

Species of *Sargassum* in the East Coast of the Gulf of Thailand

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ABSTRACT: Four species of *Sargassum* are reported from the east coast of the Gulf of Thailand. They are *Sargassum baccularia* (Mertens) C.A. Agardh, *S. binderi* Sonder, *S. oligocystum* Montagne, and *S. polycystum* C.A. Agardh. The common species are *S. binderi*, *S. oligocystum* and *S. polycystum* distributed in all the study areas while *S. baccularia* has been found only in Chantaburi and Trat Province. *S. baccularia* is similar to *S. polycystum* but lacks spines on the axis and secondary holdfast. *S. polycystum* has a secondary holdfast transformed from the primary branch on the stem. Of the three species reported, *S. baccularia*, *S. binderi* and *S. oligocystum* are new records for Thailand.

KEYWORDS: *Sargassum*, *S. baccularia*, *S. binderi*, *S. oligocystum*, *S. polycystum*, Gulf of Thailand.

INTRODUCTION

Sargassum C. Agardh (Sargassaceae, Fucales), a very large brown seaweed genus with nearly 400 species, is widely distributed in warm and temperate waters, especially in the Indo-west Pacific region and Australia.¹ Thailand is a tropical country in south-east Asia with coastline of approximately 2,650 kilometers, of which 1,880 kilometers are along the Gulf of Thailand (Pacific Ocean) and 770 kilometers along the Andaman Sea (Indian Ocean); both coasts have with a diverse seaweed flora. Reports of Thai species of *Sargassum* was first recorded by Reinbold in "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.² Lewmanomont collected *S. polycystum* from coral reefs along the Gulf of Thailand.³ Egerod collected *S. grevillei* J. Agardh on the Fifth Thai-Danish Expedition of 1966 from Koh Ra, Ranong Province the Andaman Sea.⁴ Lewmanomont collected *S. crassifolium* J. G. Agardh and *S. polycystum* from coral reefs along the Andaman Sea.³ Nateewathana *et al.*; Aungtonya and Liao compiled and updated the extensive checklist, adding *S. crassifolium*, *S. granuliferum* C. Agardh and *S. siliguosum* J. Agardh from the Reference Collection of the Phuket Marine Biological Center (PMBC).^{5,6} Ajisaka and Lewmanomont reported *S. stolonifolium* Phang et Yoshida from along the Andaman Sea.⁷ Since the first expedition, we have still not examined *Sargassum* species on the east coast of the Gulf of Thailand. This paper

presents descriptions and distribution of *Sargassum* species along the east coast of the Gulf of Thailand.

MATERIALS AND METHODS

The specimens were collected from four provinces along the east coast of the Gulf of Thailand : Chon Buri, Rayong, Chanthaburi and Trat (Fig. 1) from 2001-2004. The whole thalli (with holdfast) were collected during low tide. Specimens from the deeper area were collected by SCUBA diving. Some of the collected specimens were fixed in 4 % formaldehyde-seawater, and the remainder was dried on herbarium sheets. Important parts of the thallus were drawn and sections were stained with 1 % aniline blue intensified with 1 % HCl and mounted using a 50 % glucose syrup (Karo Syrup, Corn Products) on glass slides. The identification was based on taxonomic references for each description of type and followed: Trono (1992, 1997)^{8,9}; Tseng and Lu (1992, 1995)^{10,11}; Chiang *et al* (1992)¹²; Noro, Ajisaka and Yoshida (1994)¹³; Lewmanomont and Ogawa (1995)¹⁴; Ajisaka, Noro and Yoshida (1995)¹⁵ and Ajisaka, Phang and Yoshida (1999)¹⁶. The specimens from this study are deposited in Bangsaen Institute of Marine Science (BIMS), Burapha University and Kasetsart University Museum of Fisheries (KUMF).

RESULTS AND DISCUSSION

Four species of *Sargassum* were recorded, they are *S. baccularia*, *S. binderi*, *S. oligocystum* and *S. polycystum*. All the four species commonly grow on submerged

substrate particularly on rocks and dead corals in littoral and sublittoral zones. The plants are more abundant in Chanthaburi and Trat than Chon Buri and Rayong (Fig. 1). The common species are *S. binderi*, *S. oligocystum* and *S. polycystum* distributed along the eastern area. *S. baccularia*, *S. binderi*, *S. oligocystum* are new records for Thailand, *S. baccularia* has been found only in Chantaburi and Trat.

Key to species of *Sargassum* from the east coast of the Gulf of Thailand

- 1. Secondary holdfast transformed from stolons and main branch terete, warty or with spines. *S. polycystum*
- 1. Secondary holdfast lacking and main branches terete, without spines. 2
- 2. Primary branches terete, plants dioecious. *S. baccularia*
- 2. Primary branches compressed or flattened, plant monoecious. 3
- 3. Receptacles flattened, often twisted with dentate margins, vesicle stalks flattened. *S. binderi*
- 3. Receptacles compressed, not twisted, with apical spines, vesicle stalks terete. *S. oligocystum*

Description of the species

***Sargassum baccularia* (Mertens) C.A. Agardh (Fig. 2)**

Tseng and Lu, 1992, p. 16, fig. 17; Trono, 1992, p. 46, Fig. 93; 1997, p. 127; Ajisaka, Phang and Yoshida, 1999, p. 25, Fig. 2.

