Potential Economic Seaweeds of Hengchun Peninsula, Taiwan[1]

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Wang, W. L. *and* **Y. M. Chiang** (*Institute of Oceanography, National Taiwan University, Taipei, Taiwan, Rep. of China*). Potential Economic Seaweeds of Hengchun Peninsula, Taiwan. *Economic Botany 48(2):182–189. 1994. There are 25 genera and 76 species of economically important marine algae found in the Hengchun Peninsula. The greatest number of useful species is found in the Rhodophyta.* Sargassum *is the most common genus of the Phaeophyta and has the largest biomass and the widest distribution, but fewer useful species. The local people harvest seaweeds from natural beds for food, fodder, fish bait, fertilizer and medical purposes. However, only a few of the available seaweeds are used and in small quantities. Most of the species are seasonal and more abundant in spring and winter than in the summer. Four genera,* Sargassum, Enteromorpha, Ulva *and* Codium *have large standing crops and are widely distributed in the coastal water. Production of the other genera is lower. There are many other useful seaweeds present in this area, some of which are also used as landscape plants in aquaria and as fertilizer in horticulture. The potential commercial uses for* Halymenia microcarpa *are also briefly discussed.*

Key Words: Chlorophyta; Cyanophyta; economic seaweed; Phaeophyta; Rhodophyta; seasonal periodicity; seaweed utilization; Taiwan.

Chinese and other peoples from areas throughout the world have long utilized seaweeds for a variety of purposes. As a result of increasing interest in phycological studies and the development of new technologies, the utilization of seaweed is becoming more widespread and is of greater economic value than ever before. So far, seaweeds are mainly used in the food industry as phycocolloids (agar, alginic acid, carrageenan etc.) (Chiang 1969; Waaland 1977; Chapman and Chapman 1980; Dawes 1981; Tseng 1981). Seaweed can be also used as a source of fermentable material for producing commercial quantities of methane gas (Bryce 1977; Wheeler et al. 1979; Sivalingam 1982).

One hundred and one genera and 459 species of economically important seaweeds in the world are published by various authors (see Bonotto 1976). About 524 taxa of seaweeds have been recorded in Taiwan (Chiang and Wang 1987; Lewis and Norris 1987; Huang 1990). Economically valuable taxa from Taiwan include 33 genera (Fan 1953; Chiang 1969, 1973). Little use has been made of these seaweeds with the few exceptions of *Gelidium, Gracilaria, Porphyra* and *Monostroma*. In Taiwan, the primary source of economic seaweeds has been natural populations collected by coastal fishermen during the natural growing seasons. Therefore, the quality and quantity of seaweeds are highly variable.

In recent years, there has been a rapid increase in the use of algae for human consumption. Every year, about 2500 tons (worth U.S.$5.3 million or N.T.$212 million) of dry 'Tsu-Tsai' (*Porphyra*) and kelp are imported from Japan and Korea, which constitutes about 60% of total dry imports in Taiwan. Each year 199 tons of 'Hai-Tsai Jam' (sea vegetable jam) is imported at a value of almost U.S.$1 million (N.T.$40 million) (Liao 1985). This represents a substantial loss of currency to export. Although Taiwan has engaged in the cultivation of *Porphyra* (Chiang 1984) and *Gracilaria* (Chiang 1981), production is not enough to support the demand.

Taiwan needs to further exploit its own seaweed resources and to increase its production. For this purpose, the Hengchun area was the first selected for this study. This is an area where seaweeds are used more than in any other place in Taiwan. Our research presents a catalogue of

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economic seaweeds from the Hengchun Peninsula with information on their distribution and seasonal abundance.

Study Site

Hengchun Peninsula (Fig. 1), located at the southern tip of Taiwan, is affected by the Kuroshio Current, with an annual average surface water temperature above 27°C, and a salinity range from 34‰ to 34.5‰. The annual precipitation is 2299.9 mm concentrated in the warm season, especially in June to September. This is due to the high frequency of typhoons and thunderstorms in that period (Chu 1971).

