UNIVERSITI PUTRA MALAYSIA

GROWTH AND PRODUCTION OF SEAGRASS *CYMODOCEA SERRULATA* (R. BR.) ASCHERS ET MAGNUS AND *THALASSIA HEMPRICHII* (EHRENB.) ASCHERS IN PORT DICKSON, NEGERI SEMBILAN, MALAYSIA

ABU HENA MUSTAFA KAMAL

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BY

ABU HENA MUSTAFA KAMAL

Thesis Submitted in Fulfillment of the Requirements for the Degree of Master of Science in the Faculty of Science and Environmental Studies Universiti Putra Malaysia

July 2000

Dedication to the Departure Memory of My Grandfather
And
Beloved Parents

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

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Chairman: **Dr. Misri bin Kusnan**

Faculty: **Science and Environmental Studies**

Seagrass is one of the valuable components which contribute significantly in coastal productivity and stabilizing sea floor sediments in the shallow marine water ecosystems. Investigation on the shoot density, biomass, leaf growth, leaf production and habitat of two seagrasses, *Cymodocea serrulata* and *Thalassia hemprichii*, in a sparse, mixed stand and monospecific patches of Batu Tujuh, Port Dickson coastal area Negeri Sembilan, Malaysia are reported. Shoot density and biomass of these species was detected by placing 20 x 20 cm quadrat. Leaf growth and production was detected by leaf marking method.

The mean shoot density was 950 ± 136.42 shoots/m^2 and 632.14 ± 113.77 shoots/m^2 for *C. serrulata* and *T. hemprichii*, respectively. Above ground biomass of *T. hemprichii* was lower (13.878 ± 1.173 g AFDW/m^2) when compared to those of *C. serrulata* (20.250 ± 4.053 g AFDW/m^2). The mean leaf growth of *C. serrulata* was higher (7.66 mm/shoot/day) compare to *T. hemprichii* (7.04 ± 1.35 mm/shoot/day). The present study indicates that the seagrass *C. serrulata* and *T. hemprichii* contributes a countable portion (0.961 ± 0.227 g AFDW/m^2/day for *C. serrulata* and 0.563 ± 0.172 g AFDW/m^2/day for *T. hemprichii*) of organic matter, together with

phytoplankton and macro algae, to the total primary production in Port Dickson marine water. Relative production rates (RPR) was 0.057 ± 0.014 g/g AFDW/day for *C. serrulata* and 0.058 g/g DW/day for *T. hemprichii*. This result indicated that *T. hemprichii* produce more organic matter daily than *C. serrulata* in this marine area. The plastochrone interval of *C. serrulata* leaves was higher (14.74 ± 1.89 days) than *T. hemprichii* (12.03 ± 1.01 days), whereas, short plastochrone interval of leaves (PIL) allows a faster plant response than the long PIL.

Dissolved oxygen and pH value of seawater of Batu Tujuh seagrass bed ranged between 7.8 – 8.8 mg/l and 8.0 – 8.5, respectively. The range of salinity and light intensity were 24.0-30.0 ppt and 25.0- 1805.2 μmol/m^2/s, respectively. Concentrations of nutrients were greater in pore water than overlying seawater of this seagrass bed.

Total nitrogen content of plant tissue varied between 0.349 ± 0.024 and 1.110 ± 0.067% of DW in *C. serrulata* and 0.195 ± 0.036 – 1.586 ± 0.041% of DW in *T. hemprichii*. Total phosphorus was highest in leaves (0.276 ± 0.022 – 0.377 ± 0.034% of DW), intermediate values in rhizomes (0.157 ± 0.004 – 0.196 ± 0.021% of DW) and lowest in roots (0.100 ± 0.004 – 0.114 ± 0.003% of DW). Potassium content was relatively higher in *C. serrulata* leaves (2.267 ± 0.058% of DW) and roots (2.20 ± 0.50% of DW) in *T. hemprichii*.

