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Data Paper

# New records of benthic red algae (Rhodophyta) from Hainan Island (1990 - 2016) (taxonomic description of species and their varieties)

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## Abstract

Morphological descriptions are presented with colour photographs for species of red algae collected from Hainan Island during German-Chinese expeditions to the Island (1990, 1992) and during the authors' visits in 2008–2016. A total of 77 taxa and their varieties are described for samples collected from 2008 to 2016.

**Keywords**: red algae, Rhodophyta, Hainan Island, China

## Introduction

Hainan Island is located at the subtropical northern periphery of the Indo-Pacific Ocean in the South China Sea (18°10′-20°9′N, 108°37′-111°1′E) (Fig. 1). Shallow areas along Hainan Island coastline are occupied by coral reefs. Seagrass beds and mangroves are also present.

The marine algal flora of Hainan Island has been studied since 1933. The first big campaign to sample marine seaweeds on Hainan Island was by Chinese algologists (Tseng 2004) from 1933 to the 1980s, covering all coasts of the island (Fig. 1). This was followed by German-Chinese expeditions to Hainan Island in 1990 and 1992. Results of these expeditions were partially published (Titlyanov *et al*. 2011a, 2016; Titlyanova *et al*. 2012, 2014). During the German-Chinese expeditions, 203 taxa were collected, of these 105 (52%) were red algae, including 59 new findings.

The third sampling was performed in 2008–2016 (Fig. 1). Some of the results on the algal inventory have been published (Titlyanov *et al*. 2011a, b, 2014, 2015; Titlyanova et al. 2014). During this period, 298 species were collected in Hainan Island including 160 (54%) Rhodophyta, of these 54 taxa were newly recorded for Hainan Island, 20 taxa for China.

This paper presents descriptions of algae found for the first time in Hainan, with colour photographs of their overall morphology and anatomical details of thalli.

## Materials and Methods

Sampling of benthic macroalgae was carried out in October 2008 at Luhuitou, Dadong Hai, Xiaodong Hai, in April 2009 and in December 2010 at Luhuitou, in February–April 2012 at Luhuitou, Meixia, Wenchang, Xian Hai, Yalong Wan, in April 2014 at Luhuitou, Xiaodong Hai, Ying Ge Hai, in March 2015 at Luhuitou, Xiaodong Hai, in March–April 2016 at Luhuitou, Xiaodong Hai, Hong Tang Bay and in November–December 2016 at Luhuitou, Xiaodong Hai (Fig. 1).

Macroalgae were collected in the upper, middle, lower intertidal and the upper subtidal (from 0.5 to 4 m depth during low tide) zones by Titlyanova T.V. and Titlyanov E.A. In the upper subtidal zone, sampling was carried out by snorkeling and SCUBA diving (by Li Xiubao) during low and high tides. Algae were collected from all types of substrata. The algal collection of 2008–2016 was deposited at the A.V. Zhirmunsky Institute of Marine Biology, Far Eastern Branch of the Russian Academy of Sciences.

Fresh and dried specimens were identified by Titlyanova T.V. and Titlyanov E.A. using monographic publications, floristic studies and systematic articles cited in previous publications (Titlyanov *et al*. 2011a, b, 2014a; Titlyanova *et al*. 2012, 2014). The systematics and nomenclature followed Guiry & Guiry (AlgaeBase, http://www.algaebase.org; searched in 2017). Hierarchical classification of the phylum Rhodophyta was assessed according to Saunders & Hommersand (2004). All publications concerning studies on Hainan Island have been reviewed in Titlyanova *et al*. 2014. The previously known and newly recorded species for Hainan and China were verified using Algaebase, the Catalogue of Life China 2010: Annual Checklist and the checklist of Marine Biota of China Seas (Liu 2008). Results of these investigations represented as guidebook with descriptions and color photographs for 77 common and abundant species found during the period from 2008 to 2016.

In the following text, new findings in 1990/1992 and 2008-2016 are indicated by ♣ and ♦ for Hainan Island and by ♣♣ and ♦♦ for China, respectively.


