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Marine Plants of Pohnpei and Ant Atoll: Chlorophyta, Phaeophyta and Magnoliophyta

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Abstract—A study of marine benthic plants collected from Pohnpei Island and Ant Atoll, Federated States of Micronesia, between 1994 and 1997 documented the occurrence of 59 species of green algae (Division Chlorophyta), 16 species of brown algae (Division Phaeophyta), and 3 species of seagrasses (Division Magnoliophyta). Based on these collections and a review of the literature, the marine flora of Pohnpei now comprises 52 Chlorophyta species, 22 Phaeophyta species, and 3 seagrass species; and the list for Ant Atoll currently stands at 60 Chlorophyta species, 11 Phaeophyta species, and 2 seagrasses. New records include 20 species from Pohnpei, and 30 from Ant. Of these, 8 were taxa previously unknown from Micronesia: *Caulerpa microphysa* (Weber-van Bosse) J. Feldmann, *Derbesia fastigiata* Taylor, *Dictyota acutiloba* J. Agardh, *Enteromorpha flexuosa* (Roth) J. Agardh, *Padina boergesenii* Allender & Kraft, *Percursaria dawsonii* Hollenberg & Abbott, *Ulothrix flacca* (Dillw.) Thuret, and *Ulvella setchellii* Dangeard. Red algae (Division Rhodophyta) were also collected, and will be reported in a future paper.

Introduction

The early marine algal checklists that spanned vast expanses of the Pacific, i.e., the Caroline Islands (Okamura 1916), western Oceania (Schmidt 1928), and Micronesia (Tokida 1939) gave the first sparse records of marine plants of Pohnpei Island (previously spelled Ponape) (6°55'N, 158°15'E). Glassman (1952) compiled a list of the non-vascular plants of Pohnpei, and included relatively few marine algae. Yamada was the first phycologist to spend time on Pohnpei and its closest neighbor, Ant Atoll (32 km southwest), and to focus on their marine flora. He added to the list of recorded species, and also described several new taxa of

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Table 1. Collecting site information for Pohnpei Island and Ant Atoll.

Site #	Location	Habitat	Depth	Collecting Dates	Municipality
	Pohnpei Island				
1	Nankepkep en Parem	intertidal reef flat	1 m	11/24/94	Nett
2	Mesenpal	nearshore	1-2 m	9/18/97	Uh
3	Dehbehk Island	nearshore	1-2 m	9/18/97	Uh
4	Takaieu	nearshore	1-2 m	9/18/97	Uh
5	Areu Passage	reef flat	unknown	4/89	Madolenihmw
6	Dau Rei Rei	lagoon patch reefs	1 m	11/21/94, 8/8/96	Madolenihmw
7	Nahpali Island	nearshore inner reef	1 m	8/10/96	Madolenihmw
8	Nahpali Island	outer barrier reef	20 m	8/11/96	Madolenihmw
9	Temwen Island	reef flat	1 m	10/87, 9/15/97	Madolenihmw
10	Lohd Pa	reef flat	1 m	9/17/97	Madolenihmw
11	Rohi	nearshore	1-2 m	9/17/97	Kiti
12	Paliapailong	nearshore	1 m	9/15/97	Kiti
13	Pehleng Pass	channel	2 m	2/23/95, 2/24/95	Kiti
14	Iohl	nearshore, silty	1 m	9/16/97	Sokehs
15	Oumoar	nearshore	1 m	2/15/95, 9/16/97	Sokehs
16	Sokehs Harbor	reef flat	1 m	3/14/89	Sokehs
17	Sokehs Passage	outer reef	4-15 m	11/24/94	Sokehs
18	Sokehs Passage	inner reef	0-3 m	11/24/94	Sokehs
19	Japanese Lighthouse reef	reef flat	1-5 m	3/1/89	Nett
20	Dekehtik	reef flat	1 m	4/89	Nett
	Ant Atoll				
A	Imwinyap	inner reef flat	0-3 m	11/25/94	
B	Imwinyap	sandy lagoon	0-1 m	11/25/94	
C	Nikalap Aru	sandy lagoon	0-2 m	11/25/94	
D	Nikalap Aru	sandy channel edge	0-2 m	11/25/94	
E	Imwinyap	outer nearshore reef	0-2 m	11/27/94	
F	Tauenai Passage	channel	3-22 m	11/27/94, 8/14/96	
G	Nikalap Aru	lagoon channel wall	3-22 m	11/27/94	
H	Pasa	inner sand flat	0-1 m	11/22/94, 8/14/96	
I	Nikalap Aru	outer reef	12-27 m	11/22/94	
J	Pamuk	outer reef	12-25 m	11/22/94	
X	precise location unknown			4/89	

Caulerpa, *Dictyosphaeria*, *Halimeda*, *Rhipilia*, *Centroceras*, *Crouania*, *Dasya*, and *Wrangelia* from these islands (Yamada 1940, 1941, 1944a, 1944b). Pohnpei and Ant are mentioned in various taxonomic papers as localities of “materials examined” (Colinvaux 1968; Hollenberg 1968a, 1968b, 1968c; Trono 1968, 1969; DeWreede 1973; Taylor 1977; Itono 1980; Meneses & Abbott 1987). The most recent studies on marine plants of Pohnpei (Best & Pendleton 1980) and of Ant (Enomoto et al. 1986) are limited in scope and over twelve years old.