In situ photosynthesis varied at different depths. The highest rate of photosynthesis of both species was higher at 0.5 m depth than at 2.0 m and this could be attributed to relatively higher light intensity at depth of 0.5 m. The respiration rate remained uniform at different depths for both species. Experimental photosynthesis study showed that the light saturation was reached at 200 – 800 and 400–800 μmol/m^2/s for *C. serrulata* and *T. hemprichii*, respectively. The compensation light intensity was 20 – 40 μmol/m^2/s for *C. serrulata* and around 20 μmol/m^2/s for *T. hemprichii*. Comparing these results to *in situ* light measurements from the seagrass bed, it may be assumed that both seagrasses could penetrate deeper area in this seagrass bed. However, the photosynthesis produced at light intensity below 2.0 m depth (<108.33 ± 9.177 μmol/m^2/s for *C. serrulata* and <115 ± 1.512 μmol/m^2/s for *T. hemprichii*) probably could not support the requirement during dark period, albeit lower light compensation (20-40 μmol/m^2/s for *C. serrulata* and ± 20 μmol/m^2/s for *T. hemprichii*) showed in the experimental study.

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

PERTUMBUHAN DAN PENGELUARAN RUMPUT LAUT *CYMODOCEA SERRULATA* (R.Br.) ASCHERS ET MAGNUS DAN *THALASSIA HEMPRICHII* (EHRENB.) ASCHERS DI PORT DICKSON, NEGERI SEMBILAN, MALAYSIA

Oleh

ABU HENA MUSTAFA KAMAL

Julai 2000

Pengerusi : Dr. Misri Bin Kusnan

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Rumput laut adalah merupakan satu komponen penting yang menyumbang dengan signifikan pengeluaran persisiran pantai dan penstabilan dasar laut ekosistem pantai. Kajian terhadap kepadatan pucuk, biojisim, pertumbuhan daun, pengeluaran daun dan habitat dua rumput laut, *Cymodocea serrulata* dan *Thalassia hemprichii*, di satu kawasan terpencil, dirian bercampur dan tapak monospesifik telah dilakukan di kawasan persisiran pantai Batu Tujuh, Port Dickson, Negeri Sembilan, Malaysia. Kepadatan pucuk dan biojisim kedua-dua spesis telah ditentu menggunakan kuadrat 20 x 20 cm. Pertumbuhan dan pengeluaran daun telah ditentu menggunakan kaedah penanda daun.

Min kepadatan pucuk masing-masing bagi *C. serrulata* dan *T. hemprichii* ialah 950 ± 136.42 dan 632.14 ± 113.77 pucuk/m^2. Min biojisim *T. hemprichii* (13.878 ± 1.173 g Berat Kering Bebas Abu/m^2) adalah lebih rendah bila dibandingkan dengan *C. serrulata* (20.25 ± 4.05 g Berat Kering Bebas Abu/m^2). Min pertumbuhan daun *C. Serrulata* (7.66 mm/pucuk/hari) adalah lebih tinggi bila dibanding dengan *T. hemprichii* (7.04 ± 1.35 mm/pucuk/hari). Kajian ini menunjukkan rumput laut *C. serrulata* dan*T.*

hemprichii menyumbang sebahagian (0.961 ± 0.227 g Berat Kering Bebas Abu/m^2/hari bagi *C. serrulata* dan 0.563 ± 0.172 g Berat Kering Bebas Abu/m^2/hari bagi *T. hemprichii*) bahan organik, bersama-sama fitoplankton dan makro alga, kepada total pengeluaran primer di perairan marin Port Dickson. Kadar Pengeluaran Relatif (KPR) ialah 0.057 ± 0.014g/g Berat Kering Bebas Abu/hari bagi *C. serrulata* dan 0.058 Berat Kering Bebas Abu/hari bagi *T. hemprichii.* Keputusan tersebut menunjukkan *T. hemprichii* mengeluarkan lebih banyak bahan organik harian dari *C. serrulata* di kawasan marin yang sama. Selang plastokron daun *C. serrulata* adalah lebih tinggi (14.74 ± 1.89 hari) dari *T. hemprichii* (12.03 ± 1.01 hari), dimana, selang plastrokron daun pendek (SLP) merangsang pertumbuhan yang lebih pantas dari SLP panjang.

Nilai oksigen terlarut dan pH bagi air laut di kawasan rumput laut di Batu Tujuh dalam julat 7.8-8.8 mg/l dan 8.0-8.5. Julat kemasinan dan kekuatan cahaya masing-masing ialah 24.0-30.0 bahagian per seribu dan 25.0-1805.2 µmol/m^2/s. Kepekatan nutrien adalah lebih tinggi di dalam air tanah berbanding persekitaran air rumput laut di kawasan kajian.

