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Preliminary Study of the Seagrass Flora of Sabah, Malaysia

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ABSTRAK

Suatu tinjauan terhadap komposisi, taburan serta biomas beberapa dataran rumput laut yang terdapat di sepanjang pantai Sabah telah dilakukan. Di dalam tinjauan ini, sejumlah enam genera yang terdiri daripada sembilan spesies rumput laut telah direkodkan. Lima daripada spesies tersebut iaitu Cymodocea rotundata *Ehrenb.* et *Hempr.* ex *Aschers.,* Cymodocea serrulata *(R. Br.) Aschers.* et *Magnus,* Halodule uninervis *(Forssk.) Aschers.,* Halodule pinifolia *(Miki) den Hartog dan* Syringodium isoetifolium *(Aschers.) Dandy yang belum pernah dilaporkan sebelum ini merupakan rekod baru bagi kawasan Sabah. Spesies yang kerap ditemui di stesen-stesen persampelan ialah* Halophila ovalis *(R. Br.) J.D. Hook dan diikuti oleh* Thalassia hemprichii *(Ehrenb.) Aschers. serta* Enhalus acoroides *(L.f.) Royle. Rumput laut telah diperhatikan wujud di kawasan intertidal sehingga ke kedalaman 2.5 m dan tumbuh di atas berbagai jenis substrat seperti pecahan karang, pasir dan pasir berlumpur. Walaupun taburannya tidak menunjukkan penzonan yang spesifik, namun terdapat dua zon yang boleh dibezakan berdasarkan spesies yang paling melimpah. Dataran rumput laut di Sabah juga di dapati menghasilkan biomas yang tinggi terutamanya habitat berlumpur yang membatasi kawasan pokok bakau (contohnya biomas total* E. acoroides *sehingga mencapai 468.5 g berat kering tanpa abu. m^{-2}). Sementara dataran rumput laut di sekitar pulau yang di luar pantai seperti Pulau Sipadan,* T. hemprichii *(biomas 146 g berat kering tanpa abu. m^{-2}) didapati merupakan pengeluar biomas yang utama.*

ABSTRACT

The species composition, distribution and the biomass of different seagrass beds along the coast of Sabah have been surveyed. Nine seagrass species belonging to six genera were recorded during the survey. Five of these i.e Cymodocea rotundata *Ehrenb.* et *Hempr.* ex *Aschers.,* Cymodocea serrulata *(R. Br.) Aschers.* et *Magnus,* Halodule uninervis *(Forssk.) Aschers.,* Halodule pinifolia *(Miki) den Hartog and* Syringodium isoetifolium *(Aschers.) Dandy have not previously been reported from this area, thus represent new records for Sabah. The most frequently encountered species at the sampling stations was* Halophila ovalis *(R. Br.) J.D. Hook followed by* Thalassia hemprichii *(Ehrenb.) Aschers and* Enhalus acoroides *(L.f.) Royle. Seagrasses were observed from intertidal zone down to 2.5 m depth on various substrate types such as coral rubble, sand to muddy-sand. There was no specific zonation in the distribution of seagrasses. However, two zones may be distinguished according to the most abundant species. The seagrass beds in Sabah were also found to produce very high biomass particularly in the muddy habitat bordering mangroves (e.g. total biomass* E. acoroides *amounted to 468.5 g AFDW m^{-2}). Among the seagrass beds around the off-shore islands such as Pulau Sipadan,* T. hemprichii *(146 g AFDW m^{-2}) was found to be a very important biomass contributor.*

INTRODUCTION

At least nine species of seagrasses are found in Malaysian waters (Fortes 1990). While information regarding recent local records of seagrass are available for the Malaysian Peninsula (Phang and Pubalan 1989), knowledge of the seagrasses in Sabah, however, is almost exclusively from the three previously reported species of *Halophila ovalis* (R. Br.) Hook. f., *Thalassia hemprichii* (Ehrenb.) Aschers. and *Enhalus acoroides* (L.*f.*) Royle (den Hartog 1970) collected from Labuan, Sandakan and Lahad Datu. Furthermore, no

direct studies on the local seagrass ecosystem have yet been done though it is an important habitat for coastal fishery resources. The objectives of this study were to survey for seagrass composition, their biomass and distribution along the coast of Sabah.