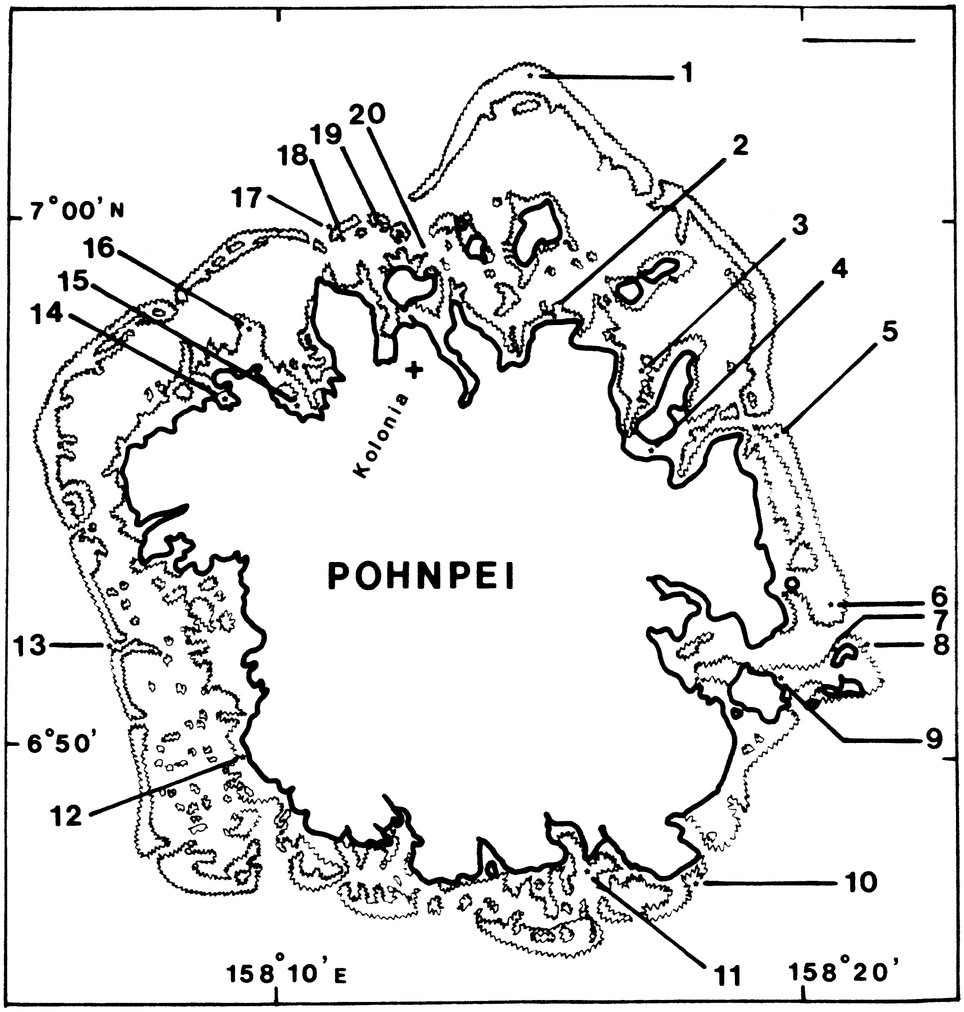

Figure 1. Collecting sites around Pohnpei Island. The scale bar in the upper right is 4 km.

In the mean time, Pohnpei and Ant have become part of the independent Federated States of Micronesia with a burgeoning human population that is increasingly dependent on marine resources for subsistence, as well as capital income. The nearshore marine waters of Pohnpei and Ant are the site of reef fishing, sponge farming, sea cucumber harvesting, *Trochus* snail collecting, sand mining, coral dredging for roads, and tourist recreation (U.S. Army Corps of Engineers 1985), yet little is known of the diversity, distribution or ecology of the primary producers.

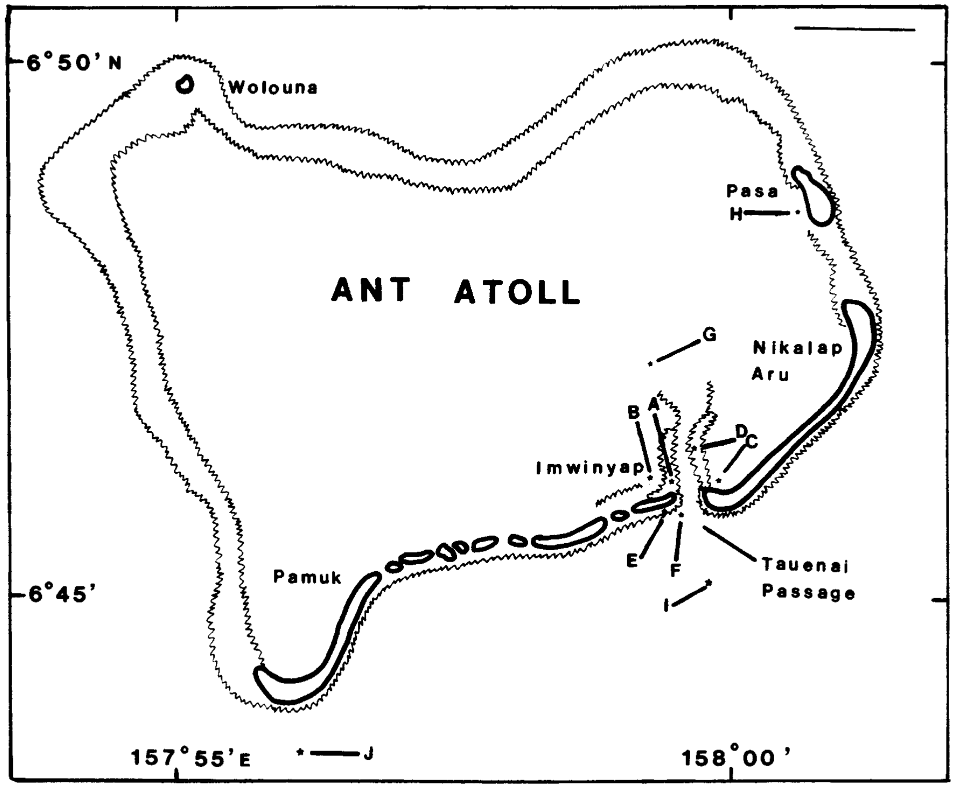

Figure 2. Collecting sites at Ant Atoll. The scale bar in the upper right is 2 km.

