UNIVERSITI PUTRA MALAYSIA

BIOLOGY AND ECOLOGY OF DOG CONCH (*Strombus canarium* Linnaeus, 1758) (GASTROPODA: STROMBIDAE) FROM MERAMBONG SHOAL, JOHOR STRAITS, MALAYSIA

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FS 2008 41

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DOCTOR OF PHILOSOPHY
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By

ZAIDI CHE COB

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

August 2008

DEDICATION

To my parents who always kept praying for me to achieve my goal, especially to my late father who passed away on January 20th 2008. May Allah bless his soul.

Al-Fatihah.

To my wife and my children who have sacrificed so much and be patient with me throughout the course of my study, and for me to be whom I am today.

To all my friend and colleagues who support me all those past years, and to technical staffs of Universiti Putra Malaysia, who provides technical support during my study.

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

BIOLOGY AND ECOLOGY OF DOG CONCH (*Strombus canarium* Linnaeus, 1758) (GASTROPODA: STROMBIDAE) FROM MERAMBONG SHOAL, JOHOR STRAITS, MALAYSIA

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

Faculty: **Faculty of Science**

Strombus canarium Linnaeus, 1758, locally known as 'siput gonggong' is a prosobranch gastropod from the family Strombidae that was highly associated with seagrass bed ecosystem. The main objectives of this study were to investigate and document the life history characteristics, biology, and ecology of the species, which are currently not well established.

This study has been conducted at Merambong Shoal, Johor Straits, Malaysia. Sample collections were conducted using a belt transect method where all individuals within the transect area were collected. The population dynamic was analyzed using both the Electronic Length Frequency Analysis (ELEFAN) and Length-based Fish Stock Assessment (LFSA) approaches, incorporated in the FiSAT software package. Apart from field observation, field experimentation and

laboratory analyses, laboratory culture experiment (from egg mass to juvenile) was also conducted, using a standard larval culture protocol.

Strombus canarium produced a long gelatinous tube of egg strand in the form of an egg mass. It took between 4.5 to 5.5 days of incubation before hatching, and the planktotrophic larvae spent between 18 to 24 days in the planktonic stage before metamorphosed. Metamorphic cue associated with bio-active materials from sediment taken from its nursery habitat showed the strongest effects compared to sediment conditioned seawater, seagrass detritus, seagrass detritus leachate, Potassium Chloride (KCL) and γ-aminobutyric acid (GABA). Changes of behavioral patterns related to metamorphosis were described, which can be divided into 3 phases: initiation, actual metamorphosis, and completion, resulted in completely camouflaged juveniles.

In their natural habitat, juveniles can be found at specific localities (nurseries), characterized by low to medium density *Halophila* bed; high sediment organic content; high sorting coefficient, and low mean grain size. The adult population was widely distributed, but present in local colonies, and was highly seasonal in abundance. Based on the gonadosomatic index (GSI), combined with other biological, ecological and behavioral observations, it could be concluded that the species was highly seasonal in reproduction, which starts from November to late March.

The population showed sexual polymorphisms where 3 different sexual morphs present i.e., males, normal females, and imposex females. Imposex was characterized by superimposition of male sexual characters on female. The imposex females showed significantly larger and heavier shell, and higher degree of outer-lip flaring compared to males and normal females. Imposex severity was defined as Stage 0 without the male genital system; Stage 1 with the appearance of rudimentary penis, but without penis duct; Stage 2 with simple prong of penis and penis duct, but without accessory; and Stage 3 with male penis complete with accessories. Development of other male characters as outlined in the general scheme of imposex evolution in prosobranchs was never observed. The percentage incidence of imposex (%I) was lower compared to other gastropod within the study areas, and there was no case of female sterility observed.

In population dynamic studies, a total of 766 males and 1322 females have been sampled from January to December 2005. Growth parameter estimation using both the ELEFAN-I and LFSA methods showed higher asymptotic length (L_∞) value in females compared to the males, but there was no significant difference in growth constant (K) and age at zero-length (t_o) of both sexes. The mean growth rate during the first year growth was estimated at 2.66 ± 0.16 mm/month for male and 4.59 ± 0.59 mm/month for female, which was comparable with the actual growth recorded using mark-recapture technique. The growth performance index (φ') was slightly lower in male (φ'=3.48) compared to the female (φ'=3.81), but both was well within the values reported for other marine gastropods. Recruitment

patterns, together with observations on spawning and copulation suggest that the species was highly synchronized (seasonal) in reproduction. The production and biomass was also seasonal, significantly higher during the wet monsoon season compared to the dry season.