MATERIALS AND METHODS

Investigations on the seagrass ecosystem along the coast of Sabah were carried out from July 1991 to June 1992. *Fig. 1* depicts the geographical location of the study area. The composition and distribution of seagrass beds were studied by wading and snorkling; specimens were taken from near shore to a depth of about 1 - 2 m during low tides. The specimens were either dried and mounted or preserved in 4% formalin in seawater. The collections have been lodged with the Marine Science Museum of the Universiti Kebangsaan Malaysia (Sabah Campus). Nomenclature, at generic and specific level, follows den Hartog (1970).

At the sampling stations of Sg. Salut, Tanjung Mengayau, Bak-Bak and Pulau Sipadan, the seagrass distributions were studied along transects perpendicular to the coastline. The transects extended from the upper shore to the low water level and continued until only very similar communities were observed over a long distance. Samples containing the above and below ground parts of the seagrasses were also collected for biomass determination, using a PVC cylinder, height 1 m and surface area 0.02 m^2, placed vertically over the sampling plots. The plants were thoroughly rinsed in sea water and taken to the laboratory. They were then separated into seagrass species and soaked in 5% phosphoric acid to remove epiphytes and subsequently rinsed in tap water. The species were fractionated into leaves, shoots, rhizomes and roots. Leaves and shoots were regarded as aboveground biomass, rhizome and roots as belowground biomass. All samples were oven dried at 105°C to constant weight. The dry matter of samples of plant fractions were combusted at 550°C for 2h and weighed again to determine the ash content (Zieman and Wetzel 1980).

RESULTS AND DISCUSSION

Distribution of Seagrasses

During the present investigation, nine species of seagrasses belonging to six genera were identified from the coastal waters of Sabah (Table 1). The maximum number of seagrasses, except *Syringodium isoetifolium* (Aschers.) Dandy, were found in several beds in Sapangar Bay in the west coast. There were also large numbers of species present from a single seagrass meadow at Bak-Bak in the Sulu Sea. Dense meadows of seagrasses with one or two dominant species have also been located in the east coast. The finding of *Cymodocea rotundata* Ehrenb. *et* Hempr. *ex* Aschers., *Cymodocea serrulata* (R. Br.) Aschers. *et* Magnus, *Halodule uninervis* (Forssk.) Aschers., *Halodule pinifolia* (Miki) den Hartog and *S. isoetifolium* represents the first record for Sabah. This finding has brought to nine the total number of seagrass species presently known from this region.

From the nine species of seagrasses found in this survey, seven were widely distributed. The most frequently encountered species was *Halophila ovalis* (R. Br.) J.D. Hook. This species was followed, according to abundance, by *Thalassia hemprichii* (Ehrenb.) Aschers, *Enhalus acoroides* (L.*f.*) Royle, *C. rotundata*, *H. uninervis*, *H. pinifolia*, *C. serrulata*. The range of remaining species, *Halophila minor* (Zoll.) den Hartog and *S. isoetifolium*, were limited. *S. isoetifolium* was restricted to one site of Bak-Bak in Kudat. This species may also occur elsewhere; however, it was not observed in the course of this study. More extensive collections may reveal the true distribution of this species in Sabah.

Although *H. ovalis* was frequently encountered from the mid intertidal zone down to a depth of 1.5m, it was very sparse in the study areas. This species inhabited a range of substrates: fine, muddy sediments in mangrove lagoons as well as coarse sandy bottoms on reef flats. At Pulau Maganting and Pulau Tabawan reef flats, the plant occurred in a wide patch and was covered by sand. Different morphological types of this species were observed. Among them, the specimens from Pulau Sipadan and Pulau Maganting were larger with broad leaves.

