



UNIVERSITI PUTRA MALAYSIA

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

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**ECOLOGY AND BIOLOGY OF SEAGRASS,
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By

MUTA HARAH BINTI ZAKARIA @ YA

**Thesis Submitted in Fulfilment of the Requirement for
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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 μM and low total phosphorus, 0.24-3.27 μM . *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 μM ; nitrite ranged 0-0.799 μM , a relatively low ammonium, from undetectable to 11.949 μM and ortho-phosphate, from undetectable to 0.903 μM .

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 ± 1480.93 shoots m^{-2}) and Pengkalan Nangka Lagoon (55161.90 ± 3553.63 shoots m^{-2}) were almost 2 and 8 times more respectively than those of Sungai Kemaman (6798.00 ± 352.94 shoots 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**

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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 μM dan kandungan total

fosforus rendah, 0.24-3.27 μM . *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 μM ; nitrit berjulat 0-0.799 μM , kandungan ammonium yang rendah, dari “undetectable” hingga 11.949 μM dan kandungan orto-fosfat, dari “undetectable” hingga 0.903 μM .

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 ± 1480.93 sulur m^{-2}) dan Mengabang Pengkalan Nangka (55161.90 ± 3553.63 sulur m^{-2}) adalah

hampir 2 dan 8 kali ganda berbanding nilai kepadatan tertinggi di Sungai Kemaman (6798.00 ± 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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TABLE OF CONTENTS

	Page
ABSTRACT	ii
ABSTRAK	v
ACKNOWLEDGEMENTS	viii
APPROVAL	ix
DECLARATION	xi
LIST OF TABLES	xv
LIST OF FIGURES	xx
LIST OF PLATES	xxiv

Chapter	Page	
I	GENERAL INTRODUCTION	1
II	DISTRIBUTION, HABITAT AND ASSOCIATED FAUNA OF <i>HALOPHILA BECCARII</i> ASCHERS. MEADOWS	16
	Abstract	16
	Introduction	18
	Materials and Methods	21
	Distribution and Habitat of <i>H. beccarii</i>	21
	Associated Fauna of <i>H. beccarii</i> Meadows	26
	Results	28
	Distribution of <i>H. beccarii</i>	28
	Habitat of <i>H. beccarii</i> Meadows	28
	Associated fauna of <i>H. beccarii</i> Meadows	48
	Macroinvertebrate Composition and Distribution at Sungai Paka Lagoon	52
	Macroinvertebrate Composition and Distribution at Pengkalan Nangka Lagoon	56
	Discussion	56
	Distribution of <i>H. beccarii</i>	56
	Habitat of <i>H. beccarii</i> Meadows	64
	Associated Fauna of <i>H. beccarii</i> Meadows	75
III	ENVIRONMENTAL CONDITIONS IN THE <i>HALOPHILA BECCARII</i> ASCHERS. MEADOWS	79
	Abstract	79
	Introduction	80
	Materials and Methods	83
	Sampling Strategy and Determination of Environmental Variables	83
	Physical Variables in <i>H. beccarii</i> Meadows	83
	Chemical Variables in <i>H. beccarii</i> Meadows	84
	Substrate in <i>H. beccarii</i> Meadows	84
	Data Analyses	86
	Results	86
	Physical Variables in <i>H. beccarii</i> Meadows	86
	Chemical Variables in <i>H. beccarii</i> Meadows	101
	Substrate in <i>H. beccarii</i> Meadows	108