Methods

Potential economic seaweeds surveys were made every four months in the Hengchun from 1986 to 1988. The vegetation of the intertidal zone was investigated using a quadrat (0.25 m^2) method along a vertical transect line set across the intertidal zone perpendicularly to the coastal line. Additional collections for economic seaweeds flora were carried out monthly. Collections were made from the littoral zone to a depth of about 20 m. The specimens collected were fixed in 5–10% formalin-seawater solution and carried to the laboratory.

Results

Species Composition of Potential Economic Seaweeds

Seventy-nine species in 25 genera of potential economic algae were found in the study area. These include: Cyanophyta, 1 genus and 1 species; Chlorophyta, 7 genera and 31 species; Phaeophyta, 2 genera and 11 species; Rhodophyta, 15 genera and 33 species (Table 1). The Rhodophyta have the greatest number of economically useful species, among them are 8 species of *Laurencia,* 7 of *Gracilaria,* 5 of *Hypnea,* 3 of *Eucheuma,* 2 each of *Porphyra* and *Dermonema, Asparagopsis taxiformis, Gelidiella acerosa, Carpopeltis maillardii, Grateloupia filicina, Halymenia microcarpa, Gigartina intermedia, Meristotheca coacta, Acanthophora spicifera* and *Chondria armata.* There are fewer genera and species in the Phaeophyta than in the other groups (Table 1), but their large biomass and wide distribution make them conspicuous. Among the brown algae, *Sargassum* is the most common genus.

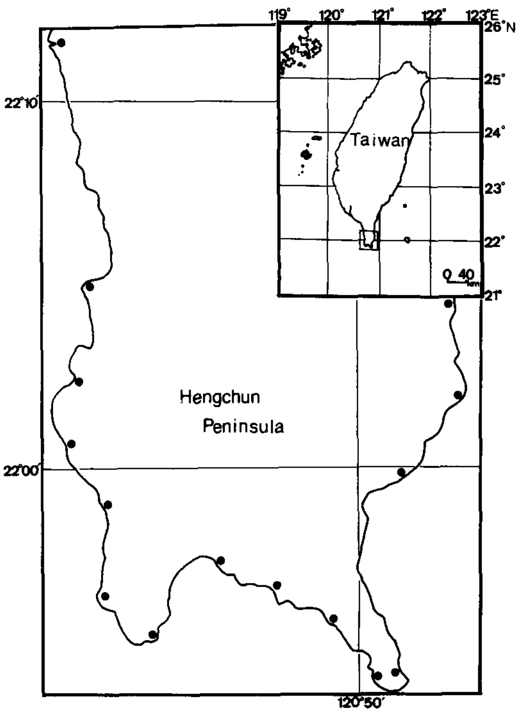

Fig. 1. A map showing localities (solid circles) where collection and study of the potential economic seaweeds were made.

Species Distribution and Seasonal Periodicity

The coverage, distribution and seasonal occurrence of potential economic seaweeds is shown in Table 1. Most species are more abundant in spring and winter, and fewer species in the summer. Many of the species have a large biomass and are widely distributed in the coastal water; they include *Sargassum* spp., *Enteromorpha* spp. and *Ulva* spp. The species of *Enteromorpha* and *Ulva* are found on the reef all year round. *Sargassum* spp. have the greatest biomass from January to early-May.

Caulerpa racemosa, Gracilaria spp., *Laurencia* spp., *Cladophora* spp., *Chaetomorpha* spp. and *Hypnea* spp. are also widely distributed in the coastal waters. Their standing crops are usually lower than the preceding group, and they appear to vary seasonally in biomass.

Monostroma latissimum, Porphyra spp., *Dermonema* spp., *Asparagopsis taxiformis, Halymenia microcarpa, Meristotheca coacta, Eucheuma* spp. and *Grateloupia filicina* are distinctly seasonal (Table 1).