T. hemprichii has been observed to grow from low water level to a depth of 2.5 m. A very large patch of almost pure stands occurred and formed the dominant seagrass species in the clear water around Pulau Sipadan and Pulau Bohay Dulang. The habitat at both localities was not uniform and consisted of patches of coral, coral sand and coarse sand. On the reef flat at Tanjung Mengayau, this species was frequently observed in association with algal beds

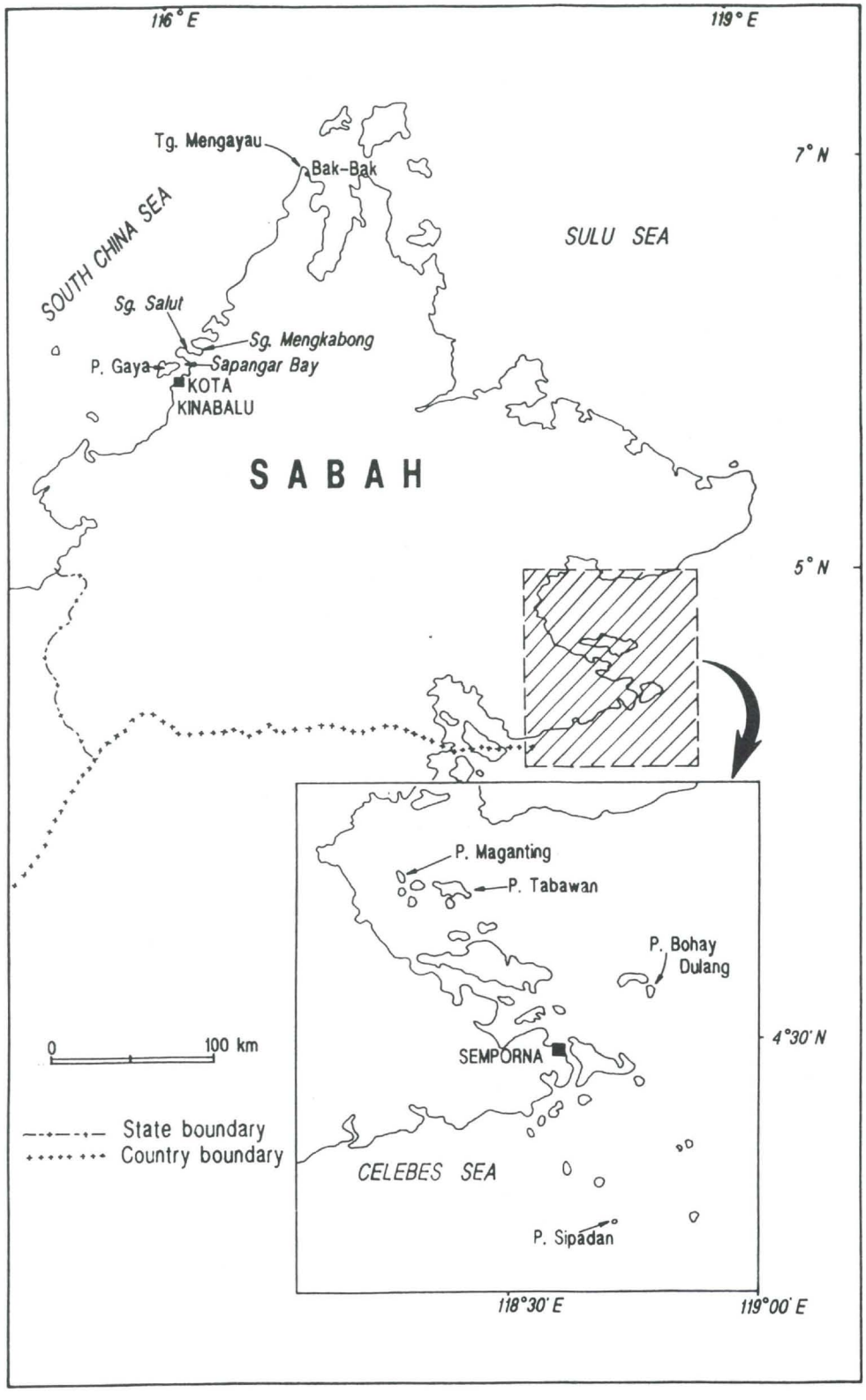

Fig. 1: Map of Sabah showing the study sites

TABLE 1

Distribution of seagrass species in different locations along the coast of Sabah, Malaysia

	Locality									
	1	2	3	4	5	6	7	8	9	10
Hydrocharitaceae										
Enhalus acoroides (L.*f.*) Royle	–	d	d	d	r	r	–	–	r	–
Halophila minor (Zoll.) den Hartog	–	r	–	–	–	–	r	r	–	–
Halophila ovalis (R. Br.) J.D. Hook.	r	c	c	r	r	r	c	c	r	r
Thalassia hemprichii (Ehrenb.) Aschers	r	c	c	r	d	d	d	–	d	d
Cymodoceaceae										
Cymodocea rotundata Ehrenb. *et* Hempr. *ex* Aschers.	–	c	c	–	r	r	–	r	–	c
Cymodocea serrulata (R. Br.) Aschers. *et* Magnus	–	r	r	–	c	c	–	–	–	–
Halodule uninervis (Forssk.) Aschers.										
Broad–leaved form	–	c	–	–	–	–	d	–	–	–
Narrow–leaved form	r	–	r	–	r	c	c	r	–	–
Halodule pinifolia (Miki) den Hartog	–	r	r	–	–	r	–	–	–	c
Syringodium isoetifolium (Aschers.) Dandy	–	–	–	–	–	c	–	–	–	–

Note: 1, Pulau Gaya; 2, Sapangar Bay; 3, Sungai Salut; 4, Sungai Mengkabong; 5, Tg. Mengayau; 6, Bak–Bak; 7, Pulau Maganting; 8, Pulau Tabawan; 9, Pulau Bohay Dulang; 10, Pulau Sipadan; –, not observed; r, rare; c, common; d, dominant