Chapter		Page
	Discussion	115
	Physical Variables in <i>H. beccarii</i> Meadows	115
	Chemical Variables in <i>H. beccarii</i> Meadows	130
	Substrate in <i>H. beccarii</i> Meadows	135
IV	VEGETATIVE AND REPRODUCTIVE MORPHOLOGY OF <i>HALOPHILA BECCARII</i> ASCHERS.	145
	Abstract	145
	Introduction	146
	Materials and Methods	147
	Results	149
	Vegetative and Reproductive Morphology in <i>H. beccarii</i>	149
	Discussion	161
V	INTERNAL MORPHOLOGY OF <i>HALOPHILA BECCARII</i> ASCHERS.	168
	Abstract	168
	Introduction	169
	Materials and Methods	170
	Results	171
	Discussion	176
VI	FLOWERING, FRUITING AND SEED RESERVE OF <i>HALOPHILA BECCARII</i> ASCHERS.	180
	Abstract	180
	Introduction	181
	Materials and Methods	182
	Results	185
	Flowering, Fruiting and Seeds in <i>H. beccarii</i> from Sungai Kemaman	185
	Flowering, Fruiting and Seeds in <i>H. beccarii</i> from Sungai Paka Lagoon	187
	Flowering, Fruiting and Seeds in <i>H. beccarii</i> from Pengkalan Nangka Lagoon	190
	Discussion	193
	Flowering, Fruiting and Seeds in <i>H. beccarii</i>	193
	Correlation between Flowering and Fruiting in <i>H. beccarii</i> and Environmental Variables	197
VII	SEED GERMINATION, SEEDLING DEVELOPMENT AND SEEDLING DISTRIBUTION OF <i>HALOPHILA BECCARII</i> ASCHERS.	203
	Abstract	203
	Introduction	204
	Materials and Methods	206
	Seeds Collection and Laboratory Germination of <i>H. beccarii</i>	206
	<i>In situ</i> Observation of Germinating Seed and Seedling Development	207
	Results	208
	Laboratory Germination of <i>H. beccarii</i>	208

Chapter		Page
	<i>In situ</i> Seedling Development of <i>H. beccarii</i>	211
	Seedling Distribution of <i>H. beccarii</i>	217
	Discussion	221
	Seed Germination in Laboratory	221
	Seedling Development	227
	Seedling Distribution	228
VIII	SHOOT DENSITY AND BIOMASS FLUCTUATION IN <i>HALOPHILA BECCARII</i> ASCHERS.	230
	Abstract	230
	Introduction	232
	Materials and Methods	234
	Results	237
	Shoot Density of <i>H. beccarii</i>	237
	Biomass and Biomass Ratio of <i>H. beccarii</i>	240
	Correlation between <i>H. beccarii</i> Shoot Density, Biomass and Environmental Variables	245
	Discussion	245
	Shoot Density of <i>H. beccarii</i>	245
	Biomass and Biomass Ratio of <i>H. beccarii</i>	252
	Correlation between <i>H. beccarii</i> Shoot Density, Biomass and Environmental Variables	271
IX	GENERAL DISCUSSION	276
	REFERENCES	288
	APPENDIX	318
	1 Determination of Physical Variables	318
	1a Total Suspended Solid (TSS)	318
	1b Sedimentation Rate	318
	2 Determination of Chemical Variables	319
	3 Particle Size Analysis	323
	4 Substrate in <i>H. beccarii</i> Meadows	324
	4a Substrate pH	324
	4b Total Phosphorus (P) Analysis	324
	4c Total Organic Nitrogen (N) Analysis	325
	5 Scanning Electron Microscopy (SEM) of <i>H. beccarii</i>	328
	6 Anatomical Study	329
	7 Physical Variables in <i>H. beccarii</i> Meadows	332
	8 Chemical Variables in <i>H. beccarii</i> Meadows	341
	9 Substrate in <i>H. beccarii</i> Meadows	346
	10 Flowering, Fruiting and Seed in <i>H. beccarii</i>	349
	11 Seedling Distribution of <i>H. beccarii</i>	352
	12 Shoot Density and Biomass of <i>H. beccarii</i>	355
	13 AG to BG ratio of <i>H. beccarii</i>	358
	BIODATA	359