Many other species, such as *Hydroclathrus*

TABLE 1. SPECIES, COVER, DISTRIBUTION, SEASONAL PERIODICITY AND UTILIZATIONS OF POTENTIAL ECONOMIC SEAWEEDS OF HENGCHUN PENINSULA, TAIWAN.

Scientific name	Collected sites[1]			Seasonal occurrence	Utilization[2]
	EC	SC	WC		
Chlorophyta					
Monostromaceae					
Monostroma latissimum Wittrock		++[3]	++	Oct.–Mar.	A
Ulvaceae					
Ulva conglobata Kjellman	+	+	+	Mar.–Sep.	A, B, C, D, H
U. fasciata Delile	++	++	++	Jan.–Dec.	A, B, C, D, H
U. lactuca Linnaeus	+++	+++	+++	Jan.–Dec.	A, B, C, D, H
U. pertusa Kjellman	+	+	+	Oct.–Jan.	A, B, C, D, H
U. reticulata Forsskål		+	+	Mar.–Oct.	A, B, C, D, H
Enteromorpha compressa (L.) Nees	+	+	+	Feb.–Apr.	A, B, D, H
E. intestinalis (L.) Nees	+	++	+	Jan.–Dec.	A, B, D, H
E. linza (L.) J. Agardh	+	++	+	Aug.–Apr.	A, B, D, H
E. plumosa Kützing	+	+	+	Aug.–Oct.	A, B, D, H
Cladophoraceae					
Chaetomorpha antennina (Bory) Kützing	+	+	+	Nov.–Aug.	A
Ch. basiretrorsa Setchell		+		Aug.–Oct.	A
Ch. crassa (C. Ag.) Kützing	++	++	++	Jan.–Dec.	A
Ch. linum (Muller) Kützing	++	++	++	Oct.–Mar.	A
Ch. spiralis Okamura		+		Oct.–Apr.	A
Cladophora meridionalis Sakai et Yoshida	+	+		Feb.–Nov.	A
Cl. patentiramea (Mont.) Kützing		+		Sep.–Nov.	A
Codiaceae					
Codium formosanum Yamada		+	+	Jan.–Apr.	A, D
C. intricatum Okamura		++	+	Jan.–Apr.	A, D
C. papillatum Tseng et Gilb.		+		Feb.–Apr.	A, D
C. reediae Silva		++	+	Feb.–Apr.	A, D
C. tenue Kützing		+		Jan.–May	A, D
Caulerpaceae					
Caulerpa parvifolia Harvey		+		Jan.–Jun.	A, I
C. racemosa var. *clavifera*					
f. *macrophysa* (Kütz.) Weber-van Bosse	+	+	++	Jan.–Dec.	A, I
f. *microphysa* Weber-van Bosse		+		Nov.–Aug.	A, I
C. racemosa var. *laete-virens* (Mont.) W.-v. B.	++	++	++	Jan.–Dec.	A, I
C. racemosa var. *peltata* (Lam.) Eubank	+	+	+	Jan.–Jul.	A, I
C. serrulata f. *lata* (Weber-van Bosse) Tseng		+		Mar.–May	A, I
C. sertularioides f. *longipes* (J. Ag.) Collins		+	+	Mar.–Jul.	A, I
C. taxifolia (Vahl) C. Agardh		+	+	Feb.–Aug.	A, I
C. webbiana f. *tomentella* (Harv.) W.-v. Bosse	++	+		Jan.–Apr.	A, I
Phaeophyta					
Scytosiphonaceae					
Colpomenia sinuosa (Mert. ex Roth) Derb. et Solier	+	++	++	Dec.–Jul.	A
Hydroclathratus clathratus (C. Ag.) Howe	+	++	+	Sep.–May	A
Sargassaceae					
Sargassum crassifolium J. Agardh	+	+	+	Sep.–Apr.	A, B, C, D
S. critaefolium C. Agardh	+	+	+	Jan.–Apr.	A, B, C, D
S. duplicatum J. Agardh	+++	+++	+++	Jan.–Apr.	A, B, C, D
S. glaucescens J. Agardh	+	++	++	Nov.–Feb.	A, B, C, D

TABLE 1. CONTINUED.