Holdfast discoid, up to 17 mm in diameter. Stem terete, warty, up to 3 mm diameter, 1.5 cm long, producing 3-5 primary branches arranged spirally. Primary branches terete, smooth, up to 200 cm long, up to 2 mm in diameter; lower leaves large, lanceolate, simple, with an asymmetrical base, up to 45 mm long and to 13 mm wide, with rounded apices, margin dentate with small teeth, midrib distinct near apices, small cryptostomata scattered; upper leaves lanceolate to linear, simple, asymmetrical base, up to 40 mm long and to 8 mm wide, with rounded or sharp apices, margin dentate with small teeth, midrib distinct near apices, small cryptostomata scattered or in rows on both sides of the midrib. Secondary branches arranged spirally, terete, smooth, up to 32 cm long and to 9 cm in branching interval; lower leaves lanceolate to linear, simple, asymmetrical base, up to 40 mm long and to 10 mm wide, with rounded apices, margin dentate with small

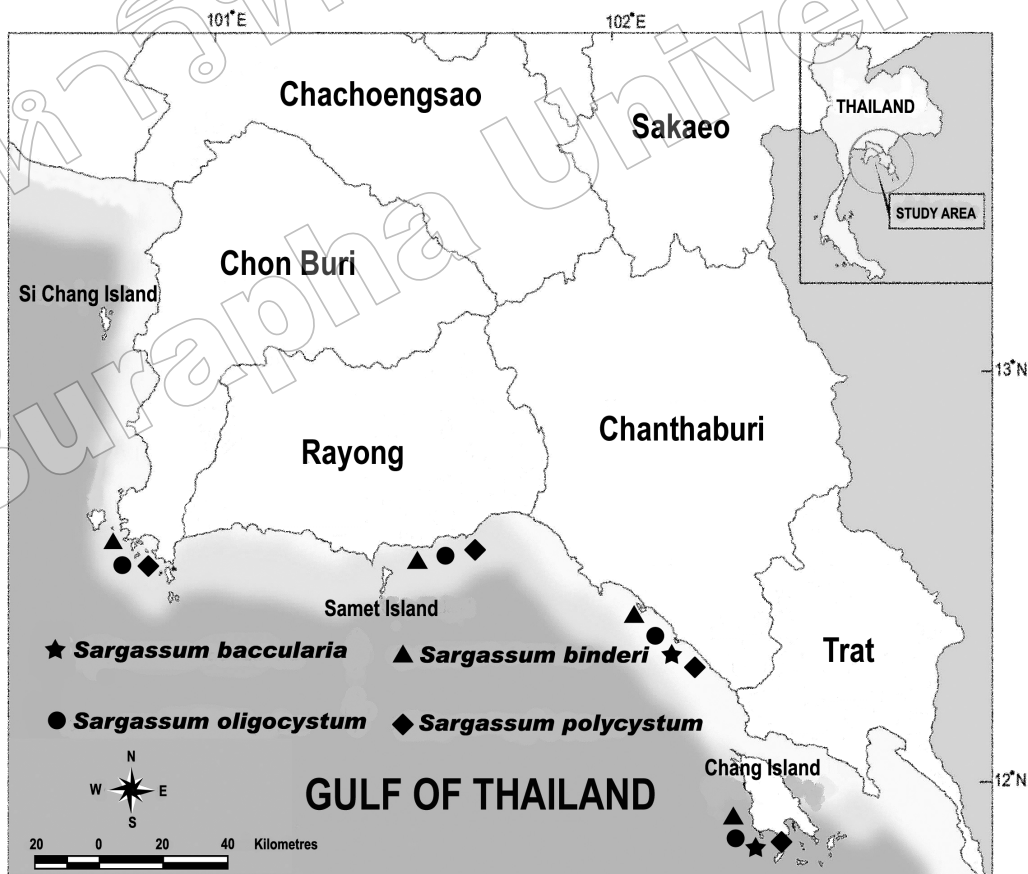


Fig 1. Study area and distribution of collection sites for *Sargassum* along the east coast of the Gulf of Thailand.

