

Distribution of Seagrasses in Micronesia¹

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Six species of seagrasses have been reported previously from the Micronesian region based on collections from 16 islands and atolls (Fosberg, 1955, 1961, 1976; Moul, 1957; Stone, 1971; den Hartog, 1970, Sachet and Fosberg, 1973, and various other authors, included in the References Cited). The six species are *Halodule uninervis*, *Cymodocea rotundata*, *Enhalus acoroides*, *Thalassia hemprichii*, *Halophila minor* and *Halophila ovalis*.

During the past years, we have collected specimens of seagrasses from various islands and atolls in Micronesia, and now feel that a discussion of their distributional patterns within this region is appropriate. Three other species of seagrasses (*Thalassodendron ciliatum*, *Syringodium isoetifolium*, and *Cymodocea serrulata*) are reported here for the first time from Micronesia. Specimens reported are deposited in the Herbarium of the University of Guam Marine Laboratory (GUAM), U.S. National Herbarium (US), and other herbaria as indicated by Index Herbariorum symbols.

The senior author acknowledges the help extended by Dr. C. den Hartog in the identification of certain of the species in 1972. We are extremely grateful to Dr. C. McMillan for calling our attention to his and J. E. Vann's recent collection of *Cymodocea serrulata* from Palau, and permitting us to cite their specimen in this paper. The collection of this third new record of seagrass for Micronesia prompted the senior author to reevaluate his recent collections from Yap and resulted in the finding of other specimens of *C. serrulata*. We are grateful to both Drs. K. W. Bridges and C. McMillan for their constructive comments on the manuscript.

Family POTAMOGETONACEAE

Thalassodendron ciliatum (Forsk.) den Hartog

Zostera ciliata Forsk.

Cymodocea ciliata (Forsk.) Ehrenb. ex Aschers.

CAROLINES. PALAU: Kayangel Atoll, inner portion of northwest barrier reef,

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2–3 m deep, I–9–71, *R. T. Tsuda 4104* (GUAM, US); inner portion of north barrier reef, 1.2 m deep, I–17–76, *R. T. Tsuda 4779* (GUAM).

Syringodium isoetifolium (Aschers.) Dandy

Cymodocea isoetifolia Aschers.

CAROLINES. PALAU: northeast point of Urukthapel I., X–15–70, *R. T. Tsuda 3793* (GUAM, US); Kayangel Atoll, off Ngajangel Islet, 1 m deep, I–17–76, *R. T. Tsuda 5080* (GUAM). YAP: Pelak, inner reef mixed with *Enhalus acoroides*, 1–2 m deep, XI–25–70, *R. T. Tsuda 3975* (GUAM, US).

Halodule uninervis (Forsk.) Aschers.

Zostera uninervis Forsk.

Halodule australis Miq.

Diplanthera uninervis (Forsk.) Aschers.

MARIANAS. Marianas, reported by Ascherson (1871) and several later writers; Guam, reported by Stone (1971) and den Hartog (1970). GUAM: s.l., Dept. of Agr. by *J. G. [Guerrero ?]*, I–21–39 (US, BISH); s.l., X–1911, *R. C. McGregor 448* (US, BISH); east coast between Ylig and Togcha Bay, IV–7–46, *G. C. Moore 404* (US); Cocos Lagoon, *Emery 10703a* (AHFH); Pago Bay, *Eldredge & Cushing 684b* (GUAM); Pago Bay, *B. C. Stone 5148* (GUAM); Agafayan Bay, south of Inarajan, *B. C. Stone 4162* (GUAM); south of Agfayan Bay, reef flat slightly exposed at low tides, VII–2–46, *F. R. Fosberg 25322* (US, BISH, GUAM); Tarague Beach, small patches on sand bottom, 1 m deep, I–31–54, *F. R. Fosberg 35676* (US, BISH, GUAM, NY, L, P, TI); Pago Bay, inner reef flat, VI–13–73, *R. T. Tsuda 4654* (US, GUAM). SAIPAN: Susupe, *Kondo* in 1952 (BISH); Susupe, *Kondo & Bronson* in 1952 (BISH); Chalan Kanoa, coral sandy bottom, 1 m deep, II–22–50, *F. R. Fosberg 31759* (US, BISH, GUAM, NY); 1.6 km south of Chalan Kanoa, sandy area, .7 m deep, II–23–68, *R. T. Tsuda 1937* (GUAM); Papau Beach, sandy inner reef flat, 1 m deep, II–25–68, *R. T. Tsuda 1972* (GUAM, US); off Pt. Muchot in Tanapag Harbor, patch reef, 1 m deep, V–17–70, *R. T. Tsuda 3141* (GUAM); Garapan, inner reef flat near shore, .5 m deep, in *Enhalus acoroides* bed, V–18–70, *R. T. Tsuda 3197* (GUAM); Marpi Beach, inner reef flat near shore, .6–1 m deep, V–19–70, *R. T. Tsuda 3267* (GUAM).

