

## THREE SPECIES OF *SARGASSUM* (PHAEOPHYCEAE) WITH COMPRESSED PRIMARY BRANCHES IN THE GULF OF THAILAND

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### ABSTRACT

Three species of *Sargassum* with compressed primary branches, *S. binderi* Sonder, *S. oligocystum* Montagne and *S. swartzii* (Turner) C.A. Agardh, have been described from the Gulf of Thailand. *S. swartzii* is the first record of this species from the coast of Thailand. A key for these three species and for each species descriptions have been completed. The clear distinction among these three species is clearly shown and discussed. *S. binderi* has slender lanceolate leaves, a dentate margin along the compressed stem of its vesicles, and clear spines along the whole margin of the flattened receptacles. *S. oligocystum* has broader lanceolate leaves with an acute to rounded apex, almost entire, spherical vesicles, and only few spines on the margin of the slightly compressed receptacles. *S. swartzii* has linear lanceolate leaves, pointed or crowned vesicles, and few spines near the tip of its almost terete receptacles.

**Keywords:** Phaeophyceae, *Sargassum binderi*, *S. oligocystum*, *S. swartzii*, the Gulf of Thailand

### INTRODUCTION

*Sargassum* C. Agardh (Sargassaceae, Fucales), a very large brown seaweed genus including nearly 400 species, is widely distributed in warm and temperate waters, especially in the Indo-west Pacific region and Australia (Tseng *et al.*, 1985). Thailand is a tropical country in south-east Asia with a coastline of approximately 2,650 kilometers, consisting of 1,880 kilometers along the Gulf of Thailand (Pacific Ocean) and 770 kilometers along the Andaman Sea (Indian Ocean); both coasts have a diverse seaweed flora. Thai species of *Sargassum* were first reported by Reinbold in the "Flora of Koh Chang" from the specimens collected by Schmidt during the Danish Expedition to Siam 1899-1900. *S. polycystum* C.A. Agardh was reported from Koh Kahdat, Trat Province situated on the east coast of the Gulf of Thailand (Schmidt, 1900-1916). Lewmanomont (1988) reported *S. polycystum* from coral reefs along the Gulf of Thailand, and *S. crassifolium*

J.G. Agardh and *S. polycystum* from the Andaman Sea. Egerod (1974) collected *S. grevillei* J.G. Agardh on the Fifth Thai-Danish Expedition of 1966 from Koh Ra, Ranong Province, the Andaman Sea (this species may be a misidentification of *S. stolonifolium* Phang et Yoshida [Ajisaka and Lewmanomont (2004)]. Nateewathana *et al.*, (1981) and Aungtonya and Liao (2002) compiled and updated the extensive checklist, adding *S. crassifolium*, *S. granuliferum* C.A. Agardh and *S. siliquosum* J.G. Agardh from the Reference Collection of the Phuket Marine Biological Center (PMBC). Ajisaka and Lewmanomont (2004) reported *S. stolonifolium* Phang et Yoshida from the Andaman Sea.

In this paper, we describe three *Sargassum* species with compressed primary branches, *S. binderi* Sonder, *S. oligocystum* Montagne and *S. swartzii* (Turner) C.A. Agardh and discuss on the clearly distinguishable characters among these species.

## MATERIALS AND METHODS

The specimens were collected from nine provinces along the Gulf of Thailand: Chon Buri, Rayong, Chanthaburi, Trat (the east coast); Prachuap Khirikhan, Chumphon, Surat Thani, Nakhon Si Thammarat and Songkhla (the west coast) (Fig. 1) from 2001-2006. Whole thalli (with holdfasts) were collected during low tide. Specimens from the deeper areas were collected by SCUBA diving. Some of the collected specimens were fixed in 4% formaldehyde-seawater, and the remainder were dried on herbarium sheets. Important morphological characters of the thallus were drawn and sections of receptacles have been prepared and stained with 1% aniline blue intensified with 1% HCl and mounted on glass slides using 50% glucose syrup (Karo Syrup, Corn Products). The specimens from this study are deposited at the Bangsaen Institute of Marine Science (BIMS), Burapha University and Kasetsart University Museum of Fisheries (KUMF).