**Fig. 1** Collection sites on Hainan Island, China. (Filled circles), collection sites of C.K. Tseng and coworkers in the 1930s–1980s (old spellings of site names); (Stars), collection sites of two German-Chinese expeditions during October−December 1990 and March−April 1992; (Plus), collection sites of T. Titlyanova, E. Titlyanov and Li Xiu Bao in 2008−2016.

**Description of algal species and taxonomic forms found in Hainan Island**

**Order STYLONEMATALES**

**Family STYLONEMATACEAE**

***Chroodactylon ornatum*** (C. Agardh) Basson (♣)

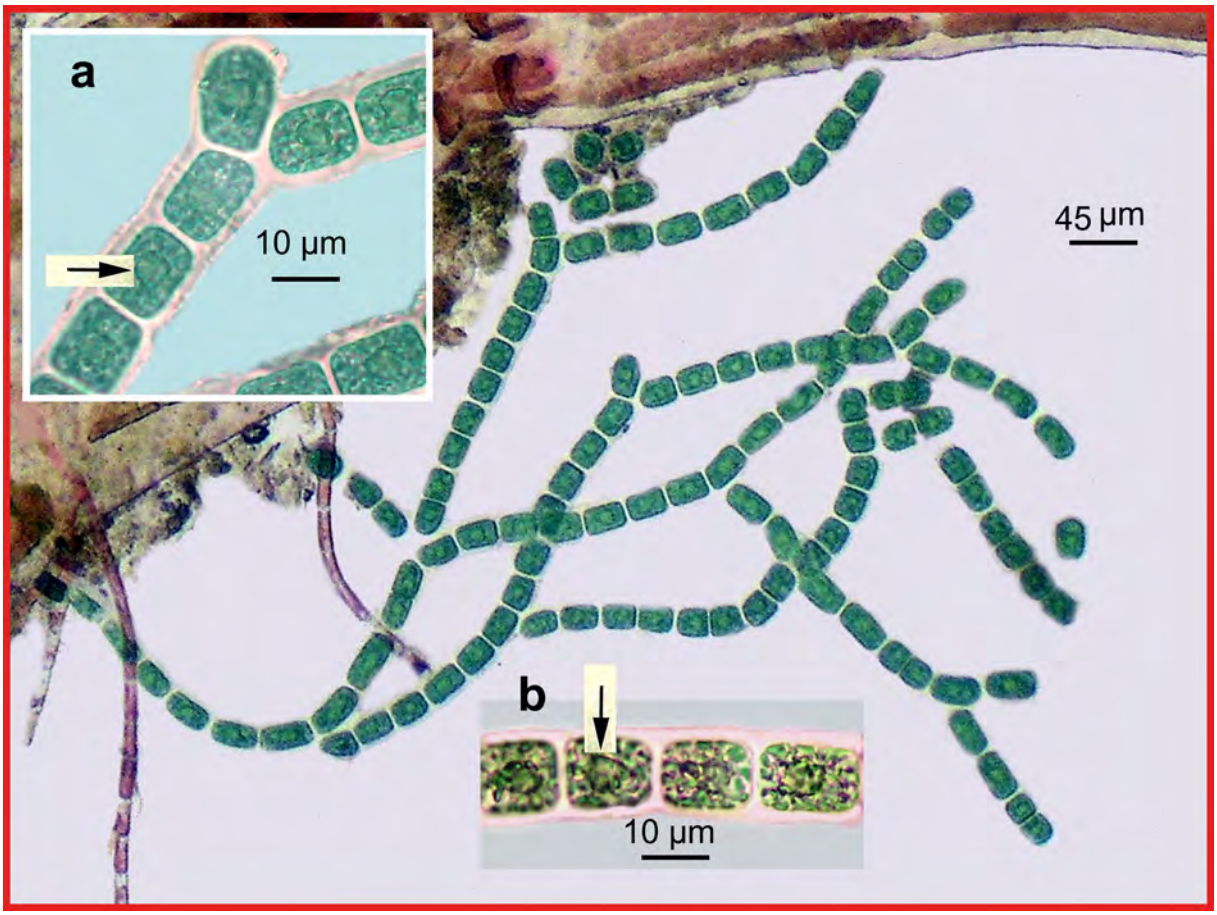


**Fig. 2** ***Chroodactylon ornatum***. Epiphytic on *Herposiphonia secunda* f. *tenella*. Hainan Island, Luhuitou, February 2012. Insets: a, b fragments showing segments consisting of cells with central pyrenoid (arrows).