LIST OF TABLES

Tables	Caption	Page
1.1	The seagrass list of the world modified from den Hartog (1970)	3
1.2	Occurrence of seagrass species in Peninsular Malaysia (Wc-west coast; Ec-east coast; S-southern) and in East Malaysia (SWc-Sabah west coast; SSE-Sabah south eastern coast; S-Sarawak)	6
2.1	Observation period, location, latitude and longitude and habitat characteristics of <i>H. beccarii</i> in the Peninsular Malaysia. * - den Hartog (1970). ELWS – ebb low water spring. For Sungai Kemaman, Sungai Paka Lagoon and Pengkalan Nangka Lagoon, salinity are given at low and high tides	29
2.2	Associated fauna at the <i>H. beccarii</i> meadow. K1-Sungai Kemaman, K2-Chukai, TS-Telaga Simpul, P1-Sungai Paka Lagoon, P2/P6-Sungai Paka bridge/river bank of Sungai Paka, P3/P4/P5-Sungai Paka shoal, PN1-Pengkalan Nangka Lagoon, PN2-Pengkalan Nangka shoal, PN3/PN4-Kampung Baru Nelayan/Kampung Sungai Tanjung, PB1/PB2-Pantai Baru Lagoon, KI-Korea Island and SP-Seberang Prai. *- not observed or recorded	50
2.3	Percentage and range occurrence (in parenthesis) of above and below ground fauna associated with <i>H. beccarii</i> meadow at Sungai Paka Lagoon, Terengganu	53
2.4	Percentage occurrence and range (in parenthesis) of above and below ground fauna associated with <i>H. beccarii</i> meadow at Pengkalan Nangka Lagoon, Kelantan	57
2.5	Location, date collection and worldwide habitat descriptions of <i>H. beccarii</i>	65
3.1	Summary of comparison of means of the different physical variables across sites. Different letters indicate significant differences at $p < 0.01$ (ANOVA, post-hoc Duncan's Multiple Range Test), i.e., $a > b > c$ etc.; ns - not significant. Value in parenthesis is the range	90
3.2	Summary of comparison of means of the different chemical variables across sites. Different letters indicate significant differences at $p < 0.01$ (ANOVA, post-hoc Duncan's Multiple Range Test), i.e., $a > b > c$ etc.; ns - not significant, ud - undetectable. Value in parenthesis is the range	103

Tables	Caption	Page
3.3	Variation of substrate composition at seagrass meadows of Sungai Kemaman, Sungai Paka Lagoon, Terengganu and Pengkalan Nangka Lagoon, Kelantan. *no seagrass was present during this time	110
3.4	Summary of comparison of means of the different chemical variables across sites. Different letters indicate significant differences at $p < 0.01$ (ANOVA, post-hoc Duncan's Multiple Range Test), i.e., $a > b > c$ etc.; ns - not significant. Value in parenthesis is the range	113
3.5	Air temperature, water temperature and salinity in seagrass meadows. ELWS – ebb low water spring, MSL – mean sea level	121
3.6	Concentration of nitrate (NO_3^-), nitrite (NO_2^-), $\text{NO}_3^- + \text{NO}_2^-$, ammonium (NH_4^+) and ortho-phosphate (PO_4^{3-}) in water in seagrass meadows. ELWS – ebb low water spring, ud – undetectable	131
3.7	Substrates of <i>H. beccarii</i> and other seagrass meadows	136
3.8	Substrate pH, total phosphorus (P) and total organic nitrogen (N) in the substrate of seagrass meadows	142
4.1	Summary of dimension analysis (given in mm) of vegetative and reproductive structures of <i>H. beccarii</i> at three sites, Sungai Kemaman, Sungai Paka Lagoon and Pengkalan Nangka Lagoon. Different letters indicate significant differences at $p < 0.01$ (ANOVA, post-hoc Duncan's Multiple Range Test), i.e., $a > b > c$ etc.; ns, not significant. Values in parenthesis are the range	155
6.1	Summary of multiple correlation analysis between mean male flower density, female flower density and fruit density of <i>H. beccarii</i> and 7 environmental variables (out of 16 analysed) at Sungai Kemaman, Sungai Paka Lagoon, Terengganu and Pengkalan Nangka Lagoon, Kelantan. The value given is Pearson's correlation. * indicate significant level at $p < 0.05$ while the rest is at $p < 0.01$	198
7.1	Seed germination of <i>H. beccarii</i> under dark and light conditions and the different developmental stages	209
7.2	Dimension analysis of seedling of <i>H. beccarii</i> up to 3-4 leaf stage from Sungai Kemaman, Sungai Paka Lagoon and Pengkalan Nangka Lagoon. Different letters indicate significant differences at $p < 0.01$ (ANOVA, Duncan's Multiple Range Test). Values in parenthesis are the range	216
7.3	Seed dormancy in different seagrass species	222