Materials and Methods

This study is based on several collections by the authors on Pohnpei and Ant spanning the years 1994 to 1997, plus a smattering of dried specimens collected by students of the College of Micronesia-FSM. Collections were made at 20 locations around the island of Pohnpei and 11 sites at Ant Atoll. The authors collected seaweeds and seagrasses at depths ranging from less than 1 m deep to 27 m deep by SCUBA diving, snorkeling, or wading. Fresh specimens were hand-picked, placed in plastic bags with ambient seawater, and preserved within 6 hours of collection as dried material or in 4% formalin-seawater solution. Studies of anatomical and reproductive structures were made later. Thalli were stained in 1% aqueous aniline blue solution and mounted on glass slides in 25% corn syrup (Karo®) solution. Identification was made by L. M. Hodgson, K. J. McDermid and I. A. Abbott using a variety of references on marine plants from Micronesia, as well as specific references on *Caulerpa* (Coppejans 1992, Coppejans & Prud'homme van Reine 1992), *Codium* (Jones and Kraft 1984), *Halimeda* (Hillis-Colinvaux 1980), *Rhipilia* (Gilbert 1978, N'Yeurt & Keats 1997), and the

Dictyotales (Allender & Kraft 1983). Distribution records of species in Micronesia were checked using Tsuda et al. (1977), Tsuda & Wray (1977), and Tsuda (1981a). Dried specimens are deposited as vouchers in the herbarium at Bernice P. Bishop Museum (BISH) in Honolulu, Hawai‘i.

Collecting Sites

Table 1 gives the complete list of collecting sites, including names, dates and information on the habitats. The site numbers and letters correspond to locations on the maps of Pohnpei Island (Fig. 1) and Ant Atoll (Fig. 2), respectively.

Results

The taxa collected and identified from Pohnpei Island and Ant Atoll are documented in Table 2 which includes author citations. The site numbers and letters refer to locations in Table 1 and Figures 1 and 2. New records for Micronesia, Pohnpei and Ant are indicated in the first column of Table 2.

Fifty-nine species of the Division Chlorophyta were identified in this study. The flora of Pohnpei and Ant is particularly rich in species of *Caulerpa* and *Halimeda.* Eleven species of *Caulerpa* were recognized, including 2 species which are new records for Pohnpei and/or Ant Atoll: *C. filicoides,* and *C. microphysa.* The microscopic examination of *Caulerpa* specimens, particularly their pyrenoid characteristics, proved to be essential to accurate identification of species. Several of the *Caulerpa* species displayed multiple growth forms, recognized as “ecads” (Coppejans 1992, Coppejans & Prud’homme van Reine 1992). Although ecad is a descriptive category and not a taxonomic unit, we included ecad distinctions in this study in order to document the great morphological (and perhaps genetic) variation that exists within this genus in Pohnpei and Ant. More studies are needed to clarify the taxonomic and ecological significance of ecads and the biodiversity they represent. Fifteen species of *Halimeda* were identified in this study, including several new records for this area: *H. bikinensis, H. cylindracea, H. distorta, H. fragilis, H. gracilis, H. minima, H. renschii, H. simulans,* and *H. taenicola.* Five species of *Rhipilia,* a genus frequently underestimated in terms of its diversity, were collected. *Rhipilia geppii* and *R. orientalis* are new records for Ant Atoll, and *R. diaphana* was not previously reported from Pohnpei.

Sixteen species of brown algae were found. This collection was dominated by specimens of *Dictyota* and *Padina.* One immature *Sargassum* specimen, unidentifiable to species, was collected from Ant Atoll. However, even this small sprig is noteworthy because Tsuda (1976) points out that *Sargassum* is rarely found on atolls.

Three species of seagrasses were found on Pohnpei: *Cymodocea rotundata, Enhalus acoroides,* and *Thalassia hemprichii.* Only *Cymodocea rotundata* and *T. hemprichii* were present on Ant, and these two species are new records for Ant Atoll.

Table 2. Species, sites, and references for collections from Ant Atoll and Pohnpei Island. The site numbers refer to locations in Table 1. New records for species are indicated in the first column: M=Micronesia, A=Ant, P=Pohnpei. The authors who previously reported the species from Ant or Pohnpei are listed in the last column. Abbreviations for references: BP80 = Best & Pendleton 1980, EJA86 = Enomoto et al. 1986, G52 = Glassman 1952, ME99 = McDermid & Edward 1999, O16 = Okamura 1916, S28 = Schmidt 1928, T39 = Tokida 1939, T68 = Trono 1968, T69 = Trono 1969, TRC74 = Tsuda et al. 1974, TFS77 = Tsuda et al. 1977, Y44 = Yamada 1944a.