comprising *Sargassum* spp., *Hypnea* sp., *Acanthophora* sp. and *Gracilaria* spp. A patch of more than 100 m in diameter and exposed during low tide was found on a muddy sandy substrate of Sungai Salut and Sungai Mengkabong. This species was also recorded on a similar substrate type in Labuan by den Hartog (1970). Specimens with fruits and flowers were observed at Bak-Bak and Tanjung Mengayau on 16 February 1992.

E. acoroides beds were common in sheltered areas such as Sapangar Bay, estuaries of Sungai Salut and Sungai Mengkabong, from mid intertidal down to a depth of 2 m. Thick stands of the plants, with luxuriant growth of epiphytic algae, occurred on the sediments of fine mud rich in detrital materials in the turbid waters of mangrove lagoons of Sungai Mengkabong and Sungai Salut. At the seaward part of the lagoon, this species was found thriving on the shallow sandy substrate together with *C. rotundata*, *H. ovalis* and *T. hemprichii*. Specimens with flowers and fruit were collected from Sungai Mengkabong on 9 July 1991.

A pure and thick stand of *C. rotundata* community with a patch of more than 30 m diameter was present at Sungai Salut. It was found exposed at low tide on a muddy and fine sandy bottom. In Sapangar Bay, the species was frequently found interspersed in areas where *E. acoroides* and *T. hemprichii* occurred. Specimens of *C. rotundata* collected from deeper habitats were taller than those in shallow and exposed zones.