Characteristics: Thallus microscopic, filamentous, in tufts, 0.2-1.0 mm high. Filaments uniseriate, simple or sparsely branched. Branching irregularly alternate or subdichotomous. Filaments 10-20 µm in diameter, composed of cylindrical to ovoid cells embedded in a mucilaginous sheath. Cells (6-)10 µm in diameter, 7.5-15 µm long at the basal portion, 10 µm in diameter, 10-20(-30) µm long above, bright bluish-green, grayish to brownish. *Chloroplast stellate* with a central pyrenoid. Reproduction by akinetes transformed from cells of filaments. Attachment by an inconspicuous basal cell. Growing epiphytically on *Cladophora socialis*, *C. laetevirens*, *Dictyosphaeria cavernosa*, *Dictyota bartayresiana*, *Sargassum polycystum*, *Ceramium marshallense*, *Ceratodictyon intricatum*, *Chondria armata*, *Gayella flaccida*.

Collection sites in Hainan. Lingchang, Dadong Hai, Luhuitou, Xiadong Hai, Yalongwan.

***Stylonema alsidii*** (Zanardini) K.M. Drew (♣)

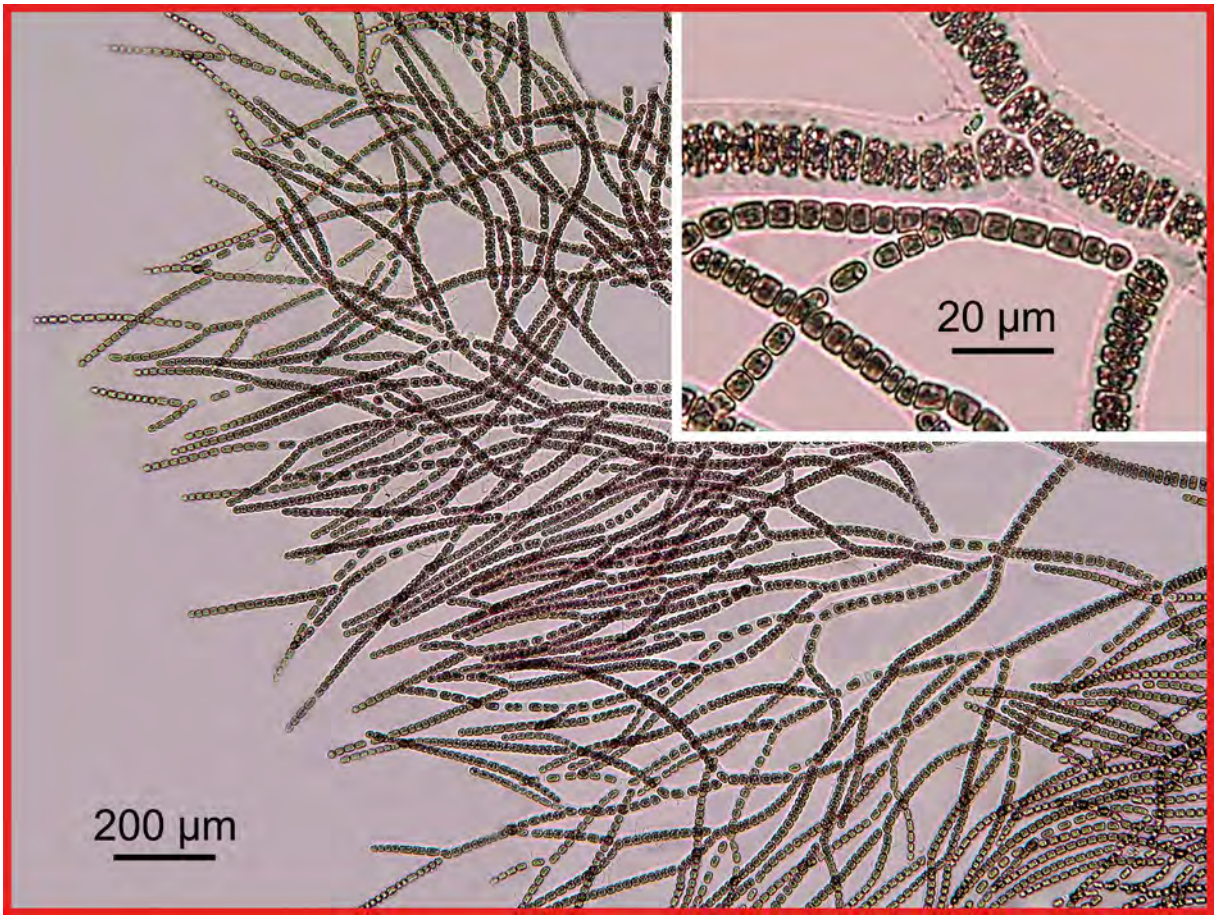


**Fig. 3** ***Stylonema alsidii.*** Overall morphology. Inset: Detail showing cells with chloroplasts containing a central pyrenoid. Hainan Island, Luhuitou, November 2010.