New record from	SPECIES	SITES	PREVIOUS ANT & POHNPEI REFERENCES
	MAGNOLIOPHYTA		
A	*Cymodocea rotundata* Ehrenb. & Hempr. Ex Aschers	B C H 7 9 10	ME99
	Enhalus acoroides (L. f.) Royle	6 7 9 14 15	TFS77 ME99
A	*Thalassia hemprichii* (Ehrenb.) Aschers	B C 6 7 9 10 15	TFS77 ME99
	CHLOROPHYTA		
A	*Acetabularia parvula* Solms-Laubach	A	
A,P	*Avrainvillea amadelpha* (Montagne) A. & E. S. Gepp	E J 9	
	Avrainvillea sp.	D	
	Boodlea composita (Harvey) Brand (=*B.siamensis*)	H 18	BP80
	Boergesenia forbesii (Harvey) J. Feldmann	A D	T68 BP80 EJA86
A	*Bryopsis pennata* Lamouroux	A	
	Caulerpa antoensis Yamada	A	Y44
	Caulerpa brachypus Harvey	A B C H	Y44 EJA86
	ecad *parvifolia* (Harvey) Cribb	B	
	Caulerpa cupressoides (Vahl) C. Agardh	6	O16 S28 T39 Y44 EJA86
	ecad *cupressoides*	A B D H	
	ecad *mamillosa* (Montagne) Weber-van Bosse	A B H	
	ecad *urvilleana* Montagne	A C F H 6	Y44 EJA86
P	*Caulerpa filicoides* Yamada		Y44 EJA86
	ecad *andamanensis* Taylor	A B E F I J 17	
	Caulerpa matsuena Yamada	A B	Y44 EJA86
M,A,P	*Caulerpa microphysa* (Weber-van Bosse) J. Feldmann	A C 16	

	Caulerpa racemosa (Forsskal) J. Agardh	4 6 15	O16 S28 T39 Y44 T68 BP80 EJA86
	ecad *clavifera* (Turner) Weber-van Bosse	A	
	ecad *laetivirens* (Montagne) Weber-van Bosse	C F H	
	ecad *peltata* (Lamouroux) Eubank	A C D H 1 18	Y44 T68 EJA86
	ecad *peltata-macrodiscus* (Decaisne) Weber-van Bosse	F J 17	
	ecad *racemosa*	13	
	Caulerpa serrulata (Forsskal) J. Agardh emend. Børgesen	4 17	Y44 T68 BP80 EJA86
	ecad *pectinata* (Weber-van Bosse) Taylor	F	
	ecad *serrulata*	6 20	
	Caulerpa sertularioides (S. G. Gmelin) Howe	20	T68 EJA86
	Caulerpa taxifolia (Vahl) C. Agardh		Y44 EJA86
	ecad *taxifolia*	B C D H	
	Caulerpa verticillata J. Agardh	C H	Y44 T68 TRC74 EJA86
	Caulerpa sp.	D F	
A	*Caulerpella ambigua* (Okamura) Prud'homme van Reine & Lokhorst	A	
	Chlorodesmis hildebrandtii A. & E.S. Gepp	17	O16 S28 T39
	Chlorodesmis sp.	8	
P	*Cladophora socialis* Kutzing	6	Y44
A, P	*Cladophora vagabunda* (Linnaeus) van den Hoek	A D H 4 15	
	Cladophora sp.	A D F 6	
A	*Cladophoropsis membranacea* (C. Ag.) Børgesen	A	
A	*Codium geppii* O. C. Schmidt	A	
M,A	*Derbesia fastigiata* Taylor	A	
	Dictyosphaeria cavernosa (Forsskal) Børgesen	A B F G	Y44 EJA86
A	*Enteromorpha clathrata* (Roth) Greville	A	
M, P	*Enteromorpha flexuosa* (Wulfen) J. Agardh	6	
P	*Halimeda bikinensis* Taylor	6	
A	*Halimeda cylindracea* Decaisne	A B C F H J	
	Halimeda discoidea Decaisne	I J 1 13 19	T68 BP80 EJA86

P	*Halimeda distorta* (Yamada) Colinvaux	8	
A, P	*Halimeda fragilis* Taylor	I J 18	
P	*Halimeda gracilis* Harvey ex J. Agardh	17 19	Y44
	Halimeda macroloba Decaisne	4 6 10 11 12 15 16 20	O16 S28 T39 T68 TRC74 BP80
	Halimeda macrophysa Askenasy	X 8 17 18	TRC74 EJA86
	Halimeda micronesica Yamada	A E I X 8 18	Y44 T68 EJA86
A, P	*Halimeda minima* (Taylor) Colinvaux	X 3	
	Halimeda opuntia (Linnaeus) Lamouroux	C D E H J 1 2 3	O16 S28 T39 Y44 G52 T68 TRC74
	Halimeda opuntia (continued)	4 6 9 10 11 12 14 15	BP80 EJA86
	Halimeda opuntia (continued)	17 18	
A	*Halimeda renschii* Hauck	E F I J	
P	*Halimeda simulans* Howe	9 15	
A, P	*Halimeda taenicola* Taylor	F I J X	
	Halimeda tuna (Ellis & Solander) Lamouroux	2	G52
	Halimeda sp.	D 8	
P	*Microdictyon okamurae* Setchell	A B H 1 6 18	Y44 EJA86
	Microdictyon sp.	A H	
	Neomeris annulata Dickie	A D	TRC74 EJA86
A	*Neomeris bilimbata* Koster	A B	
A	*Neomeris vanbosseae* Howe	A F 20	T68 BP80
M, P	*Percursaria dawsonii* Hollenberg & Abbott	6	
	Rhipidosiphon javensis (Mont.) A. & E. S. Gepp	G	EJA86
P	*Rhipilia diaphana* Taylor	17	EJA86
A	*Rhipilia geppii* Taylor	C F	
	Rhipilia micronesica Yamada	A B F I	Y44
A	*Rhipilia orientalis* A. & E. S. Gepp	F G J 17	BP80
	Rhipilia sinuosa Gilbert	G	EJA86
A	*Struvea anastomosans* (Harvey) Piccone & Grunow ex Piccone	H	
	Tydemania expeditionis Weber-van Bosse	A B C F I J X 3	O16 S28 T39 Y44