Tables	Caption	Page
7.4	Summary of seedling development in <i>Halophila</i> . + Description without duration mentioned	224
8.1a	Summary of multiple correlation analysis between <i>H. beccarii</i> shoot density, AG, BG and T biomass and 4 environmental variables (out of 16 analysed) at Sungai Kemaman. The value given is Pearson's correlation. * indicate significant level at $p < 0.05$ while the rest is at $p < 0.01$	249
8.1b	Summary of multiple correlation analysis between <i>H. beccarii</i> shoot density, AG, BG and T biomass and 9 environmental variables (out of 16 analysed) at Sungai Paka Lagoon. The value given is Pearson's correlation. * indicate significant level at $p < 0.05$ while the rest is at $p < 0.01$	250
8.1c	Summary of multiple correlation analysis between <i>H. beccarii</i> shoot density, AG, BG and T biomass and 4 environmental variables (out of 16 analysed) at Pengkalan Nangka Lagoon. The value given is Pearson's correlation. * indicate significant level at $p < 0.05$ while the rest is at $p < 0.01$	251
8.2	Comparison of shoot density of seagrass species	254
8.3	Comparison of biomass of seagrass species. AG-above ground, BG-below ground and T-total biomass	260
9.1a	Total monthly rainfall (mm) variation within-year and between-year at Sungai Kemaman, Sungai Paka Lagoon and Pengkalan Nangka Lagoon	332
9.1b	Mean daily sunshine hours (h) variation within-year and between-year at Sungai Kemaman, Sungai Paka Lagoon and Pengkalan Nangka Lagoon	333
9.1c	Mean daily global radiation (MJm^{-2}) variation within-year and between-year at Sungai Kemaman, Sungai Paka Lagoon and Pengkalan Nangka Lagoon	334
9.1d	Mean air temperature ($^{\circ}\text{C}$) variation within-year and between-year at Sungai Kemaman, Sungai Paka Lagoon and Pengkalan Nangka Lagoon	335
9.1e	Mean water temperature ($^{\circ}\text{C}$) variation within-year and between-year at Sungai Kemaman, Sungai Paka Lagoon and Pengkalan Nangka Lagoon	336
9.1f	Mean salinity (ppt) fluctuation within-year and between-year during low tide at Sungai Kemaman, Sungai Paka Lagoon and Pengkalan Nangka Lagoon	337



Tables	Caption	Page
9.1g	Mean salinity (ppt) fluctuation within-year and between-year during high tide at Sungai Kemaman, Sungai Paka Lagoon and Pengkalan Nangka Lagoon	338
9.1h	Mean total suspended solids (mg/L) variation within-year and between-year at Sungai Kemaman, Sungai Paka Lagoon and Pengkalan Nangka Lagoon	339
9.1i	Mean sedimentation rate (mg/cm ² /day) variation within-year and between-year at Sungai Kemaman, Sungai Paka Lagoon and Pengkalan Nangka Lagoon	340
9.2a	Mean water pH variation within-year and between-year at Sungai Kemaman, Sungai Paka Lagoon and Pengkalan Nangka Lagoon	341
9.2b	Mean nitrate (μM) in water variation within-year and between-year at Sungai Kemaman, Sungai Paka Lagoon and Pengkalan Nangka Lagoon	342
9.2c	Mean nitrite (μM) in water variation within-year and between-year at Sungai Kemaman, Sungai Paka Lagoon and Pengkalan Nangka Lagoon	343
9.2d	Mean ammonium (μM) in water variation within-year and between-year at Sungai Kemaman, Sungai Paka Lagoon and Pengkalan Nangka Lagoon. ud-undetectable	344
9.2e	Mean ortho-phosphate (μM) in water variation within-year and between-year at Sungai Kemaman, Sungai Paka Lagoon and Pengkalan Nangka Lagoon. ud-undetectable	345
9.3a	Mean substrate pH variation within-year and between-year at Sungai Kemaman, Sungai Paka Lagoon and Pengkalan Nangka Lagoon	346
9.3b	Mean total phosphorus (μM) in substrate variation within-year and between-year at Sungai Kemaman, Sungai Paka Lagoon and Pengkalan Nangka Lagoon	347
9.3c	Mean total organic nitrogen (μM) in substrate variation within-year and between-year at Sungai Kemaman, Sungai Paka Lagoon and Pengkalan Nangka Lagoon	348
10a	Abundance (mean no. m ⁻² ± s.e.) of male, female flowers, fruit and seed of <i>H. beccarii</i> from February 1996 to January 1999 at Sungai Kemaman, Terengganu	349
10b	Abundance (mean no. m ⁻² ± s.e.) of male, female flowers, fruit and seed of <i>H. beccarii</i> from June 1996 to January 1999 at Sungai Paka Lagoon, Terengganu	350