## RESULTS

### Key to *Sargassum* species with compressed primary branches

1. Receptacle flattened or slightly compressed..2
1. Receptacle terete .....*S. swartzii*
2. Sharp spines along the whole margin of each receptacle .....*S. binderi*
2. Only a few spines on the margin of each receptacle..... *S. oligocystum*

### Description of The Species

*Sargassum binderi* Sonder in J.G. Agardh, 1848, p. 328 (Fig. 2)

J.G. Agardh, 1889, p. 87, Figs. 26-2; Yamada, 1925, p. 245; Chou and Chiang, 1981, p. 143; Yoshida, 1988, p.10; Trono, 1992, p. 46, Figs. 1-4, 109; 1997, p. 128, Fig. 86; Tseng and Lu, 1995b, p. 96, Fig. 9; Ajisaka *et al.*, 1999, p. 28, Fig. 3

Holdfast discoid, up to 12 mm in diameter. Stem terete, smooth to warty, up to 3 mm in

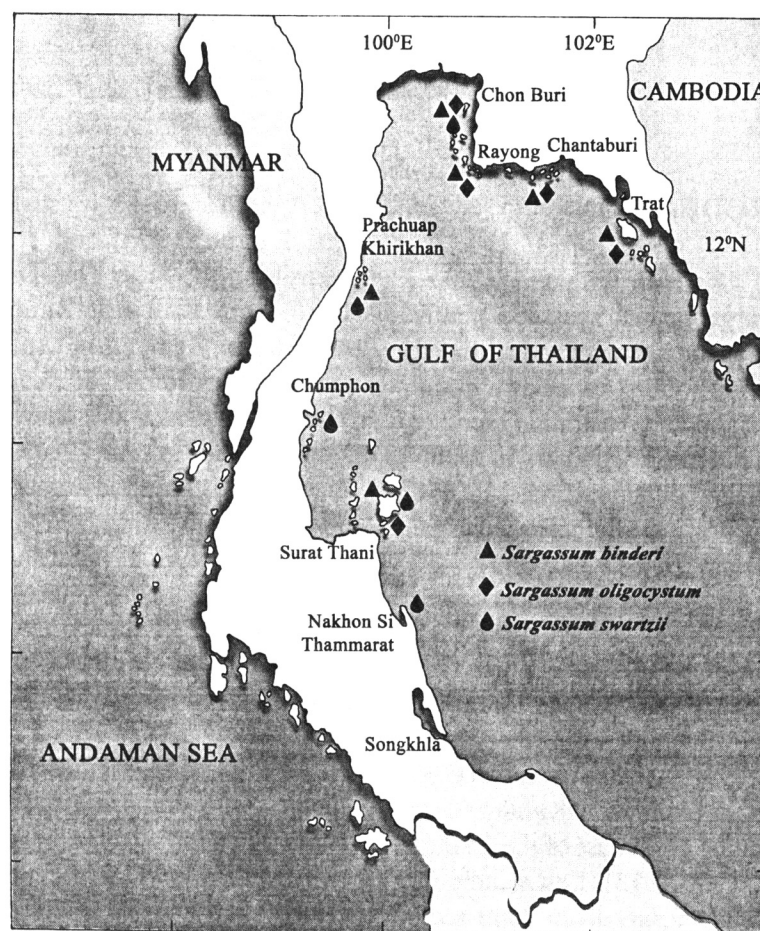
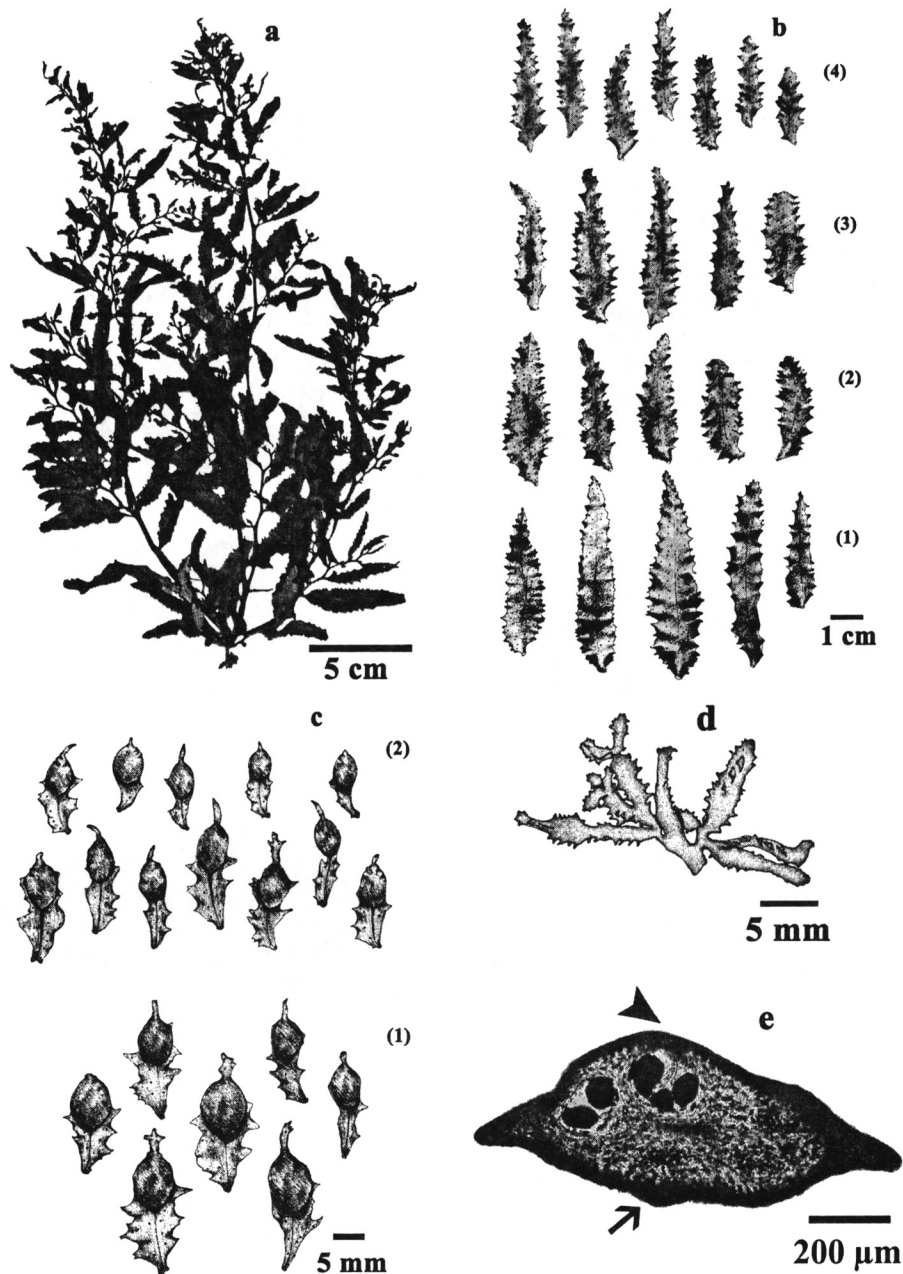


