

3. RESULTS

3.1 Diversity study

A total of 52 species were identified representing 22 species of Rhodophyta, 16 species of Chlorophyta, 9 species of Phaeophyceae in Chromophyta and 5 species of Cyanobacteria (Table 1). Of these, 9 species are believed to be new records for the Thai marine flora.

Species numbers varied during the study period and ranged from a low of 15 species (March 2004) to a high of 29 species (May and July 2004). *Lyngbya majuscula*, *Halimeda opuntia*, *Boergesenia forbesii*, *Valonia aegagropila*, *Dictyosphaeria cavernosa*, *Boodlea composita*, *Acanthophora spicifera*, *Chondrophycus tronoi*, *Ceramium mazatlanense*, *Gelidiella acerosa*, *Gracilaria salicornia*, *Hypnea spinella* and *Padina australis* were found throughout the year. On the other hand, *Symploca* sp., *Bryopsis pennata*, *Caulerpa racemosa* var. *peltata*, *Acetabularia pusilla*, *A. exigua*, *A. parvula*, *Enteromorpha flexuosa* subsp. *paradoxa*, *Valoniopsis pachynema*, *Chondrophycus papillosus*, *Polysiphonia sphaerocarpa*, *Corallophila huysmansii*, *Gracilaria irregularis*, *G. rhodymenioides*, and *Sargassum* spp. had only a single occurrence.

Table 1. Seasonality of macroalgae at Sirinat Marine National Park, Phuket Province, Thailand, between January 2004 and November 2004.

Taxa	Sheltered						Semi-exposed						Exposed					
	Jan	Mar	May	Jul	Sep	Nov	Jan	Mar	May	Jul	Sep	Nov	Jan	Mar	May	Jul	Sep	Nov
Division Cyanobacteria																		
<i>Calothrix scopulorum</i> (Weber & Mohr) C. Agardh				+	+											+		
<i>Lyngbya majuscula</i> (Dillwyn) Harvey	+	+	+	+			+	+	+				+	+	+			
<i>Lyngbya</i> sp.				+														
<i>Symploca hydroides</i> (Harvey) Kützing				+	+				+	+	+	+				+	+	+
<i>Symploca</i> sp.											+							
Division Chlorophyta																		
<i>Bryopsis pennata</i> Lamouroux																		+
<i>Caulerpa racemosa</i> var. <i>peltata</i> (Lamouroux) Eubank																		+
<i>Halimeda opuntia</i> (Linnaeus) J.V. Lamouroux		+		+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
<i>Chlorodesmis hildebrandtii</i> A. Gepp & E. Gepp																	+	
<i>Acetabularia pusilla</i> (Howe) Collins*										+								
<i>Acetabularia exigua</i> Solms-Laubach										+								
<i>Acetabularia parvula</i> Solms-Laubach										+					+			
<i>Enteromorpha flexuosa</i> (Wulfen) J. Agardh subsp. <i>paradoxa</i> (C. Agardh) Bliding																		+
<i>Anadyomene wrightii</i> Harvey ex J. Gray				+	+					+	+		+			+	+	+
<i>Boergesenia forbesii</i> (Harvey) J. Feldmann	+	+	+	+	+	+		+	+	+	+	+		+	+	+	+	+
<i>Cladophoropsis sundanensis</i> Reinbold										+	+	+				+	+	
<i>Valonia aegagropila</i> C. Agardh	+			+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
<i>Valoniopsis pachynema</i> (G. Martens) Børgesen																		+
<i>Dictyosphaeria cavernosa</i> (Forsskål) Børgesen		+	+	+	+	+	+	+	+	+	+	+	+		+	+	+	+
<i>Boodlea composita</i> (Harvey) F. Brand	+	+	+	+	+	+	+			+	+	+			+	+	+	+
<i>Struvea anastomosans</i> (Harvey) Piccone & Grunow ex Piccone	+	+	+	+						+					+	+		
Division Rhodophyta																		
<i>Jania capillacea</i> Harvey	+	+	+		+					+		+		+				+
<i>Tolyptocladia glomerulata</i> (C. Agardh) Schmitz										+	+	+	+			+	+	+
<i>Acanthophora spicifera</i> (M. Vahl) Børgesen	+	+	+		+	+	+	+	+	+	+	+		+	+	+		+
<i>Chondrophycus papillosus</i> (C. Agardh) Greville				+														
<i>Chondrophycus tranoi</i> (Ganzon-Fortes) Nam*	+	+	+	+	+	+	+	+	+	+	+	+		+	+	+	+	+

Table 1. (Continued)

Species	Sheltered			Semi-exposed			Exposed			Sheltered			Semi-exposed			Exposed		
	Jan	Mar	May	Jul	Sep	Nov	Jan	Mar	May	Jul	Sep	Nov	Jan	Mar	May	Jul	Sep	Nov
<i>Chondrophycus dotyi</i> (Saito) Nam*												+			+			
<i>Polysiphonia sphaerocarpa</i> Børgesen*									+						+			
<i>Centroceras clavulatum</i> (C. Agardh) Montagne									+							+		
<i>Ceramium mazatlanense</i> Dawson	+	+	+				+	+	+				+	+	+			+
<i>Champia parvula</i> (C. Agardh) Harvey			+		+				+									
<i>Corallophila huysmansii</i> (Weber-van Bosse) R.E. Norris*									+									
<i>Gelidiopsis variabilis</i> (J. Agardh) F. Schmitz*				+	+	+						+						
<i>Gelidiella acerosa</i> (Forskål) Feldmann & G. Hamel			+	+		+	+	+	+	+	+	+	+	+	+	+	+	+
<i>Gelidiella pannosa</i> (J. Feldmann) J. Feldmann & G. Hamel											+							
<i>Gelidium pusillum</i> (Stackhouse) Le Jolis									+									+
<i>Wurdemannia miniata</i> (Sprengel) J. Feldmann & G. Hamel*									+									
<i>Gracilaria salicornia</i> (C. Agardh) Dawson	+	+					+	+	+	+	+	+	+	+		+	+	+
<i>Gracilaria irregularis</i> Abbott															+			
<i>Gracilaria rhodymenioides</i> Millar			+												+			
<i>Hydropuntia eucheumatoides</i> (Harvey) Gurgel & Fredericq											+						+	+
<i>Hypnea spinella</i> (C. Agardh) Kützinger*	+	+	+	+	+	+		+	+	+		+	+	+		+		+
<i>Hypnea pannosa</i> J. Agardh						+										+		
Class Phaeophyceae																		
<i>Dictyota dichotoma</i> (Hudson) Lamouroux	+					+	+					+						+
<i>Padina australis</i> Hauck	+	+	+			+	+	+	+	+	+		+	+	+	+	+	+
<i>Sargassum polycystum</i> C. Agardh				+	+													
<i>Sargassum cristaefolium</i> C. Agardh*											+							
<i>Sargassum</i> sp.1					+													
<i>Sargassum</i> sp.2					+													
<i>Turbinaria conoides</i> (J. Agardh) Kützinger					+													
<i>Turbinaria ornata</i> (Turner) J. Agardh				+	+	+						+				+	+	
<i>Turbinaria decurrens</i> Bory de Saint-Vincent											+						+	

Diversity index : Sheltered area = 0.92 ± 0.07
 Semi-exposed area = 1.00 ± 0.13
 Exposed area = 0.94 ± 0.16

* new record for Thailand

Division Cyanobacteria

***Calothrix scopulorum* (Weber & Mohr) C. Agardh** (Figure 4a, b)

Maosen and Chengkui 1985, p. 16, fig. 2; Umezaki and Lewmanomont 1991, p. 33;

Lewmanomont *et al.* 1995, p. 26

Basionym: *Conferva scopulorum* Weber & Mohr

Thallus hemispherical, to 15 mm in diameter, green to dark green. Trichomes embedded in firm gelatinous matrix, 2-7 μm diameter. Gelatinous sheaths, colorless or yellow. Filament 1500-2000 μm long, 5-7 μm in diameter. Heterocysts basal, spherical to oval, 7-10 μm long.

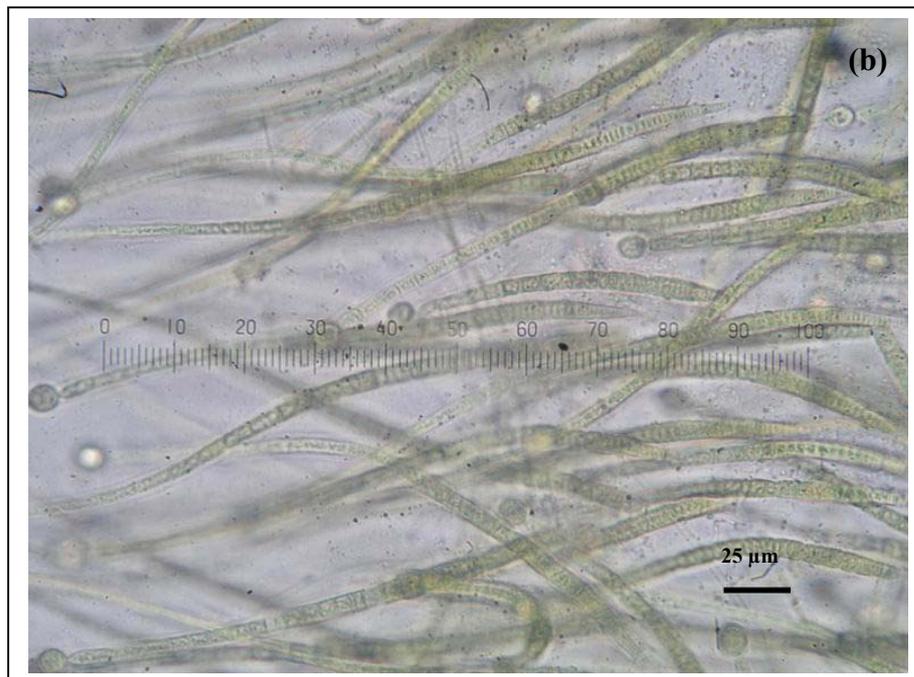


Figure 4. *Calothrix scopulorum* (Weber & Mohr) C. Agardh (a) thallus hemispherical, (b) hairlike filaments with heterocysts

***Lyngbya majuscula* (Dillwyn) Harvey** (Figure 5a, b)

Tseng 1983, p. 26, pl. 17, fig. 4; Umezaki and Lewmanomont 1991, p. 37;

Lewmanomont and Ogawa 1995, p. 19; Lewmanomont *et al.* 1995, p. 17

Basionym: *Conferva majuscula* Dillwyn

Hairlike filaments, blue-green, yellowish or blackish green. Filaments elongated, straight or slightly flexuous, 20-25 μm in diameter. Sheath hyaline, up to 3 μm in thickness, generally lamellated. Trichome 15-20 μm in diameter. Cell very short, 2-3 μm in length, cross wall not constricted, apical cell round, without calyptra.

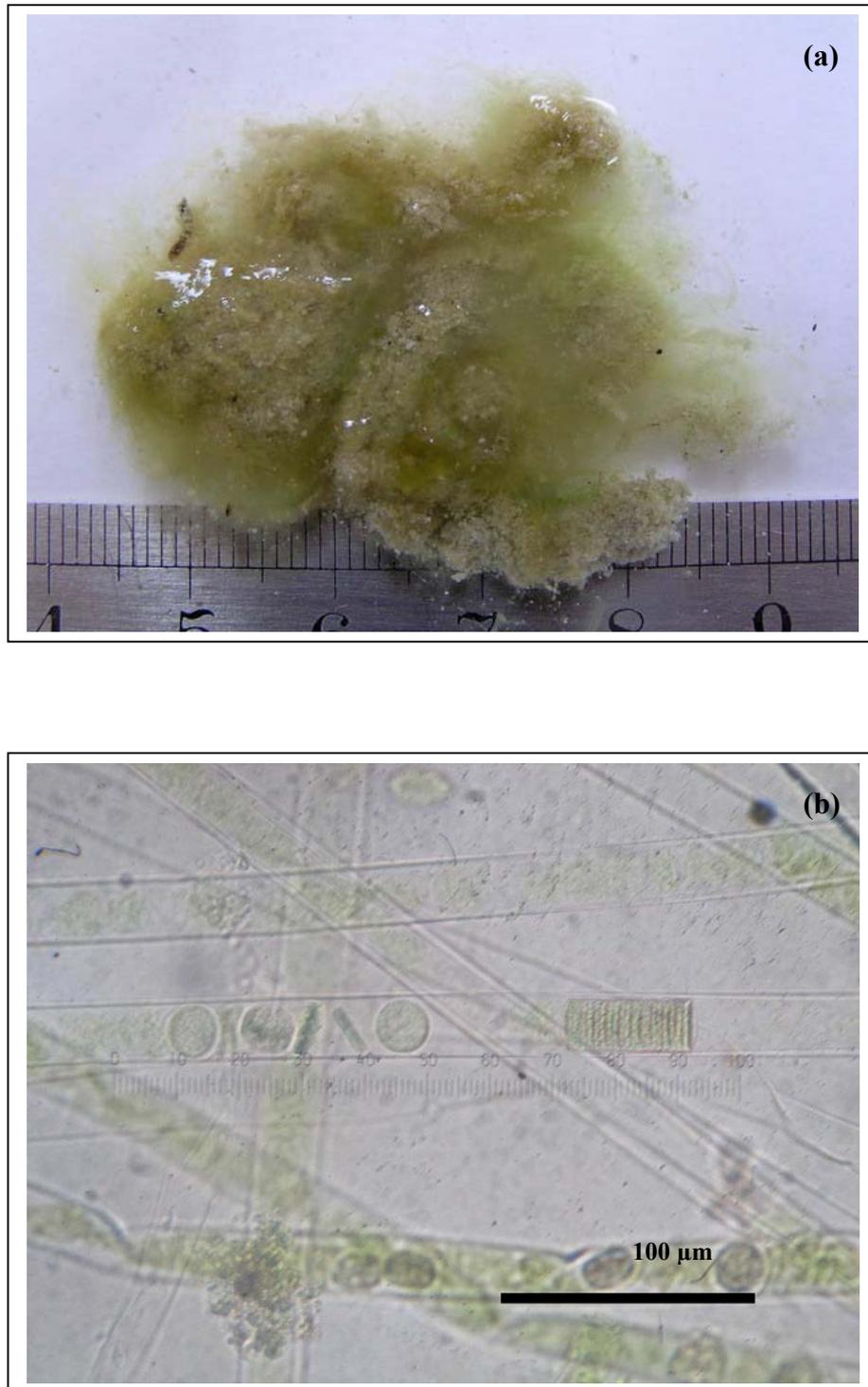


Figure 5. *Lyngbya majuscula* (Dillwyn) Harvey (a) forming tangled masses, (b) hairlike filaments with hyaline sheath

***Lyngbya* sp.** (Figure 6a, b)

Thallus filamentous, forming tangled masses, binding and intermixed with fine sediments, blue-green to black-green. Filament 18-20 μm in diameter, Cells disc-shaped, 17-20 μm in diameter, 2-3 μm in length. Sheaths colorless, thin, about 1 μm thick, broken quite easily.

Note: This species is similar to *Lyngbya majuscula* (Dillwyn) Harvey. They are similar in size of trichome, but it has a very thin sheath.

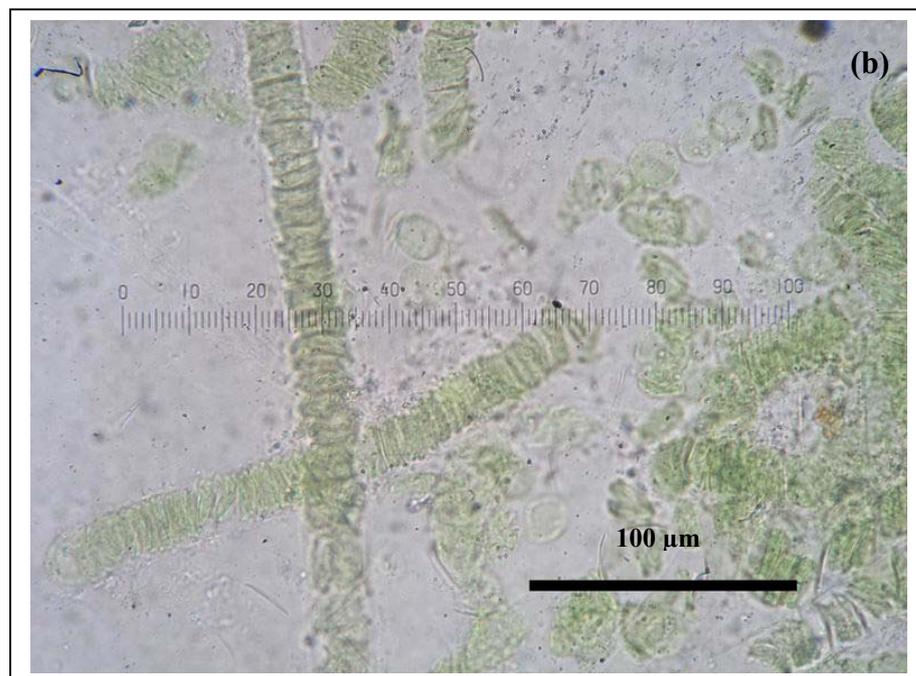


Figure 6. *Lyngbya* sp. (a) forming tangled masses, (b) filaments with thin sheaths

***Symploca hydnoides* (Harvey) Kützing** (Figure 7a, b)

Umezaki and Modelo 1987, p. 110; Umezaki and Lewmanomont 1991, p. 40;
Lewmanomont and Ogawa 1995, p. 20; Lewmanomont *et al.* 1995, p. 20; Huang
1998, p. 112; Huang 2000, p. 208

Basionym: *Calothrix hydnoides* Harvey

Thallus forming erect bundles, wick-like, to 3 cm high, blue-green to dark brown on the surface. Filaments 5-8 μm in diameter, straight, not branched. Cells 5-6 μm in diameter, 2-4 μm long, terminal cells somewhat rounded or dome-shaped, not tapered. Sheaths clear, colorless, 1-2 μm thick, slightly adherent, often empty.

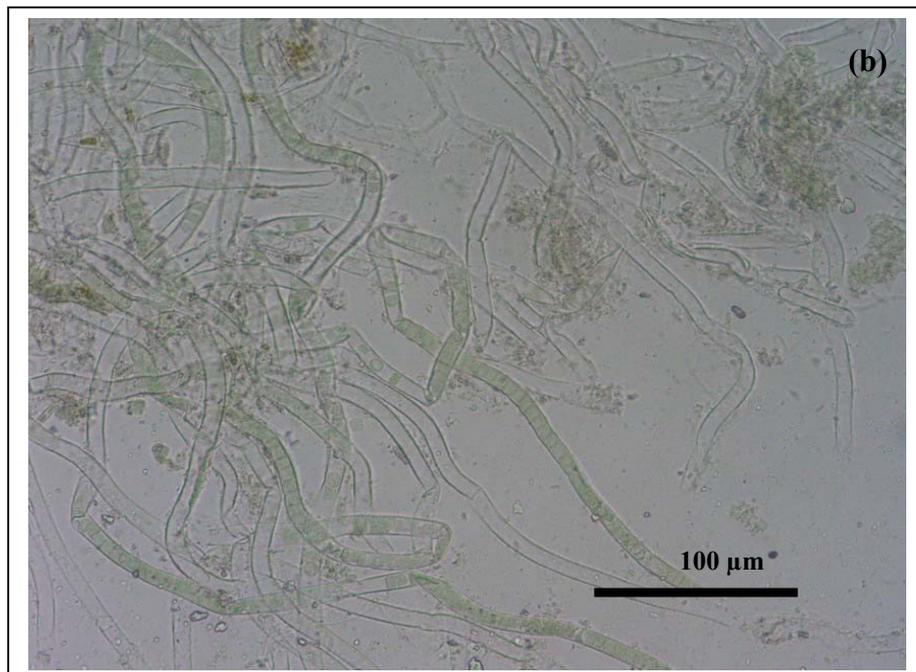
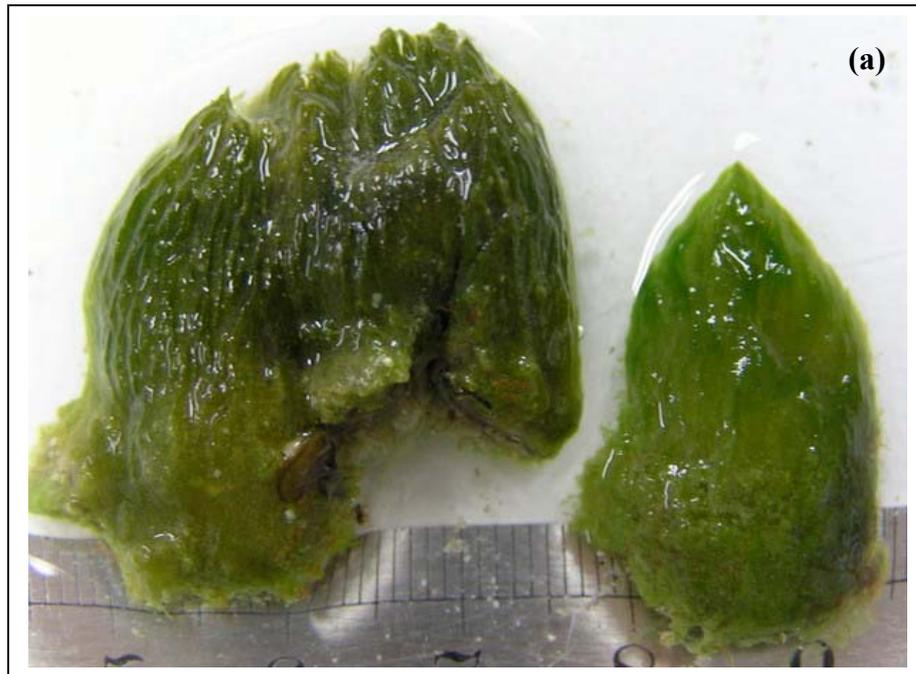


Figure 7. *Symploca hydroides* (Harvey) Kützing (a) thallus forming erect bundles, (b) straight filaments

***Symploca* sp.** (Figure 8a, b)

Thallus filamentous, forming erect bundle, 3-4 cm high, with short stalk, blue-green on the surface. Filaments 4-6 μm in diameter, straight, not branched. Cells 3-5 μm in diameter, 2-4 μm long, terminal cells somewhat rounded or dome-shaped, not tapered. Sheaths clear, colorless, 1-2 μm thick.

Note: This species is similar to *Symploca hydroides* (Harvey) Kützing. Thallus forming erect bundle with short stalk. It is rather small in size of trichome.