In conclusions, many aspects of life history, biology, and ecology of *S. canarium* had been established. However more studies are urgently needed for better understanding and better management of the species, and for advancement of the species into mariculture.

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

BIOLOGI DAN EKOLOGI SIPUT GONGGONG (*Strombus canarium* Linnaeus, 1758) (GASTROPODA: STROMBIDAE) DARI BETING MERAMBONG, SELAT JOHOR, MALAYSIA

Oleh

ZAIDI CHE COB

Ogos 2008

Pengerusi: **Profesor Madya Aziz Arshad, PhD**

Fakulti: **Fakulti Sains**

Strombus canarium Linnaeus, 1758, yang dikenali oleh penduduk tempatan sebagai ‘siput gonggong’ adalah gastropoda daripada Famili Strombidae yang mempunyai hubungan sangat rapat dengan ekosistem rumput laut. Objektif utama kajian ini adalah untuk menyiasat dan mendokumentasikan sejarah hidup, aspek biologi, dan ekologi spesis tersebut, yang sekarang ini maklumatnya agak terhad.

Kajian ini telah dijalankan di Beting Merambong, Selat Johor, Malaysia. Pengumpulan sampel dilakukan menggunakan kaedah jalur transek di mana semua individu di dalam kawasan transek dikumpulkan. Dinamik populasi dianalisa menggunakan kaedah ‘Electronic Length Frequency Analysis’ (ELEFAN) dan juga ‘Length-based Fish Stock Assessment’ (LFSA), yang terkandung dalam pakej perisian FiSAT. Selain daripada pemerhatian dan

eksperimentasi di lapangan serta analisis makmal, kultur makmal larva (dari telur hingga juvenil) juga dilakukan, menggunakan kaedah piawai bagi kultur larva.

Strombus canarium menghasilkan telur yang tersusun dalam satu tiub bergelatin yang panjang, membentuk satu gumpalan jasad telur. Ia memerlukan tempoh pengeraman dari 4.5 hingga 5.5 hari untuk menetas, menghasilkan larva planktotrofik yang hidup sebagai plankton selama 18 hingga 24 hari, sebelum menjalani proses metamorfosis. Induksi metamorfosis oleh bahan bio-aktif yang terdapat dalam sedimen dari habitat asuhan mempunyai kesan paling tinggi berbanding air laut yang diaktifkan dengan sedimen, detritus rumput laut, air peraman detritus rumput laut, Potassium Chloride (KCL) dan γ-aminobutyric acid (GABA). Perubahan kelakuan yang berkait dengan metamorfosis juga telah dikenalpasti, dan boleh dibahagikan kepada tiga fasa iaitu: inisiasi (permulaan), metamorfosis, dan fasa pengakhiran, menghasilkan juvenil yang mempunyai kesan penyamaran yang baik dengan kawasan sekelilingnya.

Di habitat semulajadinya, juvenil boleh dijumpai di lokaliti yang spesifik, yang dicirikan oleh: kawasan rumput laut *Halophila* yang berkepadatan rendah ke kepadatan sederhana; mempunyai nilai 'sorting coefficient' sedimen yang tinggi, dan purata saiz butiran sedimen yang rendah. Populasi dewasa didapati bertaburan secara meluas, tapi hadir dalam kelompok-kelompok koloni setempat, dan kelimpahannya sangat dipengaruhi oleh musim. Berdasar kepada indeks gonadosomatik (*GSI*), disamping ciri-ciri biologi, ekologi, dan aspek kelakuan,

spesis kajian boleh dirumuskan mempunyai corak pembiakan yang juga sangat di pengaruhi oleh musim, bermula dari November hingga Mac.