Characteristics: Thallus microscopic, filamentous, 0.1-4(-6) mm high, pinkish- to purplish-red, branching irregular, alternate to pseudodichotomous with wide axils. Filaments 12-25(-30) µm in diameter, consist of uniseriate rows of closely adjacent shortly cylindrical or spherical cells embedded in a thick mucilaginous sheath. Cells in surface view rectangular, quadrate, visibly shortened, with round or angular corners, (5.5-)7-13 µm in diameter, 4-16 µm long. Chloroplasts are stellate with a central pyrenoid. Attachment by basal thickened cell. Growing epiphytically on various algae (*Acetabularia calyculus*, *Anadyomene wrightii*, *Bryopsis pennata, Cladophora spp., Codium repens, Dictyosphaeria cavernosa, Feldmannia mitchelliae, Canistrocarpus cervicornis, Padina australis, Sargassum* spp., *Sphacelaria* spp., *Turbinaria ornata, Centroceras clavulatum, Ceratodictyon intricatum, Gelidium pusillum, Hypnea spinella, Jania pumila, Leveillea jungermannioides, Lophosiphonia reptabunda, Neosiphonia ferulacea, Parviphycus adnatus, Polysiphonia* spp., *Tolypiocladia condensata*).

Collection sites in Hainan. Meixia, Qukou, Nanmai, Shalao, Xincun, Lingchang, Yalongwan, Dadong Hai, Xiadong Hai, Luhuitou, Ximao Zhou, Tian Ya Hai Jiao.