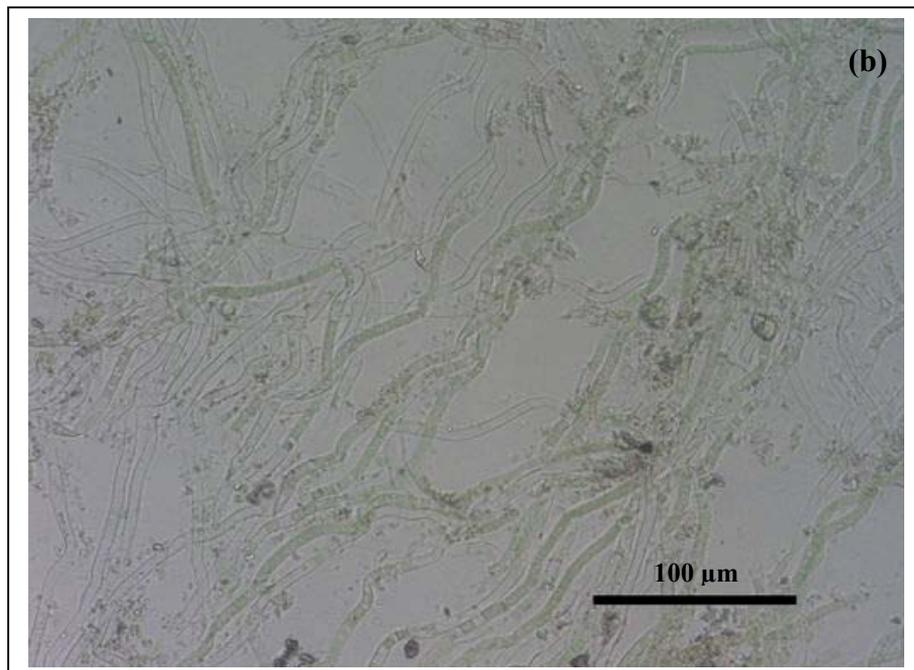


Figure 8. *Symploca* sp. (a) thallus forming erect bundles with short stalk, (b) straight filaments

Division Chlorophyta

Bryopsis pennata Lamouroux (Figure 9a, b)

Dawson 1954, p. 393, fig. 11a; Lewmanomont and Ogawa 1995, p. 28;

Lewmanomont *et al.* 1995, p. 42; Coppejans and Van Den Heede 1996, p. 52, figs. 8, 9, 12, 16, 20

Synonym: *Bryopsis plumosa* (Hudson) C. Agardh var. *pennata* (Lamouroux) Børgesen

Thallus erect, frequently in dense tufts, up to 5 cm high, main axis generally unbranched, clustered, fronds bearing pinnae most commonly in two rows growing from the margins of the axes, constricted at their base.



Figure 9. *Bryopsis pennata* Lamouroux (a) plant habit, (b) details of branchlets

***Caulerpa racemosa* (Forsskål) J. Agardh var. *peltata* (Lamouroux) Eubank**

(Figure 10)

Meñez and Calumpong 1982, p. 8, pl. 2k; Coppejans and Meinesz 1988, p. 191, fig. 24; Coppejans and Beeckman 1989, p. 388, figs. 27-29; South and N'Yeurt 1993, p. 130, fig. 23; Lewmanomont *et al.* 1995, p. 48; Skelton and South 2004, p. 300

Basionym: *Caulerpa peltata* Lamouroux

Synonyms: See Silva *et al.* (1996, p. 829)

Plants typically small; attached to substrate by simple stolon, up to 1 mm in diameter, with rhizoids issued from the undersides; bearing short cylindrical erect axes producing peltate discs, 3-5 mm in diameter, either single at the end, or bearing several discs axially arranged around the main branches. This variety is recognized as having both compressed and sub-globose racemes on an individual plant.



Figure 10. *Caulerpa racemosa* var. *peltata* (Lamouroux) Eubank

***Halimeda opuntia* (Linnaeus) Lamouroux** (Figure 11)

Dawson 1954, p. 395; Lewmanomont and Ogawa 1995, p. 52; Lewmanomont *et al.* 1995, p. 44; Trono 1997, p. 59, fig. 60

Basionym: *Corallina opuntia* Linnaeus

Synonyms: See Silva *et al.* (1996, p. 871)

Thallus composed of many calcified kidney-shaped segments, 0.2-0.5 mm long, broader than long, forming irregularly loose clumps attached by fine rhizoids at various points where segments of the thallus come in contact with the substratum, joints between segments uncalcified. Light green in color.



Figure 11. *Halimeda opuntia* (Linnaeus) J.V. Lamouroux

***Chlorodesmis hildebrandtii* A. Gepp & E. Gepp** (Figure 12a, b)

Ducker 1967, p. 164, pl. 6, 16; Egerod 1974, p. 143, figs. 44-49; Egerod 1975, p. 58;
Lewmanomont and Ogawa 1995, p. 43; Lewmanomont *et al.* 1995, p. 41; Trono
1997, p. 72, fig. 49

Thallus up to 5 cm high, forming dark green tufts on rocky substrates, attached to substrate by rhizoidal filaments. Filaments uniformly cylindrical, 100-150 µm in diameter, repeatedly and dichotomously branched filaments with evenly placed supradichotomal constrictions.

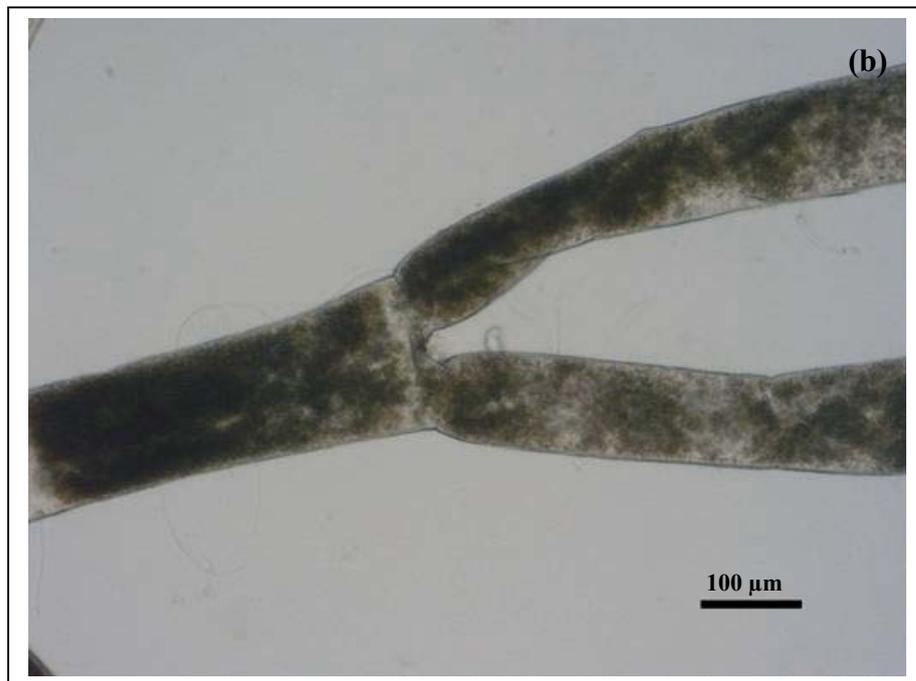


Figure 12. *Chlorodesmis hildebrandtii* A. Gepp & E. Gepp (a) plant habit, (b) dichotomously branched filaments

***Acetabularia exigua* Solms-Laubach** (Figure 13)

Egerod 1975, p. 62, figs. 34-35; Trono *et al.* 1978, p. 84, figs. 4b-f; Moorjani 1980, p. 474, fig. 4; Dong and Tseng 1985, p. 14, fig. 12, pl. 1, fig. 8; Lewmanomont *et al.* 1995, p. 51; Trono 1997, p. 89, fig. 62

Synonym: *Polyphysa exigua* (Solms-Laubach) Wynne

Thallus slightly calcified, 2-4 mm high, stipe short, slightly rugose, bearing a single apical disc. The discoid cap is composed of 7-8 gametangial rays, each ray ovoid with mammilate apex.

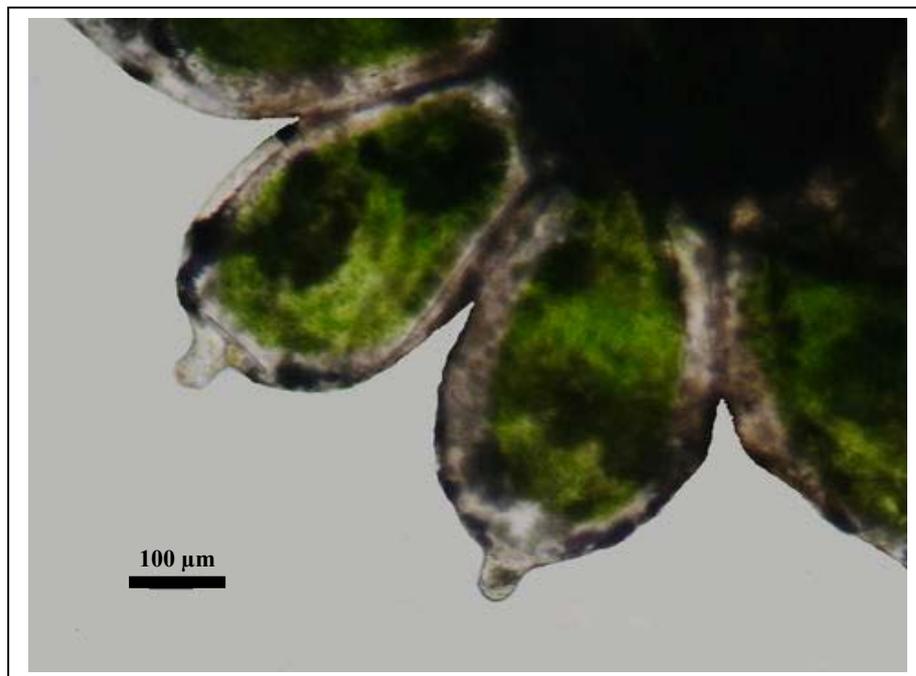


Figure 13. *Acetabularia exigua* Solms-Laubach

***Acetabularia parvula* Solms-Laubach** (Figure 14)

Egerod 1975, p. 63, figs. 36-38; Dong and Tseng 1985, p. 14, fig. 13, pl. 1, figs. 5-6, pl. 2, fig. 1; Lewmanomont *et al.* 1995, p. 51

Synonym: *Acetabularia moebii* Solms-Laubach; Trono *et al.* 1978, p. 87, fig. 4a; Moorjani 1980, p. 472, fig. 3; Trono 1997, p. 91, fig. 64

Thallus slightly calcified, 4-8 mm high, stipe slightly rugose, bearing a single flat apical gametangial disc, composed of 12-19 rays, each ray cuneate with smooth broadly rounded or emarginated distal margin.

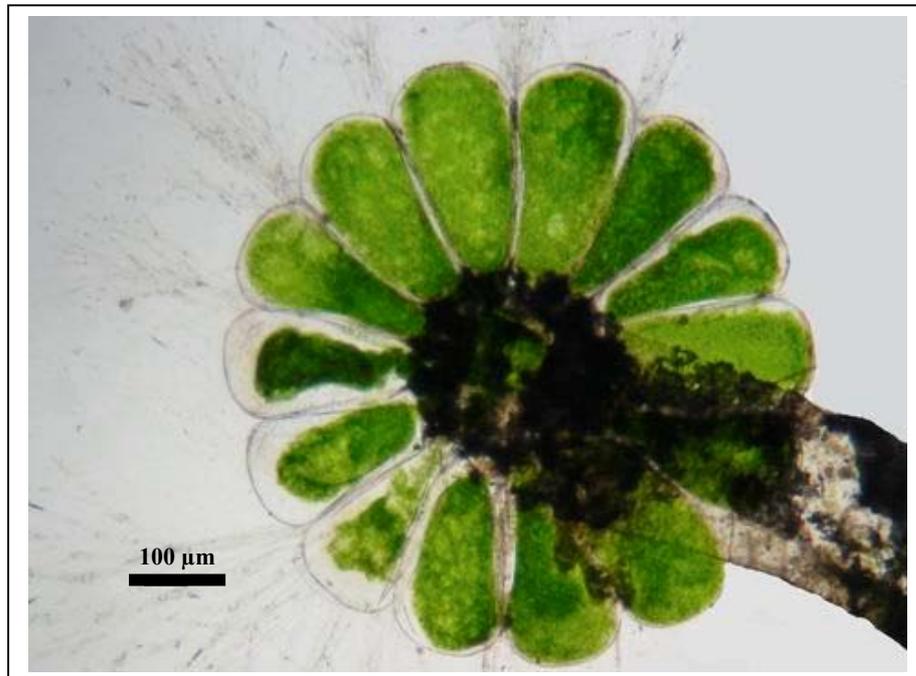


Figure 14. *Acetabularia parvula* Solms-Laubach

Acetabularia pusilla (Howe) Collins (Figure 15)

Dong and Tseng 1985, p. 12, fig. 10

Basionym: *Acetabulum pusillum* Howe

Thallus slightly calcified, 1-3 mm high, slightly rugose, bearing an apical gametangial disc. Disc nearly flat, 1 mm diameter, composed of 9-11 gametangial rays. The ray slightly cemented together laterally through calcification, obovoid-clavate to clavate-subfusiform, with blunt or obtusely apical points.

This is a new record for Thailand.

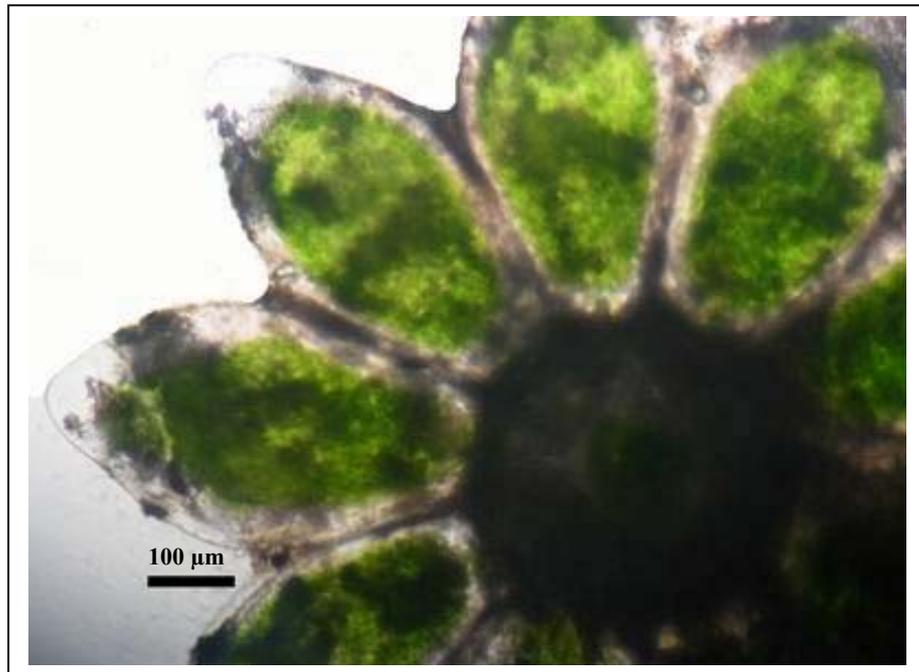


Figure 15. *Acetabularia pusilla* (Howe) Collins

***Enteromorpha flexuosa* (Wulfen) J. Agardh subsp. *paradoxa* (C. Agardh) Bliding**

(Figure 16)

Joshi and Krishnamurthy 1972, p. 122, figs. 1e, 2d, t; Egerod 1974, p. 133, figs. 1-3;

Lewmanomont *et al.* 1995, p. 31; Trono 1997, p. 7

Basionym: *Conferva paradoxa* Dillwyn

Synonyms: See Silva *et al.* (1996, p. 733)

Thallus forms light to dark green mass, forming thick tufts on the substratum, attached to substratum by a small, round basal disk, producing simple or branched frond with tubular, cylindrical stalk. Branching only at the basal portion, the branches hollow, narrow and cylindrical at the base, unbranched and becoming enlarged toward the distal end. Cells square to rectangular in surface view.

Note: This genus is now belong to *Ulva* (Tan *et al.*, 1999).



Figure 16. *Enteromorpha flexuosa* (Wulfen) J. Agardh subsp. *paradoxa* (C. Agardh) Bliding

***Anadyomene wrightii* Harvey ex J. Gray** (Figure 17a, b)

Sartoni 1992, p. 292, figs. 2b-e, figs. 3b, c; Lewmanomont *et al.* 1995, p. 30

Plants consist of fan-shaped, rounded, crisp, bright green, blades up to 5 cm high, composed of polychotomously branched filaments with numerous lateral branches.

Vein uniseriate, cell cylindrical. Attached to solid substrate by rhizoidal holdfast.



Figure 17. *Anadyomene wrightii* Harvey ex J. Gray (a) plant habit, (b) polychotomously branched filaments with lateral branches

***Cladophoropsis sundanensis* Reinbold** (Figure 18a, b)

Egerod 1974, p. 141, figs. 32-36; Egerod 1975, p. 46, figs. 8-10; Sartoni 1992, p. 313;
Lewmanomont *et al.* 1995, p. 37; N'Yeurt 2001, p. 706, fig. 16

Thallus forming bright green tufts, to 7 cm across, composed of soft, fine filaments, up to 2.5 cm in length and up to 180 μm in diameter, filaments having the same diameter throughout, with segmented basal portion attached to the substrate by many hapteroid rhizoids. Unilaterally branched, with lateral branches arising beneath a cross wall.

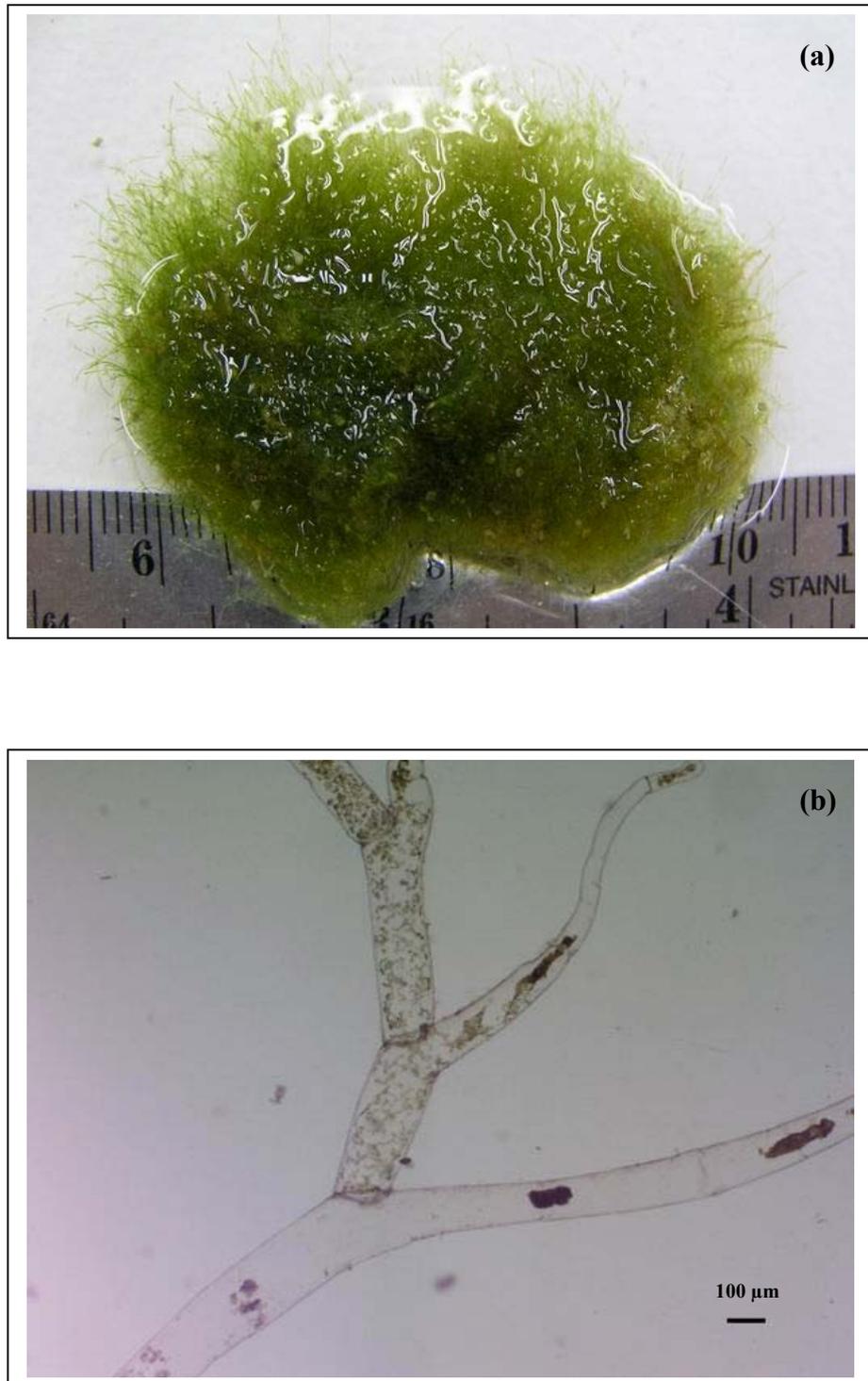


Figure 18. *Cladophoropsis sundanensis* Reinbold (a) thallus forming tufts, (b) unilaterally branched filaments

***Boergesenia forbesii* (Harvey) J. Feldmann** (Figure 19)

Trono and Ganzon-Fortes 1980, p. 9; Sartoni 1992, p. 306, fig. 7b; Lewmanomont and Ogawa 1995, p. 27; Lewmanomont *et al.* 1995, p. 34; Trono 1997, p. 21, fig. 10; Huisman 2000, p. 237

Basionym: *Valonia forbesii* Harvey

Synonym: *Pseudovalonia forbesii* (Harvey) Iyengar

Thallus is solitary or colonial, with club-shaped vesicle 2-4 cm long, liquid-filled, lower part produces rhizoid-like holdfast for attachment. Grass green to yellowish green in color, membranous, smooth and shiny when fresh.



Figure 19. *Boergesenia forbesii* (Harvey) J. Feldmann

***Valonia aegagropila* C. Agardh** (Figure 20)

Trono and Ganzon-Fortes 1980, p. 11; Lewmanomont and Ogawa 1995, p. 61;

Lewmanomont *et al.* 1995, p. 33; Trono 1997, p. 26, fig. 14

Thallus composed of large, vesicular, clavate segments, 3-10 mm long, 2-3 mm in diameter, forming succulent mats of various sizes, often clumped. Vesicles slightly constricted at the base. Light green to dark green in color.



Figure 20. *Valonia aegagropila* C. Agardh

***Valoniopsis pachynema* (G. Martens) Børgesen** (Figure 21a, b)

Egerod 1974, p. 140, fig. 29; Egerod 1975, p. 46; Tseng 1983, p. 272, pl. 135, fig. 2;
Sartoni 1992, p. 323, fig. 14d; Lewmanomont *et al.* 1995, p. 34

Basionym: *Bryopsis pachynema* G. Martens

Synonym: *Valonia confervoides* Harvey ex J. Agardh

Thallus bright green, loosely entangled, forming wide cushions, attached to substrate by irregularly branched and septate rhizoids. Branches unilateral or palmate, the coenocytes cylindrical, 3-5 mm long, 500-850 μm in diameter.