Populasi *S. canarium* menunjukkan fenomena polimorfisma seksual di mana terdapat 3 kumpulan morfologi berbeza iaitu jantan, betina normal dan betina imposex. Imposex mempunyai ciri kehadiran organ seksual jantan secara abnormal pada individu betina. Betina imposex mempunyai cangkerang yang secara signifikannya lebih besar dan lebih berat, dan darjah pengembangan bibir cangkerang yang lebih tinggi berbanding jantan dan betina normal. Tahap imposeks terhadap spesies dikelaskan kepada: Tahap 0 tanpa sebarang organ seksual jantan; Tahap 1 mempunyai penis rudimen, tanpa duktus; Tahap 2 mempunyai penis ringkas, berserta duktus, tapi tanpa aksesori; dan Tahap 3 mempunyai penis lengkap, berserta dengan duktus dan aksesori. Selain daripada itu peratus insiden imposex (%I) adalah rendah berbanding insiden ke atas gastropod lain di kawasan kajian, dan tidak ada kes betina steril yang di jumpai.

Dalam kajian dinamik populasi, sejumlah 766 jantan dan 1322 betina telah di sampel dari bulan Januari hingga Disember 2005. Penentuan parameter tumbesaran menggunakan ELEFAN-I dan LFSA menunjukkan nilai panjang asimptot (L_∞) yang lebih tinggi bagi betina berbanding jantan, namun tiada perbezaan signifikan bagi nilai pemalar tumbesaran (K) dan umur pada panjang sifar (t_o). Purata kadar tumbesaran bagi tahun pertama dianggarkan pada 2.66 ± 0.16 mm/bulan untuk jantan, dan 4.59 ± 0.59 mm/bulan untuk betina, yang agak

sama berbanding dengan nilai sebenar diperolehi secara kaedah tanda-tangkap semula. Indeks prestasi tumbesaran (φ') sedikit rendah bagi jantan (φ'=3.48) berbanding betina (φ'=3.81), namun kedua-duanya masih berada di dalam julat nilai yang dilaporkan untuk gastropoda marin yang lain. Corak rekrutmen, bersama-sama dengan pemerhatian terhadap jumlah telur dan kopulasi mencadangkan yang spesies adalah sangat bermusim dalam pembiakan. Kadar penghasilan dan biomas juga menunjukkan sifat bermusim, di mana nilainya lebih tinggi pada musim hujan berbanding musim kering.

Sebagai kesimpulan, berbagai aspek riwayat hidup, biologi, dan ekologi *S. canarium* telah berjaya dikenalpasti. Walau bagaimanapun kajian lanjut amat diperlukan untuk lebih memahami spesis tersebut, disamping pengurusan mapan sumber tersebut dapat dilakukan, dan untuk membangunkan spesies ini dalam industri marikultur.

ACKNOWLEDGEMENTS

Praise to Allah the Almighty for the strength, health, and peace of mind He provided me throughout this study.

I would like to express my sincere gratitude to my supervisor, Assoc. Prof. Dr. Aziz Arshad for the support, continued guidance and valuable collaboration during the entire process of this thesis at Universiti Putra Malaysia. Without those quality and constructive supervision and guidance, this work may not have come to completion.

I would like to thank my thesis committee members for their advice and critics on this thesis, and for continuous constructive discussion and suggestions: Assoc. Prof. Dr. Japar Sidik Bujang and Assoc. Prof. Dr. Mazlan Abd. Ghaffar.

I am also grateful to several people who were instrumental to the development of this thesis: Perumal Kuppan for his advice during laboratory culture work, Azmi for his technical assistant, and last but not least Pak Long who provide the boat service to the study site.

I certify that an Examination Committee has met on 28 August 2008 to conduct the final examination of Zaidi Che Cob on his Doctor of Philosophy thesis entitled "Aspects of Biology and Ecology of *Strombus canarium* Linnaeus, 1758 (Gastropoda; Strombidae) From Merambong Shoal, Johore, Malaysia" in accordance with Universiti Pertanian Malaysia (Higher Degree) Act 1980 and Universiti Pertanian Malaysia (Higher Degree) Regulations 1981. The committee recommends that the candidate be awarded the Doctor of Philosophy degree.

Members of the Examination Committee are as follows:

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Date: 23 October 2008

This thesis was submitted to the Senate of Universiti Putra Malaysia has been accepted as fulfilment of the requirements for the degree of Doctor of Philosophy. The members of Supervisory Committee were as follows:

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Date: 13 November 2008

DECLARATION

I declare that the thesis is based on my original work except for quotations and citations which have been duly acknowledged. I also declared that it has not been previously and is not concurrently submitted for any other degree at Universiti Putra Malaysia or at any other institutions.

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ZAIDI CHE COB

Date: 19 September 2008

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