Two forms of *H. uninervis* were recorded in the present survey. The narrow-leaved form was widely distributed and frequently observed in the lower littoral and upper sublittoral of about 30 cm depth. Very dense growth occurred in a patch of > 8m in diameter on a sandy flat in Sapangar Bay and some were exposed during low tide. The wide-leaved form, however, was only found in Sapangar Bay and Pulau Maganting in the sublittoral of about 0.5 m. No flowering specimens were found.

A wide patch of about 10 m diameter of *H. pinifolia* was observed in the lower littoral and upper sublittoral zone in the north-east of Pulau Sipadan. It was found mixed with *C. rotundata* on coarse sandy substrates. At Bak-Bak, Kudat, occasional patches were found growing together with *H. uninervis*, and *S. isoetifolium* on coral sand under about 30 cm of water. In other localities it was rare.

C. serrulata was commonly found associated with *Thalassia* beds at Tanjung Mengayau on coarse sandy substrates and coral rubbles at depth < 30 cm. It was occasionally seen to occur at Bak-Bak, Sungai Salut and Sapangar Bay.

Other species such as *H. minor* and *S. isoetifolium* were not well distributed along the coast of Sabah. The species grew in the lower littoral and sublittoral down to about 1 m depth on sandy substrates. *H. minor* was also seen to inhabit the muddy bottom in Sapangar and formed pure beds.

Seagrass Distribution Along Transect

Fig (2a - d) illustrates the zonation of seagrass vegetation at 4 selected localities, distributed along transects perpendicular to the shoreline. In general, the most important area for seagrass was from the mid intertidal to upper subtidal zone where mixed vegetation of seagrass grow together. There was no specific zonation in the distribution of seagrasses. However, two zones may be distinguished according to the most abundant species. Zone 1 was characterized by the dominance of *C. rotundata* and *H. uninervis* (narrow-leaved form). These species occupied the intertidal zones and were well exposed at low tide and appeared brownish due to prolonged exposure to air and sun (Sungai Salut and Bak-Bak). The substrate on this zone is predominated by silt or fine sand and sometimes overlaid by soft to compacted mud. Other associated species, *H. ovalis* and *H. pinnifolia* may also be present in this zone (Tanjung Mengayau and Pulau Sipadan).

Zone 2, which extends from lower intertidal to upper subtidal areas was dominated by either *E. acoroides* or *T. hemprichii* depending on the habitat. In the sheltered area such as the Sungai Salut estuaries, where the substrates were composed of an upper layer of silt and mud overlying blackish coarse sand, *E. acoroides* was found to dominate and its roots could penetrate to a depth of 40 cm. Other seagrass species such as *H. ovalis*, *C. serrulata* and *H. uninervis* were also present but at a lower density. In the waved-exposed stations, where the substrates were sandy, coarse sand or coral rubbles, this zone was dominated by *T. hemprichii* (Tg. Mengayau and Pulau Sipadan). At Bak-Bak, *S. isoetifolium* and *C. serrulata* were also found to co-exist with equal density.