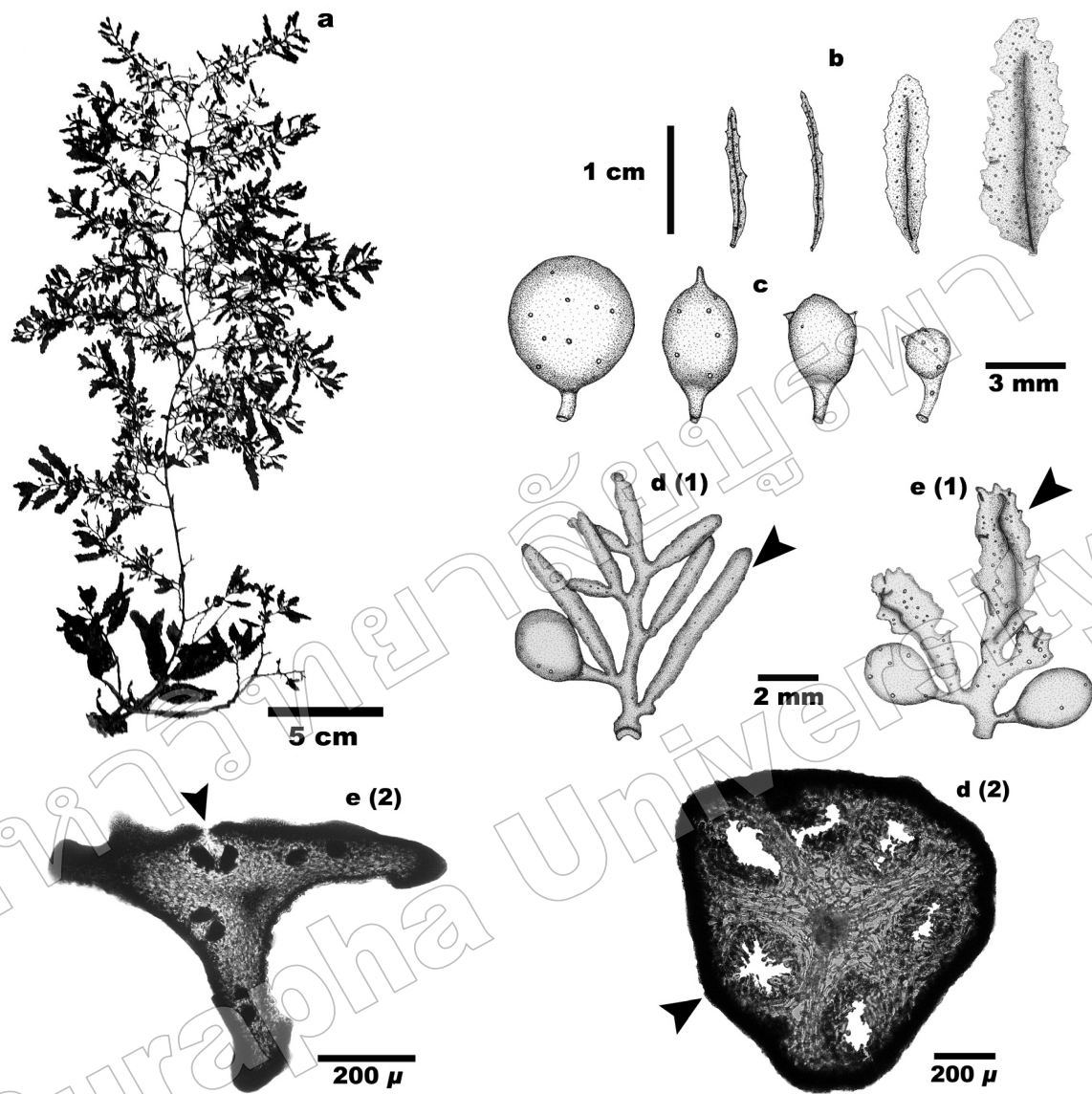


Fig 2. *Sargassum baccularia* (Mertens) C.A. Agardh. a. Habit., b. Leaves., c. Vesicles., d. (1) Male receptacles (arrowhead), (2) Transverse section of male receptacle showing male conceptacles (arrowhead)., e. (1) Female receptacles (arrowhead), (2) Transverse section of female receptacle showing female conceptacles (arrowhead).

teeth, midrib distinct near apices, small cryptostomata scattered or in rows on both sides of the midrib; upper leaves lanceolate to linear, simple, asymmetrical base, up to 30 mm long and to 4 mm wide, with rounded or sharp apices, margin dentate with small teeth, midrib distinct near apices and evanescent, small cryptostomata arranged in rows on both sides of the midrib (Fig. 2b). Vesicles spherical, sometimes elliptical, up to 4.5 mm long, to 4 mm wide and to 3 mm thick, entire at the apices, sometimes mucronate, stalks terete, usually shorter than the vesicles themselves (Fig. 2c).

Plants dioecious. Male receptacles long, terete, up

to 10 mm long and to 2 mm wide, with smooth surface, simple to once to twice furcate (Figs. 2d (1-2)). Female receptacles triquetrous, up to 10 mm long and to 2 mm wide, with a warty surface, sometimes bearing spines near the apex, simple to furcated (Figs. 2e (1-2)). Male and female receptacles arranged in a raceme, pseudozygocarpic with a vesicle.

Remarks: This species has no secondary holdfast and sometimes has a few spines or otherwise smooth branches. It is similar to *S. polycystum*, which has secondary holdfast transformed from the stolon and heavily muricate on main branches¹⁶. This is the first

record from Thailand.

***Sargassum binderi* Sonder** (Fig. 3)

Trono, 1992, p. 46, Figs. 1-4, 109; 1997, p. 128, Fig. 86; Tseng and Lu, 1995, p. 96, Fig. 9; Ajisaka, Phang and Yoshida, 1999, p. 28, Fig. 3.