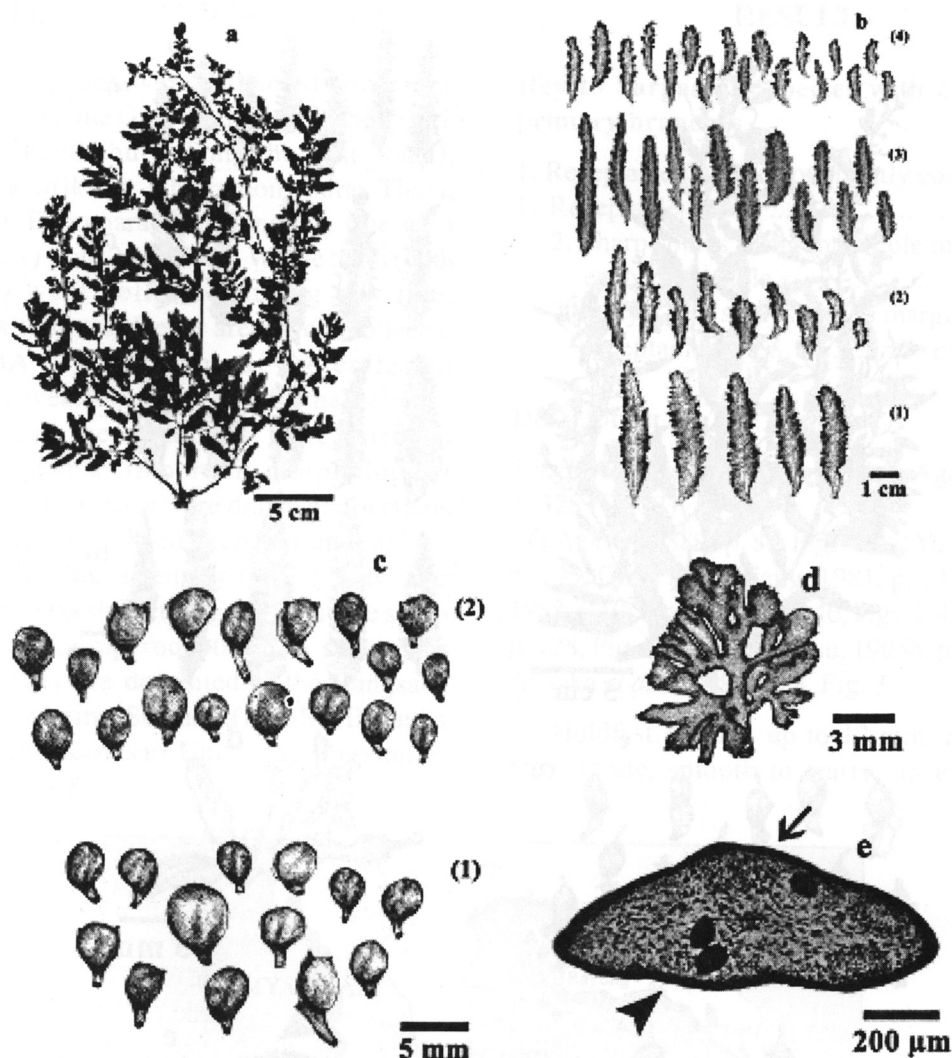
Figure 1. Study area and distribution of collecting sites along the Gulf of Thailand