Figure 21. *Valoniopsis pachynema* (G. Martens) Børgesen (a) plant habit, (b) palmate branching

***Dictyosphaeria cavernosa* (Forsskål) Børgesen** (Figure 22a, b)

Egerod 1974, p. 140, fig.30; Tseng 1983, p. 268, pl. 133, fig. 5; Sartoni 1992, p. 319, fig. 13a; Lewmanomont and Ogawa 1995, p. 48; Lewmanomont *et al.* 1995, p. 35; Trono 1997, p. 24, fig. 12

Basionym: *Ulva carvernos*a Forsskål

Synonyms: See Silva *et al.* (1996, p. 795)

Thallus sac-like, hollow, spherical when young, irregularly lobed and ruptured when old, to 3 cm diam., light green. Primary cells spherical 0.5 mm in diameter, forming one layer, appearing honeycomb-like, adhering to one another by microscopic hapteroid cells. Hapteroid cells forming continuous rows at abutment of primary cells, alternately opposite one another. Rhizoids short, branched or unbranched, issued from cell in the basal region.

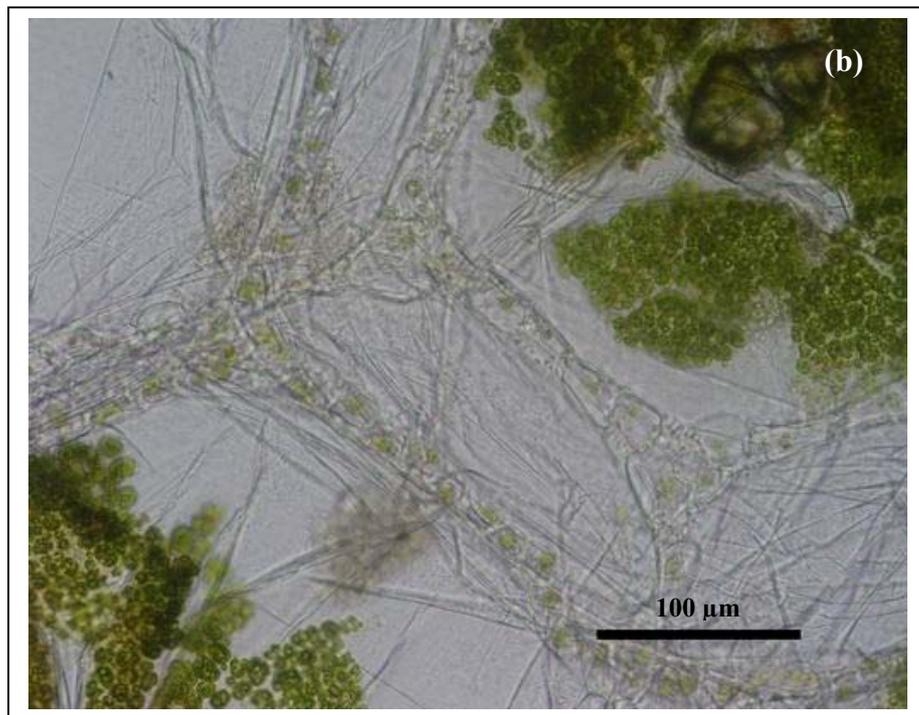


Figure 22. *Dictyosphaeria cavernosa* (Forsskål) Børgesen (a) thallus sac-like, (b) hapteroid cells forming continuous rows

***Boodlea composita* (Harvey) Brand** (Figure 23a, b)

Egerod 1975, p. 50, fig. 19; Trono and Ganzon-Fortes 1980, p. 15; Sartoni 1992, p. 306, fig. 7c; Lewmanomont and Ogawa 1995, p. 26; Lewmanomont *et al.* 1995, p. 36; Trono 1997, p. 22, fig. 11; Huisman 2000, p. 238

Basionym: *Conferva composita* Harvey

Synonyms: See Silva *et al.* (1996, p. 789)

Thallus spongiose, forming reticulate cushions, branching irregular in the basal portion, composed of much-branched filaments that become attached to other branches, forming amorphous sponge-like tufts, with soft texture and bright green color.

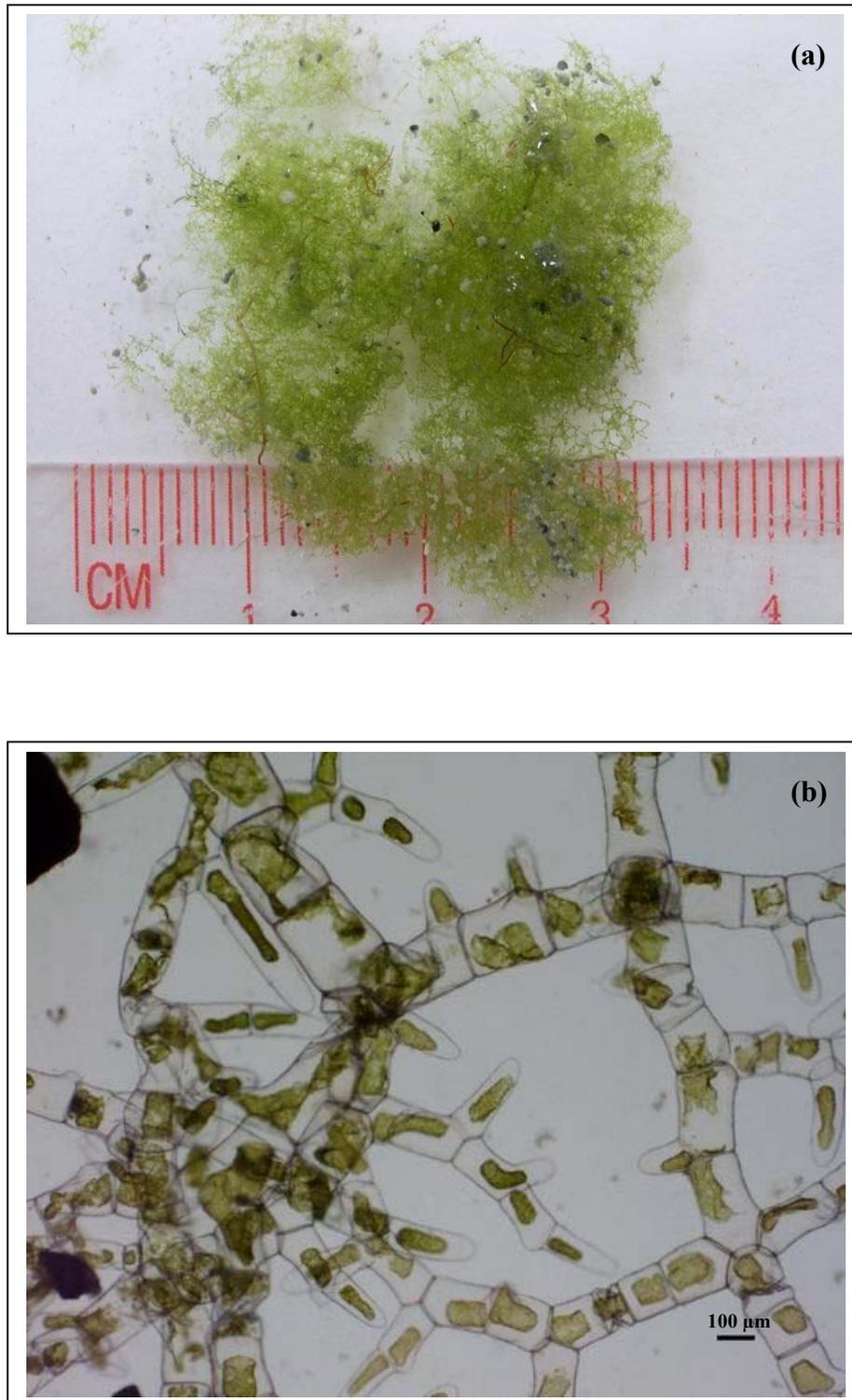


Figure 23. *Boodlea composita* (Harvey) F. Brand (a) thallus spongiöse, (b) irregular branches

***Struvea anastomosans* (Harvey) Piccone & Grunow ex Piccone** (Figure 24a, b)

Egerod 1975, p. 50, fig. 15; Sartoni 1992, p. 317, figs. 12b, c; Lewmanomont and Ogawa 1995, p. 57; Lewmanomont *et al.* 1995, p. 36; Trono 1997, p. 23

Basionym: *Cladophora anastomosans* Harvey

Synonym: See Silva *et al.* (1996, p. 798) as *Struvea delicatula* Kützing

Reticulate leaf-like thallus about 1 cm high, arising from a segmented, stoloniferous system attached to the substrate by septate rhizoids. Stipe simple or rarely branched, bearing distally pairs of opposite lateral branches in one plane.

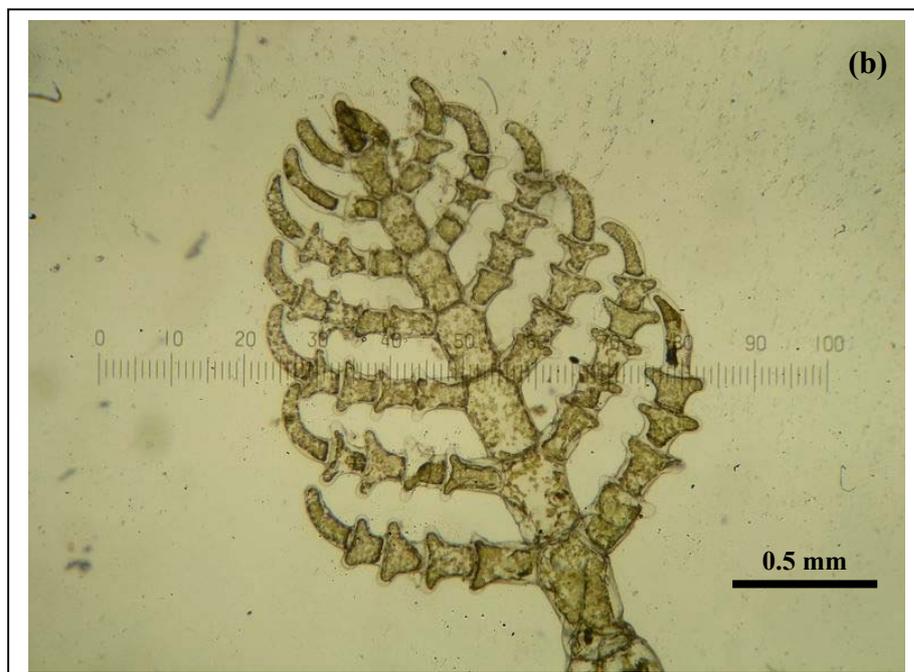


Figure 24. *Struvea anastomosans* (Harvey) Piccone & Grunow ex Piccone
(a) leaf-like thallus, (b) pairs of opposite lateral branches

Division Rhodophyta

***Jania capillacea* Harvey** (Figure 25a, b)

Dawson 1954, p. 432, figs. 41a, b; Trono and Ganzon-Fortes 1980, p. 69;

Lewmanomont *et al.* 1995, p. 78; Littler and Littler 2003, p. 34

Plants delicate, tightly packed in clumps or small cushions, less than 1 cm high.

Branches are cylindrical, slender, calcified, branching repeatedly dichotomous.

Segments are 100-200 μm in diameter and are 1000-1500 μm long. Joints flexible, not calcified.

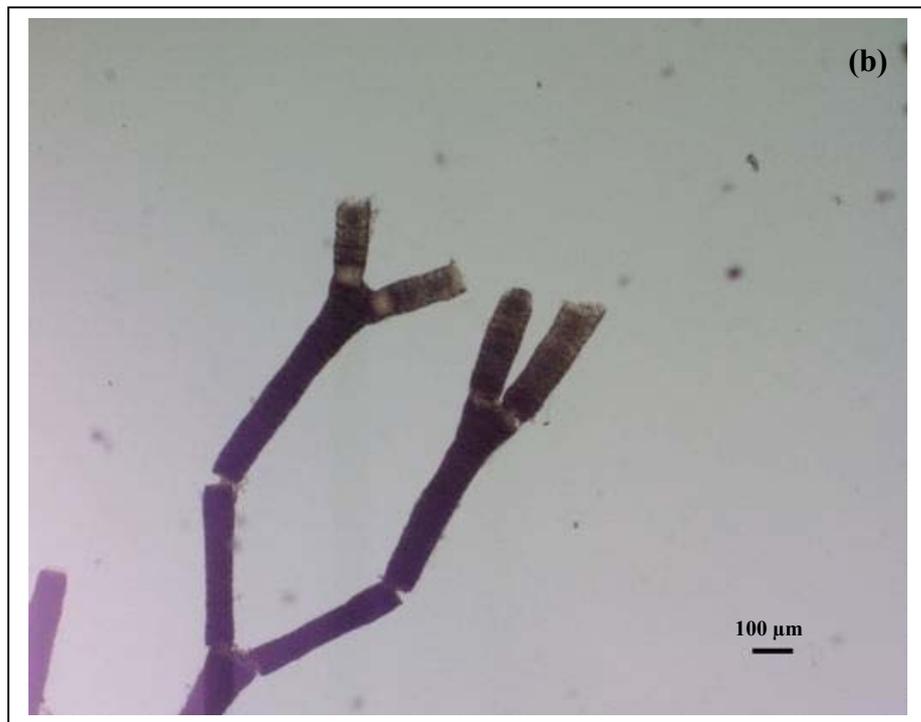
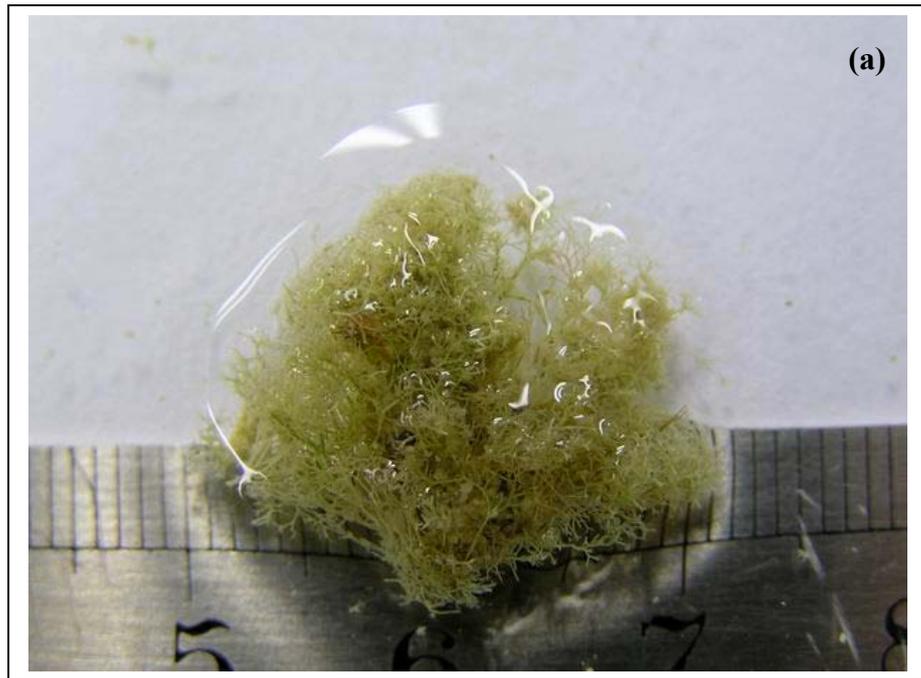


Figure 25. *Jania capillacea* Harvey (a) plant habit, (b) dichotomous branching, not calcified at joints

***Tolypocladia glomerulata* (C. Agardh) Schmitz** (Figure 26a-d)

Dawson 1954, p. 452, figs. 59b, c; Cribb 1983, p. 135, pl. 68, fig. 4; Tseng 1983, p. 160, fig. 4; Lewmanomont *et al.* 1995, p. 90; Millar *et al.* 1999, p. 575; Huisman 2000, p. 179

Basionym: *Hutchinsia glomerulata* C. Agardh

Synonyms: See Silva *et al.* (1996, p. 555)

Thallus dark brownish red, soft membranous, erect, fine, attached by unicellular rhizoids. Main axis alternately branched, branches arranged spirally around the axis. Structurally the thallus is uniaxial with each axial cell surrounded by a ring of four pericentral cells. Tetrasporangia on the ultimate branchlets, tetrahedrally divided.

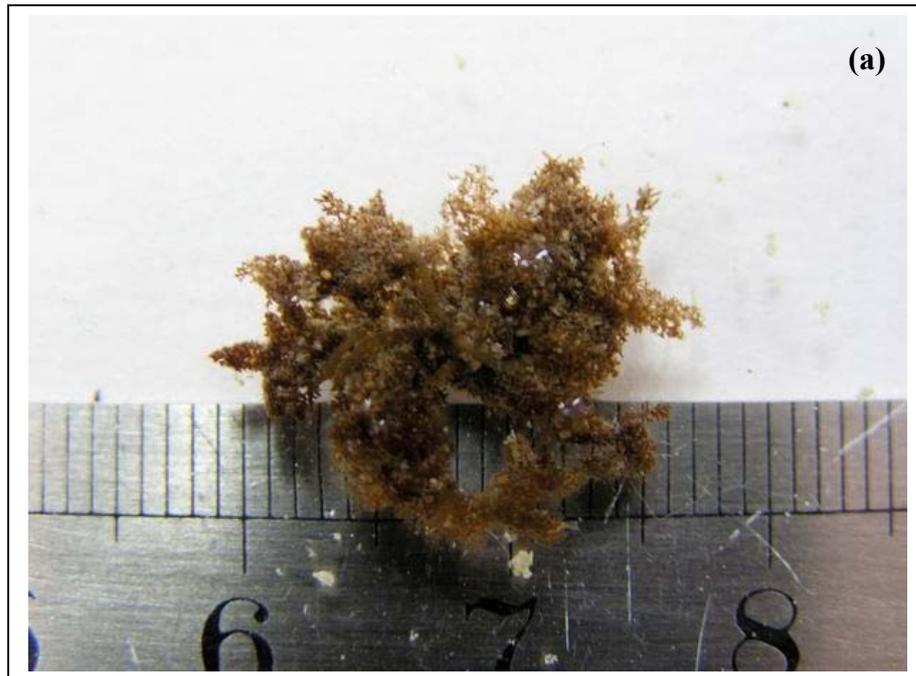


Figure 26. *Tolypocladia glomerulata* (C. Agardh) Schmitz (a) thallus forming dense tuft, (b) plant habit

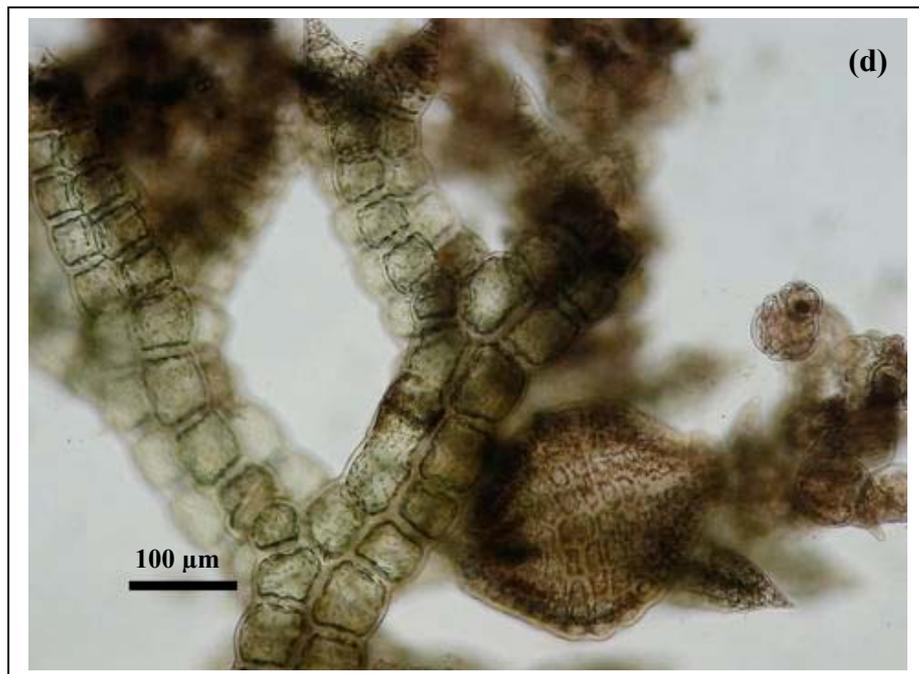
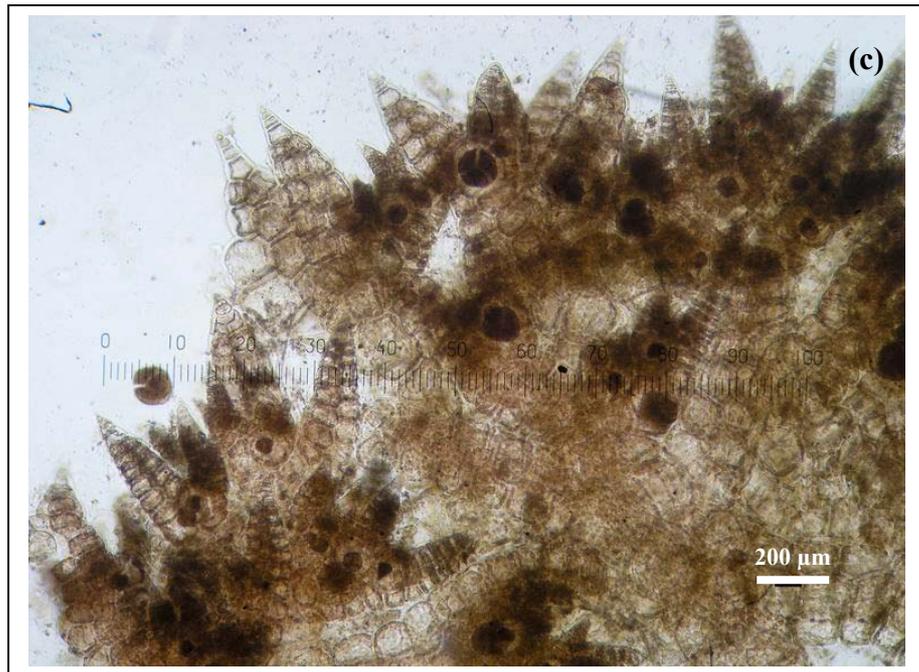


Figure 26. (Continued) (c) tetrasporangia on the ultimate branchlets, (d) cystocarp on the main branch

***Acanthophora spicifera* (Vahl) Børgesen** (Figure 27)

Dawson 1954, p. 456, figs. 61a, b; Lewmanomont and Ogawa 1995, p. 90;

Lewmanomont *et al.* 1995, p. 89; Trono 1997, p. 255, fig. 159

Basionym: *Fucus spicifer* Vahl

Synonyms: See Silva *et al.* (1996, p. 471)

Thallus erect, succulent, up to 15 cm tall, laxly branched, with small discoid holdfast; branches terete throughout, cover by spirally arranged branchlets bearing short spinelike growths.



