UNIVERSITI PUTRA MALAYSIA

BIOLOGICAL STUDIES ON SONNERATIA CASEOLARIS OBTAINED FROM THE SELANGOR RIVER, PENINSULAR MALAYSIA

LOO KHAI KIN.

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BIOLOGICAL STUDIES ON *SONNERATIA CASEOLARIS* OBTAINED FROM THE SELANGOR RIVER, PENINSULAR MALAYSIA

By

LOO KHAI KIN

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

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DEDICATION

This master thesis is especially dedicated to the following most patient persons in my life who made the impossible, possible.

My parents,

sisters and my wife.

Thank to God.

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

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Chairman : Misri Kusnan, PhD

Faculty : Science

Sonneratia caseolaris is a display tree for fireflies in Kuala Selangor. Fireflies has become a tourist attraction to this area and contribute to the economy of the people related to the industry. *S. caseolaris* trees are found in abundance in certain sections along the Selangor river which are influenced by both freshwater from the upperstream and seawater during high tide.

Analysis of the important elements in the plants showed that the nitrogen content in the sediment, branches and leaves were 1.50 ± 0.05 mg/g, 5.62 ± 0.14 mg/g and 22.79 ± 1.08 mg/g, respectively. The soil nitrogen content was decreasing from the upper stream to the seaward sites. The nitrogen content of the leaves of *S. caseolaris* grown in the upper stream was higher than those of trees grown in the seaward sites. The phosphorus content in the sediment, branches and leaves were 1.02 ± 0.03 mg/g, 0.258 ± 0.01 mg/g and 0.58 ± 0.03 mg/g, respectively. The phosphorus content in the leaves of trees at the upper stream was higher than those of the seaward sites. The potassium content in sediment, branches and leaves were 9.27 ± 0.31 mg/g, 14.69 ± 0.58 mg/g and 31.85 ± 1.10 mg/g, respectively. The distribution of

potassium was more at the seaward sites and to a lesser extent at the upper stream. However, the potassium concentration in leaves grown at the upper stream was higher than the seaward sites. These results suggest the influence of water movement in distributing nutrients to the *S. caseolaris* habitat along the Selangor river system.

S. caseolaris produced large numbers of fruits that may contain over a thousand seeds per fruit of which around 90% are viable. Seed germination seems to be the only way of propagation of this plant. Laboratory studies showed that high salinity inhibited the germination seeds of *S. caseolaris*. The inhibition was proportional with the salinity. Only about 2% of the seeds germinated in seawater. The present study also showed that salinity affected the stem height of the seedlings. The stem height was reduced at 13.0 and 26.0‰ salinity. The xylem, pith cells, parenchyma cells of the cortex and air spaces of the stem seedlings were also smaller than the stem of the seedlings treated at lower salinity (0 - 6.5‰). The shape of leaves grown under high salinity (13.0 and 26.0‰) were more rounded and the leaves of the seedlings grown under low salinity (0, 3.3 and 6.5‰) were longer. The leaf mesophyll and the parenchyma cells of the seedlings exposed to high salinity (13.0 and 26.0‰) were also smaller than the seedlings exposed to low salinity (0 - 6.5‰). The increase of salinity had resulted in the increase of the vapor pressure deficit, which on the other hand, reduced transpiration and stomata conductance.

This study also showed that suspended solids and inundation levels may influence the growth of the seedlings. The stem height, total and average leaf area, length and width of the leaf and root fresh weight and internal structure of the seedlings were varied with the levels of suspended solids and the inundation level.

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

BEBERAPA KAJIAN BIOLOGI TENTANG *Sonneratia caseolaris* YANG DIDAPATI DARI SUNGAI SELANGOR, SEMENANJUNG MALAYSIA

oleh

LOO KHAI KIN

Oktober 2005

Pengerusi : Misri Kusnan, PhD

Fakulti : Sains

Sonneratia caseolaris adalah pokok kediaman untuk kelip-kelip di Kuala Selangor. Kelip-kelip telah menarik pelancong ke tempat ini dan memberi sumbangan kepada ekonomi kepada penduduk ang berkaitan dengan industri ini. Pokok *S. caseolaris* boleh dijumpai dengan banyak di beberapa kawasan sepanjang Sungai Selangor yang dipengaruhi oleh air tawar dari hulu sungai dan air masin dari hilir sungai.