Scientific name	Collected sites[1] EC	SC	WC	Seasonal occurrence	Utilization[2]
S. ilicifolium (Turner) C. Agardh	+	+++	+	Jan.–Apr.	A, B, C, D
S. kushimotense Yendo	++	+		Oct.–Apr.	A, B, C, D
S. polycystum C. Agardh	+++	+++	+++	Oct.–Apr.	A, B, C, D
S. sandei Reinbold	+++	+++	+++	Feb.–Mar.	A, B, C, D
S. serratifolium (C. Ag.) C. Agardh		+	+	Mar.–Apr.	A, B, C, D
S. siliquosum J. Agardh	+	++	++	Dec.–Apr.	A, B, C, D
Rhodophyta					
Bangiaceae					
Porphyra vietnamensis Tanaka et P.-H. Ho	++			Nov.–Mar.	A, D
Porphyra sp.	+			Jan.–Mar.	A, D
Dermonemataceae					
Dermonema frappieri (Mont. et Mill.) Børgesen	++	+		Nov.–Apr.	A
D. pulvinatum (Grun. et Holm.) Fan		+		Feb.–Apr.	A
Bonnemaisoniaceae					
Asparagopsis taxiformis (Delile) Trevisan	+	+	+	Jan.–May	A
Gelidiellaceae					
Gelidiella acerosa (Forssk.) Feldm. et Hamel	+	+	+	Aug.–Apr.	A, F
Halymeniaceae					
Carpopeltis maillardii (Mont. & Mill.) Chiang	+	+	+	Jan.–Dec.	A, G
Grateloupia filicina (Lam.) C. Agardh			++	Jan.–Apr.	A, G
Halymenia microcarpa (Montagne) Silva	+	++	+	Jan.–Dec.	A, G, I
Gigartinaceae					
Gigartina intermedia Suringar	+	++	+	Jan.–May	A, G
Gracilariaceae					
Gracilaria arcuata Zanardini	+	+	+	Jan.–Apr.	A, F
G. chorda Holmes		+		Feb.–Apr.	A, F
G. coronopifolia J. Agardh	+	++	++	Jan.–Dec.	A, F
G. eucheumoides Harvey		+	+	Mar.–Dec.	A, F
G. incurvata Okamura		+		Aug.–Sep.	A, F
G. salicornia (C. Agardh) Dawson		+		Oct.–Jan.	A, F
G. vieillardii P. C. Silva		+		Apr.–May	A, F
Solieriaceae					
Eucheuma arnoldii Weber-van Bosse		++	++	Feb.–May	A, F, G
E. cottonii Weber-van Bosse	+	+		Nov.–Jul.	A, F, G
E. serra (J. Ag.) J. Agardh	+	+++	+	Feb.–Dec.	A, F, G
Meristotheca coacta Okamura		+	++	Mar.–Dec.	A, G
Hypneaceae					
Hypnea cervicornis J. Agardh	+	+++	+	Oct.–Jul.	A, F
H. charoides Lamouroux	+	+++	+	Oct.–Jul.	A, F
H. japonica Tanaka		+		Dec.–Jun.	A, F
H. pannosa J. Agardh	+	++	++	Jan.–Dec.	A, F
H. saidana Holmes		+		Sep.–Apr.	A, F
Rhodomelaceae					
Acanthophora spicifera (Vahl) Børgesen	+	+	+	Jan.–Dec.	A
Chondria armata (Kützing) Okamura	+	+	+	Jan.–Dec.	A, D
Laurencia brongniartii J. Agardh	+	++	+	Apr.–Dec.	A, D
L. flexilis var. *tropica* (Yamada) Xia et Zhang	+	++	+	Jan.–Dec.	D

TABLE 1. CONTINUED.