Figure 27. *Acanthophora spicifera* (M. Vahl) Børgesen

***Chondrophycus papillosus* (C. Agardh) Garbary and Harper** (Figure 28)

Garbary and Harper 1998, p. 195

Basionym: *Chondria papillosa* C. Agardh

Synonym: *Laurencia papillosa* (C. Agardh) Greville; Trono and Ganzon-Fortes 1980, p. 103; Nam and Saito 1991, p. 87; Lewmanomont and Ogawa 1995, p. 128;

Lewmanomont *et al.* 1995, p. 92; Trono 1997, p. 266, fig. 166

Thallus cylindrical, cartilaginous, dark brown to purple, composed of several erect branches, 6-12 cm high, growing from small holdfast. Branching irregular, branches densely covered by wartlike growths.



Figure 28. *Chondrophycus papillosus* (C. Agardh) Greville

***Chondrophycus tronoi* (Ganzon-Fortes) Nam** (Figure 29)

Nam 1999, p. 463

Basionym: *Laurencia tronoi* Ganzon-Fortes 1982, p. 404, figs. 1-2

Synonym: *Laurencia* sp.; Ganzon-Fortes and Trono 1982, p. 39, figs. 1-2

Thallus dark brown or purple, cartilaginous, forming thick clumps or dense mats on sandy or rocky substrates. Branching is irregularly alternate. Branches are cylindrical to slightly compressed with tapered, subacute apices.

This is a new record for Thailand.



Figure 29. *Chondrophycus tronoi* (Ganzon-Fortes) Nam

***Chondrophyucus dotyi* (Saito) Nam** (Figure 30)

Nam 1999, p. 463

Basionym: *Laurencia dotyi* Saito 1969, p. 154, fig. 9a-c, 10a-b; Wynne 1993, p. 17

Forming clumps which have a few erect axes standing on a discoid holdfast, without stoloniferous basal branches, up to 5 cm high, cartilaginous. Branching alternately or oppositely, distichous. Colour brownish purple or somewhat greenish when fresh, changing to black upon drying.

This is a new record for Thailand.



Figure 30. *Chondrophyucus dotyi* (Saito) Nam

***Polysiphonia sphaerocarpa* Børgesen** (Figure 31a, b)

Taylor 1960, p. 576; Hollenberg 1968, p. 87, figs. 10, 21, 24, 26, 27, 28; Kapraun 1980, p. 81, figs. 190-192; Kapraun and Norris 1982, p. 233, fig. 112; Cribb 1983, p. 134; Yoon 1986, p. 22, fig. 13; Coppejans and Millar 2000, p. 338

Thallus 0.5-1.5 cm high, forming mats, attached by unicellular rhizoids. Filaments 50-200 μm in diameter, 100-180 μm long, pseudodichotomously branched, branches arising independent of trichoblasts, at intervals of 7-11 segments, with 4 pericentral cells, uncorticated. Tetrasporangia 50 μm in diameter, numerous and spirally seriate on upper and middle parts of branchlets.

This is a new record for Thailand.

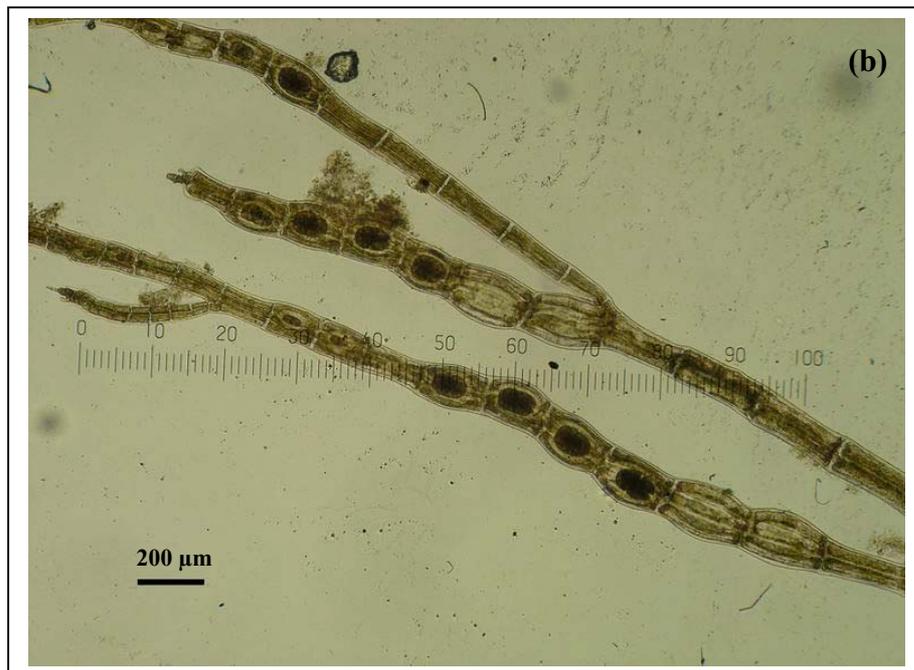


Figure 31. *Polysiphonia sphaerocarpa* Børgesen (a) thallus forming mats, (b) pseudodichotomously branched thallus with tetrasporangia

***Centroceras clavulatum* (C. Agardh) Montagne** (Figure 32a, b)

Dawson 1954, p. 446, fig. 54h; Cribb 1983, p.75, pl. 25, figs. 2-3; Boo and Lee 1985, p.298, figs. 1-6; Lewmanomont and Ogawa 1995, p. 98; Lewmanomont *et al.* 1995, p. 89; N'Yeurt 2001, p. 816

Basionym: *Ceramium clavulatum* C. Agardh

Synonyms: See Silva *et al.* (1996, p. 389)

Fine branched filaments forming a dense turf 3-4 cm high, filaments erect to creeping on substratum. Thallus segmented, with distinct nodal and internal regions, node with verticillate spines that are 2 cells long, internodes 100-160 μm in diameter, 140-175 μm long in mid-thallus. Axial cells completely covered by a cortex of longitudinal rows of cells, rectangular in surface view.

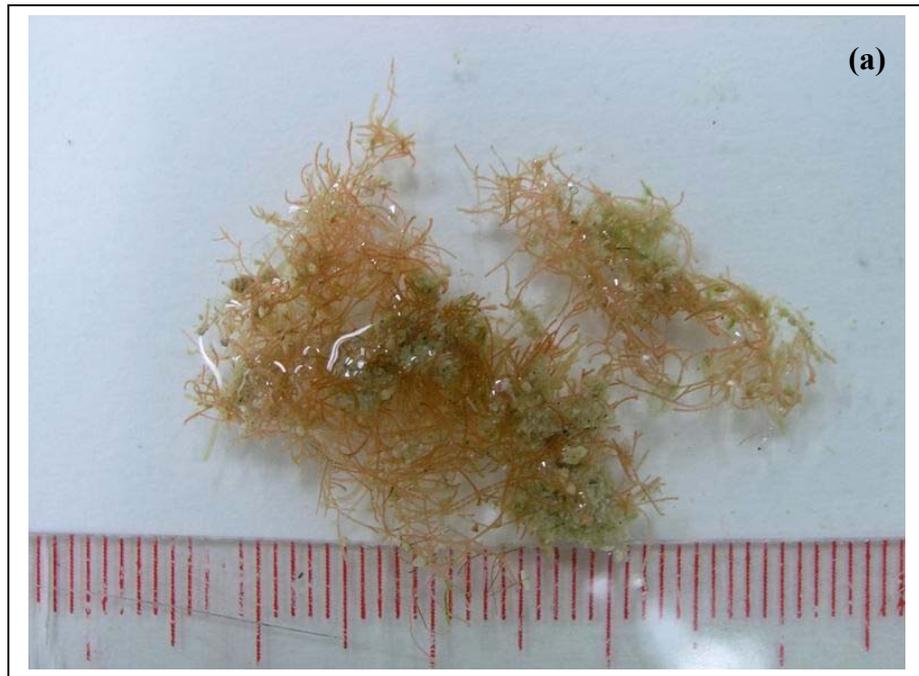


Figure 32. *Centroceras clavulatum* (C. Agardh) Montagne (a) thallus forming dense turf, (b) verticillate spines at nodes

***Ceramium mazatlanense* Dawson** (Figure 33a, b)

Dawson 1950, p. 130, pl. 2, figs. 14-15; Dawson 1954, p. 448, figs. 55e,f; Dawson 1962, p. 59, pl. 23, figs. 1-2; Cribb 1983, p. 85, pl. 62, figs. 1-3; Lewmanomont *et al.* 1995, p. 86

Thallus epiphytic, 3-4 mm high, attached by rhizoids issued from the ventral surface of prostrate, basal filaments; erect filaments 90-100 μm in diameter, rather irregularly dichotomously branched, corticated only at the nodes, without secondary cortical expansion, cortical band very short, 25-30 μm in greatest diameter. Internodes elongated below, sometimes to 120 μm long.

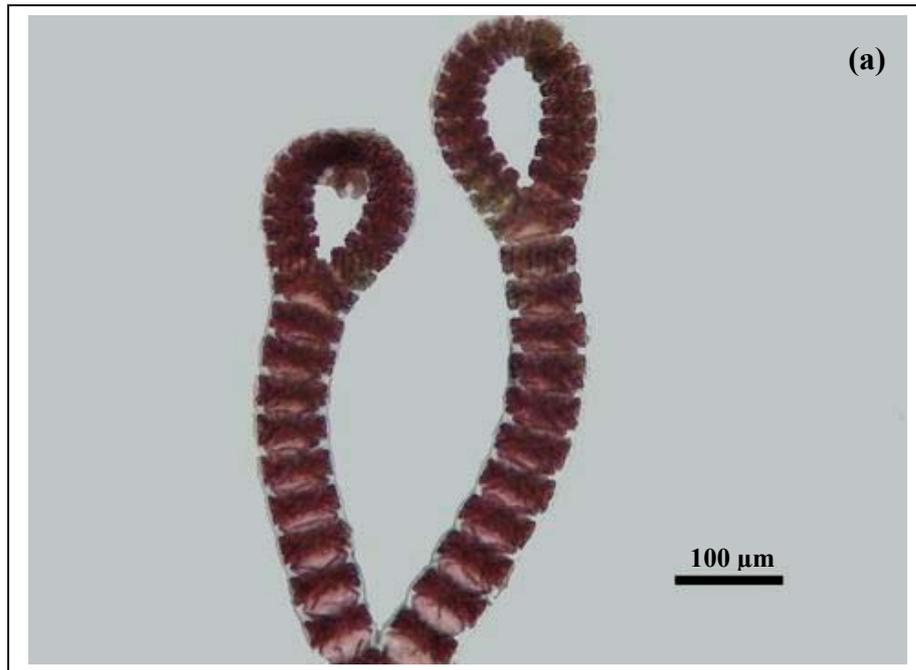


Figure 33. *Ceramium mazatlanense* Dawson (a) dichotomous branching, (b) cortical cells at nodes

***Champia parvula* (C. Agardh) Harvey** (Figure 34a, b)

Taylor 1960, p. 490, pl. 61, fig. 4; Cribb 1983, p. 70, pl. 21, fig. 1; Tseng 1983, p. 122, pl. 64, fig. 2; Lewmanomont *et al.* 1995, p. 85; Millar *et al.* 1999, p. 564

Basionym: *Chondria parvula* C. Agardh

Synonyms: See Silva *et al.* (1996, p. 346)

Plants tufted, pale, dull red, pinkish brown or greenish, crisply membranous in texture, to 3 cm high. Branches cylindrical, hollow, slightly to distinctly constricted at regular intervals to form somewhat barrel-like segments, 0.5-1.0 mm in diameter, branching irregular to alternate, the tips of the branches obtuse. Tetrasporangia 30-50 μm in diameter, scattered in the branches, tetrahedrally divided.

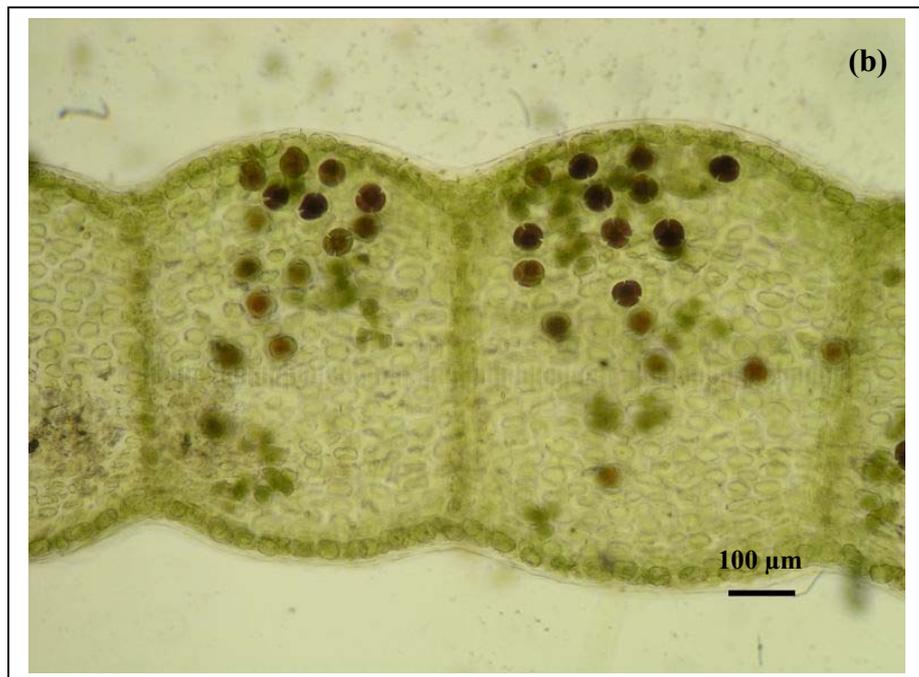


Figure 34. *Champia parvula* (C. Agardh) Harvey (a) plant habit, (b) tetrasporangia in the segments

***Corallophila huysmansii* (Weber-van Bosse) Norris** (Figure 35a, b)

Norris 1993, p. 396; South *et al.* 2001, p. 563

Basionym: *Ceramium huysmansii* Weber-van Bosse 1923, p. 322, fig. 115; Dawson 1954, p. 446, fig. 55d; Hommersand 1963, p. 238; fig. 28; Cribb 1983, p. 83, pl. 60, figs. 1-2

Synonym: *Ceramiella huysmansii* (Weber-van Bosse) Børgesen 1953, p. 47, figs. 18-19

Erect branches to 2 mm high, irregularly alternately branched. Filament in mature portions 100-200 μm diameter. Axes are completely corticated, the cortication comprised of units.

This is a new record for Thailand.

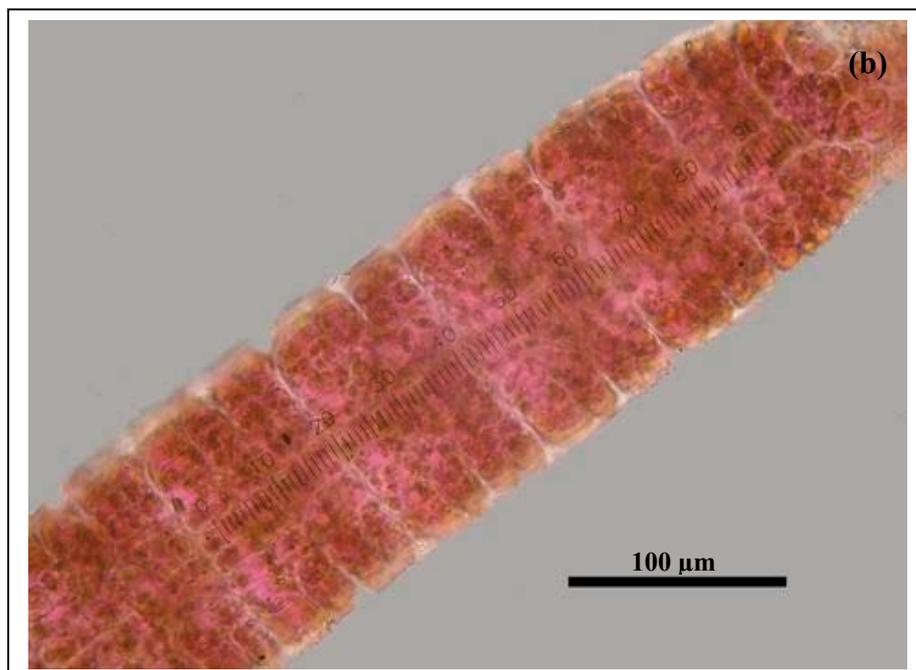
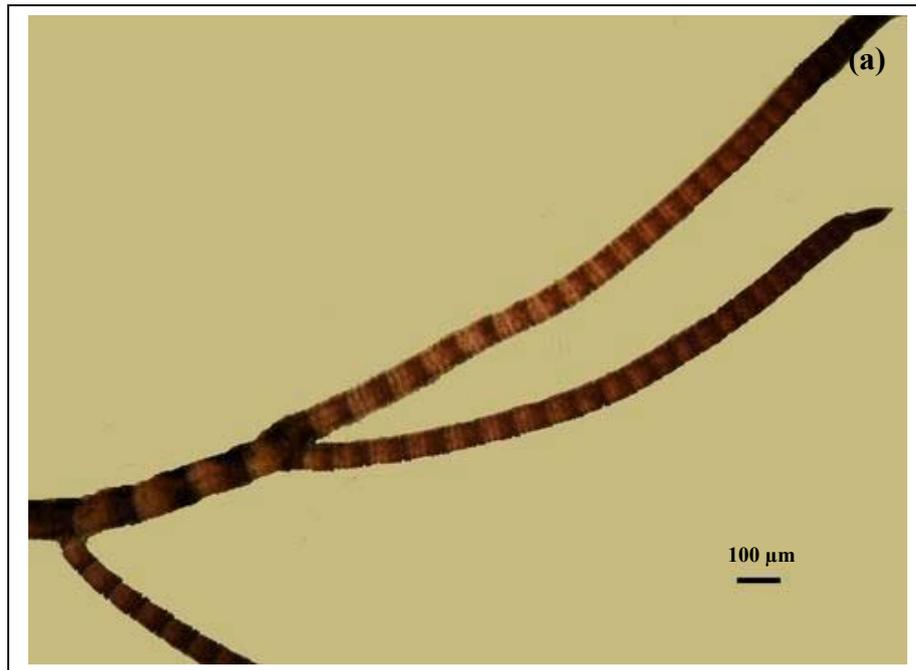


Figure 35. *Corallophila huysmansii* (Weber-van Bosse) R.E. Norris
(a) irregularly branching, (b) completely cortication

***Gelidiopsis variabilis* (J. Agardh) Schmitz** (Figure 36a, b)

Norris 1987, p. 240, figs. 1-9, 12-13; Saunders *et al.* 1999, p.35

Basionym: *Gelidium variabile* J. Agardh

Synonyms: See Silva *et al.* (1996, p. 362)

Thalli form bushy, wiry clumps, attached to the substrate by rhizoids. The lower branches are somewhat creeping and entangled. The upper ones are erect, filamentous, about 2-4 mm high, cylindrical to slightly compressed, 180-250 μm in diameter. Branching irregular. In cross section, outer cortical cells are smaller than the central core of medullary cells.

This is a new record for Thailand.

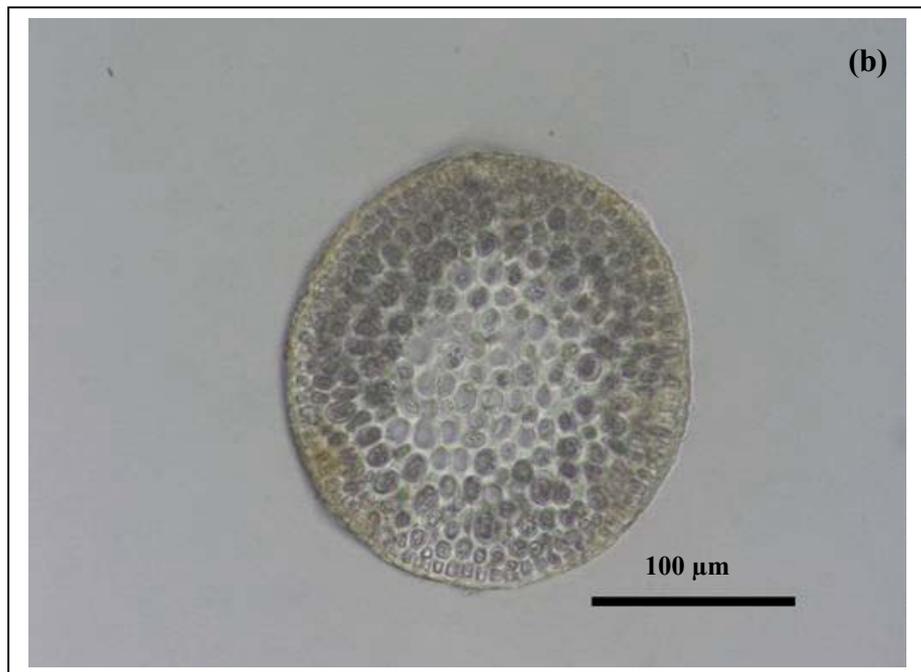


Figure 36. *Gelidiopsis variabilis* (J. Agardh) F. Schmitz (a) plant habit, (b) thallus cross section

***Gelidiella acerosa* (Forsskål) Feldmann & Hamel** (Figure 37a, b)

Cribb 1983, p. 29, pl. 6, fig. 1; Santelices and Stewart 1985, p. 21, fig. 6; Jun-fu and Enzhan 1988, p. 109, fig. 1; Santelices 1988, p. 93, fig. 1; Lewmanomont and Ogawa 1995, p. 105; Lewmanomont *et al.* 1995, p. 75; Trono 1997, p. 179, fig. 113; Millar *et al.* 1999, p. 554; Santelices and Flores 2004, p. 109, figs. 1-3

Basionym: *Fucus acerosus* Forsskål

Synonyms: See Silva *et al.* (1996, p. 149)

Thallus forming a loose mat rising from a creeping stolon, attached to substratum by stoloniferous rhizoids. Thallus up to 5 cm high, erect axes are cylindrical or very slightly compressed, normally with opposite or subopposite pinnae which are fine, needle-like.