Holdfast discoid, up to 12 mm in diameter. Stem terete, smooth to warty, up to 3 mm diameter, 1 cm long, producing 6-8 primary branches arranged spirally. Primary branches flattened or compressed, smooth, up to 46 cm long and to 5 mm wide; lower leaves large, lanceolate, simple, asymmetrical base, up to 77 mm long and to 16 mm wide, with rounded apices, margin entire to dentate with small teeth, midrib distinct near apices or vanishing midway, small cryptostomata scattered; upper leaves slender lanceolate, simple, with an asymmetrical to cuneate base, to 66 mm long and 11

mm wide, with rounded or slightly sharp apices, margin dentate with small teeth, midrib vanishing near apices, small and scattered cryptostomata. Secondary branches arranged distichously, slightly compressed, smooth, up to 40 cm long and to 3.8 cm in branching interval; lower leaves lanceolate to linear, simple, asymmetrical base, up to 64 mm long and to 15 mm wide, with rounded apices or sharp apices, margin dentate with sharp teeth, midrib vanishing near apices, small cryptostomata scattered, sometimes arranged in rows on both sides of the midrib; upper leaves lanceolate to linear, simple, asymmetrical to cuneate base, up to 7 mm long and to 9 mm wide, with sharp apices, margin dentate with sharp teeth, midrib vanishing near apices, small cryptostomata arranged in rows on both sides of the midrib, sometimes scattered (Fig. 3b). Vesicles spherical to elliptical, up to 10 mm long, to 6 mm wide

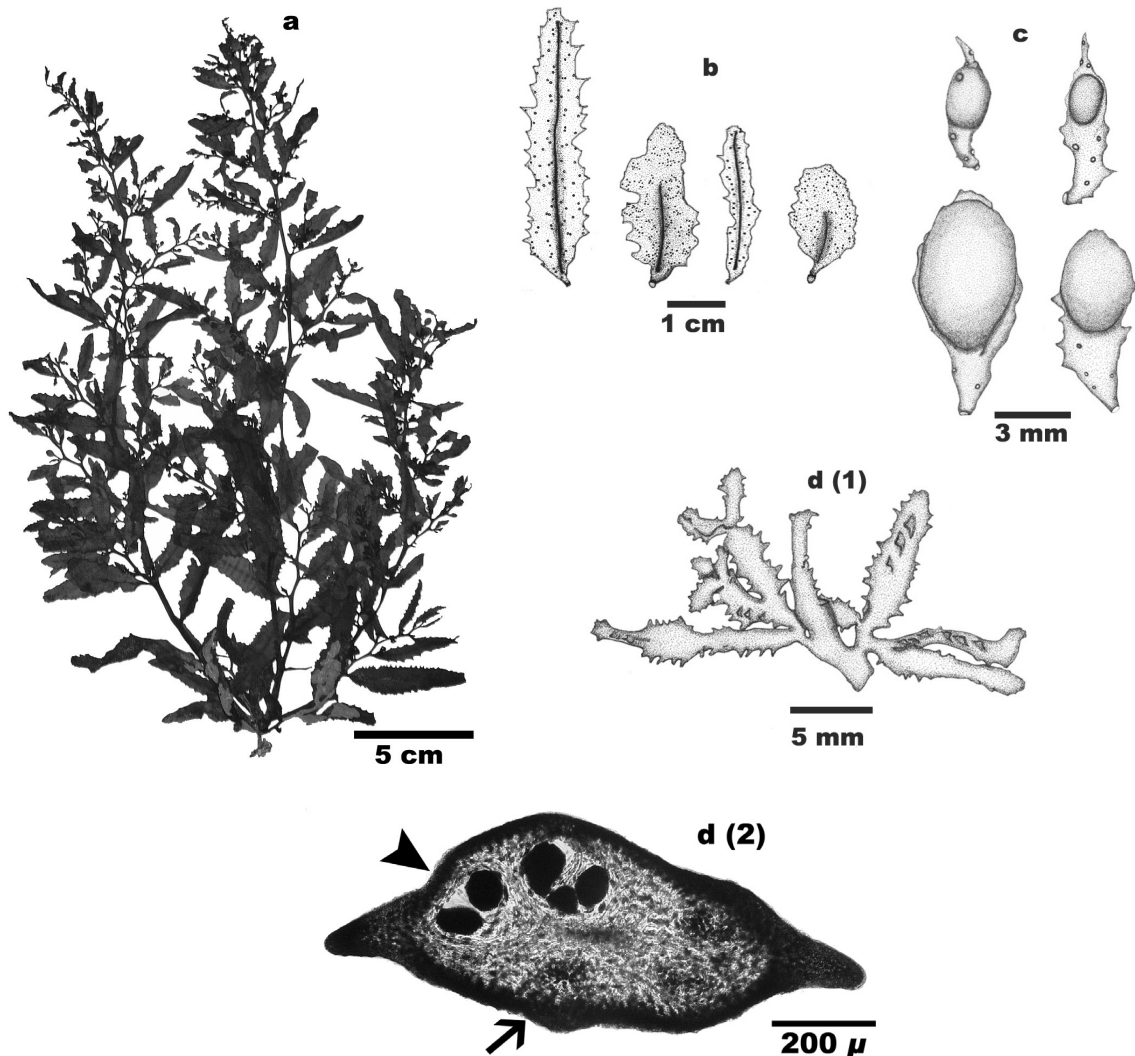


Fig 3. *Sargassum binderi* Sonder. a. Habit., b. Leaves., c. Vesicles., d. (1) Androgynous receptacles, (2) . Transverse section of receptacles showing male conceptacles (arrow) and female conceptacles (arrowhead).

and to 5 mm thick, often mucronate at the apices, sometimes entire, stalks flattened, usually longer than the vesicles (Fig. 3c).