CAROLINES. PALAU: east side of Urukthapel I., X–15–70, *R. T. Tsuda 3794* (GUAM, US).

Cymodocea rotundata Ehrenb. and Hempr. ex Aschers.

CAROLINES. Palau and Kusaie, reported by Hosokawa (1943); Palau and Ifaluk Atoll, reported by den Hartog (1970). PALAU: Babelthuap Island, Melekiok, tidal sand flat on fringing reef, IV–5–50, *F. R. Fosberg 32519* (US); Kayangel Atoll, ca. .6 km north of Ngajangel Islet, lagoon reef flat, .5 m deep, I–15–76, *R. T. Tsuda 5077a* (GUAM); Angaur Island, west coast south of phosphate works, dense turf on fringing reef exposed at extreme low tides, III–9/10–50, *F. R. Fosberg 31961* (US, BISH, GUAM). YAP: Gagil, 1.5 m deep, silty sand bottom, I–11–69, *M. V. C.*

Falanruw 1208 (GUAM, US). WOLEAI ATOLL: Wottagai Islet, dense sod with other species, in shallow water in front of lagoon beach, VIII-8-65, *F. R. Fosberg 47051* (US, BISH, GUAM); Falalis Islet, sod in shallow water in front of lagoon beach, VIII-8-65, *F. R. Fosberg 46975* (US, BISH, GUAM). IFALUK ATOLL: *D. P. Abbott & M. Bates 145* (US); Ifaluk Islet, in shallow water on sand bottom, VIII-13-65, *F. R. Fosberg 47238* (US, BISH, K). TRUK: Pis Islet, large beds in shallow water on fringing reef in lagoon, almost exposed at low tides, VI-3-46, *F. R. Fosberg 24632* (US, BISH, GUAM, NY); sandy substratum in boat harbor, 1 m deep, VI-17-70, *R. T. Tsuda 3468* (GUAM); Moen Island, west side in sandy mangrove area, .3 m deep, VI-18-70, *R. T. Tsuda 3507* (GUAM).

Cymodocea serrulata (R. Br.) Aschers. & Magnus

CAROLINES. PALAU: east side of Urukthapel I., in coral sand with *Halodule uninervis* and *Enhalus acoroides*, small protected harbor with rock wall (old Japanese boat dock), III-24-77, *C. McMillan 771* (US, GUAM, TEX). YAP: Colonia, off Yap Hospital, reef flat, .3 m deep, III-4-77, *R. T. Tsuda 5211* (US, GUAM, TEX).

Family HYDROCHARITACEAE

Enhalus acoroides (L. f.) Royle

Stratiotes acoroides L. f.

MARIANAS. Guam, reported by Merrill (1914) and several later writers. GUAM: s.l., *Mertens s.n.* (LE); *Guam Experiment Station 457* (US, BISH); *McGregor 544* (BISH); east coast between Ylig and Togcha Bays, 0.6 m deep, IV-7-46, *G. C. Moore 403* (US); Mana Bay, opposite Ypan, *B. C. Stone 4064* (GUAM); south of Agfayan Bay, reef flat slightly exposed at low tide, VII-2-46, *F. R. Fosberg 25323* (US, BISH, GUAM); Achang Bay, large beds in shallow water of lagoon, sandy mud bottom, I-30-54, *F. R. Fosberg 35663* (US, BISH, GUAM, NY, L, P); Nimitz Beach, IV-22-67, *R. T. Tsuda 1826* (GUAM); Pago Bay, inner reef flat, II-8-76, *R. T. Tsuda 4775* (GUAM). SAIPAN: Garapan Lagoon, opposite Gualo Rai, inner reef flat near shore, .5 m deep, V-18-70, *R. T. Tsuda 3199* (GUAM); offshore in harbor, IV-20-49, *P. E. Cloud s.n.* (US, BISH).