Jumlah kandungan nitrogen tisu tumbuhan berbeza-beza antara 0.349 ± 0.024 dan 1.110 ± 0.067% berat kering bagi *C. serrulata* dan 0.195 ± 0.036-1.586 ± 0.041% berat kering bagi *T. hemprichii.* Nilai tertinggi fosforus didapati pada daun (0.276 ± 0.022-0.377 ± 0.034% berat kering) diikuti nilai perantaraan di rizom (0.157 ± 0.004-0.196± 0.021% berat kering) dan terendah (0.100 ± 0.004 – 0.114 ± 0.003% berat kering) di akar. Kandungan potassium adalah agak tinggi pada daun *C. serrulata* (2.267 ± 0.058% berat kering) dan akar *T. hemprichii* (2.20 ± 0.50% berat kering).

Fotosintesis *In situ* berbeza pada kedalaman berbeza. Kadar fotosintesis tertinggi bagi kedua-dua spesis ialah pada kedalaman 0.5 m dan ini mungkin disebabkan oleh kekuatan cahaya yang lebih tinggi pada kedalaman 0.5 m dari 2.0 m. Kadar respirasi adalah tetap pada kedalaman yang berbeza bagi kedua-dua spesis. Kajian fotosintesis mendapati ketepuan cahaya bagi *C. serrulata* ialah 200-800 $\mu mol/m^2/s$ dan *T. hemprichii* ialah 400-800 $\mu mol/m^2/s$. Kekuatan cahaya pampasan masing-masing bagi *C. serrulata* dan *T. hemprichii* ialah 20-40$\mu mol/m^2/s$ dan sekitar 20$\mu mol/m^2/s$. Berasaskan perbandingan keputusan ukuran cahaya ini dengan pengukuran *In situ* di tapak rumput laut, kedua-dua rumput laut ini mungkin berupaya menembus ke kawasan lebih dalam. Walau bagaimanapun, fotosintesis yang dihasilkan pada kekuatan cahaya melewati kedalaman 2 m ($<108.33 \pm 9.177$ $\mu mol/m^2/s$ bagi *C. serrulata* dan $< 115 \pm 1.512$ $\mu mol/m^2/s$ bagi *T. hemprichii*) berkemungkinan tidak berupaya menampung keperluan rumputlaut semasa tempoh gelap walhal nilai pampasan cahaya (20-40 $\mu mol/m^2/s$ bagi *C. Serrulata* dan 20 $\mu mol/m^2/s$ bagi *T. hemprichii*) diperolehi dalam kajian ini memadai keperluan tersebut.

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CHAPTER I

INTRODUCTION

Seagrasses are the pastures of the ocean and usually distributed in shallow soft or sandy bottom of estuaries and along the coastal margins of tropical, subtropical and temperate marine water. They are monocotyledon plants, which have numerous important ecological roles in the shallow marine water coasts, especially with regard to marine productivity (Figure 1).

Seagrasses are similar to flowering plants on terrestrial environment. Unlike marine algae they have roots systems to gain a foothold in drifting sand, which is subsequently stabilized. Due to the presence of extensive roots and rhizomes they are unique among the submerge marine and estuarine plants (Zieman, 1975a). They are able to adapt and survive in saline medium and able to withstand wave and tidal current. Besides this, they are also able to carry out hydrophilous pollination and seed dispersal when fully submerged (Arber, 1920; den Hartog, 1967, 1970).

The meadows of seagrass have been recognised as one of the richest and most productive marine ecosystems, reaching large biomass and being relatively long live components of coastal and estuarine ecosystems (Thayer *et al.*, 1977; Zieman and Wetzel, 1980). Their role in the cycling of essential elements (i.e. nitrogen and phosphorus) is important owing to their ability to accumulate these elements, affecting the nutrient turnover in these systems. The bed of seagrass is one of the most conspicuous and wide spread biotope types in the shallow marine environment throughout the world. A dense vegetation of seagrass produces a great quantity of organic material by itself and also offers a good substrate for epiphytic smaller algae, diatoms and sessile fauna. The vegetation acts as traps for sediment and minute suspended particles, both organic and inorganic are deposited in this biotope. However, in marine water it also creates unique microhabitats for small animals.