Plants monoecious. Receptacles androgynous, flattened, often twisted, up to 18 mm long and to 2 mm wide, sharply dentate at the margin, simple to furcate, racemously arranged, clustered (Figs. 3d (1-2)).

Remarks: This species and *S. oligocystum* overlap in many characters. Our specimens resemble quite closely the specimens from China and Malaysia^{11,16}, in the form of their flattened primary branches; spherical to elliptical vesicles which are often mucronate at their apices, sometimes entire, stalks and receptacles flattened, receptacles twisted, with a sharply dentate margin. This is the first record from Thailand.

***Sargassum oligocystum* Montagne**

(Fig. 4)

Trono, 1992, p. 60, Figs. 35-38, 115; 1997, p. 143, Fig. 94; Noro, Ajisaka and Yoshida, 1994, p. 27, Fig. 3; Tseng and Lu, 1995, p. 100, Fig. 10; Lewmanomont and Ogawa, 1995, p. 83; Ajisaka, Phang and Yoshida, 1999, p.34, Fig. 8.

Holdfast discoid, up to 12 mm in diameter. Stem terete, smooth, up to 4 mm diameter, 12 mm long, producing 6-8 primary branches arranged spirally. Primary branches flattened or compressed, smooth, up to 49 cm long and to 4 mm wide; lower leaves lanceolate to spatulate, with simple asymmetrical base, up to 54 mm long and to 18 mm wide, with rounded apices, margin entire to dentate with small teeth, midrib distinct, vanishing near apices, small cryptostomata