CAROLINES. Palau, reported by Abe (1937) and later writers; Yap, reported by Volkens (1901) and later writers; Truk, reported by Hosokawa (1937); Ponape, reported by Glassman (1952); Mokil, reported by Glassman (1953). PALAU: s.l., *Fehlmann* in 1955 (US); east coast of Babelthuap Island, Melekiok, tidal sand flat on fringing reef, IV-5-50, *F. R. Fosberg 32518* (US); Melekeal [Melekiok ?], VII-14-56, *B. C. Stone 1309-A* (BISH); east end of Urukthapel Island, 1-2 m deep, III-12-50, *F. R. Fosberg 32027* (US); on Neco's Island, *Halstead and Mote* in 1967 (GUAM); 400 m SSE of Arumaten Point on west side of Babelthuap Island, III-12-70, *R. T. Tsuda 3010* (GUAM, US). YAP: submerged 4 ft [1.2 m] at high tide, II-27-48, *C. C. Y. Wong 548* (US, BISH); Pelak, inner reef near shore, 1-2 m deep, XI-25-70, *R. T. Tsuda 3974* (GUAM, US). IFALUK ATOLL: in sandy margin of

lagoon, Fan Nap, IX-7-53, *D. P. Abbott & M. Bates 143* (US, BISH). TRUK: sandy bottom, tidal flats, submerged, IX-26-47, *C. C. Y. Wong 150* (US, BISH); Tol Island, muddy bottom, 1-1.5 m deep, V-24-46, *E. Y. Hosaka 2731* (US, BISH, GUAM, NY, L); Eten Island, inner reef flat in sandy area, 1 m deep, VI-20-70, *R. T. Tsuda 3516* (GUAM); Moen Island, Mwan Village, 1 m deep, V-69, *R. T. Tsuda 2855* (GUAM). PONAPE: Nanmatol Islet, Matalanim District, shallow lagoon bottom inside island, VIII-11-46, *F. R. Fosberg 26368* (US, BISH, GUAM, NY); Madolenihm, outer reef close to reef edge, VIII-22-68, *R. T. Tsuda 2353* (GUAM); Lauger Island, near seaplane ramp, *Dawson 14062* (US); vicinity of Colonia, *S. F. Glassman 2508* (BISH). KUSAIE: s.l., *Mertens s.n.* (LE); Iyara River, *T. Hosokawa 9445* (BISH).

Thalassia hemprichii (Ehrenb.) Aschers.

Schizotheca hemprichii Ehrenb.

Zostera marina sensu Gaudichaud, non L.

MARIANAS. Guam, reported by Stone (1971) but presence doubtful since no specimen has been collected to date.

CAROLINES. Yap, reported by Volkens (1901); Ifaluk Atoll and Satawal Atoll, reported by den Hartog (1970); Pingelap and Kusaie, reported by St. John (1948 a & b); Truk, reported by Hosokawa (1937). PALAU: east coast of Babelthuap Island, Melekiok, tidal sand flat on fringing reef, IV-5-50, *F. R. Fosberg 32517* (US); 400 m SSE of Arumaten Point, west side of Babelthuap Island, inner reef flat, III-12-70, *R. T. Tsuda 3012* (GUAM); Melekeal [Melekiok?], VII-14-56, *B. C. Stone 1309-B* (BISH); Ng'edobel Island, reef flat, shallow water on sandy bottom, XI-20-68, *F. R. Fosberg 50563* (US, BISH, GUAM, NY); Aurapushekaru Island, coral substratum, 2-5 m deep, I-1-71, *R. T. Tsuda 4075* (GUAM); Kayangel Atoll, lagoon reef flat, .6 km north of Ngajangel Islet, .5 m deep, I-15-76, *R. T. Tsuda 5076* (GUAM). YAP: 4 m SW of Tomil Harbor entrance, outer barrier reef, 2-3 m deep, XI-24-70, *R. T. Tsuda 3962* (GUAM, US); lagoon, between Map Island and Rumung Island, in *Enhalus acoroides* bed, XI-29-70, *R. T. Tsuda 4010* (GUAM); Donitsch Island, reef flat, .6 m deep, I-5-76, *R. T. Tsuda 4758* (GUAM).

EAURIPIK ATOLL: Eauripik I., shallow lagoon VIII-12-65, *F. R. Fosberg 47096* (US, BISH, NY, P, K, L, TI, CANB, MO). WOLEAI ATOLL: Wottagai I., VIII-8-65, *F. R. Fosberg 47053* (US). IFALUK ATOLL: Falarik I., by Fan Nap, along sandy margin of lagoon, IX-8-53, *D. P. Abbott & M. Bates 145* (US, BISH); Ifaluk I., VIII-13-65, *F. R. Fosberg 47240* (US, BISH, NY, K, P). TRUK: north side of Dublon Island, mangrove area, VI-4-70, *R. T. Tsuda 3394* (GUAM); Moen, patch reef, 1 m deep, III-31-75, *R. T. Tsuda 5083* (GUAM). NOMWIN ATOLL: Nomwin Islet, shallow lagoon water near shore, V-29-46, *F. R. Fosberg 24598* (US, BISH, GUAM, NY). SATAWAN ATOLL: Moch I., 50 cm deep at low tide, I-24-50, *D. Anderson 1114* (US, BISH, NY, L). KAPINGAMARANGI: Ringutora I., in shallow water on lagoon shore, VIII-25-54, *W. A. Niering 721* (US, BISH). PONAPE: Net, 1-1.5 m deep in lagoon, VIII-29-68, *R. T. Tsuda 2372* (GUAM); Madolenihm,