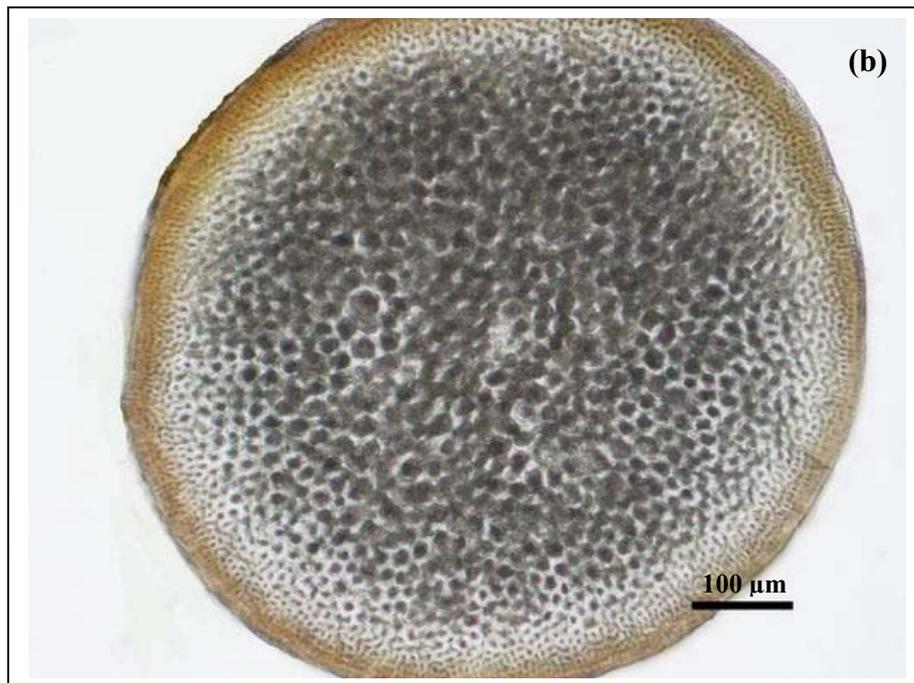


Figure 37. *Gelidiella acerosa* (Forsskål) Feldmann & G. Hamel (a) plant habit, (b) thallus cross section

***Gelidiella pannosa* (J. Feldmann) J. Feldmann & G. Hamel** (Figure 38a, b)

Egerod 1971, p. 127, figs. 29-31; Cribb 1983, p. 31, pl.6, fig. 2; Hatta and Prud'homme van Reine 1991, p. 356, fig. 5; Lewmanomont *et al.* 1995, p. 75

Basionym: *Echinocaulon pannosum* J. Feldmann

Synonym: *Gelidiella tenuissima* Feldmann & Hamel; Dawson 1954, p. 422, fig. 33e

Thallus cartilaginous, cylindrical or somewhat compressed, up to 10 mm high, basal stolons branched, attached to the substrate by fibrous peg-like haptera; erect portions terete to slightly compressed, simple to sparsely divided, linear fronds, mat-forming,

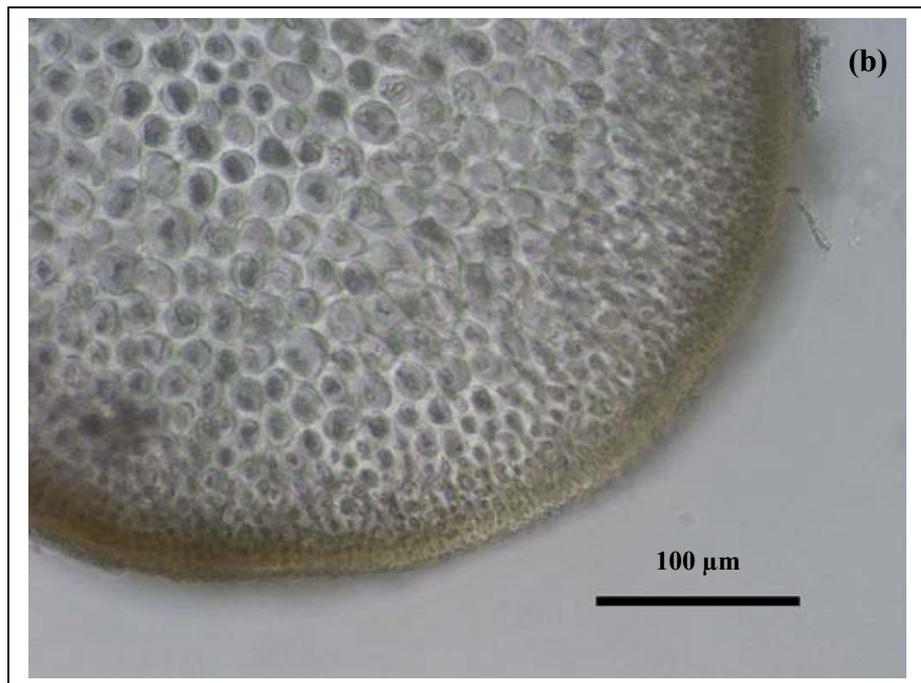


Figure 38. *Gelidiella pannosa* (J. Feldmann) J. Feldmann & G. Hamel (a) plant habit, (b) thallus cross section

***Gelidium pusillum* (Stackhouse) Le Jolis** (Figure 39)

Dawson 1954, p. 420, figs. 31a-c; Egerod 1971, p. 129, figs. 32-49; Akatsuka 1981, p. 453, pl. 1, fig. 3, pl. 3, fig. 11; Santelices 1988, p. 102, fig. 9; Hatta and Prud'homme van Reine 1991, p. 364, fig. 8; Lewmanomont *et al.* 1995, p. 74; Bangmei *et al.* 2002, p. 193, figs. 50-53

Basionym: *Fucus pusillus* Stackhouse

Plants purplish red, subcartilaginous, small, up to 10 mm high, mat-forming, attached to the substratum by disk-like haptera. Branching irregular, in many plane. Cortical cells somewhat angular or rounded to ovate in surface view, 4-8 μm in diameter, irregularly arranged. In cross section, outer cortical cells rounded to ovate, inner cortical cell rounded, in 2-3 layers, medulla cells also rounded.



Figure 39. *Gelidium pusillum* (Stackhouse) Le Jolis

***Wurdemannia miniata* (Sprengel) J. Feldmann & G. Hamel (Figure 40)**

Børgesen 1929, p. 77; Dawson 1944, p. 263; Dawson 1954, p. 424, fig. 35; Taylor 1960, p. 361; Hatta and Prud'homme van Reine 1991, p. 375, fig. 14

Plants tufted, 10-20 mm high, consisting of terete prostrate axes, 100-200 μm in diameter, attached to substratum by disk-like haptera. Branching irregular. Cortical cells in surface view angular, longitudinally elongate, somewhat regularly arranged in longitudinal rows. In cross section outer layer cortical cells subquadrangular, inner cortical cells and medullar cells rounded.

This is a new record for Thailand.



Figure 40. *Wurdemannia miniata* (Sprengel) J. Feldmann & G. Hamel

***Gracilaria salicornia* (C. Agardh) Dawson** (Figure 41a, b)

Abbott 1994, p. 116; Lewmonomont *et al.* 1995, p. 82; Yamamoto and Siew- Moi 1997, p. 91, figs. 1-13; Ohno *et al.* 1999, p. 109, fig. 9; Terada *et al.* 1999, p.121, figs. 1-3

Basionym: *Sphaerococcus salicornia* C. Agardh

Synonyms: See Silva *et al.* (1996, p. 175)

Plants succulent and firm, creeping to nearly erect, up to 3-6 cm long, attached by irregularly discoid holdfast that gives rise to a single axis or many aggregated fronds. Fronds distinctly segmented, branched 2-4 times; each segment clavate, tapering below, inflated distally with depressed truncate apices. Color variable, maroon to pink when fresh, turning darker upon drying.

***Congracilaria babae* Yamamoto**

Yamamoto 1986, p. 287, figs. 1- 16; Yamamoto 1991, p. 382, figs. 1-9

Thalli hemiparasitic on *Gracilaria salicornia* surfaces, distributed randomly throughout. Fronds typically mushroom-like appearance, or convoluted mass with a very short stipe or none at all, up to 3 mm high, up to 3 mm in diameter.

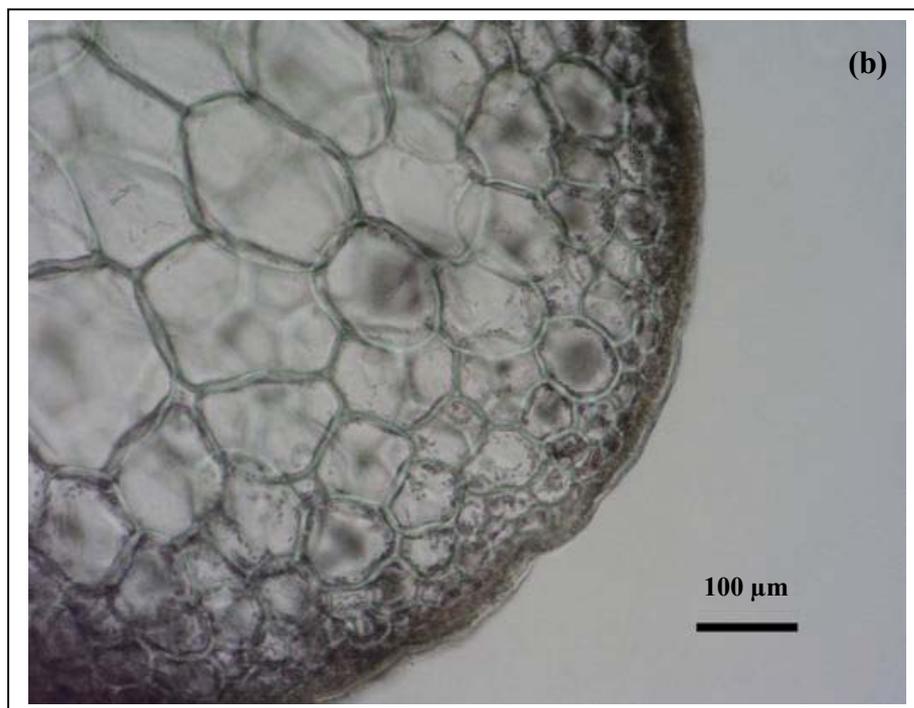
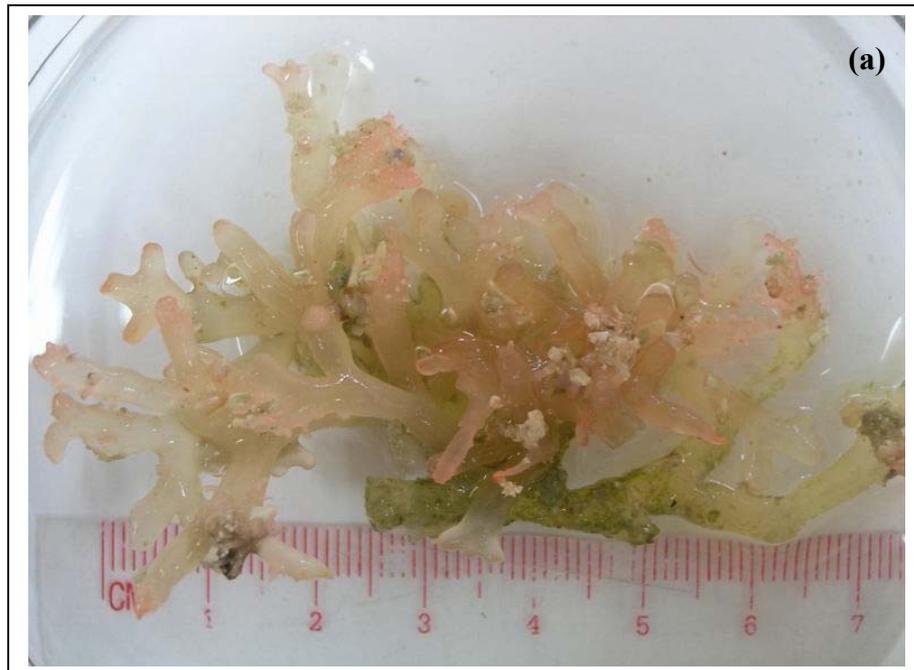


Figure 41. *Gracilaria salicornia* (C. Agardh) Dawson (a) plant habit, (b) thallus cross section

***Gracilaria irregularis* Abbott** (Figure 42a, b)

Abbott 1988, p. 141, figs. 2, 5-6; Lewmanomont *et al.* 1995, p. 80

Thallus erect, succulent, 3-10 cm tall with a percurrent cylindrical axis, 2.0-2.5 mm in diameter. Branching irregular, occasionally secund; branches always narrower than main axes. Fronds in transverse section consisting of medulla of large cells, 300-750 μm in diameter, cortex one to two cells thick, cells much smaller.

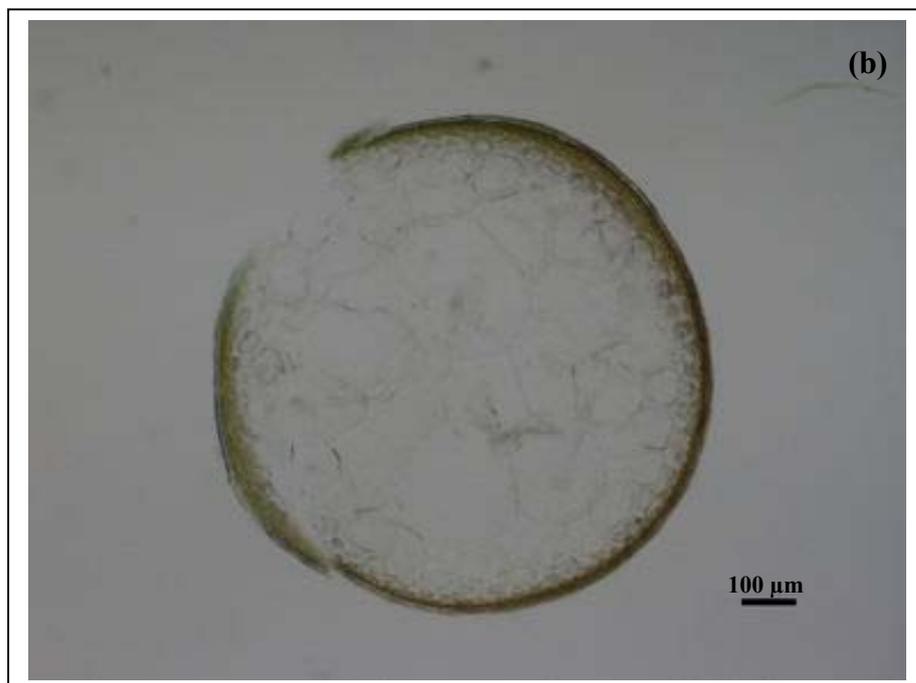


Figure 42. *Gracilaria irregularis* Abbott (a) plant habit, (b) thallus cross section

***Gracilaria rhodymenioides* Millar** (Figure 43a, b)

Millar 1997, p. 114, figs. 5-12; Millar and Bangmei 1999, p. 114, fig. 1; Millar, *et al.* 1999, p. 555; Coppejans and Millar 2000, p. 318; Lewmanomont and Chirapart 2004, p. 206

Plant cartilaginous, erect to horizontally spreading, growing in loose to dense tuft, 2-5 cm high, fronds flattened except for terete stipe, 3-7 mm long and 2-4 mm diameter. Blades flattened, di- or trichotomously divided, 2-5 mm wide, 200-250 μ m thick, with entire margins and obtuse apices.

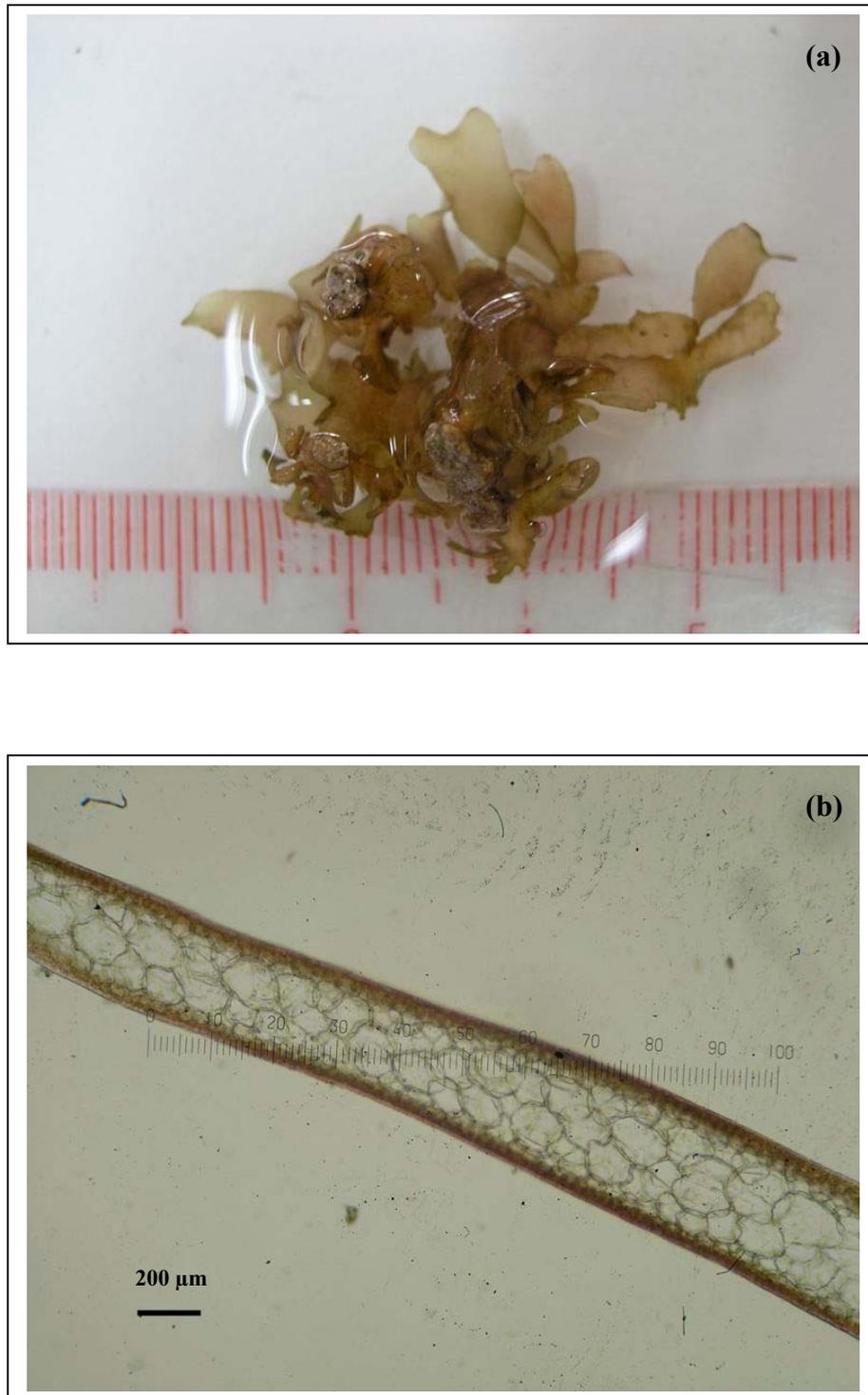


Figure 43. *Gracilaria rhodymenioides* Millar (a) plant habit, (b) thallus cross section

***Hydropuntia eucheumatoides* (Harvey) Gurgel & Fredericq (Figure 44)**

Gurgel and Fredericq 2004: 40: 155

Basionym: *Gracilaria eucheumatoides* Harvey; Meneses and Abbott 1987, p. 192, fig. 6; Withell *et al.* 1994, p. 311; Lewmanomont *et al.* 1995, p. 80; Ohno *et al.* 1999, p. 104, fig. 5; Silva *et al.* 1996, p. 168; Terada and Yamamoto 2002, p. 226, figs. 1-7

Thallus slightly compressed, varying in length, up to 19 cm long, thick and succulent, prostrate on rock, attached to the substratum by small discoid holdfasts, branching irregularly, pinnately, dichotomously. Branches 1-3 cm long, 0.5-1.0 cm wide, 0.2-0.5 cm thick with irregularly disposed marginal dentitions.



Figure 44. *Hydropuntia eucheumatoides* (Harvey) Gurgel & Fredericq

***Hypnea pannosa* J. Agardh** (Figure 45)

Trono and Ganzon-Fortes 1980, p. 81; Tseng 1983, p. 100, pl. 53, fig. 1;

Lewmanomont and Ogawa 1995, p. 125; Lewmanomont *et al.* 1995, p. 83; Chiang 1997, p. 173; Huisman 2000, p. 78

Synonym: *Hypnea musciformis* (Wulfen) Lamouroux var. *cornuta* Harvey, see Silva *et al.* (1996, p. 304)

Thallus turf-like, forming thick mats, branching irregular, branches cylindrical to slightly compressed, 0.3-2.0 mm broad, with pointed ultimate branchlets. In cross section, a single central axial cell is present at the center of the frond, surrounded by medullary cells.



Figure 45. *Hypnea pannosa* J. Agardh

***Hypnea spinella* (C. Agardh) Kützing** (Figure 46a, b)

Cribb 1983, p. 60, pl. 15, fig. 4; Chiang 1997, p. 175, fig. 15; Trono 1997, p. 239;
Yamagishi and Masuda 1997, p. 149, figs. 30-32

Basionym: *Sphaerococcus spinellus* C. Agardh

Synonyms: See Silva *et al.* (1996, p. 307)

Thallus subcartilaginous in texture, forming small, compact tufts on rocks, attached to substratum by primary discoid holdfasts. Branching irregular, issued in all directions, the branches spreading, the smallest, ultimate branchlets spine-like; main branches slender, with variable lengths, terete, 1-2 mm in diameter, in cross section medullary cells large, surrounding an axial cell, becoming progressively smaller outward. Tetrasporangia formed in the proximal, middle or distal, swollen part of ultimate branchlets.

This is a new record for Thailand.