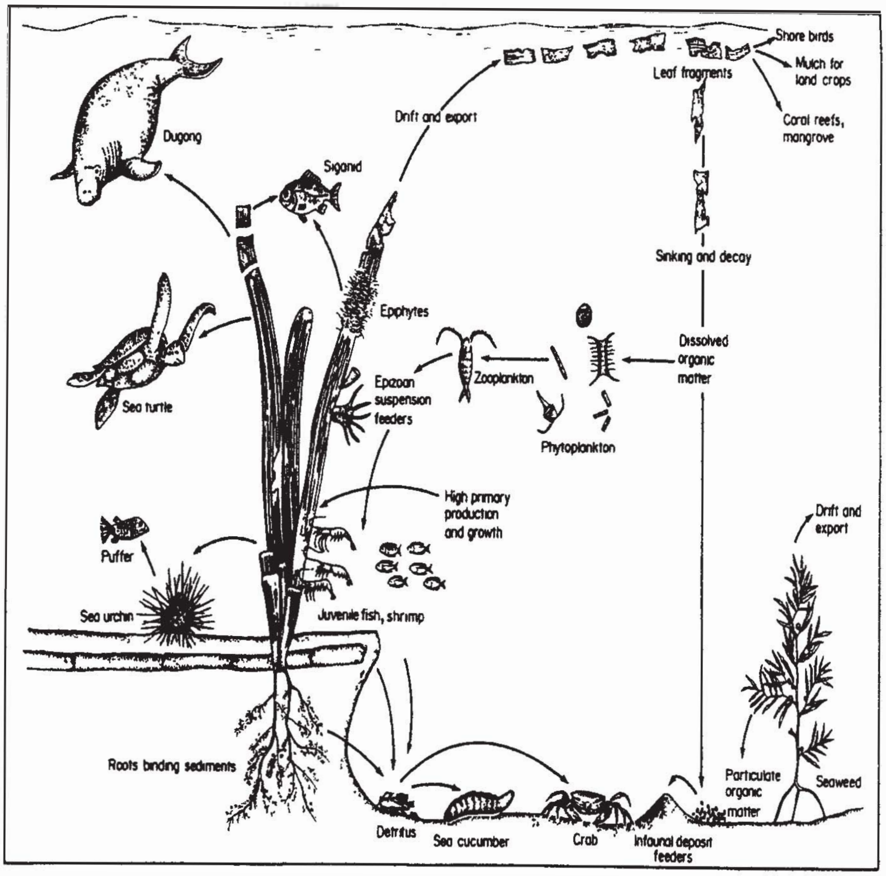

Figure 1. Seagrass ecosystem and their functions in a tropical marine environment (Fortes, 1990)

The contribution of seagrasses in the estuarine and marine ecosystems summarised by wood *et al.* (1969) are as follows: (1) seagrasses have high growth rate and high organic productivity; (2) they act as food for only limited number of organisms while living (like turtles, dugong and parrot fish etc.), but supply huge quantities of detrial materials to its resident microbes which provide a major food source for the estuarine ecosystem; (3) the leaves support large numbers of epiphytic organisms that create a favourable conditions and which are grazed extensively; (4) seagrass take part to sulphate reduction and maintains an activity of sulphur cycle in the estuarine sediments by providing organic matter; (5) the dense leaves promote sedimentation of organic and inorganic particles after reducing the current velocity near the sediment surface and (6) the roots and rhizomes bind the sediment together and with the additional protection given by the leaves, surface erosion in reduced.

In the past the significance of seagrasses for natural balance in shallow coastal waters has been grossly underestimated and has even been denied. Petersen (1918, In: Rasmussen, 1970) was the first to recognized the overall importance of seagrasses in the coastal ecosystems and in recent years it has become apparent that seagrasses contribute significantly to the maintenance of the coastal ecosystem of the tropics and near tropics in numerous way (Wood *et al.*, 1969; Zieman; 1974). Nowadays the conviction has grown that common plant with most productive in the ocean, as seagrasses must be of immense ecological importance. Consequently, "seagrass ecosystems" have become a popular focus for research (McRoy and McMillan, 1977).

The roles played by seagrass beds are diverse and economically significant in a number of ways. On the other hand, the marine resources of Malaysia greatly contribute to the national economy. Among the marine resources, seagrass ecosystems play an important role toward creating a good quality of marine environment. In this regard, the living marine resources as well as seagrasses are