Tables	Caption	Page
10c	Abundance (mean no. $m^{-2} \pm s.e.$) of male, female flowers, fruit and seed of <i>H. beccarii</i> from June 1997 to January 1999 at Pengkalan Nangka Lagoon, Kelantan	351
11a	Abundance (mean no. $m^{-2} \pm s.e.$) of <i>H. beccarii</i> seedling and seed from February 1996 to January 1999 at Sungai Kemaman, Terengganu	352
11b	Abundance (mean no. $m^{-2} \pm s.e.$) of <i>H. beccarii</i> seedling and seed from June 1996 to January 1999 at Sungai Paka Lagoon, Terengganu	353
11c	Abundance (mean no. $m^{-2} \pm s.e.$) of <i>H. beccarii</i> seedling and seed from June 1997 to January 1999 at Pengkalan Nangka Lagoon, Kelantan	354
12a	Continuous pattern of mean shoot density (no. m^{-2}) and mean AG, BG and T biomass (g DW m^{-2}) at Sungai Kemaman, Terengganu	355
12b	Periodic pattern of mean shoot density (no. m^{-2}) and mean AG, BG and T biomass (g DW m^{-2}) at Sungai Paka Lagoon, Terengganu	356
12c	Periodic pattern of mean shoot density (no. m^{-2}) and mean AG, BG and T biomass (g DW m^{-2}) at Pengkalan Nangka Lagoon, Kelantan	357
13	AG to BG biomass ratio of <i>H. beccarii</i> at Sungai Kemaman, Sungai Paka Lagoon and Pengkalan Nangka Lagoon. * Absence of plants	358

LIST OF FIGURES

Figures	Caption	Page
1.1	The morphology of <i>Halophila</i> leaves. a. <i>H. ovalis</i> , <i>H. minor</i> , <i>H. decipiens</i> (though different in size, structure) with simple paired leaves. b. <i>H. beccarii</i> has rosette of 4-12 leaves. c. <i>H. spinulosa</i> has a compound leaf. All figures are actual size of seagrass	7
1.2	The geographical distribution of <i>H. beccarii</i> in the Indo-west Pacific region between Tropic of Cancer and the Equator covering countries; 1-India, 2-Sri Lanka, 3-Myanmar, 4-Thailand, 5-Vietnam, 6-Hong Kong, 7-Philippines, 8-Siagapore, 9-Malaysia	9
2.1	Location map of <i>H. beccarii</i> in Peninsular Malaysia. Area 1-Sungai Kemaman, Chukai, Telaga Simpul (see Fig. 2.2a). Area 2-Sungai Paka Lagoon, Sungai Paka bridge/river bank of Sungai Paka, Sungai Paka shoal (see Fig. 2.2b). Area 3-Pengkalan Nangka Lagoon, Pengkalan Nangka shoal, Kampung Baru Nelayan/Kampung Sungai Tanjung, Pantai Baru Lagoon (see Fig. 2.2c). Area 4-Korea Island, Seberang Prai	22
2.2a	The sites of <i>H. beccarii</i> at K1-Sungai Kemaman, K2-Chukai and TS-Telaga Simpul, Terengganu	23
2.2b	The sites of <i>H. beccarii</i> at P1-Sungai Paka Lagoon, P2/P6-Sungai Paka bridge/river bank of Sungai Paka and P3/P4/P5-Sungai Paka shoal, Terengganu	24
2.2c	The sites of <i>H. beccarii</i> at PN1-Pengkalan Nangka Lagoon, PN2-Pengkalan Nangka shoal, PN3/PN4-Kampung Baru Nelayan/Kampung Sungai Tanjung and PB1/PB2-Pantai Baru Lagoon, Kelantan	25
2.3	Percentage occurrence (%) of above and below ground of common gastropod (<i>Batillaria zonalis</i> and <i>Clithon oualaniensis</i>) and bivalve (<i>Diplodonta cumingii</i>) of <i>H. beccarii</i> meadow at Sungai Paka Lagoon, Terengganu	55
2.4a	Percentage occurrence (%) of above and below ground of common gastropod of <i>H. beccarii</i> meadow at Pengkalan Nangka Lagoon, Kelantan	60
2.4b	Percentage occurrence (%) of above and below ground of common bivalve of <i>H. beccarii</i> meadow at Pengkalan Nangka Lagoon, Kelantan	61
3.1a	Total monthly rainfall (mm) variation within-year and between-year at: A-Sungai Kemaman, B-Sungai Paka Lagoon, C-Pengkalan Nangka Lagoon. D-dry month, W-wet month	87