Scientific name	Collected sites[1] EC	SC	WC	Seasonal occurrence	Utilization[2]
L. papillosa (C. Ag.) Greville		+		Sep.–Jun.	A, D
L. pinnata Yamada		+		Jan.	A, D
L. undulata Yamada		+		Jan.–Apr.	A, D
Cyanobacteria					
Mastigocladaceae					
Brachytrichia quoyi (C. Ag.) Born. et Flah.	+	+	+	Feb.–May	A

[1] EC = the eastern coast of Hengchun; SC = the southern coast of Hengchun; WC = western coast of Hengchun.
[2] A = food; B = fodder; C = fertilizer; D = medicine; E = alginic acid; F = agar; G = carageenan; H = fish bait; I = landscape plant in aquaria.
[3] + = Covering 0–30% of substratum surface; ++ = Covering 31–70% of substratum surface; +++ = Covering 71–100% of substratum surface.

clathratus and *Colpomenia sinuosa* of the Phaeophyta, are abundant from March to April. Except for the above-mentioned species, the standing biomass of seaweeds is small and seasonal distributions of most species are limited.

There are a few differences found on the economic algal communities of all collected sites. On exposed rocks of the upper littoral zone where wave action is heavy, *Porphyra* spp. were only found on the eastern coast during November. The number of plants of this genus increased greatly during January, and decreased greatly during March. In the upper littoral zone, *Monostroma latissimum* was found growing abundantly on rocks of the western and the southern coasts during November, whereas it was replaced by a great number of *Ulva* spp. and *Enteromorpha* spp. during January. In the lower littoral zone, *Grateloupia filicina* only blooms on rocks or reefs of the western coast from January to March. In the sublittoral zone, *Codium* can also be found as blooms of the western and the southern coasts from February to April. Except for these differences, the economic algal communities on the western, the southern and the eastern coasts of Hengchun are similar.

Generally, the supralittoral zone of this area is poor in vegetation, only small patches of *Brachytrichia quoyi* can be found growing on rocks from February to May. In the littoral zone, *Ulva fasciata, U. lactuca, Enteromorpha intestinalis, Caulerpa racemosa* var. *laete-virens, C. racemosa* var. *clavifera* f. *macrophysa,* and *Chondria armata* can be found growing on rocks all year round. During November, the economic algal community in the middle littoral zone is a mixture of *Enteromorpha* spp., *Ulva lactuca, U. pertusa, Chaetomorpha spiralis, Gelidiella acerosa, Hypnea* spp., *Acanthophora spicifera* and *Laurencia* spp. growing abundantly on rocks and reefs. During January, the plants of *Caulerpa racemosa* var. *peltata* and *Gigartina intermedia* in the middle littoral zone were found in addition to the algae previously mentioned. The number of plants of *Colpomenia sinuosa, Hydroclathrus clathratus, Gelidiella acerosa* and *Gigartina intermedia* greatly decreased in the middle littoral zone during April. From June to September, the vegetation of the littoral zone is relatively poor.

In the lower littoral zone, there were *Carpopeltis maillardii, Laurencia* spp., *Hypnea cervicornis, H. pannosa* and *Gracilaria coronopifolia* growing abundantly. During May, a great number of *H. cervicornis* were found, but they decreased greatly during June. From July to September, they were replaced by *Gracilaria coronopifolia* interspersed with *Caulerpa racemosa* var. *laete-virens, C. racemosa* var. *clavifera* f. *macrophysa* and *Meristotheca coacta* on rocks of the lower littoral zone. *Hypnea pannosa* replaced many of these plants during October.

On the limestone-platform of the upper and the middle littoral zones, scattered patches of *Enteromorpha* spp., *Chaetomorpha* spp., *Caulerpa racemosa* var. *clavifera* f. *macrophysa, C. racemosa* var. *laete-virens, Colpomenia sinuosa, Hydroclathrus clathratus, Sargassum crassifolium, S. polycystum, Halymenia microcarpa, Hypnea pannosa, Acanthophora spicifera, Chondria armata* and *Laurencia flexilis* var. *tropica* were found growing in tidal pools during November. During January, a number of plants of *Caulerpa racemosa* var. *peltata, C. webbiana* f. *tomentella* and *Sargassum duplicatum* were found in addition to those which were growing during November. During April, *Gracilaria eucheumoides* were the dominant algae in the tidal pools. From June to September, in the tidal pools *Ulva lactuca, Caulerpa racemosa* var. *clavifera* f. *macrophysa* and *C. racemosa* var. *laete-virens* were abundant.

