



**UNIVERSITI PUTRA MALAYSIA**

**ECOLOGY AND BIOLOGY OF SEAGRASS, *HALOPHILA BECCARII*  
ASCHERS, IN PENINSULAR MALAYSIA**

**MUTA HARAH BINTI ZAKARIA @ YA**

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*HALOPHILA BECCARII* ASCHERS. IN PENINSULAR MALAYSIA**

**By**

**MUTA HARAH BINTI ZAKARIA @ YA**

**Thesis Submitted in Fulfilment of the Requirement for  
the Degree of Doctor of Philosophy in the  
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Abstract of thesis presented to Senate of the Universiti Putra Malaysia in fulfilment of the requirement for the degree of Doctor of Philosophy

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**Chairman : Assoc. Prof. Dr. Japar Sidik Bujang**  
**Faculty : Science and Environmental Studies**

Distribution, occurrence and habitats of *Halophila beccarii* Aschers. were surveyed in coastal areas of Peninsular Malaysia. Of the many sites discovered, three were selected for detailed studies on seasonal dynamics involving monthly monitoring of environmental and biological variables. Surveys and monitoring were conducted simultaneously from February 1996 to January 1999. Data sets were analysed with multiple linear regression analysis for correlation between environmental and biological variables. *Halophila beccarii* was recorded at six sites in Terengganu: Sungai Kemaman, Chukai, Telaga Simpul, Sungai Paka Lagoon, Sungai Paka bridge-river bank of Sungai Paka and Sungai Paka shoal; four sites in Kelantan: Pengkalan Nangka Lagoon, Pengkalan Nangka shoal, Kampung Baru Nelayan-Kampung Sungai Tanjung and Pantai Baru Lagoon and two sites in Penang: Korea Island and Seberang Prai. *Halophila beccarii* occurred in brackish water and occasionally in marine habitats. They grew on substrates; sandy loam, loam, silty clay loam, silt loam, loamy sand, sandy muddy, calcareous muddy that are acidic (pH 3.46-5.55) and slightly above neutral (pH 5.83-7.88) and have substantial concentration of total organic nitrogen, 34.05-54.26  $\mu\text{M}$  and low total phosphorus, 0.24-3.27  $\mu\text{M}$ . *Halophila beccarii* grew in dynamic habitats, constantly changed, the



time scale can be variables from diurnal, seasonal within-year and between-year. *Halophila beccarii* tolerates a daily fluctuation of salinity 0-28.00 ppt and 0-31.46 ppt during low and high tides and 0-5.00 ppt during the prolonged period of 2-3 consecutive wet months. It grew in water temperature of 24.67-38.20°C and survived up to 40.00°C and tolerated short exposures of 2-3 hours to the sun and air during the day low tide. Nutrient concentrations in water were widely variable; nitrate ranged 0.160-29.970  $\mu\text{M}$ ; nitrite ranged 0-0.799  $\mu\text{M}$ , a relatively low ammonium, from undetectable to 11.949  $\mu\text{M}$  and ortho-phosphate, from undetectable to 0.903  $\mu\text{M}$ .

The internal morphology of vegetative organs of *H. beccarii* at Sungai Kemaman, Sungai Paka and Pengkalan Nangka Lagoons are similar, but significantly differences in external morphology of vegetative organs between plants of the three sites exist. Sungai Paka and Pengkalan Nangka Lagoons plants have longer leaf length, narrow leaf width and higher leaf length:leaf width ratio and longer petiole length when compared to plants of Sungai Kemaman. In the reproductive phase, the Sungai Paka and Pengkalan Nangka Lagoons, plants have almost double (maximum of 7 seeds) the number of seeds per fruit than Sungai Kemaman (maximum of 4 seeds) plants. Pronounced differences were also detected in resource allocation patterns. Sungai Paka and Pengkalan Nangka Lagoons plants have extremely high values in shoot density and biomass achieved in a very short time, while Sungai Kemaman plants presents lower values maintained throughout the year. Peak values in Sungai Paka Lagoon ( $10305.56 \pm 1480.93$  shoots  $\text{m}^{-2}$ ) and Pengkalan Nangka Lagoon ( $55161.90 \pm 3553.63$  shoots  $\text{m}^{-2}$ ) were almost 2 and 8 times more respectively than those of Sungai Kemaman ( $6798.00 \pm 352.94$  shoots  $\text{m}^{-2}$ ). Biomass changes are also related to changes in shoot density. Sungai Paka



and Pengkalan Nangka Lagoons plants exhibited 4.3-5.4 times and 16.1-19.0 times more in peak biomass (AG, BG and total) compared to those of Sungai Kemaman.