**Figure 2.** *Sargassum binderi* Sonder. a. Habit, b. Leaves: (1) primary leaves in lower parts, (2) primary leaves in upper parts, (3) secondary leaves in lower parts, (4) secondary leaves in upper parts, c. Vesicles: (1) primary branches, (2) secondary branches, d. Androgynous receptacles, e. Transverse section of receptacle showing male conceptacles (arrow) and female conceptacles (arrowhead).

diameter, about 1 cm long, producing 6-8 spirally arranged primary branches. Primary branches flattened to compressed, smooth, up to 46 cm long, and up to 5 mm wide. Secondary branches distichously arranged, slightly compressed, smooth, up to 40 cm long, branching interval of up to 4 cm. Lower leaves slender lanceolate, simple, with asymmetrical base, up to 8 cm long, and up to 16

mm wide, with acute to round apex, margin entire to dentate with sharp teeth, midrib distinct near apex, small cryptostomata scattered; upper leaves slender lanceolate, simple, with asymmetrical to cuneate base, up to 7 cm long, and up to 11 mm wide, with acute to round apex, margin dentate with small teeth, midrib vanishing near apex, small and cryptostomata scattered. Vesicles spherical



**Figure 3.** *Sargassum oligocystum* Montagne. a. Habit, b. Leaves: (1) primary leaves in lower parts, (2) primary leaves in upper parts, (3) secondary leaves in lower parts, (4) secondary leaves in upper parts, c. Vesicles: (1) primary branches, (2) secondary branches, d. Androgynous receptacles, e. Transverse section of receptacle showing male conceptacles (arrow) and female conceptacles (arrowhead).

to elliptical, up to 10 mm long, up to 6 mm wide, and up to 5 mm thick, often mucronate at the margin and pointed, occasionally entire, stalk flattened, with dentate margin, usually as long as the vesicle or longer than the vesicle.

Plants monoecious. Receptacles androgynous, flattened, often twisted, up to 18 mm long, up to 2 mm wide, sharply dentate along the whole margin, simple to furcate, racemously arranged.

Habitat: Growing on rocks and dead corals of intertidal to subtidal areas.

Distribution: Trat Province: Chang Islands and Kut Island. Chantaburi Province: Khung Kraban. Rayong Province: Suan Son, Man Nai Island and

Saket Island. Chon Buri Province: Nang Rong Beach, Samae San Island and Kham Island. Prachuap Khirikhan Province: Thong Lang Beach. Surat Thani Province: Samui Island.