Figures	Caption	Page
3.1b	Mean daily sunshine hours (h) variation within-year and between-year at: A-Sungai Kemaman, B-Sungai Paka Lagoon, C-Pengkalan Nangka Lagoon. D-dry month, W-wet month	91
3.1c	Mean daily global radiation (MJm^{-2}) variation within-year and between-year at: A-Sungai Kemaman, B-Sungai Paka Lagoon, C-Pengkalan Nangka Lagoon. D-dry month, W-wet month	92
3.1d	Mean air temperature ($^{\circ}\text{C}$) variation within-year and between-year at: A-Sungai Kemaman, B-Sungai Paka Lagoon, C-Pengkalan Nangka Lagoon. D-dry month, W-wet month	94
3.1e	Mean water temperature ($^{\circ}\text{C}$) variation within-year and between-year at: A-Sungai Kemaman, B-Sungai Paka Lagoon, C-Pengkalan Nangka Lagoon. D-dry month, W-wet month	95
3.1f	Mean salinity (ppt) fluctuation within-year and between-year at: A-Sungai Kemaman, B-Sungai Paka Lagoon, C-Pengkalan Nangka Lagoon, ...low tide, __high tide, D-dry month, W-wet month	97
3.1g	Mean total suspended solids (mg/L) variation within-year and between-year at: A-Sungai Kemaman, B-Sungai Paka Lagoon, C-Pengkalan Nangka Lagoon, D-dry month, W-wet month	98
3.1h	Mean sedimentation rate ($\text{mg}/\text{cm}^2/\text{day}$) variation within-year and between-year at: A-Sungai Kemaman, B-Sungai Paka Lagoon, C-Pengkalan Nangka Lagoon, D-dry month, W-wet month	100
3.2a	Mean water pH variation within-year and between-year at: A-Sungai Kemaman, B-Sungai Paka Lagoon, C-Pengkalan Nangka Lagoon	102
3.2b	Mean nitrate (μM) in water variation within-year and between-year at: A-Sungai Kemaman, B-Sungai Paka Lagoon, C-Pengkalan Nangka Lagoon	104
3.2c	Mean nitrite (μM) in water variation within-year and between-year at: A-Sungai Kemaman, B-Sungai Paka Lagoon, C-Pengkalan Nangka Lagoon	106
3.2d	Mean ammonium (μM) between-year at: A-Sungai Kemaman, B-Sungai Paka Lagoon, C-Pengkalan Nangka Lagoon	107
3.2e	Mean ortho-phosphate (μM) in water variation within-year and between-year at: A-Sungai Kemaman, B-Sungai Paka Lagoon, C-Pengkalan Nangka Lagoon	109