Analisis elemen penting dalam pokok menunjukkan kandungan nitrogen dalam sedimen, dahan dan daun adalah 1.50 ± 0.05 mg/g, 5.62 ± 0.14 mg/g and 22.79 ± 1.08 mg/g. Kandungan nitrogen tanah didapati semakin berkurangan dari hulu ke hilir sungai. Kandungan nitrogen dalam daun *S. caseolaris* yang tumbuh di hulu sungai adalah lebih tinggi dari di hilir sungai. Kandungan fosforus dalam sedimen, dahan dan daun adalah 1.02 ± 0.03 mg/g, 0.258 ± 0.01 mg/g and 0.58 ± 0.03 mg/g. Kandungan fosforus dalam daun pokok di hulu sungai adalah lebih tinggi dari hilir sungai. Kandungan kalium dalam sedimen, dahan dan daun adalah 9.27 ± 0.31 mg/g, 14.69 ± 0.58 mg/g and 31.85 ± 1.10 mg/g. Penyebaran kalium dalam sedimen adalah lebih di kawasan hilir sungai. Walaubagaimanapun, kandungan kalium dalam daun

bertumbuh di hulu sungai adalah lebih dari di hilir sungai. Keputusan ini mencadangkan adanya pengaruh pergerakan air dalam penyebaran nutrien di kawasan pertumbuhan *S. caseolaris* di sepanjang Sungai Selangor.

S. caseolaris mengeluarkan banyak buah yang mengandungi sehingga seribu biji dalam satu buah dan 90% adalah biji boleh bercambah. Percambahan adalah satu-satunya cara bagi pokok ini membiak. Kajian makmal menunjukkan saliniti yang tinggi akan menyekat percambahan biji *S. caseolaris.* Sekatan ini berhubungkait dengan saliniti. Hanya 2% biji bercambah dalam air laut. Kajian ini juga menunjukkan saliniti mempengaruhi tinggi pokok. Pokok adalah rendah dalam saliniti 13.0 dan 26.0‰. Xilem, sel pith, sel parenkima dalam korteks dan ruang kosong dalam batang pokok ini adalah lebih kecil dari pokok hidup dalam 0 - 6.5‰. Bentuk daun bertumbuh dalam saliniti tinggi (13.0 dan 26.0‰) adalah lebih bulat, manakala bertumbuh dalam saliniti rendah (0-6.5‰) adalah lebih panjang. Mesofil dan parenkima dalam daun bertumbuh dalam saliniti tinggi (13.0 dan 26.0‰) adalah lebih kecil dari salinti rendah (0 - 6.5‰). Penambahan saliniti akan meninggikan tekanan wap defisit tetapi mengurangkan fotosintesis, transpirasi dan rintangan stomata.

Kajian ini juga menunjukkan pepejal terampai dan tahap rendaman mungkin mempengaruhi pertumbuhan anak pokok. Tinggi, jumlah dan purata luas daun, panjan dan lebar daun, berat basah akar dan struktur dalaman dalam anak pokok adalah berlainan dalam kepekatan pepejal terabung dan tahap rendaman yang berlainan.

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I certify that an Examination Committee met on 6 October 2005 to conduct the final examination of Loo Khai Kin on his master thesis entitled "Biological Aspects of *Sonneratia caseolaris* in Kuala Selangor" 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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27 DEC 2005

This thesis submitted to the Senate of Universiti Putra Malaysia and has been accepted as fulfilment of the requirement for the degree of Master of Science. The members of the Supervisory Committee are as follows:

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Date: 12 JAN 2006

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 not been previously or concurrently submitted for any other degree at UPM or other institutions.

LOO KHAI KIN

Date: 5.12.05

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ha	Hectare
%	Percent
‰	Part per thousand
kg	Kilogram
km	Kilometer
L	Liter
m	Meter
mg	Milligram
mm	Millimeter
^0C	Degree Celsius
mM	MilliMolar
NaCl	Sodium chlorite
μmol	MicroMolar
CO_2	Carbon dioxide
s	second

CHAPTER 1

INTRODUCTION

Mangrove plants are salt tolerant plants of tropical and subtropical intertidal regions of the world, which are under regular or occasional inundation by water of riverine, estuaries or oceanic origin (Hamilton and Snedaker, 1984; Lacerda, 1998). Mangrove plants are well known to be resistant to high salinity and waterlogged conditions. They are also able to tolerate high concentration of nutrients and heavy metals (Chen *et al.*, 1995).