*Sargassum oligocystum* Montagne, Voy. Pot. Sud. Bot. 1:67, 1845. (Fig. 3)

Reinbold, 1913, p. 156; Grunow, 1915, p. 383; Pham, 1967, p. 295; Tseng, 1983, p. 234, pl. 118, Fig. 1; Noro et al., 1994, p. 27, Fig 3; Tseng and Lu, 1995b, p. 100, Fig. 10; Lewmanomont and Ogawa, 1995, p. 83; Ajisaka et al., 1999, p. 34, Fig. 8

Holdfast discoid, up to 12 mm in diameter. Stem terete, smooth, up to 4 mm in diameter, about 12 mm long, producing 6-8 spirally arranged primary branches. Primary branches flattened to compressed, smooth, up to 49 cm long, and up to 4 mm wide. Secondary branches distichously arranged, terete to slightly compressed, smooth, up to 19 cm long, branching interval of up to 5 cm. Lower leaves broad lanceolate to spatulate, with simple, asymmetrical base, up to 6 cm long, and up to 18 mm wide, with round apex, margin entire to dentate with small teeth, midribs distinct, vanishing near apex, small cryptostomata scattered; upper leaves lanceolate to spatulate, with simple, asymmetrical base, up to 4 cm long, and up to 19 mm wide, with rounded apex, margin entire to dentate with small teeth, midrib vanishing near apex, small cryptostomata scattered. Vesicles spherical to elliptical, up to 4 mm long, up to 4 mm wide, and up to 3 mm thick, usually entire at the apex, seldomly with small appendages, stalk terete, usually much shorter than the vesicle.

Plants monoecious. Receptacles androgynous, slightly compressed, up to 9 mm long, up to 3 mm wide, warty or with few spines on the margin, simple to furcated twice or three times, racemosely arranged.

Habitat: Growing on rocks and dead corals of reef flats to subtidal areas.

Distribution: Trat Province: Kut Island. Chantaburi Province: Khung Kraban and Khung Wiman. Rayong Province: Man Nai Island and Samet Island. Chon Buri Province: Nang Rong Beach and Samae San Island. Surat Thani Province: Samui Island.

*Sargassum swartzii* (Turner) C.A. Agardh, Sp. Algarum, vol.1, 11, 1820. (Fig.4)

Basionym: *Fucus swartzii* Turner, Fuci, vol. 4, pl. 248, 1819.

C.A. Agardh, 1824, p. 296; J.G. Agardh, 1848, p. 328; 1889, p. 85, pl. 26.1; Reinbold, 1913, p. 157; Grunow, 1915, p. 381; Setchell, 1935, p. 3, pl. 1; Yamada, 1942, p. 25, fig. 1; Pham, 1967, p. 293, Fig. 13; Tseng, 1983, p. 238, pl. 120, Fig. 1; Noro et al., 1994, p. 27, Figs. 4, 9; Tseng and Lu, 1995a, p. 79, Fig. 10; Ajisaka, 2002, p. 82, Figs. 12-15

Holdfast discoid, up to 17 mm in diameter. Stem terete, smooth, up to 4 mm in diameter, about 7 mm long, producing 4-8 spirally arranged primary branches. Primary branches compressed, smooth, up to 140 cm long, and up to 6 mm wide. Secondary

branches distichously arranged, compressed, smooth, up to 63 cm long, branching interval of up to 8 cm. Lower leaves elongate to linear lanceolate, simple, with asymmetrical base, up to 8 cm long, and up to 11 mm wide, usually with acute apex, margin dentate, midrib distinct near apex, small cryptostomata scattered; upper leaves linear lanceolate, simple, with asymmetrical base, up to 6 cm long, and up to 6 mm wide, with acute apex, margin dentate with small teeth, midrib vanishing near apex, small cryptostomata arranged in one row. Vesicles usually elliptical, simple, up to 10 mm long, up to 6 mm wide, and up to 5 mm thick, usually pointed or occasionally with a short crown leaf, margins entire, stalk terete to slightly compressed or cuneate (terete at the lower part and compressed at the upper part), usually as long as the vesicles, occasionally longer than the vesicles.