From reproductive phenology, the Pengkalan Nangka and Sungai Paka Lagoons plants are annuals. The life cycle with the eventual death of plants takes 5-7 months at Sungai Paka Lagoon and 8 months for Pengkalan Nangka Lagoon. Sungai Kemaman plants are perennial, exhibiting life cycle of continuous growth, flowering, fruiting and dissemination of fruits or seeds. In all sites, whether as annual or perennial, their progressive life cycle development were correlated with extrinsic environmental factors. Air and water temperature, daily sunshine hours, daily global radiation, salinity, substrate pH and nitrate concentration were factors involved in flowering and fruiting. With respect to sites there was no consistent trend observed, suggesting factors may be site specific. Air and water temperature, daily global radiation, daily sunshine hours, salinity and, substrate total phosphorus, pH and total organic nitrogen were correlated to the fluctuation in shoot density and biomass allocation of *H. beccarii*, but as in flowering and fruiting these were site specific. This emphasize the plasticity shown by *H. beccarii*, which allows a single species to exist over a broad geographical area, in different habitats and under different environmental conditions.



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

**EKOLOGI DAN BIOLOGI RUMPUT LAUT,  
*HALOPHILA BECCARII* ASCHERS. DI SEMENANJUNG MALAYSIA**

Oleh

**MUTA HARAH BINTI ZAKARIA @ YA**

**Mac 2001**

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Tinjauan terhadap taburan, kehadiran dan habitat *Halophila beccarii* Aschers. telah dilakukan di kawasan pesisir pantai Semenanjung Malaysia. Daripada beberapa kawasan yang ditemui, tiga kawasan dipilih bagi kajian terperinci mengenai dinamik bermusim yang melibatkan pemantauan bulanan variabel persekitaran dan biologi. Tinjauan dan pemantauan telah dijalankan serentak dari Februari 1996 hingga Januari 1999. Set data dianalisa menggunakan analisis regresi berganda untuk perhubungan di antara parameter persekitaran dan biologi. *Halophila beccarii* telah direkod sekurang-kurangnya di enam kawasan di Terengganu: Sungai Kemaman, Chukai, Telaga Simpul, Mengabang Sungai Paka, jambatan Sungai Paka-tebing Sungai Paka dan beting Sungai Paka; empat kawasan di Kelantan: Mengabang Pengkalan Nangka, beting Pengkalan Nangka, Kampung Baru Nelayan-Kampung Sungai Tanjung dan Mengabang Pantai Baru dan dua kawasan di Pulau Pinang: Pulau Korea dan Seberang Prai. *Halophila beccarii* menduduki habitat air payau dan kadangkala di kawasan marin. Ia tumbuh di atas substrat; loam berpasir, loam, loam liat berkelodak, loam berkelodak, lumpur berpasir, lumpur berkalsium yang masam (pH 3.46-5.55) dan melebihi takat neutral (pH 5.83-7.88) dan mempunyai kandungan total nitrogen organik tinggi, 34.05-54.26  $\mu\text{M}$  dan kandungan total

fosforus rendah, 0.24-3.27  $\mu\text{M}$ . *Halophila beccarii* meduduki habitat dinamik, sentiasa berubah, skala masa boleh berbeza, diurnal, bermusim dalam setahun dan di antara tahun. *Halophila beccarii* bertoleransi kepada perubahan harian saliniti 0-28.00 ppt semasa air surut dan 0-31.46 ppt semasa air pasang dan 0-5.00 ppt pada jangkamasa berpanjangan berturutan 2-3 bulan pada musim hujan. Ia tumbuh di dalam air bersuhu 24.67-38.20°C dan mampu bertahan sehingga 40.00°C dan pendedahan jangkamasa pendek 2-3 jam pada matahari dan udara semasa air surut siang hari. Kandungan nutrien di dalam air mempunyai perbezaan yang luas; kandungan nitrat berjulat 0.160-29.970  $\mu\text{M}$ ; nitrit berjulat 0-0.799  $\mu\text{M}$ , kandungan ammonium yang rendah, dari “undetectable” hingga 11.949  $\mu\text{M}$  dan kandungan orto-fosfat, dari “undetectable” hingga 0.903  $\mu\text{M}$ .

