fisheries and Aquatic Science***. **ISSN, 1816-4927, 8(2): 412–418.**