Plants monoecious. Receptacles terete, occasionally slightly compressed, up to 16 mm long, and up to 2 mm wide, simple to furcated two-five times, bearing few spines near the apex, arranged in a cyme to compound cyme, pseudozygocarpic with a vesicle.

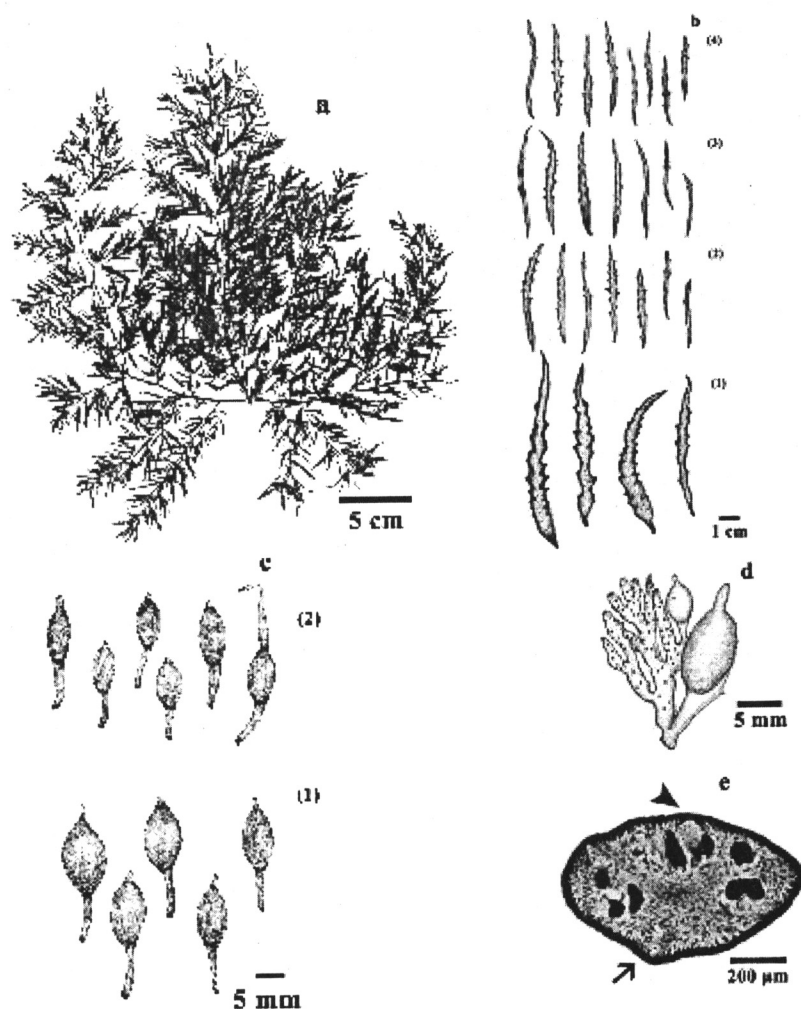
Habitat: Growing on rocks and dead corals of intertidal to subtidal areas.

Distribution: Chon Buri Province: Nang Rong Beach. Prachuap Khirikhan Province: Thong Lang Beach. Chumphon Province: Ban Bang Jak and Ban San Siam. Surat Thani Province: Samui Island. Nakhon Si Thammarat Province: Hin Ngam Beach.

## DISCUSSION

*Sargassum binderi*, *S. oligocystum* and *S. swartzii* are often confused at the South-East Asian coasts because they have compressed primary branches and monoecious (androgynous) receptacles. Morphological characters were compared for these three species in Thailand (Table 1).

*Sargassum binderi* has been characterized by the receptacles with sharply spinous margin in the original description (J.G. Agardh, 1848) and this was recognized in the descriptions of Chinese specimens (Tseng and Lu, 1995b). Womersley and Bailey (1970) suggested that *S. binderi* was a synonym of *S. oligocystum*. However, we retain *S. binderi* on the basis of its character receptacles with a clear spinous margin. *S. oligocystum* has



**Figure 4.** *Sargassum swartzii* (Turner) C.A. Agardh. a. Habit, b. Leaves: (1) primary leaves in lower parts, (2) primary leaves in upper parts, (3) secondary leaves in lower parts, (4) secondary leaves in upper parts, c. Vesicles: (1) primary branches, (2) secondary branches, d. Androgynous receptacles, e. Transverse section of receptacle showing male conceptacles (arrow) and female conceptacles (arrowhead).