The economic algal communities at the edges of indentations of the middle and lower littoral zones were quite complex. There were *Ulva lactuca, Chaetomorpha crassa, Caulerpa racemosa* var. *laete-virens, Sargassum* spp., *Carpopeltis maillardii* and *Gracilaria eucheumoides* growing abundantly in November. By January, the economic algal community of this area had not changed very much from that of November. By April, the quantity of algae of this area had increased very much over that of January; the marked change resulted from a great number of *Gracilaria arcuata* and *Eucheuma serra* which occupied the edges of indentations of the middle and the lower littoral regions. *Laurencia* spp. and other algae grew among them. From June to September, the vegetation of the edges of the littoral zone decreased greatly.

In the lower littoral and the sublittoral zones, young plants of *Sargassum* spp. were found from July to September and there was a belt of *Sargassum* from January to April. During June, the biomass of *Sargassum* decreased greatly because of the high frequency of thunderstorms and typhoons.

In the sublittoral zone, a number of plants of *Halymenia microcarpa* and *Asparagopsis taxiformis* were found from February to April. During June, a great number of *Laurencia brongniartii* were found growing on reefs.

Seaweeds Utilization

The local inhabitants use seaweed as human and animal food, fish bait, fertilizer, and for medical purposes (Table 1). The majority of edible seaweeds are those which belong to the genera *Brachytrichia, Monostroma, Caulerpa, Porphyra, Dermonema, Gracilaria, Halymenia, Grateloupia* and *Laurencia*. The blue-green algae (cyanobacteria) genus *Brachytrichia*, the green *Caulerpa* and the red *Gracilaria, Dermonema, Halymenia, Grateloupia* and *Laurencia* are the most popular of sea vegetables. These are eaten raw after being dipped in sauce, blanched as a salad vegetable, or pickled with sauce. The sauce is prepared by combining vinegar, ginger, garlic, sugar, chilli and a little rice wine. The seaweed is mixed with this sauce and may also be fried with meat. *Monostroma* or *Porphyra* is put in soup with egg and some scallion. Limited quantities of *Monostroma* are processed for "Hai-Tsai Jam" (sea vegetable jam).

Seaweeds used for medical purposes and fertilizer include the brown algal genus *Sargassum*. Thalli of this genus are collected by coastal residents. The sun dried material is then purchased by merchants to be processed, principally for its medical value. However, the local people do use *Sargassum* to treat hypertension by boiling a small amount of the dried algae in water and drinking it as a tea.

The only seaweed used locally for animal food, is *Ulva* (for feeding pigs).

Enteromorpha and *Ulva* species are often used by fishermen as bait. These are specifically used to catch 'white hair' (*Kyphosus*) and 'black hair' (*Girella*) fish.

Discussion

Hengchun is a tropical site, and the seaweed flora is poor (Taniguti 1971) with only 88 genera and 161 species (Chiang and Wang 1987). About three-fourths of the economic genera (including *Monostroma, Enteromorpha, Ulva, Caulerpa, Sargassum, Porphyra, Halymenia, Gracilaria, Grateloupia* and *Laurencia*) of Taiwan are found in this area, however, only small quantities are commercially collected and production is very low. The most abundant seaweeds including species of *Hypnea* and *Codium* have not been utilized. The reason for this is the inhabitants do not know how to utilize them and their natural production is low.

Both *Sargassum* and *Eucheuma* are utilized widely (Okazaki 1971; Waaland 1977). According to Chou (1977), the natural production of *Sargassum* along the Hengchun shores is about 600 tons dry weight per year, which is not sufficient to support an industry for the extraction of alginic acid. Production could be increased by culturing this species on artificial blocks.