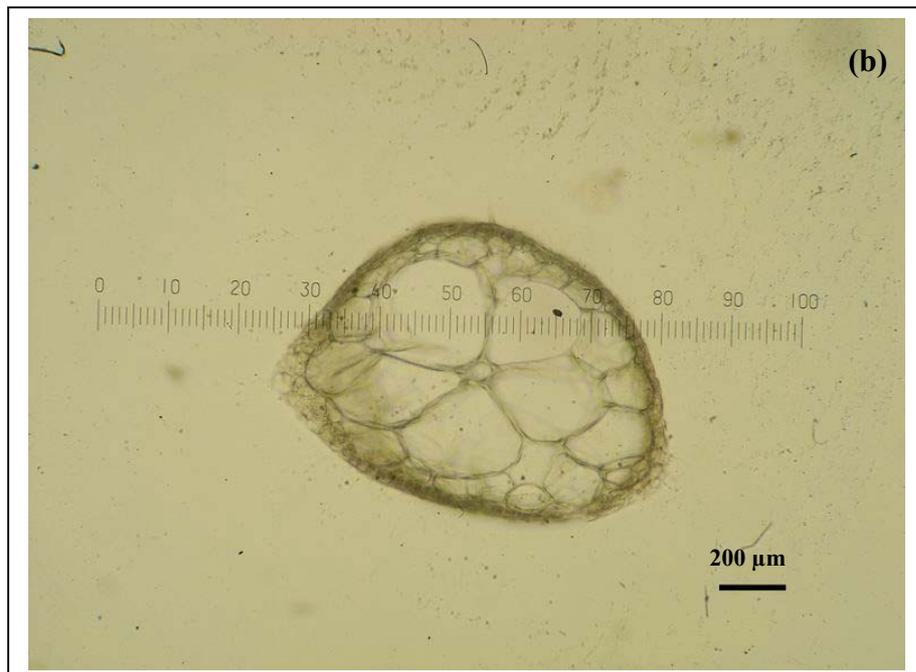


Figure 46. *Hypnea spinella* (C. Agardh) Kützing (a) plant habit, (b) thallus cross section

Class Phaeophyceae

Dictyota dichotoma (Hudson) Lamouroux (Figure 47)

Egerod 1974, p. 149, figs. 75-79; Lewmanomont and Ogawa 1995, p. 71;

Lewmanomont *et al.* 1995, p. 56; Trono 1997, p. 107; Huisman 2000, p. 189

Basionym: *Ulva dichotoma* Hudson

Synonyms: See Silva *et al.* (1996, p. 590)

Thallus a loose tuft, up to 20 cm high, growing from a discoid holdfast. Branching is irregularly dichotomous. The branches strap-shaped, linear, 3-6 mm wide, tips bifurcate and rounded.



Figure 47. *Dictyota dichotoma* (Hudson) Lamouroux

***Padina australis* Hauck** (Figure 48a, b)

Lewmanomont 1980, p. 757, pl. 1, fig. 1, pl. 2, figs. 5-6; Allender and Kraft 1983, p. 85, figs. 5c, 6b; Farrant and King 1989, p. 388, figs. 11-12; Lewmanomont and Ogawa 1995, p. 75; Lewmanomont *et al.* 1995, p. 58; Trono 1997, p. 112, fig. 77; Geraldino *et al.* 2005, p. 109, fig. 1f, 2a

Thallus fan-shaped, growing in tufts, 3-8 cm high, surfaces lightly calcified. The blade is divided into several fan-shape lobes, to 2-6 cm wide, with inrolled outer margins, composed of 2 layers of cells throughout, cell of upper layer smaller than those of the lower. Hair lines alternate on the lower and upper surfaces. Sporophyte with tetrasporangial sori, 0.5-0.8 mm wide, usually median in position in the glabrous zone, without indusium.



Figure 48. *Padina australis* Hauck (a) plant habit, (b) two cell layers with tetrasporangia

***Sargassum polycystum* C. Agardh** (Figure 49a-c)

Dawson 1954, p. 406, figs. 22t, u; Tseng 1983, p. 236, fig. 1; Yoshida 1988, p. 17, fig. 14; Tseng and Baoren 1988, p. 47, figs. 13, 26-27; Lewmanomont and Ogawa 1995, p. 84; Lewmanomont *et al.* 1995, p. 65; Trono 1997, p. 147, figs. 96a, b; Ajisaka *et al.* 1999, p. 36, figs. 6a, b

Synonym: See Silva *et al.* (1996, p. 695)

Thallus yellow-brown, up to 150 cm long, with short cylindrical stipe 5-10 mm long. Holdfast small, discoid. Stolons terete, irregularly or alternately branched with many small spines. Leaflike blades ovate, oblong to lanceolate with dentate margins, midrib conspicuous, many small spherical air bladders, 0.5-1.0 mm in diameter, receptacle cylindrical.



Figure 49. *Sargassum polycystum* C. Agardh (a) plant habit, (b) oblong leaflike with dentate margin, (c) air bladders

***Sargassum cristaefolium* C. Agardh** (Figure 50a-c)

Trono 1992, p. 50, figs. 12-15, 113; Trono 1977, p. 133, figs. 89a, b; Tseng and Baoren 1997, p. 16, figs. 3, 10

Synonyms: See Silva *et al.* (1996, p. 665)

Thallus yellow-brown. Holdfast discoid, producing a stipe, cylindrical, about 6-8 mm long. Primary branches arising from the upper parts of the axis, cylindrical, smooth. Leaves thick, oblong, up to 2.0- 2.5 cm long, 1.0-1.5 cm wide, base symmetrical to somewhat slightly asymmetrical in some, cuneate, stalk short, margin finely and irregularly serrate or dentate, some teeth duplicated, tip obtuse-rounded, midrib only apparent up to the mid-portion of leaf, cryptostomata distinct, numerous, irregularly scattered on leaves. Vesicles cylindrical or subcylindrical, about 4-5 mm in diameter, round at apices, most of them with earlike wings on both sides of the vesicle.

This is a new record for Thailand.



Figure 50. *Sargassum cristaefolium* C. Agardh (a) plant habit, (b) irregular serrate margin of leaf, (c) ear like wings of the vesicle.

***Sargassum* sp.1** (Figure 51a-c)

Thallus yellow-brown, up to 40 cm long, with short cylindrical stipe 5-10 mm long. Leaves thick, ovate, oblong, up to 1.5- 3.0 cm long, 1.0-1.5 cm wide, with finely serrate and dentate margin. Many small spherical air bladder, 3-5 mm in diameter, most of them with short spine at apices.

Note: Only a single specimen



Figure 51. *Sargassum* sp.1 (a) plant habit, (b) oblong leaflike with dentate margin, (c) spherical air bladder

***Sargassum* sp.2** (Figure 52a, b)

Thallus yellow-brown, up to 55 cm long, with short cylindrical stipe 5-8 mm long. Holdfast small, discoid. Stolons terete, irregularly branched. Leave thick, oblong to lanceolate with dentate margins. Many small spherical air bladder, 2-3 mm in diameter.

Note: Only a single specimen



Figure 52. *Sargassum* sp.2 (a) plant habit, (b) lanceolate leaflike with dentate margins

***Turbinaria conoides* (J. Agardh) Kützing** (Figure 53)

Tseng 1983, p. 240, pl. 121, fig. 3; Lewmanomont and Ogawa 1995, p. 85;

Lewmanomont *et al.* 1995, p. 66; Trono 1997, p. 152, fig. 98

Basionym: *Turbinaria vulgaris* J. Agardh var. *conoides* J. Agardh

Synonym: *Turbinaria denudata* Bory de Saint-Vincent

Thallus erect, up to 20 cm high, arising from a spreading branched holdfast. Main axes terete, smooth. Blade composed of slender stalk, 0.5-1.0 cm long, expanded into subcircular, trumpet-shaped foliar parts, the expanded portions with irregularly dentate margin. Receptacles in clusters, attached to the stalk of blade. Yellowish-brown to dark brown in color.



Figure 53. *Turbinaria conoides* (J. Agardh) Kützing

***Turbinaria ornata* (Turner) J. Agardh** (Figure 54)

Dawson 1954, p. 405, fig. 21; Tseng 1983, p. 242, pl. 122, fig. 2; Lewmanomont and Ogawa 1995, p. 87; Lewmanomont *et al.* 1995, p. 66; Trono 1997, p. 155, fig. 100; Huisman 2000, p. 226

Basionym: *Fucus turbinatus* Linnaeus var. *ornata* Turner

Synonyms: See Silva *et al.* (1996, p. 713)

Thallus erect, dark brown, to 15 cm high, with branches issued irregularly in all directions. Blade 1-2 cm long, blade stalk cylindrical, expanded into a nearly circular foliar part resembling a stout trumpet, with irregularly toothed margin and 3-5 distinctive intramarginal crown teeth, with an embedded air bladder in the middle. Receptacles attached to the stalk of blade.



Figure 54. *Turbinaria ornata* (Turner) J. Agardh

***Turbinaria decurrens* Bory de Saint-Vincent** (Figure 55)

Lewmanomont and Ogawa 1995, p. 86; Lewmanomont *et al.* 1995, p. 67; Trono 1997, p. 154, fig. 99

Synonym: *Turbinaria vulgaris* J. Agardh var. *decurrens* (Bory de Saint-Vincent) J.

Agardh

Thallus erect, up to 15 cm high, main axis with few branches arising from a spreading branched holdfast. Blade 1-2 cm long, obpyramidal, blades arranged spirally around the main axis, triangular in cross section, expanded at the end, the edges with fine serrations, containing a central air bladder. Receptacles attached to the base of the stalk.



Figure 55. *Turbinaria decurrens* Bory de Saint-Vincent

3.2 Abundance and distribution study

3.2.1 Abundance and distribution of macroalgae in each season at each site.

Species diversity index (H') was relatively similar throughout the year. Fluctuations in H' were more pronounced spatially than seasonally. Diversity averaged 0.92 ± 0.07 , 1.00 ± 0.13 and 0.94 ± 0.16 for the sheltered, semi-exposed and exposed areas, respectively. The highest diversity was found at the semi-exposed area, while the lowest diversity was found at the sheltered area.

The seasonality of macroalgae species at the site was less uniform. During both dry season and wet season, *Lyngbya majuscula* and *Padina australis* showed greatest average of percentage cover, 31.66% and 27.77%, respectively (Figure 56o, p). *Acanthophora spicifera* (Figure 56a), *Boodlea composita* (Figure 56d), *Gracilaria salicornia* (Figure 56l), *Hypnea spinella* (Figure 56m) and *Valonia aegagropila* (Figure 56t) had greatest percentage cover during dry season and became less abundant during wet season. In contrast, during wet season, *Boergesenia forbesii* (Figure 56c), *Ceramium mazatlanense* (Figure 56e), *Chondrophyucus tronoi* (Figure 56g) *Gelidiella acerosa* (Figure 56j) exhibited a higher percentage cover than dry season.

Generally, most seaweed species exhibited greatest abundance at the semi-exposed area such as *Anadyomene wrightii*, *Dictyosphaeria cavernosa*, *Gelidium pusillum* and *Lyngbya majuscula*. The green alga, *Boodlea composita*, however, was common at the sheltered area. It showed the greatest percentage cover at the sheltered area and becoming less in abundance at semi-exposed and exposed areas. Some species, *Gelidiella acerosa* and *Chondrophyucus tronoi* were common at the exposed

area. There was no significant difference in percentage cover of algae among shore levels ($P>0.05$). However, some species became dominant at certain shore level, for example, three species of brown algae (*Turbinaria conoides*, *Turbinaria decurrens*, *Turbinaria ornata*) were common at the lower intertidal area.

Thirteen species were found throughout the entire study period. These included one species of blue-green algae, *Lyngbya majuscula*, five species of green algae, *Halimeda opuntia*, *Boergesenia forbesii*, *Valonia aegagropila*, *Dictyosphaeria cavernosa*, *Boodlea composita*, six species of red algae, *Acanthophora spicifera*, *Chondrophycus tronoi*, *Ceramium mazatlanense*, *Gelidiella acerosa*, *Gracilaria salicornia*, *Hypnea spinella* and one species of brown algae, *Padina australis*.

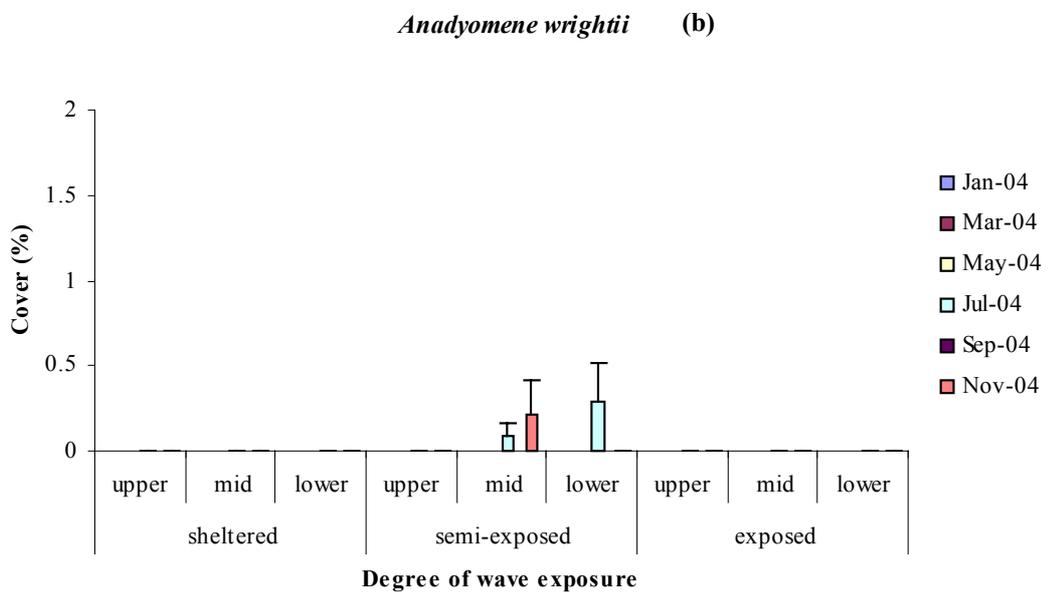
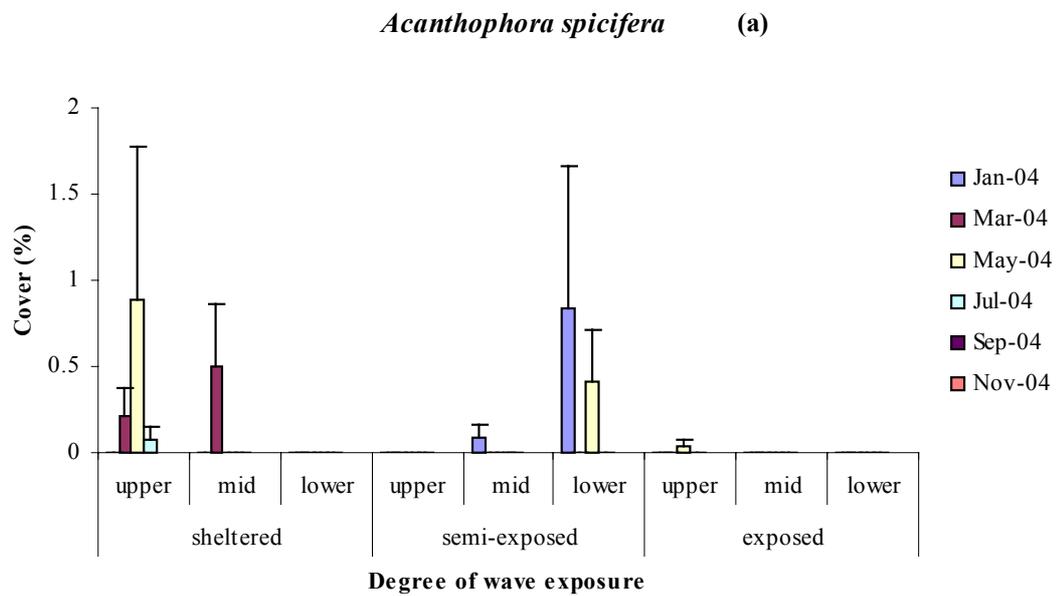
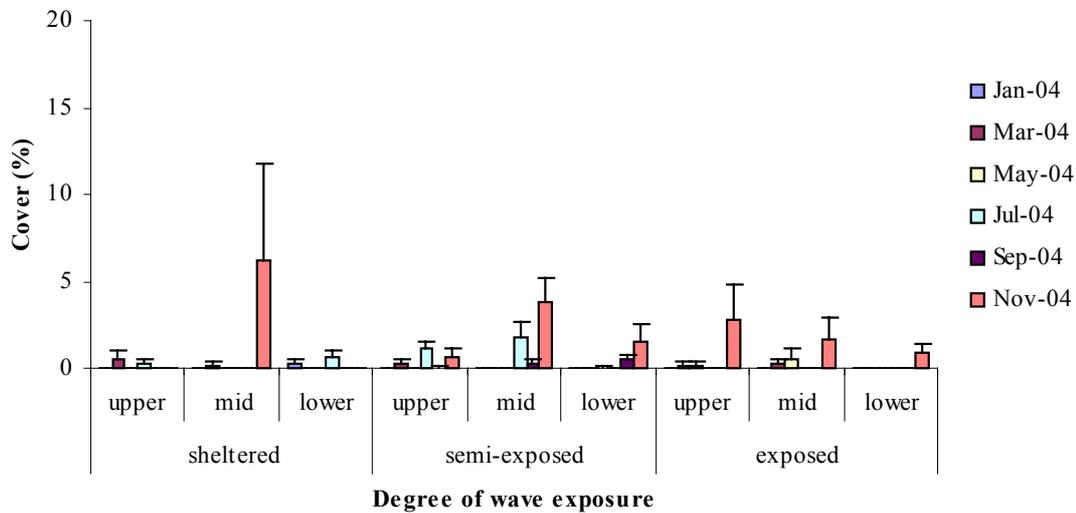


Figure 56. Effect of wave exposure (sheltered, semi-exposed and exposed areas) in each season on algal percentage cover which showed significant relationships.

Boergesenia forbesii (c)



Boodlea composita (d)

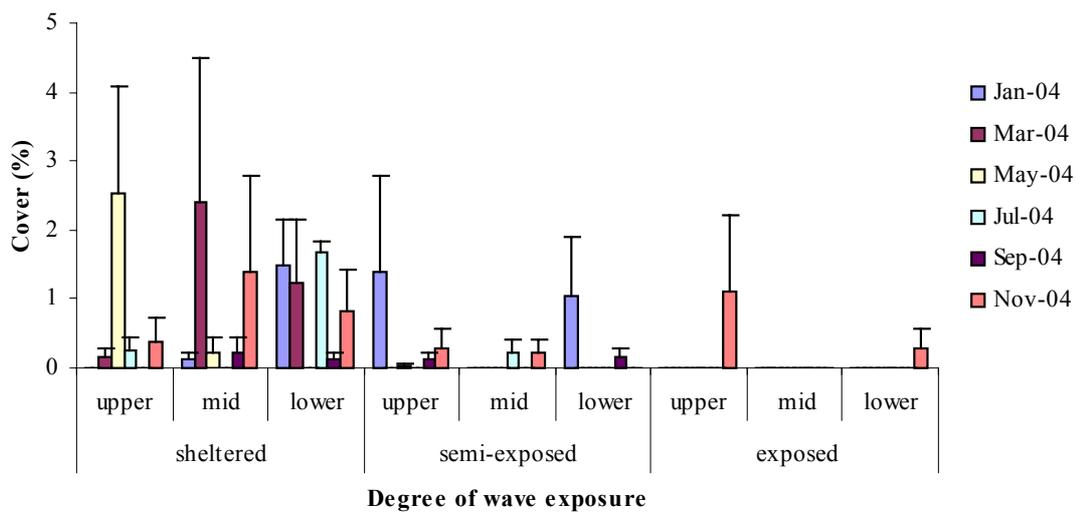
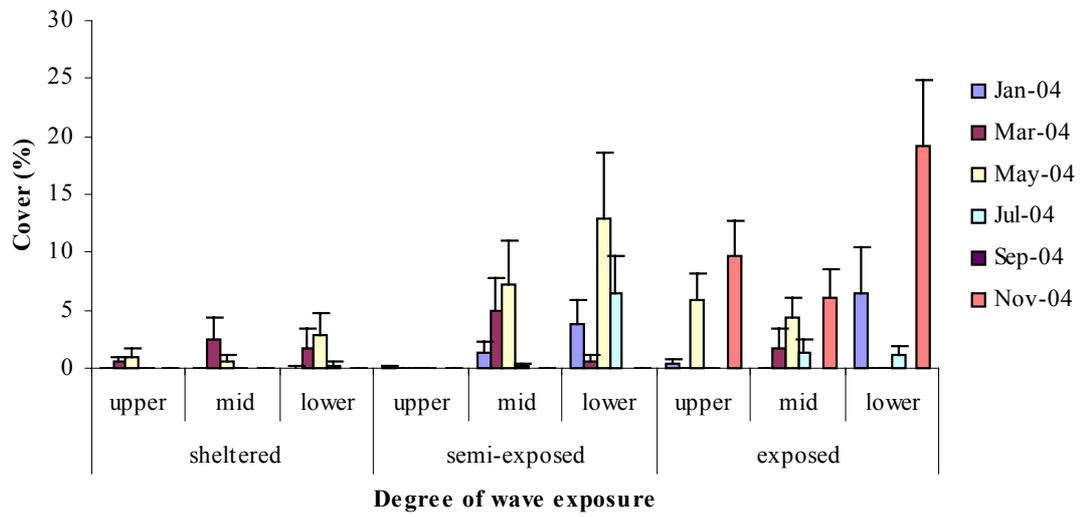


Figure 56. (Continued)

Ceramium mazatlanense (e)



Cladophoropsis sundanensis (f)

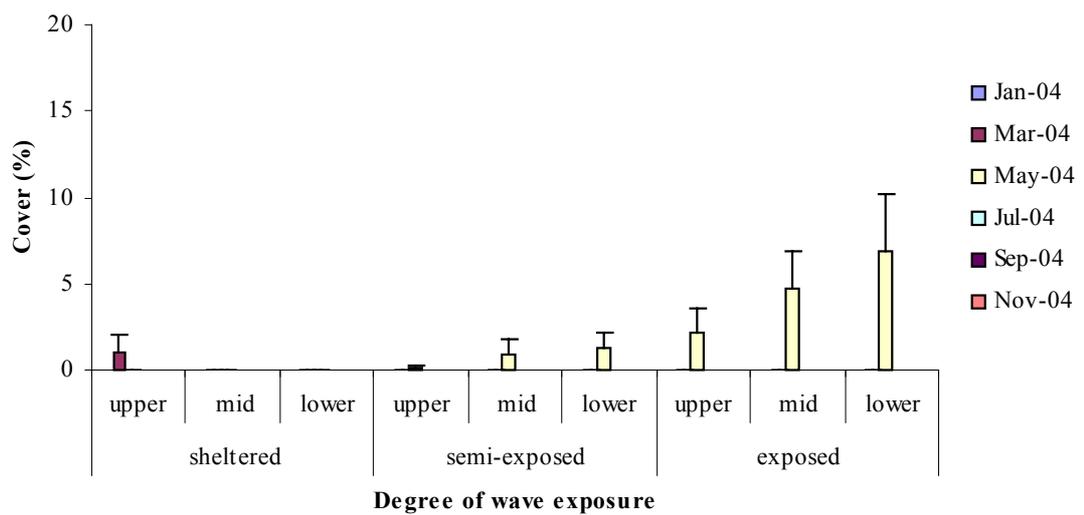
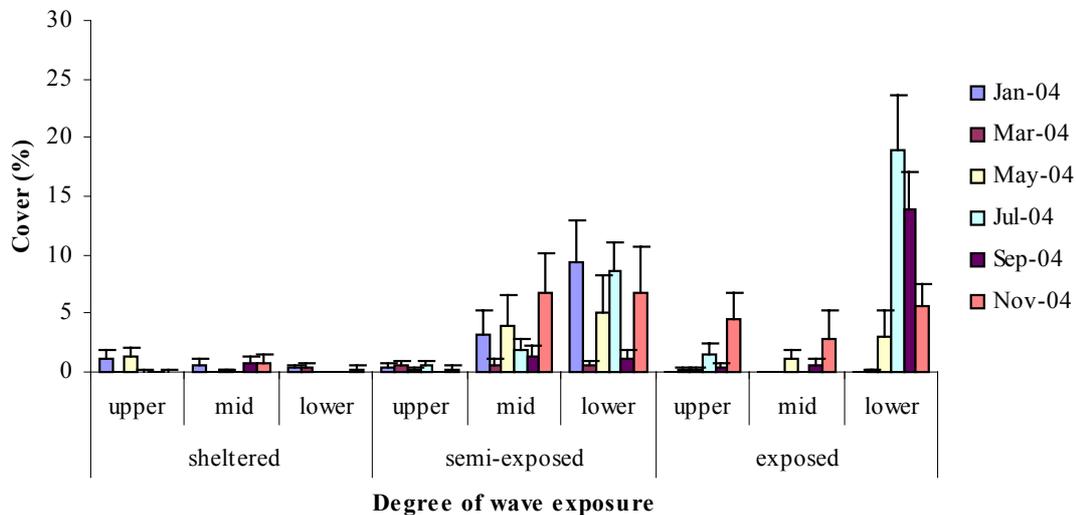