receptacles with only apical spines (Noro *et al.*, 1994). *S. binderi* from Thailand closely resembles to the specimens reported from China and Malaysia (Tseng and Lu, 1995b; Ajisaka *et al.*, 1999) in the morphology of its vesicles and receptacles. These vesicles are spherical to elliptical, often mucronate and pointed at their apex, occasionally entire. The stalk of the vesicle is flattened, has a clear dentate margin and is usually as long as the vesicle or longer than the vesicle. Receptacles are monoecious, flattened, twisted and having sharply spinous margin. Noro *et al.*, (1994) reported this species is “mostly monoecious or rarely dioecious”, however we observed only monoecious in our materials.

*Sargassum oligocystum* from Thailand closely resembles the specimens from Malaysia (Ajisaka *et al.*, 1999) and Japan (Ajisaka *et al.*, 1995) in the morphology of their compressed primary branches; spherical to elliptical vesicles with entire apex, occasionally with small appendages on one side or both sides, and terete stalks which are shorter than the vesicles; receptacles slightly compressed, warty or with few spines on the margin, and pseudozygocarpic. However, our specimens (monoecious) differ from those of China (Tseng and Lu, 1995b) and the Philippines (Trono, 1992) which are dioecious. Noro *et al.*, (1994) reported that *S. oligocystum* has receptacles with apical spines. Tseng (1983)

**Table 1.** Comparison of three species of *Sargassum* with compressed primary branches in the Gulf of Thailand.

Characters	<i>S. binderi</i>	<i>S. oligocystum</i>	<i>S. swartzii</i>
Primary branch	compressed	compressed	compressed
length(max)	46 cm	49 cm	140 cm
width(max)	5 mm	4 mm	6 mm
Leaves			
morphology	slender lanceolate	broad lanceolate	linear lanceolate
apex	acute to rounded	rounded	acute
length (max)	8 cm	6 cm	8 cm
width (max)	16 mm	18 mm	11 mm
Vesicles			
morphology	spherical to elliptical	spherical to elliptical	elliptical
length(max)	10 mm	4 mm	10 mm
width(max)	6 mm	4 mm	6 mm
depth(max)	5 mm	3 mm	5 mm
apex	spines, pointed	round, rarely pointed	pointed, crowned
stalk	flattened, longer than vesicle	terete, shorter than vesicle	terete to cuneate, same length as vesicle
margin of stalk	dentate	smooth	smooth
Receptacles	androgynous	androgynous	androgynous
morphology	flattened	compressed	terete or slightly compressed
length(max)	18 mm	9 mm	16 mm
width(max)	2 mm	3 mm	2 mm
spines	sharp along the margin	few on the margin	few near the tip

reported in Chinese specimens that the vesicles are ovate or ellipsoidal, often crowned and mucronate at the apices, and borne on subcylindrical stalks, while the receptacles were flattened, forked, with coarsely spinous margins.

*Sargassum swartzii* has spines only at the tips of receptacles (J.G. Agardh, 1848). However, Noro *et al.*, (1994) reported that *S. oligocystum* has receptacles with apical spines and *S. swartzii* has receptacles without spines. It is very confusing. Tseng and Lu (1995a, 1995b) reported that *S. swartzii* had receptacles with small apical spines, but they did not include any information on receptacles in Chinese specimens of *S. oligocystum*. Thai specimens of *S. swartzii* closely resemble to the specimens from China (Tseng and Lu, 1995a, 1995b) and Malaysia (Ajisaka, 2002) in having lanceolate to linear lanceolate leaves, which are acute at the apex; vesicles elliptical, pointed at the apex, with entire margins, cuneate stalks; receptacles compressed, usually terete or

slightly compressed. Thai specimens distinctly differ from those of Australia (Noro *et al.*, 1994) in having linear leaves, elliptical vesicles, and usually terete receptacles. *Sargassum swartzii* has some resembling characters with *S. binderi* and *S. oligocystum*. However, *S. swartzii* is distinguished easily by its linear leaves and cymosely arranged receptacles with few spines near the tips. This species is a new record for Thailand.

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