	Tydemania expeditionis (continued)	6 13 19	T68 BP80 EJA86
	Udotea argentea Zanardini	A X	Y44 EJA86
M, A	*Ulothrix flacca* (Dillw.) Thuret	A	
M, A	*Ulvella setchellii* Dangeard	A	
	Valonia aegagropila C. Agardh	B C 6	S28 T39 EJA86
	Valonia sp.	B	
	Ventricaria ventricosa (J. Agardh) Olsen & J. West	C F G H J 6	T68 TRC74 BP80 EJA86
	PHAEOPHYTA		
A	*Dictyopteris repens* (Okamura) Borgesen	A J	
M,A,P	*Dictyota acutiloba* J. Agardh	C F 2	
	Dictyota bartayresiana Lamouroux	16	Y44 TRC74 BP80
A	*Dictyota divaricata* Lamouroux	G H 6 20	T69
A,P	*Dictyota friabilis* Setchell	D G H 1 6 18	
	Dictyota sp.	A J G 6 8 17	
A	*Hincksia breviarticulata* (J. Agardh) Silva	H	BP80
	Hincksia sp.	H	
A	*Hydroclathrus clathratus* (C. Agardh) Howe	H 2 16	O16 S28 T39 T69 BP80
	Lobophora variegata (Lamouroux) Womersley	A D E 1 6	Y44 T69 BP80
	Padina australis Hauck	4 12 15	T69
M, P	*Padina boergesenii* Allender & Kraft	16	
	Padina tenuis Bory (=? *P. boryana* Thivy)	1 6 16	Y44 T69 TRC74
	Padina sp.	C 2 4 6 11	
P	*Rosenvingea intricata* (J. Agardh) Borgesen	20	
	Sargassum cristaefolium C. Agardh	1	O16 T39
	Sargassum polycystum C. Agardh	6 16	BP80
	Sargassum sp.	H	
	Sphacelaria sp.	A D 6	
	Turbinaria decurrens Bory	18	BP80
	Turbinaria ornata (Turner) J. Agardh	A H 1 6	O16 S28 T39 Y44 T69 BP80