Figures	Caption	Page
3.3a	Mean substrate pH variation within-year and between-year at: A-Sungai Kemaman, B-Sungai Paka Lagoon, C-Pengkalan Nangka Lagoon	112
3.3b	Mean total phosphorus (μM) in substrate variation within-year and between-year at: A-Sungai Kemaman, B-Sungai Paka Lagoon, C-Pengkalan Nangka Lagoon	114
3.3c	Mean total organic nitrogen (μM) in substrate variation within-year and between-year at: A-Sungai Kemaman, B-Sungai Paka Lagoon, C-Pengkalan Nangka Lagoon	116
3.4	The geographical distribution of <i>H. beccarii</i> (India-Partasarathy <i>et al.</i> , 1988a, 1991; Jagtap, 1991; Thailand-Lewmanomont <i>et al.</i> , 1996; Vietnam-van Tien, 1998; Hong Kong-Morton and Wu, 1975; Hodgkiss and Morton, 1978; Sarawak-den Hartog, 1970; Peninsular Malaysia-This Study) and the annual rainfall (The Times Atlas of the World, 1980; The ASEAN Climatic Atlas, 1982). • <i>H. beccarii</i> bed or meadow,  2000.00-3000.00 mm annual rainfall,  1000.00-1500.00 mm annual rainfall	118
6a	Abundance (mean no. $\text{m}^{-2} \pm \text{s.e}$) of male, female flowers, fruit and seed of <i>H. beccarii</i> from February 1996 to January 1999 at Sungai Kemaman, Terengganu. D-dry month, W-wet month	186
6b	Abundance (mean no. $\text{m}^{-2} \pm \text{s.e}$) of male, female flowers, fruit and seed of <i>H. beccarii</i> from June 1996 to January 1999 at Sungai Paka Lagoon, Terengganu. D-dry month, W-wet month	188
6c	Abundance (mean no. $\text{m}^{-2} \pm \text{s.e}$) of male, female flowers, fruit and seed of <i>H. beccarii</i> from June 1997 to January 1999 at Pengkalan Nangka Lagoon, Kelantan. D-dry month, W-wet month	191
7a	Abundance (mean no. $\text{m}^{-2} \pm \text{s.e}$) of <i>H. beccarii</i> seedling (left Y axis) and seed (right Y axis) from February 1996 to January 1999 at Sungai Kemaman, Terengganu	218
7b	Abundance (mean no. $\text{m}^{-2} \pm \text{s.e}$) of <i>H. beccarii</i> seedling (left Y axis) and seed (right Y axis) from June 1996 to January 1999 at Sungai Paka Lagoon, Terengganu	219
7c	Abundance (mean no. $\text{m}^{-2} \pm \text{s.e}$) of <i>H. beccarii</i> seedling (left Y axis) and seed (right Y axis) from June 1997 to January 1999 at Pengkalan Nangka Lagoon, Kelantan	220