shallow channel, VIII-17-74, *R. T. Tsuda 4753* (GUAM); Nanmatol I., VIII-11-46, *F. R. Fosberg 26368a* (BISH); Lauger Is., near seaplane ramp, I-7-56, *E. Y. Dawson 14061* (US). MOKIL ATOLL: Kalap I., Tarabus, in shallow water, VII-2-49, *S. F. Glassman 2627* (US). PINGELAP ATOLL: *St. John & Fischer 21453* (BISH).

MARSHALLS: Ujelang Atoll, reported by Fosberg (1955, 1976) and den Hartog (1970); Jaluit Atoll, reported by Fosberg (1961, 1976); Ailinglapalap Atoll, reported by Fosberg (1976). UJELANG ATOLL: Ujelang I., lagoon beach at east end, II-4-52, *F. R. Fosberg 34189* (US, BISH). AILINGLAPALAP ATOLL: Airik, tidal channel, VIII-26-46, *F. R. Fosberg 26880* (US, BISH, GUAM, NY). JALUIT ATOLL, Pinglap I., bottom of lagoon IV-28-58, *F. R. Fosberg 39467* (US).

GILBERTS: Onotoa Atoll, reported by Moul (1957) and Fosberg (1976); Tarawa Atoll, reported by Catala (1957) and Fosberg (1976). ONOTOA ATOLL: North I., lagoon, north of jetty, VII-20-51, *E. T. Moul 8188* (US, BISH).

Halophila ovalis (R. Br.) Hook. f.

Caulinia ovalis R. Br.

Halophila ovata Gaudichaud

CAROLINES: Ifaluk, reported by den Hartog (1970). PALAU: Ngechelobel Island, shallow water on sandy bottom, XI-20-68, *M. V. C. Falanruw 1004* (GUAM); Ng'edobel Island, north of Eil Malk, 1 m deep, XI-20-68, *F. R. Fosberg 50564* (US, BISH); 400 m SSE of Arumaten Point on west side of Babelthuap Island, inner reef, III-12-70, *R. T. Tsuda 3019* (GUAM); Aurapushekaru Island, coral substratum, 2-5 m deep, I-1-71, *R. T. Tsuda 4059* (GUAM); Malakal, lagoon reef front, 3 m deep, I-10-76, *R. T. Tsuda 4770* (GUAM); Kayangel Atoll, lagoon reef flat, exposed during low tides, I-13-76, *R. T. Tsuda 5074* (GUAM); lagoon, 1 km W of southern tip of Ngajangel I., Kayangel, 9 m deep, I-15-76, *R. T. Tsuda 5075* (GUAM). YAP: 4 km SW of Tomil Harbor entrance, outer barrier reef, 2-3 m deep, XI-24-70, *R. T. Tsuda 3957* (GUAM); Donitsch Island, reef flat, .6 m deep, I-5-76, *R. T. Tsuda 4759* (GUAM). WOLEAI ATOLL: Wottagai Islet, shallow water of lagoon, VIII-8-65, *F. R. Fosberg 47052* (US, BISH). IFALUK ATOLL, by Fan Yap, *D. P. Abbott & M. Bates 144* (BISH); Ship's pass between Ella I. and Falielang, *Harry et al.* in 1953 (BISH). TRUK: Moen, patch reef, 1.2 m deep, III-31-75, *R. T. Tsuda 5081* (GUAM).

Halophila minor (Zoll.) den Hartog

Halophila ovata sensu auct. non Gaudichaud

Lemnopsis minor Zoll.