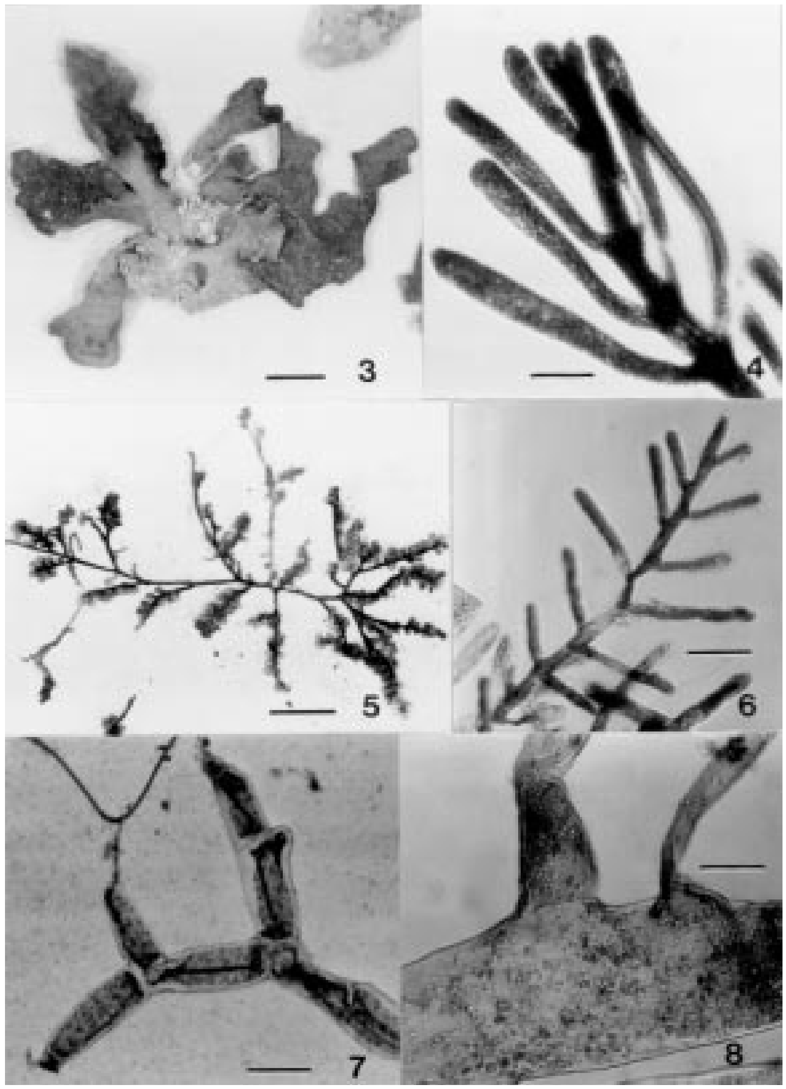

Fig. 3. *Avrainvillea amadelpha,* a widespread species with thick, felted, irregular blades. New record for Pohnpei and Ant, specimen #22187, scale bar = 1.2 cm. Fig. 4. *Bryopsis pennata* with characteristic pinnate branches which are non-septate when vegetative, but become septate when reproductive. New record for Ant, specimen #22616a, scale bar = 55µm. Fig. 5. *Caulerpa microphysa* outwardly indistinguishable from *Caulerpa racemosa,* but microscopically can be recognized by single pear-shaped pyrenoids in each chloroplast. New record for Pohnpei, Ant and Micronesia, specimen #KM4135, scale bar = 1.7 cm. Fig. 6. *Caulerpella ambigua,* showing vegetative branches which will become entirely reproductive, as distinguished from members of the genus *Caulerpa* in which individual ramuli become reproductive. New record for Ant, specimen #22616b, scale bar = 60µm. Fig. 7. *Cladophora vagabunda,* showing branches that originate as protrusions from distal corners of cells which are later cut off by a cell wall. The cells contain a diffuse reticulate chloroplast. New record for Pohnpei and Ant, specimen #22614, scale bar = 150µm.

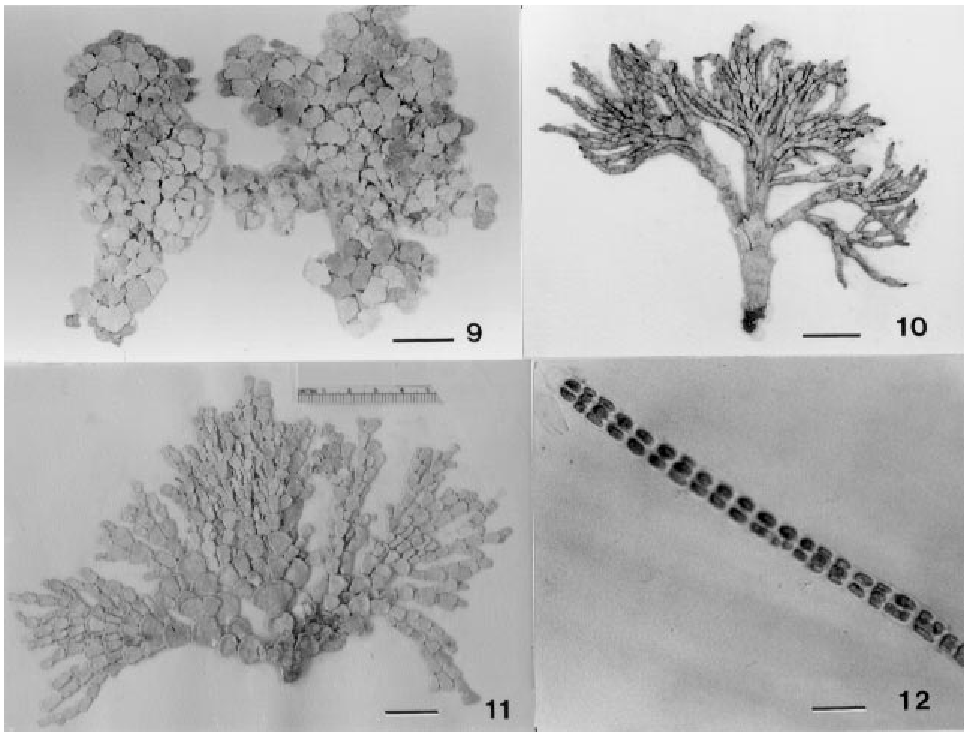

Fig. 8. *Derbesia fastigiata*, showing tubular erect branches with no septa at the branch points. Cells contain small discoid chloroplasts. New record for Ant and Micronesia, specimen #22629, scale bar = 150µm. Fig. 9. *Halimeda fragilis* with a small holdfast region, branching in multiple planes as in *Halimeda opuntia*, but characteristically shiny white with heavy calcification. Internally, distinguished by separated filaments at nodes and separated peripheral utricles. New record for Pohnpei and Ant, specimen #22297, scale bar = 2.2 cm. Fig. 10. *Halimeda minima*, a bushy, erect plant with cylindrical or trilobed segments longer than broad, and several segments fused at the base of the thallus. New record for Pohnpei and Ant, specimen #KM4175b, scale bar = 1.0 cm. Fig. 11. *Halimeda taenicola* with a small holdfast region and trapezoidal segments slightly raised at the margins. The lowermost 1 or 2 segments compressed-cylindrical, similar to, but lacking the swollen utricles of, *Halimeda discoidea*. New record for Pohnpei and Ant, specimen #KM4164, scale bar = 2.0 cm. Fig. 12. *Percursaria dawsonii*, a close relative of *Ulva* with band-shaped plastids, distinguished by a slender, unbranched thallus with 2 sligthly staggered, longitudinal rows of isodiametric cells. New record for Pohnpei and Micronesia, specimen #22583, scale bar = 37µm.

Overall, 20 species are new records for Pohnpei, and 30 species are new records for Ant Atoll. Several of these new records are highlighted in Figs. 3–12 to show the characteristic morphology or distinguishing traits of the species. Eight taxa are previously unknown or unreported from Micronesia: *Caulerpa microphysa, Derbesia fastigiata, Dictyota acutiloba, Enteromorpha flexuosa, Padina boergesenii, Percursaria dawsonii, Ulothrix flacca,* and *Ulvella setchellii. Caulerpa microphysa* is distinguished by the single, large, pyriform pyrenoid

Table 3a. Chlorophyta and Phaeophyta previously reported from Pohnpei, but not collected from Pohnpei in this study. Abbreviations for references same as Table 2.