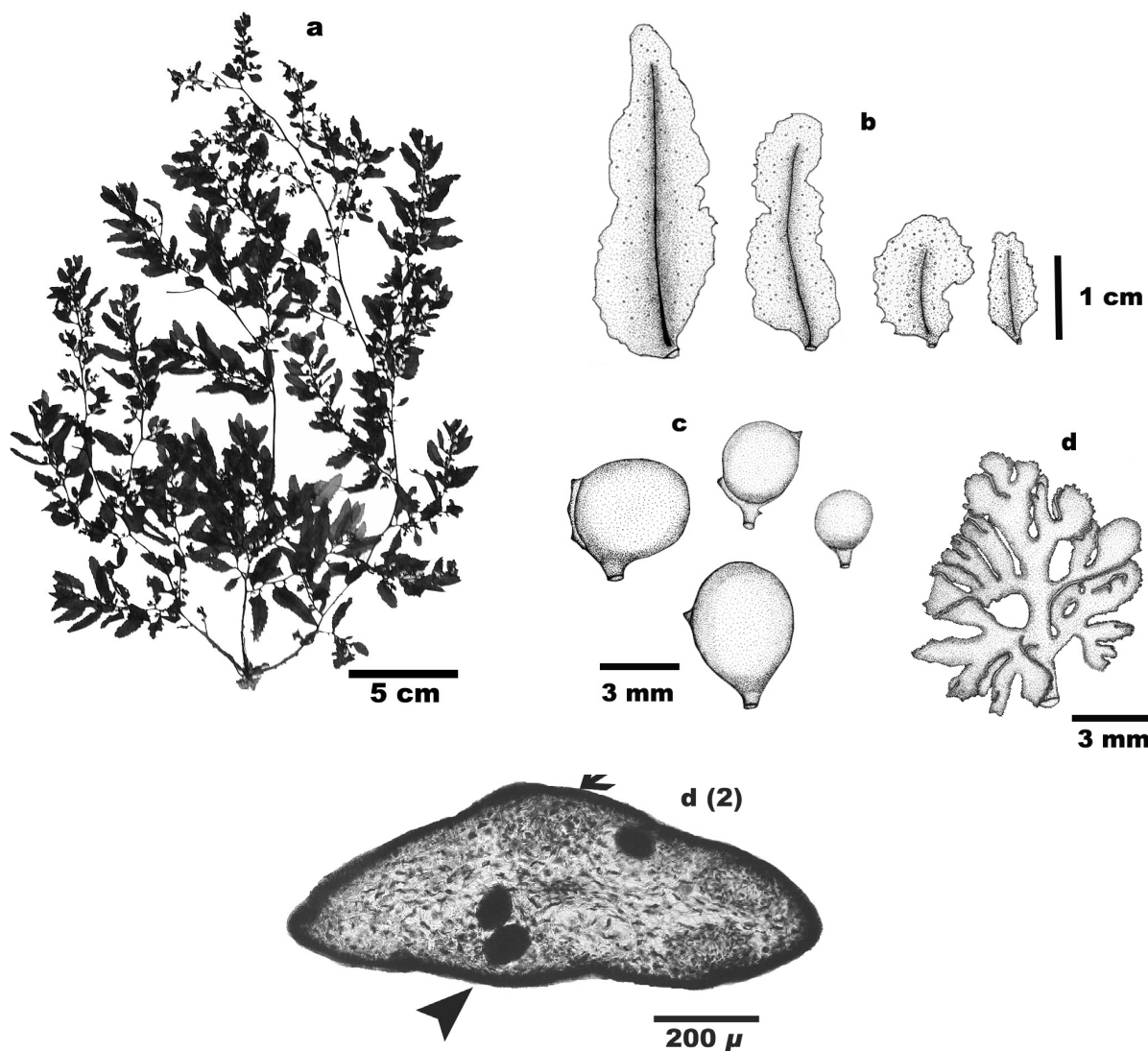


Fig 4. *Sargassum oligocystum* Montagne. a. Habit., b. Leaves., c. Vesicles., d. (1) Androgynous receptacles, (2) Transverse section of receptacles showing male conceptacles (arrow) and female conceptacles (arrowhead).

scattered; upper leaves lanceolate to spatulate, with simple asymmetrical base, up to 35 mm long and to 19 mm wide, with rounded apices, margin entire to dentate with small teeth, midrib vanishing near apices, small cryptostomata scattered. Secondary branches arranged distichously, terete to slightly compressed, smooth, up to 19 cm long and to 5.3 cm in branching interval; lower leaves lanceolate to spatulate, simple, asymmetrical base, up to 34 mm long and to 10 mm wide, with rounded apices, margin entire to dentate with small teeth, midrib vanishing near apices, small cryptostomata scattered; upper leaves lanceolate to spatulate, simple, asymmetrical base, up to 24 mm long and to 8 mm wide, with rounded apices, margin entire to dentate with small teeth, midrib vanishing near apices, small cryptostomata scattered (Fig. 4b). Vesicles spherical to elliptical, up to 4 mm long, to 4 mm wide and to 3 mm thick, entire at the apices, sometimes provide appendage, stalks terete, usually shorter than the vesicles (Fig. 4c).

Plants monoecious. Receptacles androgynous, slightly compressed, up to 9 mm long and to 3 mm wide, warty to few spines at the margin, simple to furcated 2 or 3 times, racemosely arranged, clustered, pseudozygocarpic with vesicles (Figs. 4d (1-2)).

Remarks: Our specimens resemble quite closely the specimens from Malaysia¹⁶, in the form of their compressed primary branches; spherical to elliptical vesicles, entire at the apices, sometimes with an appendage, stalks terete; receptacles slightly compressed, warty to few spines at the margin. Our specimens also differ from those from China¹¹ and Philippines^{8,13}, in that the latter have flattened primary branches, and are dioecious. This is the first record from Thailand.

***Sargassum polycystum* C.A. Agardh** (Fig. 5)

Chiang *et al.*, 1992, p. 36, Figs. 1-12; Trono, 1992, p. 63; 1997, p. 147, Fig. 96; Ajisaka, Noro and Yoshida, 1995, p. 34, Figs. 19-20; Lewmanomont and Ogawa, 1995, p. 84; Ajisaka, Phang and Yoshida, 1999, p. 36, Fig. 6.

Holdfast discoid, up to 13 mm in diameter. Stem terete, warty, up to 3 mm diameter, 4 mm long, bearing up to 5 stolons and 7-9 primary branches arranged spirally. Stolons terete or slightly compressed at their proximal portions, up to 12 cm long and to 2 mm wide. Primary branches usually muricate with prolifically branched spines (Fig. 5f), transformed into stolon and secondary holdfast (Fig. 5g), up to 200 cm long and to 2 mm in diameter; lower leaves elliptical to lanceolate, simple, asymmetrical or with a cuneate base, up to 45 mm long and to 13 mm wide, with rounded apices, margin dentate with coarse teeth, midrib distinct, vanishing near apices, small and scattered

cryptostomata; upper leaves lanceolate to linear, simple, asymmetrical to a cuneate base, up to 40 mm long and to 10 mm wide, with rounded to sharp apices, margin dentate with coarse teeth, midrib distinct, vanishing near apices, small cryptostomata scattered to arranged in rows on both sides of the midrib. Secondary branches arranged spirally, terete, crowded with spines, up to 60 cm

long and to 16 cm in branching interval; lower leaves linear-lanceolate to spatulate, simple, asymmetrical to acunate base, up to 30 mm long and to 7 mm wide, with rounded to sharp apices, margin dentate with coarse teeth, midrib distinct, vanishing near apices, small cryptostomata scattered to arranged in rows on both sides of the midrib; upper leaves linear-lanceolate to spatulate, simple, symmetrical to a cuneate base, up to 25 mm long and to 6 mm wide, with rounded to sharp apices, margin dentate with coarse teeth, midrib distinct, vanishing near apices, small cryptostomata scattered to arranged in rows on both sides of the midrib (Fig. 5b). Vesicles spherical to obovate, to 8 mm long, to 6 mm wide and to 5 mm thick, entire at the apices or with earlike wings on both sides of the vesicles, stalks terete, usually shorter than the vesicles themselves (Fig. 5c).