Morfologi dalaman organ vegetatif *H. beccarii* di Sungai Kemaman, Mengabang Sungai Paka dan Pengkalan Nangka adalah sama tetapi perbezaan yang amat ketara dapat dilihat pada morfologi luaran organ vegetatif untuk tumbuhan bagi ketiga-tiga kawasan tersebut. Tumbuhan di Mengabang Sungai Paka dan Pengkalan Nangka mempunyai daun lebih panjang, lebar daun sempit dan nisbah panjang:lebar daun tinggi, panjang petiol yang lebih berbanding tumbuhan dari Sungai Kemaman. Bagi fasa pembiakan, tumbuhan dari Mengabang Sungai Paka dan Pengkalan Nangka mempunyai hampir dua kali ganda (maksimum 7 biji) bilangan biji setiap buah berbanding Sungai Kemaman (maksimum 4 biji). Perbezaan nyata juga dapat dilihat pada corak pembahagian sumber. Tumbuhan Mengabang Sungai Paka dan Pengkalan Nangka mempunyai nilai tinggi bagi kepadatan sulur dan biojisim dalam jangkamasa yang singkat, sementara tumbuhan Sungai Kemaman menunjukkan nilai rendah dan stabil sepanjang tahun. Nilai kepadatan sulur tertinggi dari Mengabang Sungai Paka ( $10305.56 \pm 1480.93$  sulur  $\text{m}^{-2}$ ) dan Mengabang Pengkalan Nangka ( $55161.90 \pm 3553.63$  sulur  $\text{m}^{-2}$ ) adalah

hampir 2 dan 8 kali ganda berbanding nilai kepadatan tertinggi di Sungai Kemaman ( $6798.00 \pm 352.94$  sulur  $m^{-2}$ ). Perubahan biojisim juga mempunyai perkaitan dengan perubahan kepadatan sulur. Tumbuhan Mengabang Sungai Paka dan Pengkalan Nangka menunjukkan 4.3-5.4 kali ganda dan 16.1-19.0 kali ganda lebih banyak bagi nilai biojisim tertinggi (atas tanah-AG, bawah tanah-BG dan jumlah) berbanding kawasan Sungai Kemaman.

Dari fenologi pembiakan, tumbuhan Mengabang Pengkalan Nangka dan Sungai Paka adalah tumbuhan setahun (annual). Peringkat kitaran hidup *H. beccarii* sehingga ke peringkat mati amnya mengambil masa 5-7 bulan di Mengabang Sungai Paka dan 8 bulan di Mengabang Pengkalan Nangka. Tumbuhan Sungai Kemaman adalah tumbuhan tahunan (perennial), yang mempamerkan kitaran hidup pertumbuhan berterusan, berbunga, berbuah dan menyebarkan buah atau biji. Di semua kawasan, samada tumbuhan setahun atau tahunan, tahap perkembangan kitaran hidup berkolerasi dengan faktor-faktor persekitaran luaran. Suhu udara dan air, jumlah jam sinaran harian, sinaran global harian, saliniti, pH substrat dan kandungan nitrat merupakan faktor yang memainkan peranan dalam pembungaan dan pemuahan. Kesemua kawasan tidak menunjukkan tren yang sama, dan ini memperlihatkan bahawa faktor di atas bergantung kepada kawasan tertentu. Suhu udara dan air, sinaran global harian, jumlah jam sinaran harian, saliniti dan, total fosforus, pH dan total nitrogen organik substrat berkolerasi dengan perubahan kepadatan sulur dan pembahagian biojisim *H. beccarii*, tetapi seperti dalam pembungaan dan pemuahan ia bergantung pada kawasan tertentu. Ini menekankan bahawa keplastikan yang ditunjukkan oleh *H. beccarii* membolehkan suatu spesies wujud di kawasan geografi yang luas, habitat berbeza dan di bawah keadaan persekitaran berbeza.



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I certify that an Examination Committee met on 13<sup>th</sup> March 2001 to conduct the final examination of Muta Harah Binti Zakaria @ Ya on her Doctor of Philosophy thesis entitled "Ecology and Biology of Seagrass, *Halophila beccarii* Aschers. in Peninsular 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 relevant degree. Members of the Examination Committee are as follows:

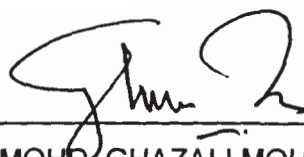
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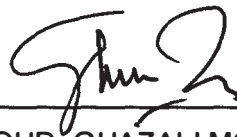


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This thesis submitted to the Senate of Universiti Putra Malaysia has been accepted as fulfilment of the requirement for degree of Doctor of Philosophy.



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## DECLARATION

I hereby declare that the thesis is based on my original work except for quotations and citations, which have been duly acknowledged. I also declare that it has not been previously or currently submitted for any other degree at UPM or other institutions.



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MUTA HARAH BINTI ZAKARIA @ YA

Date: 13 April 2001

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