SPECIES	REFERENCES
CHLOROPHYTA	
Avrainvillea erecta	T68
Avrainvillea nigricans	T68
Avrainvillea obscura	TRC74
Boodlea vanbossae	T68
Borgesenia forbesii	T68, BP80
Caulerpa fastigiata	T68
Caulerpa freycinetti var. boryana	O16, S28, T39
Caulerpa okamurai	O16, S28, T39
Caulerpa plumeris	O16, S28, T39
Caulerpa verticillata	T68, TRC74
Chaetomorpha crassa	T68
Chlorodesmis comosa (=C. fastigiata)	S28, T39, T68
Cladophora patentirama	S28, T39
Codium arabicum	T68
Codium edule	T68
Halimeda incrassata	BP80
Neomeris annulata	TRC74
Spongocladia vaucheriaeformis	O16, S28, T39
Valonia fastigiata	T68, BP80
Valonia utricularis	T68
PHAEOPHYTA	
Colpomenia sinuosa	O16, S28, T39
Dictyota patens	O16, S28, T39
Dilophus radicans	O16, S28, T39
Hincksia breviarticulata	BP80
Padina pavonia (=P. pavonica)	O16, S28, T39
Ralfsia pangoensis	BP80
Sargassum ilicifolium	G52
Sphacelaria rigida	T69

present in its chloroplasts, and is known from Indonesia and New Guinea. *Derbesia fastigiata* is reported from Hawai‘i and California. The type locality of *Dictyota acutiloba* is Hawai‘i, and it has been recorded as far south as Lord Howe Island in Australia. *Enteromorpha flexuosa*, whose type locality is Yugoslavia, is also known from Hawai‘i, British Columbia to Central America, and the Galápagos Islands. *Padina boergesenii* has blades 3-cell layers thick, and is based on specimens from the West Indies and Australia. Wynne (1998) describes this *Padina* as “broadly distributed in the tropics,” and agrees with Allender & Kraft (1983) that specimens of *P. gymnospora* from India, the Phillipines and Vietnam need to be examined to determine their relation to *P. boergesenii*. Schmidt (1928) reported *P. gymnospora* from the Marianas Islands in northern Micronesia, but

Table 3b. Chlorophyta and Phaeophyta previously reported from Ant, but not collected from Ant in this study. Abbreviations for references same as Table 2.

SPECIES	REFERENCES
CHLOROPHYTA	
Anadyomene wrightii	EJA86
Bryopsis harveyana	EJA86
Caulerpa lentillifera	EJA86
Caulerpa sertularioides	EJA86
Cladophora socialis	Y44
Codium repens	EJA86
Dictyosphaeria bokotensis	Y44
Dictyosphaeria mutica	Y44
Halimeda cuneata	O16, S28, T39, EJA86
Halimeda gracilis	Y44
Halimeda incrassata	Y44
Valonia utricularis	EJA86
Valoniopsis pachynema	EJA86
PHAEOPHYTA	
Dictyota bartayresiana	Y44
Padina minor (=P. tenuis,=?P.boryana)	Y44
Sphacelaria novaehollandiae	Y44

without voucher material to compare to our specimens from Pohnpei, and in light of the taxonomic questions raised by other authors, we list *P. boergesenii* here as a new record for Micronesia. The type locality of *Percursaria dawsonii* is Pacific Grove in Central California, and it was recently reported from Baja California, Mexico (Aguilar-Rosas & Aguilar-Rosas 1998). *Ulothrix flacca* is known from Japan, Alaska, California, with a type locality of Wales. *Ulvella setchellii* is reported from the coast of Washington to Baja California, as well as France (type locality).

None of the species were found at all 31 sites. The most frequently occurring species, *Halimeda opuntia*, was collected from 18 sites; *Tydemania expeditionis* from 11 locations; *H. macroloba* from 8 localities on Pohnpei (but was noticeably absent on Ant Atoll); *Thalassia hemprichii* and *Caulerpa filicoides* ecad *andamanensis* from 7 sites each; and *Caulerpa racemosa* ecad *peltata*, *Cymodocea rotundata*, *Dictyota friabilis*, *H. micronesica*, *Microdictyon okamurae* and *Ventricaria ventricosa* were each reported from 6 of the sites.

Discussion

On the basis of previous papers that have documented the marine flora of Pohnpei (Okamura 1916; Schmidt 1928; Tokida 1939; Glassman 1952; Trono 1968, 1969; Tsuda et al. 1974; Best & Pendleton 1980), and our own recent findings, 52 species of Chlorophyta, 22 species of Phaeophyta, and 3 species of

Table 4. Numbers of species of Chlorophyta and Phaeophyta from islands of the Western and Central Pacific.

ISLANDS	NUMBERS OF SPECIES Chlorophyta	Phaeophyta	REFERENCES	LOCATION Latitude	Longitude
Caroline Islands (11 island groups from Palau to Pohnpei, but not Guam)	68	20	Trono 1968, 1969	0º to – 11º N	134º to – 165º E
Kayangel Atoll (Palau)	27	7	Tsuda 1981b	8º 03' N	134º 43' E
Yap	41	15	Tsuda & Belk 1972	9º 30' N	138º 09' E
Ifaluk Atoll	46	3	Abbott 1961	7º 15' N	144º 27' E
Guam	69	27	Tsuda 1972a	13º 30' N	144º 40' E
Chuuk (Truk)	42	12	Tsuda 1972b	7º 28' N	151º 51' E
Ant Atoll	60	11	this study and Yamada 1944a, Enomoto et al. 1986	6º 54' N	157º 58' E
Pohnpei	52	23	this study and Okamura 1916, Schmidt 1928, Tokida 1939, Glassman 1952, Tsuda et al. 1974, Best & Pendleton 1980	6º 55' N	158º 15' E
Enewetak Atoll (Marshall Islands)	89	24	Taylor 1950, Dawson 1957, Gilmartin 1960, Tsuda 1987	11º 18' N	162º 28' E
Kwajalein, Jaluit, Majuro, Arno (southern Marshall Islands)	64	12	Dawson 1956	6º to – 9º N	167º to – 172º E
Gilbert Islands (Kiribati)	22	5	Tsuda 1964	2º N to – 2º S	173º to – 176º E
Howland and	8	4	Tsuda & Trono 1968	0º 48' N	176º 38' W
Baker Islands				0º 13' N	176º 28' W
Canton Is. (Phoenix Islands)	21	9	Dawson 1959	2º 50' N	171º 43' W
Christmas Island (Line Islands)	21	4	Gilbert 1983	1º 55' N	157º 20' W