MARIANAS: Marianas Islands, reported by Gaudichaud (1827) and many later writers; Guam, reported by Stone (1971) and den Hartog (1970); Saipan, reported by den Hartog (1970). GUAM: Pago Bay, inner reef flat, sandy substratum, almost exposed at low tides, VI-12-73, *R. T. Tsuda 4777* (GUAM); Pago Bay, 2 m deep, *R. T. Tsuda 4653* (GUAM); Apra Harbor, coral sand bottom, 12 m, IV-30-66, *M. Evans 1885* (US); Mana Bay opposite Ypan, *B. C. Stone 4063* (GUAM); Agfayan

Bay, in shallow lagoon, VII-22-62, *B. C. Stone s.n.* (US); Asanite Bay, 1 m deep, *Cone 1* (GUAM); *B. C. Stone 5049* (GUAM); Hoover Beach, 3 m deep, *Cone 18* (GUAM); Orote Point, near Agat Bay, *Cone 51* (GUAM); Asan, offshore from Camp Asan, *Cone 52* (GUAM). SAIPAN: 1.6 km south of Chalan Kanoa, sandy area, 1.5 m deep, II-23-68, *R. T. Tsuda 1948* (GUAM, US); Tanapag Harbor, off Point Muchot, patch reef, 1 m deep, V-18-70, *R. T. Tsuda 3222* (GUAM, US); Garapan Lagoon, inner reef flat, .5 m deep, in *Enhalus acoroides* bed, V-18-70, *R. T. Tsuda 3198* (GUAM); Chalan Kanoa, 1 m deep, II-22-50, *F. R. Fosberg 31760* (US, BISH).

CAROLINES: Palau, reported by Tuyama (1940). YAP: Colonia, among *Thalassia hemprichii* and *Enhalus acoroides* on reef flat off Yap Hospital, 1 m deep, III-4-77, *R. T. Tsuda 5212* (GUAM); Colonia, patch reef, sandy area off Yap Hospital, 2 m deep, III-6-77, *R. T. Tsuda 5217* (GUAM).

Discussion

Several distinct patterns in the geographic distribution of the seagrasses seem to be evident based on past and present collections. If we focus our attention to that area lying between 0° and 10° N latitude, we find a distinct attenuation of species (Table 1) as one moves west to east—Palau (9 species), Yap (7), Truk (4), Ponape (2), Mokil (2), Pingelap (1), Kusaie (3), Marshalls and Gilberts (1). Only three species of seagrasses are known from the Mariana Islands which lie slightly north.

Table 1. Distribution of seagrass species in Micronesia showing attenuation from west (Palau) to east (Marshalls). The Marianas, the western and middle Caroline atolls, and the Gilbert Islands are not shown in the table. Collecting in the Caroline atolls is still very inadequate.

Species	Islands and Longitude (E)							
	Palau 134°	Yap 138°	Truk 151°	Ponape 158°	Mokil 160°	Pingelap 161°	Kusaie 163°	Marshalls 171°
<i>Halodule uninervis</i>	×							
<i>Cymodocea serrulata</i>	×	×						
<i>Cymodocea rotundata</i>	×	×	×				×	
<i>Enhalus acoroides</i>	×	×	×	×	×		×	
<i>Thalassia hemprichii</i>	×	×	×	×	×	×	×	×
<i>Halophila ovalis</i>	×	×	×					
<i>Halophila minor</i>	×	×						
<i>Syringodium isoetifolium</i>	×	×						
<i>Thalassodendron ciliatum</i>	×							

Kusaie seems to be the easternmost limit of *Enhalus acoroides* since specimens have not been found in the Marshalls or the Gilberts. One plausible reason for this may be the partial restriction of this species to high islands, i.e., islands of igneous origin. Thus far, *E. acoroides* is known only from Guam, Saipan, Palau, Yap, Truk, Ifaluk, Ponape, Mokil, and Kusaie. The Marshalls and Gilberts are all low



Fig. 1. Stand of *Thalassodendron ciliatum* observed in the lagoon of Kayangel Atoll. Photo taken by C. E. Birkeland on January 17, 1976.

islands, i.e., islands of limestone composition. A detailed search was made for this species at Kayangel Atoll, Palau Islands, but no specimens were found. This distribution pattern seems to be quite real, since the size of individual plants and their preference for shallow sandy areas makes this species difficult to go unnoticed.

The presence of *Thalassodendron ciliatum* only in the lagoon of Kayangel Atoll is most interesting, since only two small patches are known from the lagoon. One patch was found in January 1971 and the other in January 1976 (Fig. 1). Perhaps, further search in other areas of Palau may one day reveal further stands of this species. Likewise, *Halophila minor* seems to be almost restricted to the Mariana Islands, with a single unverified record from Palau (Babelthuap) and two collections from Yap, whereas *H. ovalis* is found on the more southern islands of Palau, Yap, Woleai, Ifaluk and Truk. Further surveys on Ponape, the eastern Carolines, and low islands of the Marshalls may reveal *Halophila ovalis*. The disjunct distribution of *Halodule uninervis* on Palau and the southern Marianas, but not on Yap, is unusual.

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