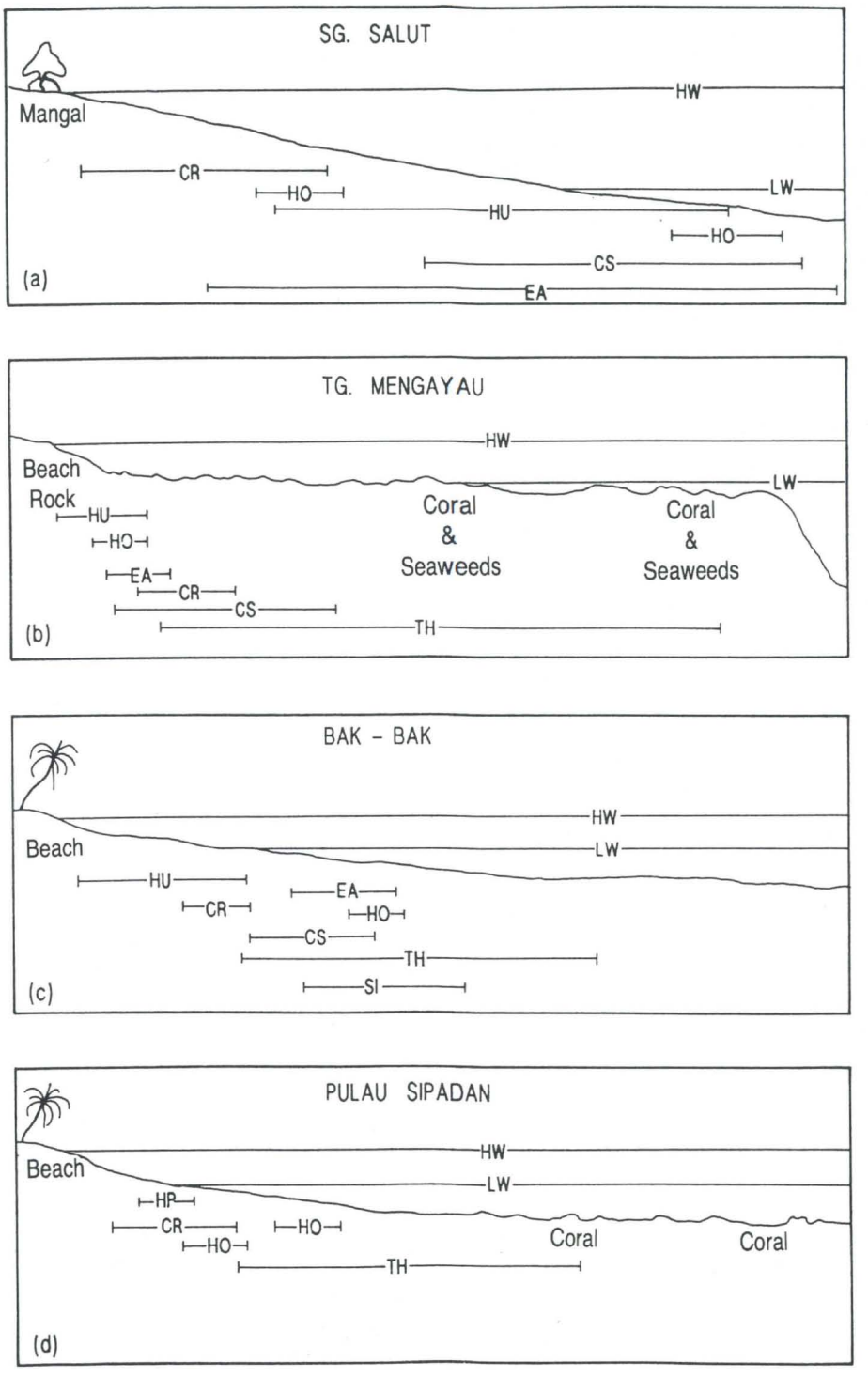

Fig. 2(a - d): Diagrammatic representation of the zonation pattern of seagrass vegetation along transects perpendicular to the shoreline at four different localities around Sabah. Approximate length of transects; Tg. Mengayau 300 m, Sg. Salut and Bak-Bak 200 m, P. Sipadan 150 m. Tidal amplitude (HW minus LW) approximately 1 - 2m. EA = Enhalus acoroides; *TH* = Thalassia hemprichii; *HO* = Halophila ovalis; *CS* = Cymodocea serrulata; *HU* = Halodule uninervis; *CR* = Cymodocea rotundata

TABLE 2

Biomass data of seagrass species in the quantitative samples (0.02 m^2) taken from Sg. Salut (23 - 25 Jan., 1992) and Pulau Sipadan (11 May, 1992)