Magnoliophyta (seagrasses) are reported from waters surrounding Pohnpei Island (Tables 2 & 3a). Similarly, by combining the past work of Yamada (1944a) and Enomoto et al. (1986) with results of our study, the marine flora of Ant Atoll consists of 60 species of Chlorophyta, 11 species of Phaeophyta, and 2 species of seagrasses (Tables 2 & 3b). The species richness of Chlorophyta and Phaeophyta from Pohnpei and Ant is comparable to other Micronesian and Polynesian islands in the Western and Central Pacific (Table 4). However, when comparing the flora of these islands, one must remember the great variation among the islands in terms of geographical location, isolation, age, origin, size, elevation (high islands vs. low atolls), oceanographic conditions, rainfall, and also, number of scientific collections. Enewetak has been the focus of many marine studies, and its marine flora is rich and well-known. However, the marine flora of other Central Pacific islands is known only from limited collections, sometimes by non-phycologists, such as the marine algae of Howland and Baker Islands. With further taxonomic study, the seaweed species richness and diversity of under-studied islands, including Pohnpei and Ant, will surely increase, and important information will be gained about biodiversity, biogeography and endemism of Pacific marine algae and seagrasses. Already, the new records determined in this study expand our knowledge of the geographical ranges of these taxa.

The geographic distributions of marine plants are primarily attributed to water temperature and the temperature responses or tolerances of species (Lobban & Harrison 1994, Lüning 1990, Breeman 1988). Water temperature is also the basis of the delineation of large-scale phytogeographic regions for benthic marine plants (van den Hoek 1984). Our present concepts about seaweed biogeography are based on phenological studies and temperature response experiments that focused on temperate species in the North Atlantic, polar species, and tropical species of the Caribbean (Pakker et al. 1995, Cambridge et al. 1990).

In addition to temperature, other factors are recognized as possible contributors to the diversity and biogeography of marine plants (van den Hoek 1984, Breeman 1988, Lüning 1990, Santelices 1992, Silva 1992, Smith 1992, Mukai 1993, Harper & Garbary 1997), including distance, island age, daylength, habitat variety and availability, short-term climate events (e.g., El Niño Southern Oscillations), paleoclimates, and paleo-oceanography. Other factors are characteristics of the marine plants themselves, including habitat requirements, dispersability, and herbivore vulnerability. Which factors are important in the tropical Pacific?

The marine floras of the oceanic Pacific islands are lumped by van den Hoek, Lüning and others within a huge phytogeographic region: the Tropical Indo-West Pacific Region which stretches 22,000 km from East Africa to the Tuamotus. Warm water temperatures unite this vast region of diverse land masses and complex oceanographic conditions. The tropical Pacific oceanic islands which are spread over a substantial area of ocean from 135°E (Palau) to 135°W (Tuamotus), are certainly as significant, biogeographically, as the islands and shores of the Atlantic. However, understanding of the marine algal distribution patterns and their causes in the tropical Pacific is virtually nonexistent. It has been assumed that "in general, the stock of seaweed species of these central Pacific oceanic islands is relatively small and consists mainly of immigrated, widely distributed species accompanied by a few endemics" (Lüning 1990, p. 232). Although many of the marine plant genera and species reported from Pohnpei and Ant are pantropical (i.e., *Caulerpa sertularioides, Boodlea composita, Dictyosphaeria cavernosa, Neomeris annulata, Padina australis, Dictyota divaricata*) or have an Indo-West Pacific distribution (i.e., *Neomeris vanbosseae, Tydemania expeditionis, Cymodocea rotundata, Enhalus acoroides, Thalassia hemprichii*) which might be explained simply based on temperature and by the eastward flowing Equatorial Counter Current (at 7°N latitude), until we have better taxonomic data on more Pacific islands and the details of their individual oceanographic conditions, we can only make guesses about endemism and biogeographic affinities. It will be important to examine the marine flora of more far-flung islands.

Identifying and listing the composition of the marine flora of Pohnpei and Ant is just a beginning. More quantitative work on marine plant abundance and zonation patterns and ecology in Pohnpei and Ant is needed. McDermid & Edward (1999) have carried out a preliminary ecological assessment of one seagrass meadow in Pohnpei, but vast areas of nearshore, lagoon and barrier reef habitats remain unstudied. In Pohnpei and Ant, the speciose genera of *Caulerpa* and *Halimeda* seem to invite future studies on growth patterns, competition, reproductive ecology, physiological ecology, and their roles in the marine food web and carbon cycle. With the growing concern in Micronesia for the conservation of sea turtles, for the management of coastal fish populations, and for the protection of coral reefs, there is an obvious need for a greater understanding of the marine ecosystems, including marine plants.

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