Plants dioecious. Male receptacles long, terete, up to 15 mm long and to 1 mm wide, with warty surface, simple to forked once (Figs. 5d (1-2)). Female receptacles terete to slightly compressed, up to 4 mm long and to 1 mm wide, with warty surface, simple to forked once (Figs. 5e (1-2)). Male and female receptacles arranged in a raceme, halozygocarpic with vesicles.

Remarks: This species has a secondary holdfast transformed from stolons (modified primary branches) and is heavily muricate on primary branches.^{12,15,16} Our specimens sometimes lacked stolons. It is easily distinguished from other species of *Sargassum* in Thailand.

In this paper, four species of *Sargassum* were found in the east coast of the Gulf of Thailand, three of which are the first record from Thailand. All earlier reports on *Sargassum* in this area only recorded *S. polycystum*; we think that *S. polycystum* is similar to *S. baccularia* and that these species were confused because *S. polycystum* sometimes lacked stolons and spines.

ACKNOWLEDGEMENTS

We are deeply indebted to Professor Khanjanapaj Lewmanomont for reading and improving the manuscript. Our thanks go to the Institute of Marine Science, Burapha University; the Faculty of Fisheries, Kasetsart University and the Department of Natural Resources, Graduate School of Global Environmental Studies, Kyoto University. This study was supported by

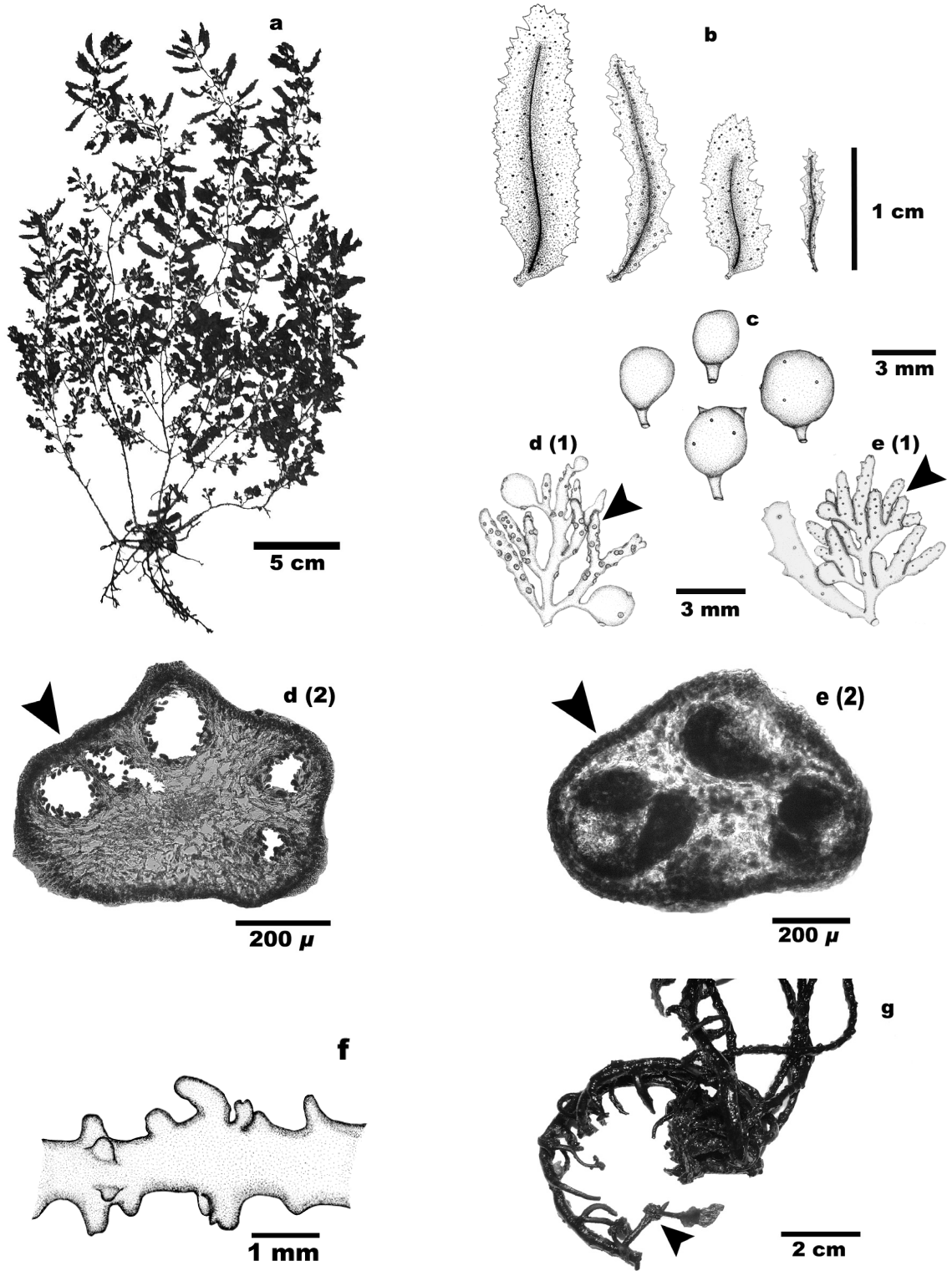


Fig 5. *Sargassum polycystum* C.A. Agardh. a. Habit., b. Leaves., c. Vesicles., d. (1) Male receptacles (arrowhead), (2) Transverse section of male receptacle showing male conceptacles (arrowhead)., e. (1) Female receptacles (arrowhead), (2) Transverse section of female receptacle showing female conceptacles (arrowhead)., f. Spines on primary branch., g. Secondary holdfast (arrowhead).