Figure 56. (Continued)

Chondrophyucus tronoii (g)



Dictyosphaeria cavernosa (h)

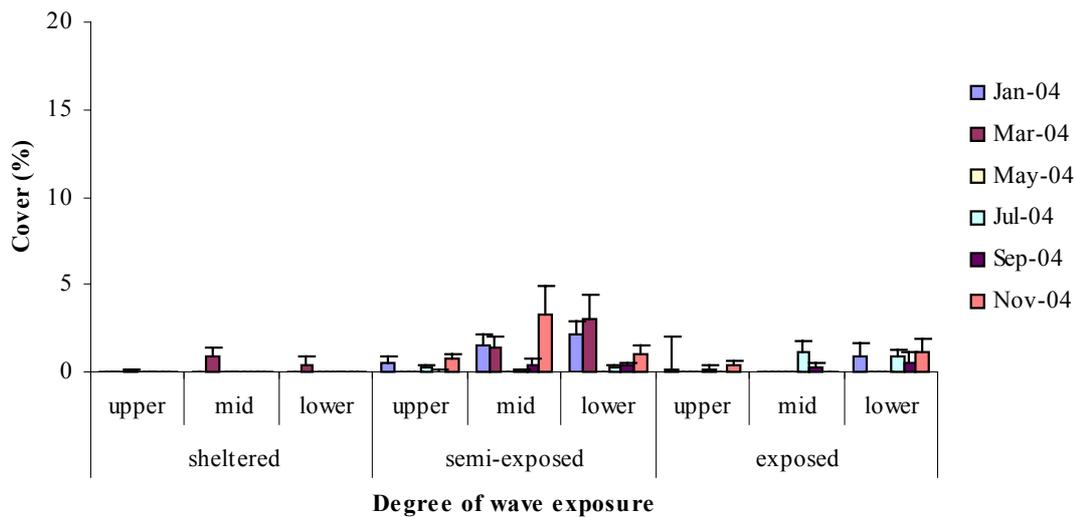


Figure 56. (Continued)

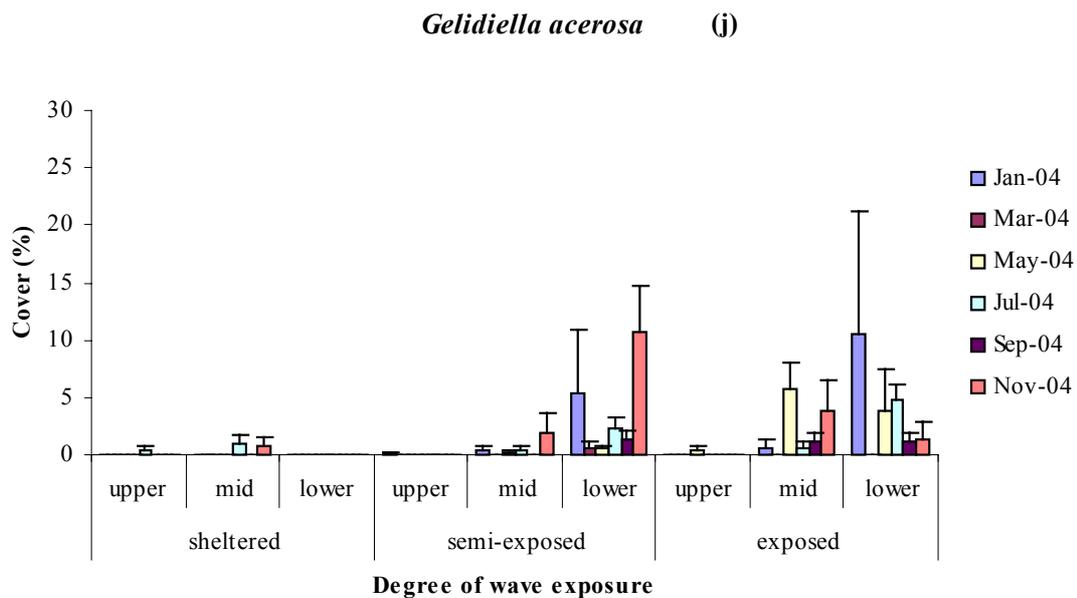
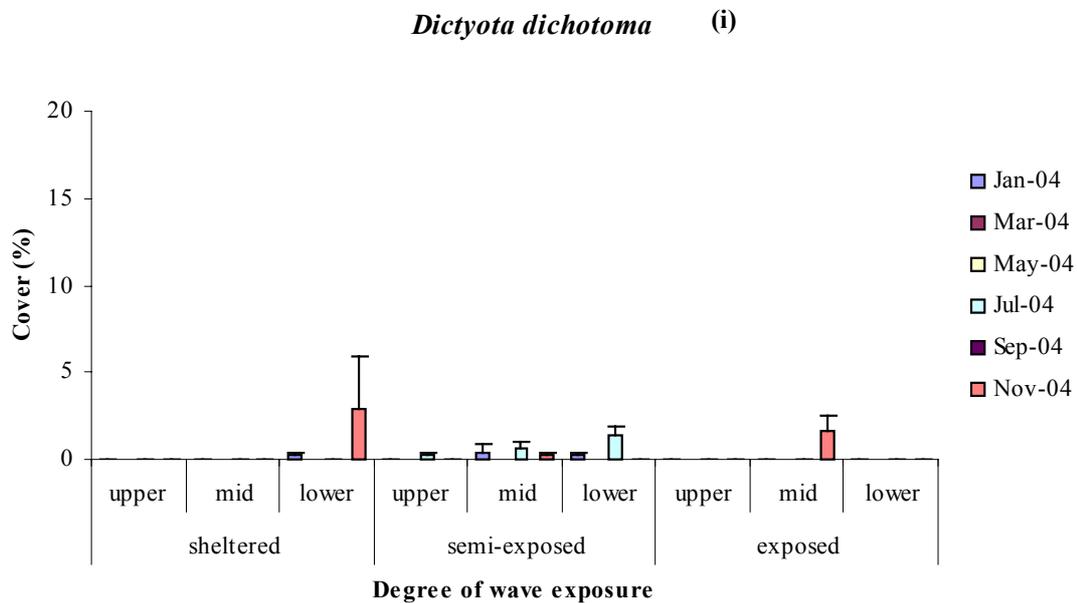


Figure 56. (Continued)

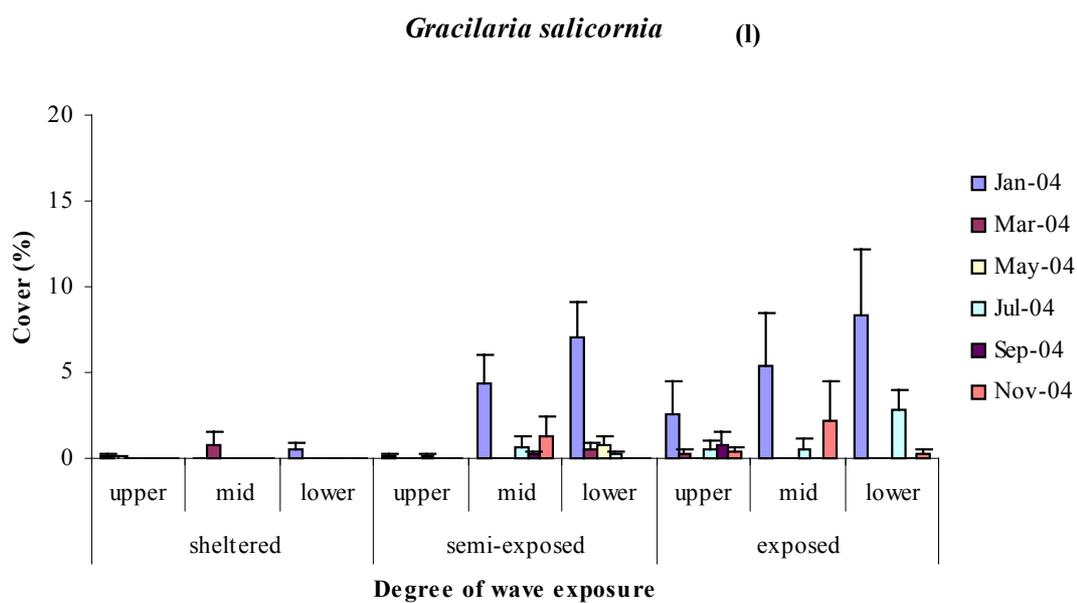
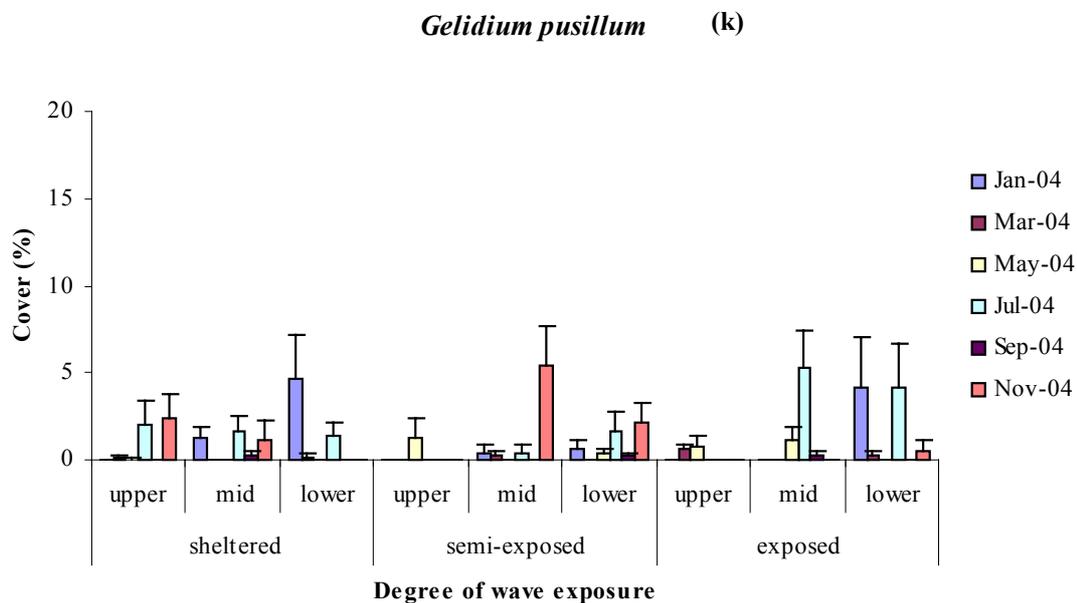
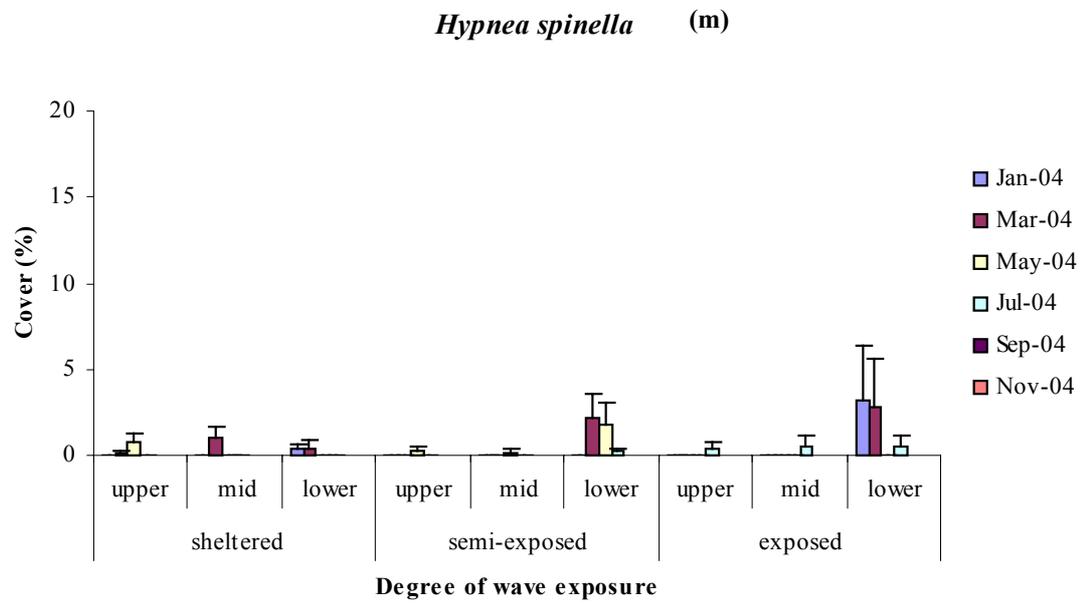


Figure 56. (Continued)



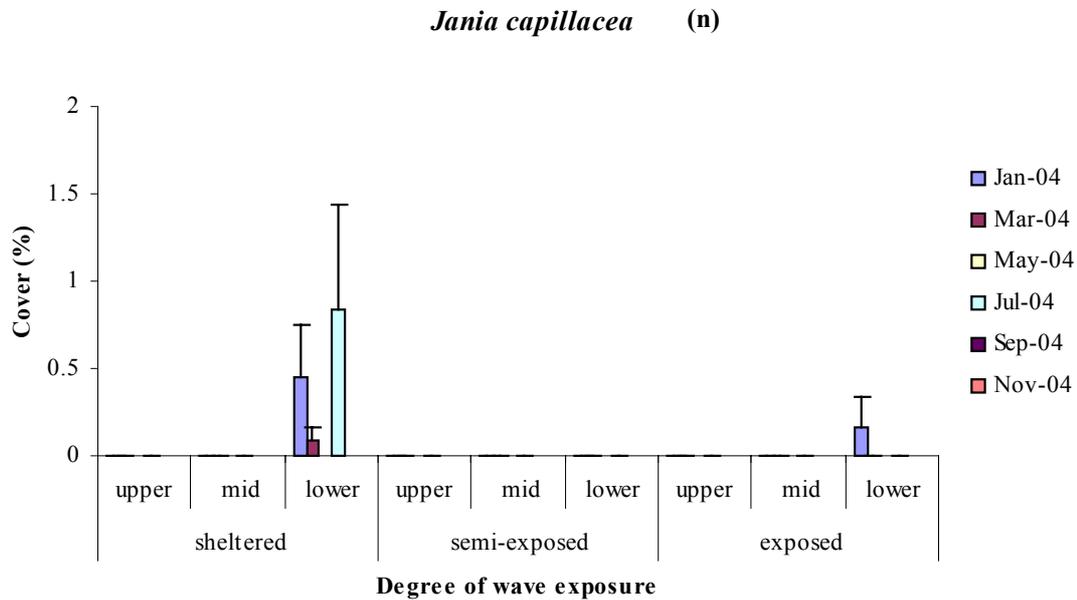
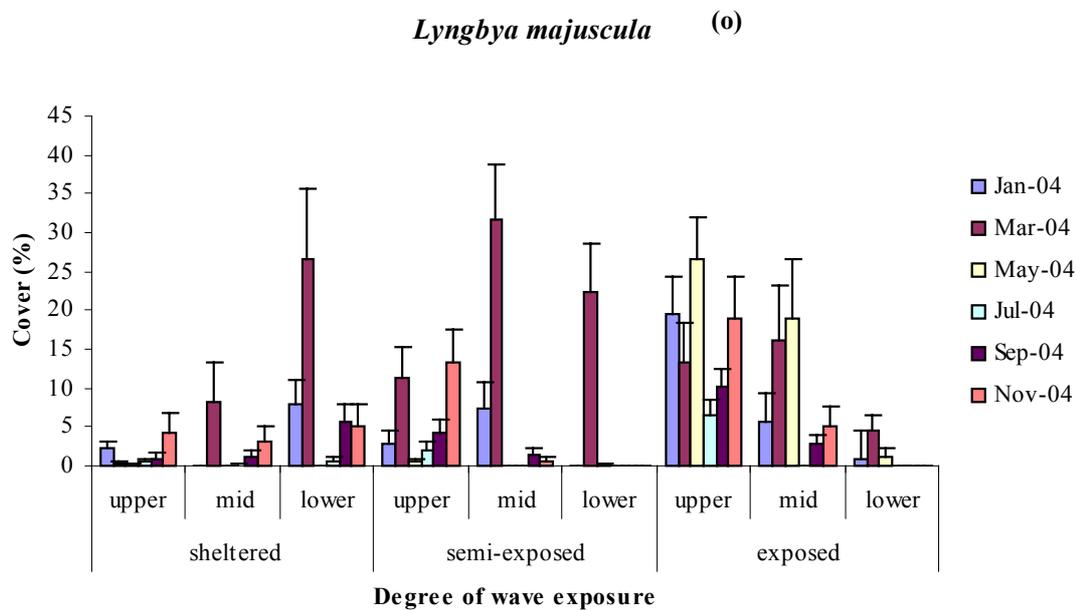


Figure 56. (Continued)



Padina australis (p)

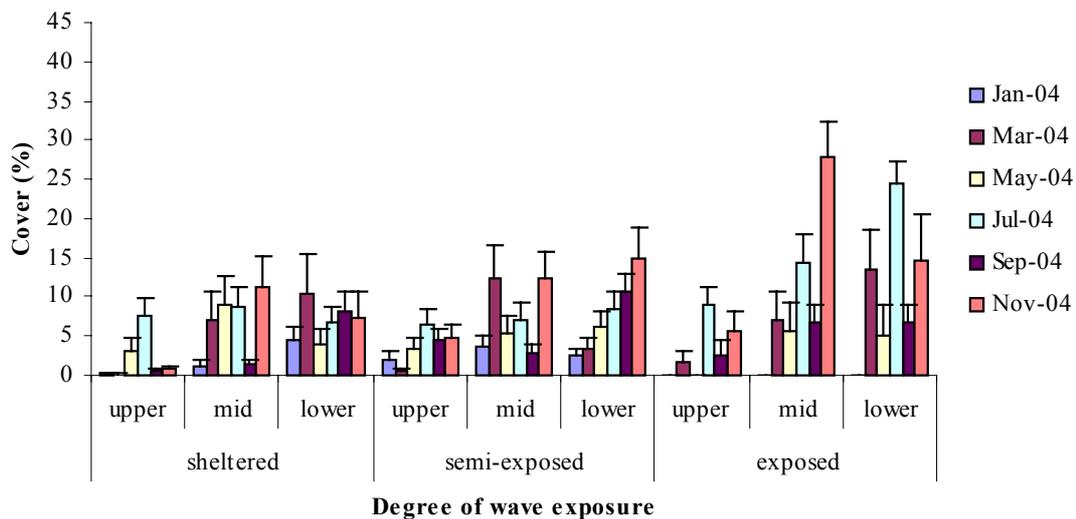
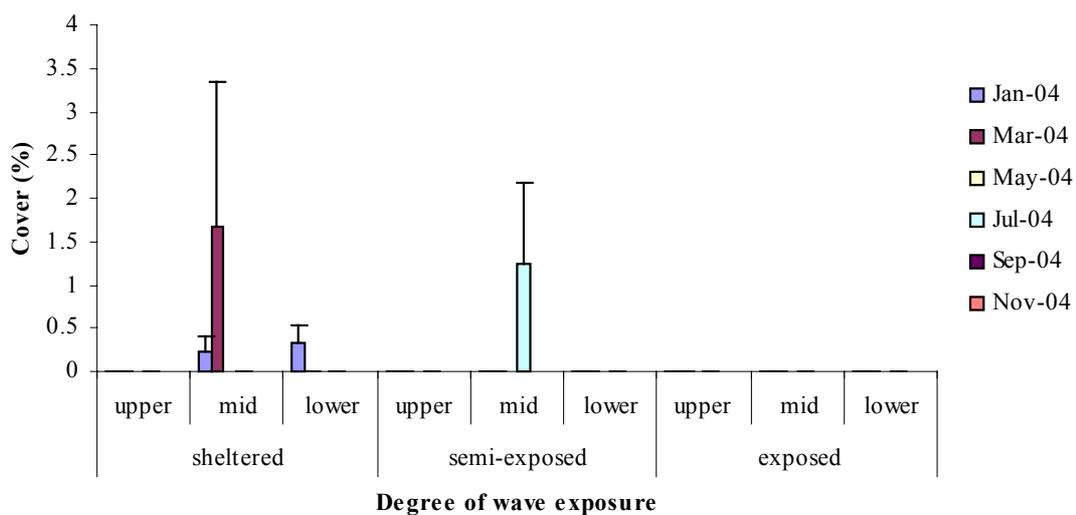


Figure 56. (Continued)

Struvea anastomosans (q)



Tolypocladia glomerulata (r)