Species	Locality	Type of vegetation	No. of samples	Mean AFDW gm^{-2} (± s.e.) AGB	BGB	Total	Ratio AGB : BGB
E. acoroides	Sg. Salut	Mixed	82	34.8± 3.5	433.8 ± 33.2	468.5± 33.7^{D}	1 : 12.5
C. rotundata	Sg. Salut	Pure stands	39	61.7± 4.5	144.5 ± 9.7	206.0± 12.9^{C}	1 : 2.3
C. rotundata	Sg. Salut	Mixed	30	17.2± 2.9	46.4 ± 8.1	63.6± 10.7^{B}	1 : 2.7
C. rotundata	P. Sipadan	Mixed	10	3.9± 1.8	11.4 ± 4.9	15.3± 6.6^{A}	1 : 2.9
C. serrulata	Sg. Salut	Mixed	24	6.8± 2.7	5.9 ± 2.1	12.8± 3.8^{A}	1 : 0.9
H. uninervis	Sg. Salut	Mixed	42	2.7± 0.4	6.9 ± 1.5	8.6± 1.4^{A}	1 : 2.6
H. ovalis	Sg. Salut	Mixed	13	0.6± 0.1	(entire plant)	0.6± 0.1^{A}	
T. hemprichii	P. Sipadan	Pure stands	10	34.7± 5.0	111.5 ± 16.2	146.2± 19.0^{B}	1 : 3.2

The values within the column with the same letter were not significantly different ($p < 0.05$) with the LSD Test.

Seagrass Biomass

No information is available on the biomass of seagrass in Sabah. The present studies on the biomass of leaves and shoot (above ground-biomass or AGB) as well as of rhizomes and roots (below-ground biomass or BGB), of seagrass species from Sg. Salut and Pulau Sipadan are shown in Table 2. Although biomass data for certain seagrass species from the Malaysian Peninsula are available (Mohd. Kusairi 1992), they may not be compared directly with the local data of this study, because different methods and data expression were used.

The results indicate that the seagrass beds particularly in the muddy habitat bordering mangroves were found to produce dense biomass. For example, the major biomass contributor in the habitat of Sungai Salut was *E. acoroides* (ANOVA), the largest seagrass species in the Indo-West Pacific (Table 2). This was followed by *C. rotundata* (pure stands and mixed vegetation). *E. acoroides* had a mean total (entire plant) biomass amounting to 468.5 g AFDW.m^{-2}, about 93% of which was contributed from its below-ground parts. However, this value is only 11.2% of the higher mean biomass of *E. acoroides* vegetation from the Flores Sea region (Nienhuis *et al.* 1989). The biomass of *C. rotundata* in pure stands was 206 g AFDW.m^{-2} which is comparable to the mean biomass (201 g AFDW. m^{-2}) of the species reported from Papua New Guinea (Brouns 1987). The largest proportion of the biomass values was attributed to the below-ground parts (about 70%). *C. rotundata* has a ratio of above-ground biomass (AGB) : below-ground biomass (BGB) of 1 : 2.3 in pure stands with the tendency of developing larger below-ground biomass in mixed vegetation (ratio 1: 2.7). *H. uninervis* studied from the mixed vegetation had a total biomass of 8.6 g AFDW. m^{-2}, with BGB about 3 times larger than AGB. Total biomass of *C. serrulata* and *H. ovalis* was 12.8 and 0.6 g AFDW.m^{-2}. These data of local *H. uninervis, C. serrulata* and *H. ovalis* are comparable to those for similar species from the Flores Sea, Indonesia (Nienhuis *et al.* 1989).

In contrast, the highest total biomass in the off-shore island of Pulau Sipadan in the Celebes Sea was recorded for *T. hemprichii* (146.2 g AFDW. m^{-2}). About 76% of the biomass of this species consisted of below-ground parts. The biomass of *C. rotundata* at this locality was significantly lower compared to that from Sg. Salut habitat (ANOVA). However, these data are within the observed range of those species from the Flores Sea, Indonesia (Nienhuis *et al.* 1989).

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