the JSPS Multilateral Core University Program on Coastal Marine Science, Japan.

REFERENCES

1. Tseng CK Yoshida T and Chiang YM (1985) East Asiatic Species of *Sargassum* subgenus *Bactrophycus* J. Agardh (Sargassaceae, Fucales), with Keys to the Section and Species. In: *Taxonomy of Economic Seaweeds with reference to some Pacific and Caribbean species* (Edited by Abbott IA and Norris JN), pp. 1-14. California Sea Grant College Program.
2. Schmidt J (1900-1916) Flora of Koh Chang. Contributions to the Knowledge of the Vegetation in the Gulf of Siam. Bianco Luno, Copenhagen, 444 pp.
3. Lewmanomont K (1988) Marine Algae of Coral Reefs of Thailand. *Thai Fisheries Gazette*. **41**, 561-8.
4. Egerod L (1974) Report of the Marine Algae Collected on the Fifth Thai-Danish Expedition of 1966. *Botanica Marina*. **17**, 130-57.
5. Nateewathana A Tantichodok P Busarawich S and Sirivejabandhu R (1981) Marine Organisms in the Reference Collection. *Phuket mar biol Cent Res Bull* **28** 43-82.
6. Aungtonya C and Liao LM (2002) Marine Flora (Algae and Seagrasses) in the Reference Collection of the Phuket Marine Biological Center, Thailand. *Phuket mar biol Cent Res Bull* **64**, 65-80.
7. Ajisaka T and Lewmanomont K (2004) Variations in the Basal System and Stolons of *Sargassum stolonifolium* in the Andaman Sea. In: *Taxonomy of Economic Seaweeds with reference to some Pacific and other locations vol. 9* (Edited by Abbott IA and McDermid KJ), pp. 57-72. The Hawaii Sea Grant College Program.
8. Trono GC Jr (1992) The Genus *Sargassum* in the Philippines. In: *Taxonomy of Economic Seaweeds with reference to some Pacific and Western Atlantic species vol. 3* (Edited by Abbott IA), pp. 43-94. California Sea Grant College.
9. Trono GC Jr. (1997) Field Guide and Atlas of the Seaweed Resources of the Philippines. Bookmark, Inc. Philippines. 306 pp.
10. Tseng CK and Lu Baoren (1992) Studies on the Malacocarpic *Sargassum* of China: II. *Racemosae* J. Agardh. In: *Taxonomy of Economic Seaweeds with reference to some Pacific and Western Atlantic species vol. 3* (Edited by Abbott IA), pp. 11-34. California Sea Grant College.
11. Tseng CK and Lu Baoren (1995) Studies on the Glomerulate *Sargassum* of China: III. The Species Group *Binderia*. In: *Taxonomy of Economic Seaweeds with reference to some Pacific species vol. 5* (Edited by Abbott IA), pp. 93-106. California Sea Grant College System.
12. Chiang Young-Meng Yoshida T Ajisaka T Trono GC Jr Tseng CK and Lu Baoren. (1992) Distribution and Variation in *Sargassum polycystum* C.A. Agardh (Fucales, Phaeophyta). In: *Taxonomy of Economic Seaweeds with reference to some Pacific and Western Atlantic species vol. 3* (Edited by Abbott IA), pp. 35-42. California Sea Grant College.
13. Noro T Ajisaka T and Yoshida T (1994) Species of *Sargassum* Subgenus *Sargassum* (Fucales) with Compressed Primary Branches. In: *Taxonomy of Economic Seaweeds with reference to some Pacific species vol. 4* (Edited by Abbott IA), pp. 23-31. California Sea Grant College.
14. Lewmanomont K and Ogawa H (1995) Common Seaweeds and Seagrasses of Thailand. Faculty of Fisheries, Kasetsart University. 164 pp.
15. Ajisaka T Noro T and Yoshida T 1995. Zygoecarpic *Sargassum* Species (Subgenus *Sargassum*) from Japan. In: *Taxonomy of Economic Seaweeds with reference to some Pacific species vol. 5* (Edited by Abbott IA), pp. 11-44. California Sea Grant College System.
16. Ajisaka T Phang SM and Yoshida T (1999) Preliminary Report of *Sargassum* Species Collected from Malaysian Coasts. In: *Taxonomy of Economic Seaweeds with reference to some Pacific species vol. 7* (Edited by Abbott IA), pp. 23-41. California Sea Grant College System.