There has been success in the cultivation of *Eucheuma* and *Caulerpa racemosa* in the shallow seas of the Philippines (Krauss 1977; Doty 1980; Tseng 1981). Taiwan may also try cultivating these species in a similar fashion, in order to increase production.

There are many phycocolloid-producing seaweeds in this area such as *Sargassum, Gratelou-*

pia, Halymenia, Eucheuma, Gracilaria, Gelidiella, Carpopeltis and *Meristotheca* (Table 1). Currently none is used for extracting phycocolloids because of low production. Mass culture would be needed to supply seaweeds for this purpose. Other useful seaweeds present include *Caulerpa* spp. and *Halymenia microcarpa,* all of which are used as landscape plants in aquaria. About one-tenth of aquaria stores in Taiwan sell these algae. The former alga costs N.T.$100 per 10 cm^2, the latter one costs N.T.$150 per 15 cm thallus. A "seaweed solution" made from *Sargassum,* is also used as a foliar fertilizer to improve fruit qualities in horticultural crops.

Economic Potential

The global current supply of carageenan comes from two red algal genera *Kappaphycus* and *Eucheuma* of the Philippines and Indonesia, which produce kappa and iota carrageenans respectively (McHugh 1991; Trono 1992; Luxton 1993). The lambda carrageenan supply of the world comes from harvesting natural populations of *Chondrus crispus* from Canada, New England and Northern Europe (Cheny et al. 1981). There is no commercially cultivated source of lambda carageenan. Therefore, if a red alga contains lambda-rich carrageenan and can be cultivated easily on a commercial scale, it would be of industrial interest. Recently, in the course of studies on the Halymeniaceae of Taiwan, it has been found that *Halymenia microcarpa* is an ideal seaweed, and has been successfully cultivated on a small scale twice (Chiang 1992). We believe that farming *Halymenia microcarpa* on an industrial scale is now workable.

In addition to lambda carrageenan extract (Science Newsletter 1991) the yield of which was high (Lii personal communication), *Halymenia microcarpa* is also used as food in Hawaii (Tokuda et al. 1987). This red alga can also be used to remove nitrogen waste in a crustacean aquarium system. The uptake rate of three forms of nitrogen (ammonium, nitrate and nitrite) of *Halymenia microcarpa* is higher than *Ulva fasciata, Hypnea japonica, Eucheuma cottonii, E. spinosum* and *Sargassum duplicatum* (Chen 1993).

Perhaps the greatest potential for *H. microcarpa* is the production of lambda carrageenan extract. Of those carrageenophytes, *H. microcarpa* is the most promising as it produces a high-level of carrageenan extract and has a relatively fast growth rate. However, it would have to be cultured to enhance its utilization, as it does not grow abundantly in Hengchun. The greater biomass of *Grateloupia filicina* within the same area may make it a potentially important source of lambda carageenan.

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Book Review

Determinator of Broomrapes of the USSR Flora. E. S. Teryokhin, G. V. Schibakina, N. B. Szaphimovich and T. J. Kravtsova. Nauka, St. Petersburg. 1993. 124 pp. (hardcover), illus. In Russian with English summary. Price not available.

The USSR flora is rich in the Orobanchaceae and the family has been the subject of studies by these authors for many years. This book, the latest in a series of publications on the family, deals mainly with morphology and includes helpful SEM pictures of seed surfaces as well as copious diagrams and pictures of fruits, pericarps, stigmas, and androecial features. Seven genera are recognized in the USSR flora. *Phelipanche* is treated as distinct from *Orobanche*; the widespread and serious agronomic week known as *Orobanche ramosa* now becomes *Phelipanche ramosa.* Using these morphological studies, a new classification scheme is presented requiring several new taxonomic combinations.

The classic monograph of Beck-Managetta of 60 years ago was based on excruciatingly fractured taxonomy even including forms and subforms often obfuscating an understanding of the family and relationships within it. This current monograph provides a clear overview of the family and paves the way for further investigations. Hopefully, these new studies will include modern molecular systematics.

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