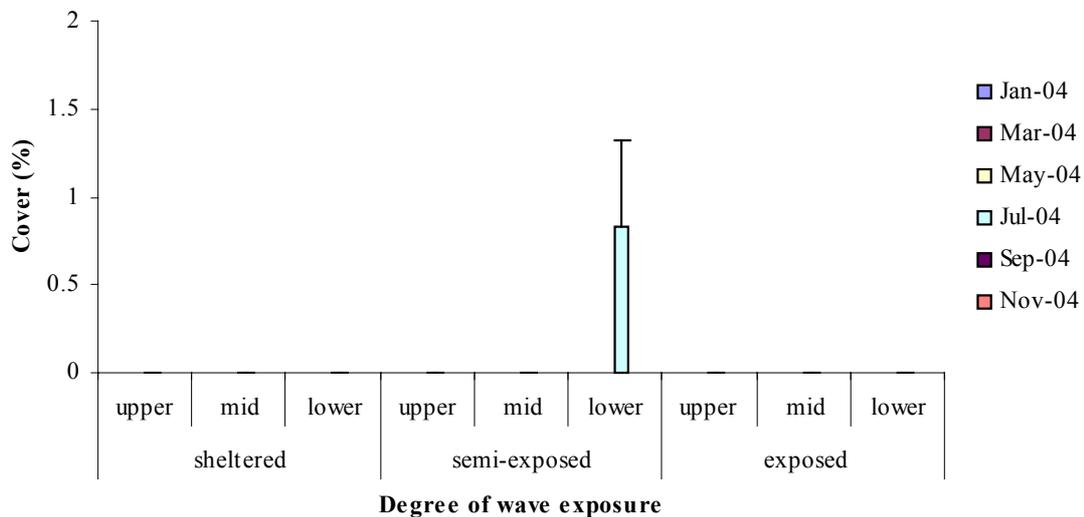
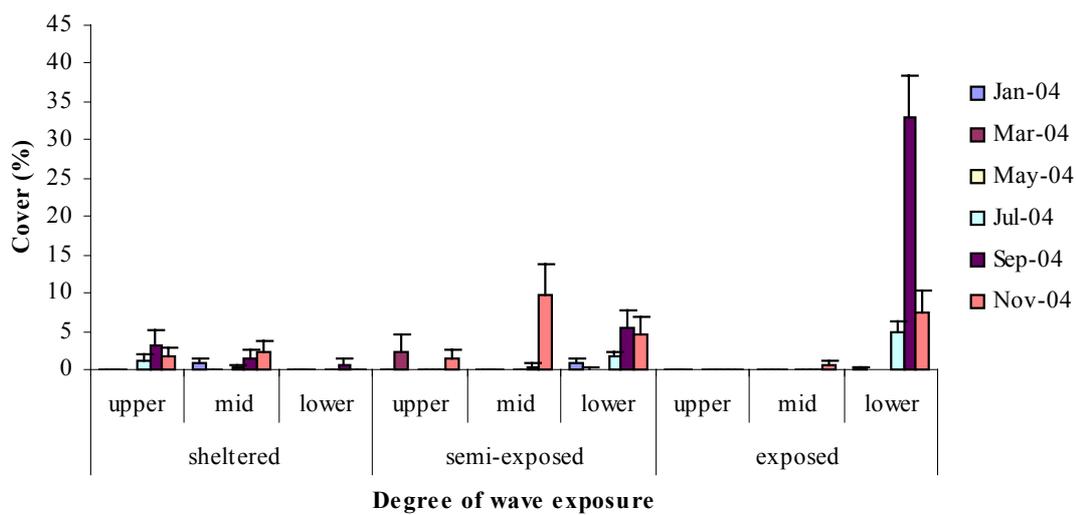


Figure 56. (Continued)

Turbinaria ornata (s)



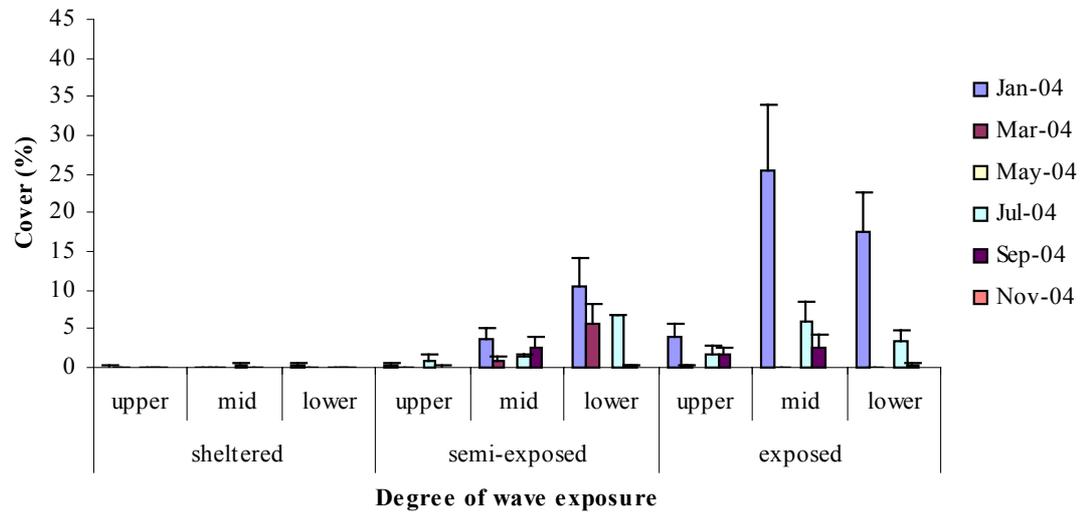
Valonia aegagropila (t)

Figure 56. (Continued)

3.2.2 The relationships between species distributions and environmental factors.

The first eigenvalue of CCA was 0.253 and species-environment correlations of the first two axes were high, 0.821 and 0.790, respectively (Table 2). The sum of the first two canonical eigenvalues is 0.459 and the seven environmental variables in conjunction account for 45% of the variance in the coverage of the macroalgae investigated in the analysis.

From the seven original variables, the CCA identified five environmental variables explaining variance in seaweed distribution data. Figure 57 showed that some species relate to the important variables. The direction of nutrient (PO_4^{3-}) indicated the relative positions of species distributions along the phosphate gradient. Thus, species such as *Ceramium mazatlanense*, *Cladophoropsis sundanensis* and *Enteromorpha flexuosa* were found mainly in sites of high phosphate concentration, while light positively affected *Gracilaria salicornia*. *Padina australis* showed a positive relationship with air and water temperature; this suggested that this species could tolerate high levels of wave exposure.

Table 2. Axis summary statistics for CCA analysis.

Number of canonical axes : 3

Total variance (“inertia”) in the species data : 2.263

	Axis 1	Axis 2	Axis 3
Eigenvalue	.253	.206	.161
Variance in species data			
% of variance explained	11.2	9.1	7.1
Cumulative % explained	11.2	20.2	27.4
Pearson Correlation, Spp-Envt*	.821	.790	.677
Kendall (Rank) Corr., Spp-Envt	.526	.487	.326

* Correlation between sample scores for an axis derived from the species data and the sample scores that are linear combinations of the environmental variables. Set to 0.000 if axis is not canonical.

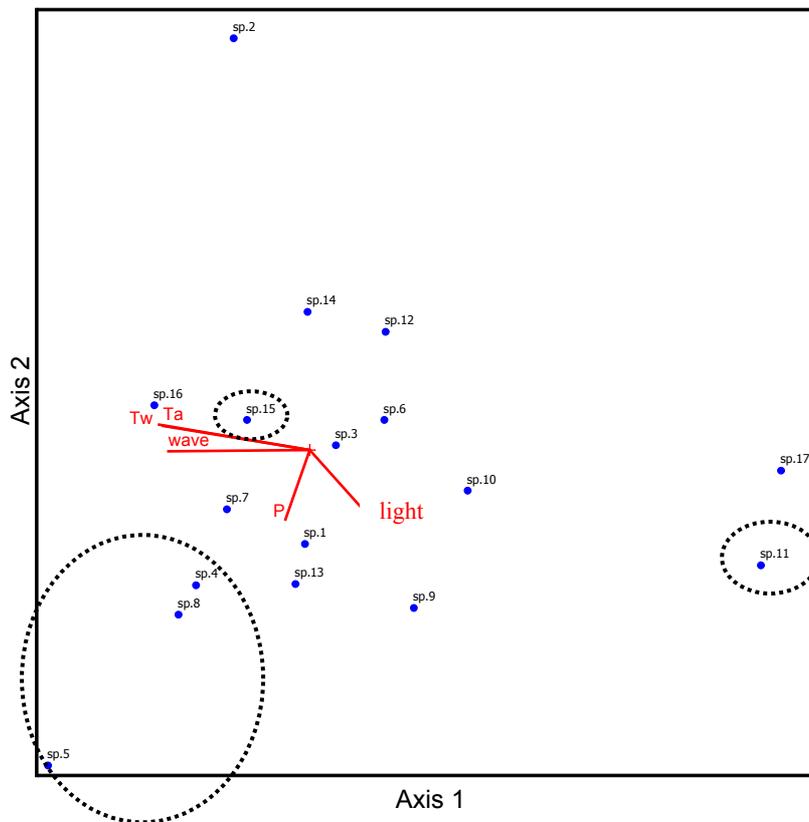


Figure 57. Canonical correspondence analysis ordination of cover data with respect to 7 environmental factors.

light = light

wave = wave motion

Ta = air temperature

Tw = water temperature

sp.1 = *Acanthophora spicifera*

sp.10 = *Gelidium pusillum*

sp.2 = *Lyngbya* sp.

sp.11 = *Gracilaria salicornia*

sp.3 = *Boodlea composita*

sp.12 = *Hypnea spinella*

sp.4 = *Ceramium mazatlanense*

sp.13 = *Chondrophyucus tronoi*

sp.5 = *Cladophoropsis sundanensis*

sp.14 = *Lyngbya majuscula*

sp.6 = *Dictyosphaeria cavernosa*

sp.15 = *Padina australis*

sp.7 = *Dictyota dichotoma*

sp.16 = *Turbinaria ornata*

sp.8 = *Enteromorpha flexuosa* subsp. *paradoxa*

sp.9 = *Gelidiella acerosa*

sp.17 = *Valonia aegagropila*

3.3 Variations in morphology and reproduction of *Acanthophora spicifera* and *Chondrophyucus tronoi*

3.3.1 Morphology study

Acanthophora spicifera

Thallus erect, succulent, up to 15 cm tall, loosely branched, with small discoid holdfast; from the holdfast, erect fronds begin to branch out. The main branches have short, determinate branchlets that are irregularly shaped and spinose. Branchlets are hook-like, brittle and fragment easily under heavy wave action.

Chondrophyucus tronoi

Forming clumps which have a few erect axes standing on a discoid holdfast, without stoloniferous basal branches, up to 5 cm high, cartilaginous. Branching alternately or oppositely distichous. Colour brownish purple or somewhat greenish when fresh, changing to black upon drying.

3.3.2 Variations in height and diameter

There were significant differences in height and diameter of both *Acanthophora spicifera* (Figure 58) and *Chondrophyucus tronoi* (Figure 59) among sites and seasons ($P < 0.05$). The height of *C. tronoi* was negatively correlated with the degree of wave exposure ($R = -0.360$, $P < 0.01$, $N = 384$) (Figure 60), suggesting that plants in sheltered area were taller than plants in exposed areas, while there was no significant correlation between degree of wave exposure and height of *A. spicifera*.

Surprisingly, *A. spicifera* were not found in July at sheltered area, and in September at all sites. Then they were found in November, with higher in height and diameter.

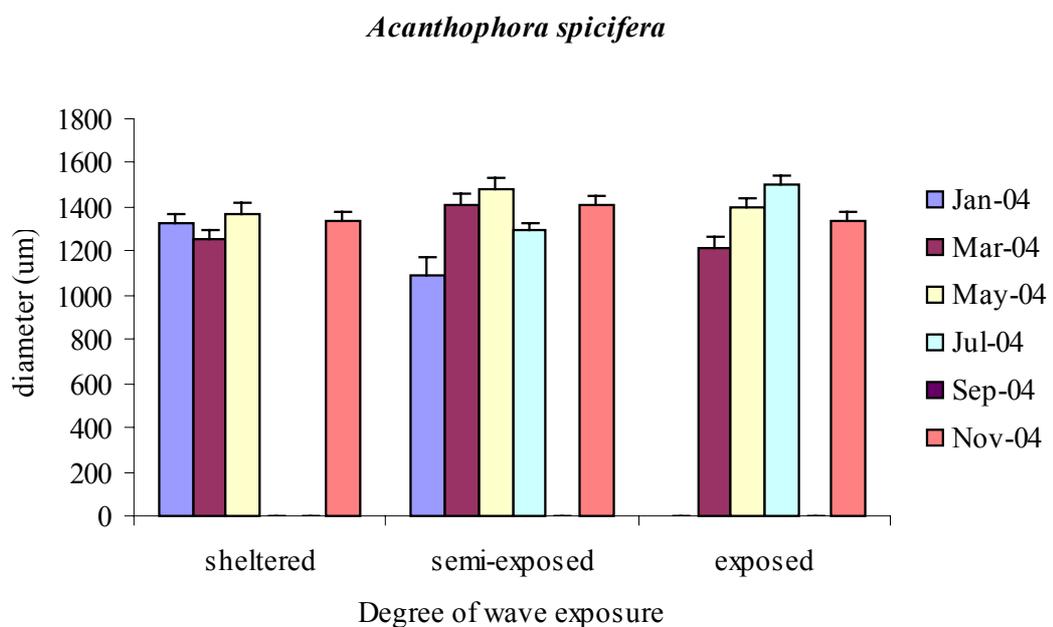
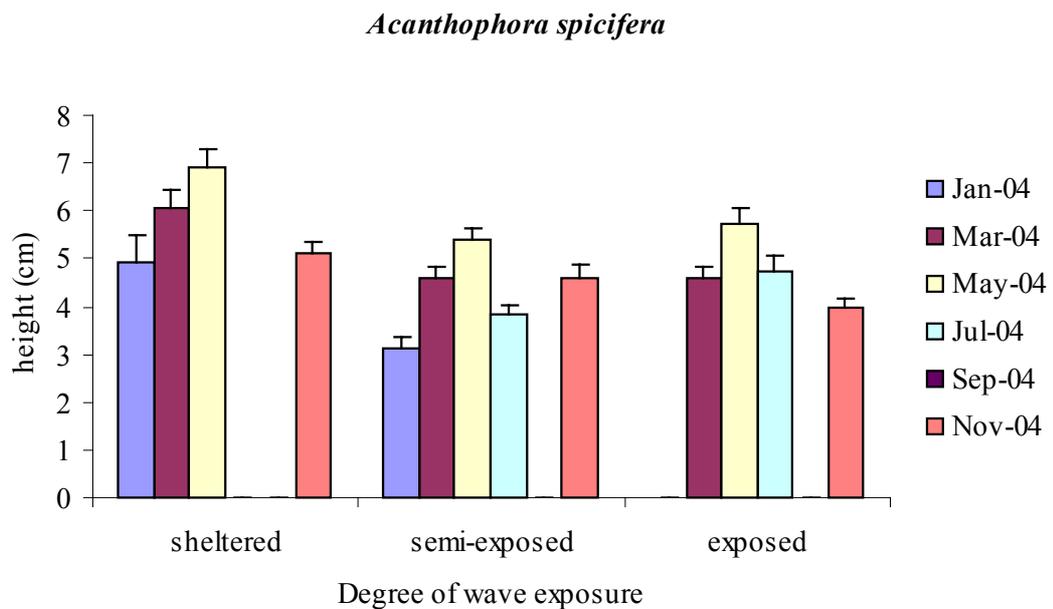


Figure 58. Height and diameter of *Acanthophora spicifera* each season and site.

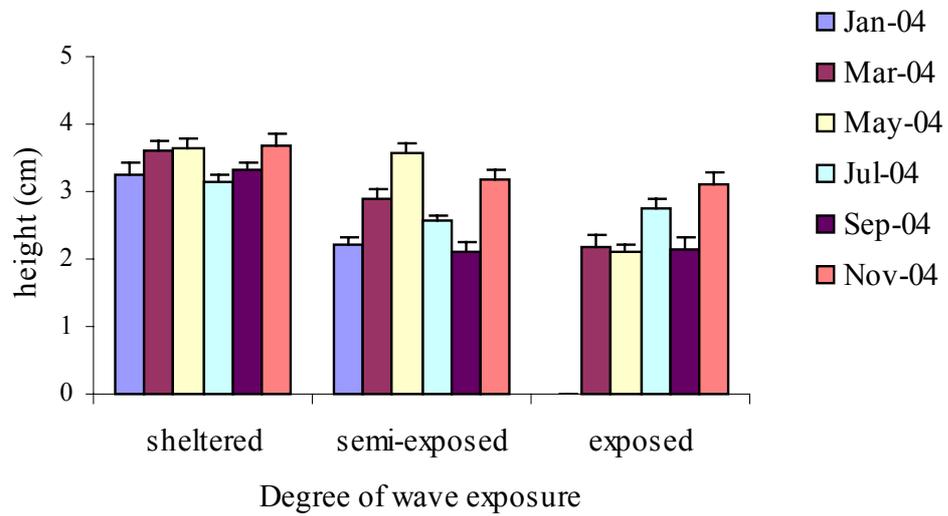
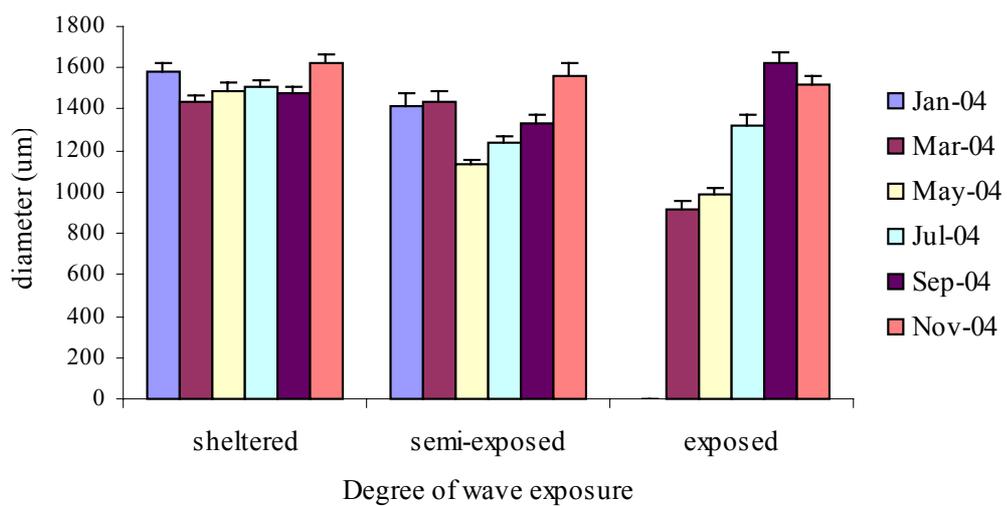
Chondrophyucus tranoi*Chondrophyucus tranoi*

Figure 59. Height and diameter of *Chondrophyucus tranoi* each season and site.

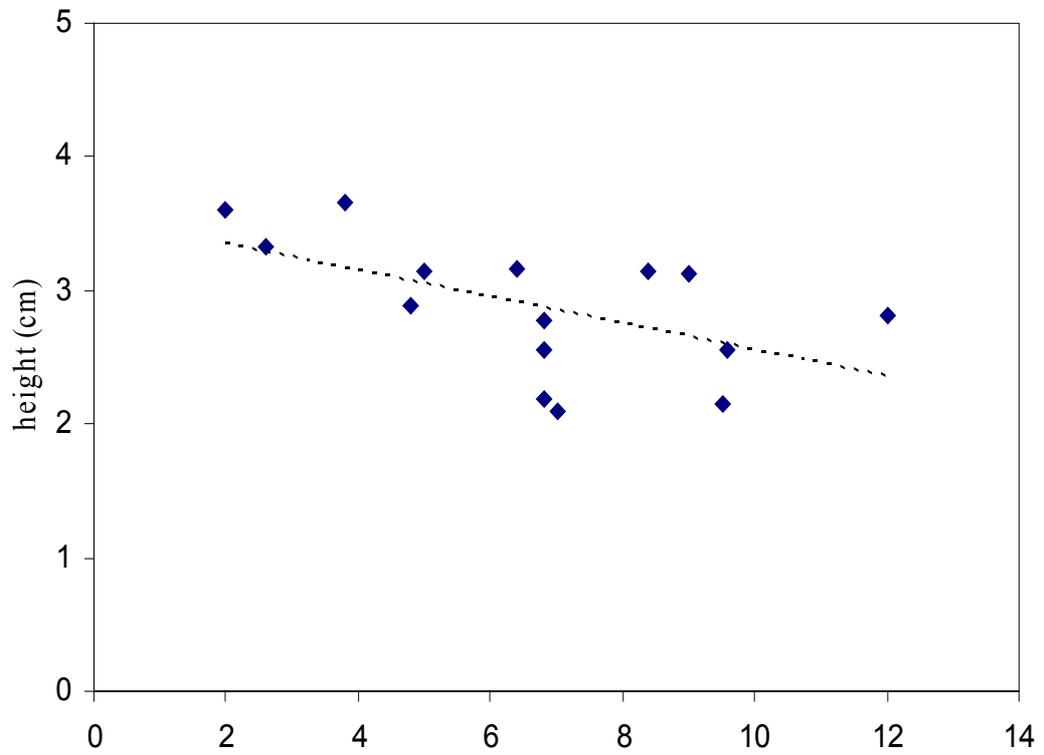


Figure 60. Correlations of the degree of wave exposure and height of *Chondrophycus tranoi* ($R = -0.360$, $P < 0.01$, $N = 384$)

3.3.3 Branching pattern of *Acanthophora spicifera* and *Chondrophyucus tranoi* at the sites.

The number of primary and secondary branches of *Acanthophora spicifera* and *Chondrophyucus tranoi* were similar at all sites, branching patterns of plants from all 3 sites had the same series. Comparisons of numbers of branches showed that there were no significant differences among sites in numbers of primary ($P=0.75$) and secondary branches ($P=0.56$) of *A. spicifera*, and there were no significant differences among sites in numbers of primary ($P=0.69$) and secondary branches ($P=0.51$) of *C. tranoi*.

3.3.4 Variations in reproduction of *Acanthophora spicifera* and *Chondrophyucus tranoi* at the site.

The reproduction of both *Acanthophora spicifera* and *Chondrophyucus tranoi* were investigated, total of 540 plants were examined throughout the study. There was no reproductive structures of these two species were found during this study.

3.4 Physical factors study

The physical factors were recorded bimonthly: January and March represent the dry season, whilst May, July, September and November represent the rainy season.

There were significant variations in temperature, salinity and wave current among sites ($P < 0.01$, $N = 15$). The average water temperature was 30.75- 31.33 °C during the dry season and 31.27- 33.16 °C during the rainy season, whilst average air temperature was 28.1- 29.8 °C during the dry season and 30.33- 32.44 °C during the rainy season. Average salinity during the dry season was 32.94- 34.55 psu, and 32.67- 33 psu during the rainy season, which were in the narrow range.

The average wave current was 3.5 ± 0.28 , 7.2 ± 0.21 and 9.4 ± 0.7 m/s in sheltered, semi-exposed and exposed area, respectively during the dry season while the average wave current was 4.9 ± 0.4 , 6.7 ± 0.2 and 8.4 ± 0.54 m/s during the rainy season.

There were no significant variations in nutrients (PO_4^{3-} , NO_3^-) among sites ($P > 0.05$). The phosphate and nitrate concentration were 1.4 and 0.9 mg/l during dry season, 0.03 and 2.83 mg/l during rainy season.