Figures	Caption	Page
8.1	Sungai Kemaman: a. Continuous pattern of mean shoot density (no. m ⁻² , left Y axis) and mean AG, BG and T biomass (g DW m ⁻² , right Y axis). b. Mean air temperature (°C) correlated with mean shoot density, AG, BG and T biomass. c. Mean daily global radiation (MJm ⁻²) correlated with mean shoot density and AG biomass. d. Mean salinity (ppt) correlated with mean shoot density, AG, BG and T biomass	238
8.2	Sungai Paka Lagoon: a. Periodic pattern of mean shoot density (no. m ⁻² , left Y axis) and mean AG, BG and T biomass (g DW m ⁻² , right Y axis). b. Mean daily sunshine hours (h) correlated with mean shoot density, AG, BG and T biomass. c. Mean water temperature (°C) correlated with mean shoot density, AG, BG and T biomass. d. Mean total phosphorus (µM) in substrate correlated with mean shoot density, AG, BG and T biomass	239
8.3	Pengkalan Nangka Lagoon: a. Periodic pattern of mean shoot density (no. m ⁻² , left Y axis) and mean AG, BG and T biomass (g DW m ⁻² , right Y axis). b. Mean daily sunshine hours (h) correlated with mean shoot density, AG, BG and T biomass. c. Mean substrate pH correlated with mean shoot density, AG and T biomass. d. Mean total organic nitrogen (µM) in substrate correlated with mean shoot density, AG, BG and T biomass	241
8.4	AG to BG biomass ratio of <i>H. beccarii</i> . a. Sungai Kemaman (February 1996 to January 1999). b. Sungai Paka Lagoon (June 1996 to January 1999). c. Pengkalan Nangka Lagoon (June 1997 to January 1999). D-dry month, W-wet month	244
8.5a	Relationship between log ₁₀ mean AG, BG and T biomass (mg DW m ⁻²) and log ₁₀ mean shoot density (no. m ⁻²) of <i>H. beccarii</i> at Sungai Kemaman from February 1996 to February 1997	246
8.5b	Relationship between log ₁₀ mean AG, BG and T biomass (mg DW m ⁻²) and log ₁₀ mean shoot density (no. m ⁻²) of <i>H. beccarii</i> at Sungai Paka Lagoon from June 1996 to January 1999	247
8.5c	Relationship between log ₁₀ mean AG, BG and T biomass (mg DW m ⁻²) and log ₁₀ mean shoot density (no. m ⁻²) of <i>H. beccarii</i> at Pengkalan Nangka Lagoon from June 1997 to January 1999	248
8.6	Relationship between log ₁₀ mean AG and BG biomass (mg DW m ⁻²) of <i>H. beccarii</i> at Sungai Kemaman, Sungai Paka Lagoon and Pengkalan Nangka Lagoon	269
9.1	Stages in life cycle of annual <i>H. beccarii</i> at Sungai Paka Lagoon and Pengkalan Nangka Lagoon	281
4c	Sketch of Markham apparatus	326

LIST OF PLATES

Plates	Caption	Page
2.1	10 x 10 cm and 5 cm depth block cut by the sides and lifted from the substrate	27
2.2	Sungai Kemaman: <i>Halophila beccarii</i> occupying the middle intertidal to upper intertidal area covered by sediment and under the exposure to air and sun during day low spring tide	33
2.3	Chukai: <i>Halophila beccarii</i> patches grow on the sandy substrate at the middle intertidal to upper intertidal area of Kemaman river bank, the patches receive direct domestic sewage and effluents from the town centre	33
2.4	Telaga Simpul: <i>Halophila beccarii</i> grows among the pneumatophores of <i>Sonneratia griffithii</i> and under the exposure to air and sun during the day lowest spring tide	35
2.5a	Sungai Paka Lagoon: Visible <i>H. beccarii</i> patches in the middle intertidal area and under the exposure to air and sun during the day low spring tide	35
2.5b	Sungai Paka Lagoon: <i>Halodule pinifolia</i> (A) started to colonize the <i>H. beccarii</i> (B) bed in May 1998	36
2.6a	Sungai Paka bridge/river bank of Sungai Paka: <i>Halophila beccarii</i> grows in the mudflat area among the pneumatophores of <i>Sonneratia caseolaris</i> and <i>Nypa fruticans</i> clumps	36
2.6b	Sungai Paka bridge/river bank of Sungai Paka: The mud was dry and flaky during drier month of January 1997	38
2.6c	Sungai Paka bridge/river bank of Sungai Paka: Browning of <i>H. beccarii</i> leaves leading to death as observed during the drier month of January 1997	38
2.7a	Sungai Paka shoal: The monospecific meadow of <i>H. beccarii</i> inhabiting the centre of the shoal on sandy muddy substrate	39
2.7b	Sungai Paka shoal: <i>Modiolus senhausii</i> usually grows beneath the <i>H. beccarii</i> meadow at the centre of the shoal	39
2.8a	Pengkalan Nangka Lagoon: <i>Halophila beccarii</i> grows as an extensive dense monospecific meadow on sandy substratum	40
2.8b	Pengkalan Nangka Lagoon: In the upper intertidal area dense <i>H. beccarii</i> coexists with seaside grass, <i>Fimbristylis dichotoma</i>	40