Lacerda *et al.* (1993) reported that there is a total area of 4,062,335 ha mangroves in America, whereas, there are 3,257,700 ha mangroves in Africa (Diop, 1993) and 6,877,600 ha in Asia (Saenger *et al.,* 1983). The highest species diversity occurs in Asia with a total of more than 70 species recorded, followed by 20-30 species in Africa. Among 70 species of true mangrove plant, 65 of them contribute significantly to the structure of mangrove forests. Approximately 40 of these species found in Southeast Asia, about 15 species are found in African and 10 species in America (Fields, 1995). Kitamura *et al.* (1997) had recorded 27 species of true mangroves in Bali and Lombok, Indonesia. In addition there were 1 species of mangrove fern, 1 species of palm, 2 species of mangrove shrub and 19 species coastal plants associated with the mangrove. Saberi (2000) had recorded seventeen species of true mangrove and seven species of sub-mangrove plants in the transition zone to dry land forest in *Rhizophora mucronata* dominated area in Sungai Pulai, Kukup and Sepang mangrove forest.

Mangroves play an important role in protection and stabilization of the coastal zone, nursery ground for a variety of economically important molluscs, crustaceans and fish and are sources of important products to coastal human populations in the form of timber, firewood and charcoal, chemicals, medicine and waterways for aquaculture (Lacerda, 1998) and sanctuary of wildlife. Mangroves have been used as venues for scientific research and educational activities (Department of Primary Industries, 1990). The mangrove ecosystem at Kuala Selangor is an example with such value in the country. Mangrove area at Kuala Selangor is unique for its fireflies, *Pteroptyx tener*, that became tourist attraction. They were observed in great numbers in selected *Sonneratia caseolaris* trees, which formed their important habitat.

As for socio-economic benefit of the tourism industry, it was reported that each boatman could earn about RM 360 to RM 640 per month in Kampung Kuantan. Of those visiting this area 68% were locals and 32% were foreigners. Of the foreigners, the highest numbers came from Japan, UK and other ASEAN countries (notably Singapore). Two thirds of all visitors came to know of the fireflies though word of mouth (PE Research Sdn. Bhd., 2001).

In Kuala Selangor the largest populations of *Sonneratia caseolaris* are found between Kampung Lanun and Batu Lapan about 24 kilometers along the Selangor river. *Sonneratia caseolaris* vegetation spread out in low salinity along the river. *Metroxylon sago*, *Nypa fruticans*, and *Acanthus ilicifolius* are also spread out in low salinity and associated with *S. caseolaris*.

However, the mangrove area worldwide, including in Kuala Selangor, Malaysia are decreasing naturally or anthropogenically. There are a number of factors leading to the degradation of mangrove ecosystem, such as climate (Galloway, 1982), water temperature (Galloway, 1982), tides (Chapman, 1976; Fields, 1995), wave action (Fields, 1995), salinity (Chapman, 1976; Fields, 1995), soil composition (Chapman, 1976; Fields, 1995), accretion rate (Chapman, 1976), soil aeration (Chapman, 1976) and animal biota (Chapman, 1976; Fields, 1995). With the growing population and changing technology, there is increasing pressure to develop mangrove areas for residential, commercial, agricultural and recreational purposes. For example, during the Cultural Revolution of the 1960s large areas of mangroves were destroyed along the coast of southern China and replaced by paddy fields for growing rice (Field, 1995). The reclaimed land proved unsuitable and today much of it lies derelict. In Thailand and the Philippines large areas of mangroves have been converted to fish and shrimp ponds for commercial production. In Kalimantan, mangroves have been chipped for paper production. In other countries e.g. Thailand, mangroves have been destroyed for mining, port construction and replacement agriculture.

Dam building and sewage dumping are example of activities that can cause the increase of salinity seawards (Mastaller, 1997). Salinity play an important role on the growth of mangroves (Chapman, 1976; Field, 1995; Mastaller, 1997). Plants vary greatly in their tolerance to salinity (Hesse, 1971). The harmful effects of excess salts upon plant growth is partly due to a specific effect of certain ions and partly to the increase in osmotic pressure around the plant roots which inhibits water uptake (Hesse, 1971). These will affect the seed germination, growth and physiological parameter of the plants especially respiration, water balance and