**Order ERYTHROPELTIDALES**

**Family ERYTHROTRICHIACEAE**

***Erythrotrichia carnea*** (Dillwyn) J. Agardh ( ♣ )

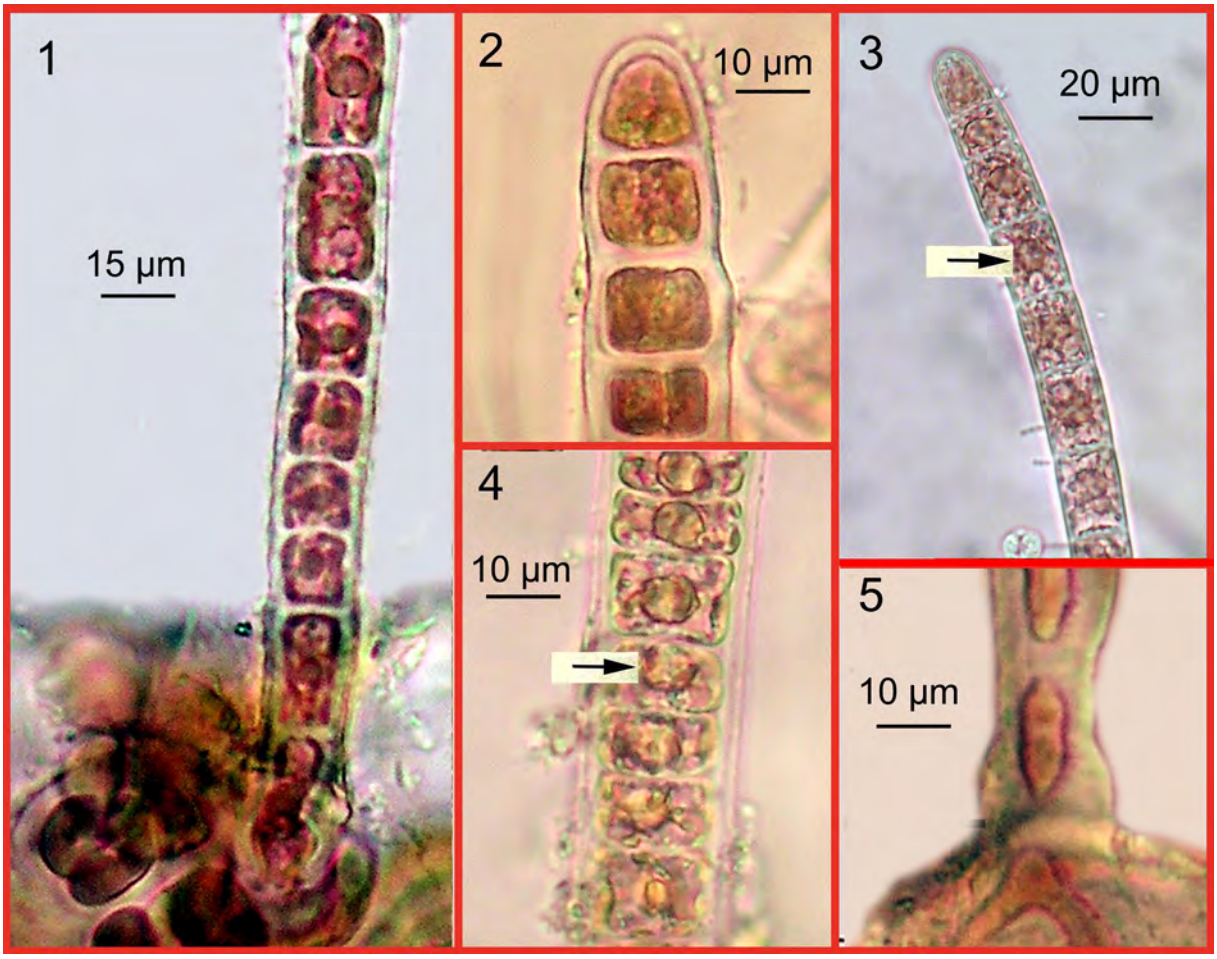


**Fig. 4** ***Erythrotrichia carnea.*** 1. Overall morphology. 2. Apex. 3, 4. Details showing chloroplasts with a large pyrenoid (arrows). 5. Basal portion. Hainan Island, Luhuitou. February 2012.

Characteristics: Thallus erect, 0.5-5(-8) mm high, fine filamentous. Filaments simple, unbranched, cylindrical, uniseriate, 10-20(-27) µm in diameter, rose-red. Cells quadrangular to roundish rectangular, 0.5-2 diameters long. Cell walls thin, gelatinous. Chloroplast stellate with a central pyrenoid. Monosporangia develop in the upper portion of filaments. Attachment by a single, lobed extension of the basal cell. Commonly epiphytic on larger algae (*Anadyomene wrightii, Caulerpa serrulata, Chaetomorpha linum, Cladophora* spp., *Phyllodictyon anastomosans stalk, Valoniopsis pachynema, Canistrocarpus cervicornis, Dictyota bartayresiana, Hydroclathrus clathratus, Padina* spp., *Sphacelaria* spp., *Sargassum* spp., *Turbinaria ornata, Acanthophora spicifera, Bostrychia tenella, Ceramium* spp., *Centroceras minutum*, *C. clavulatum, Champia parvula, Chondria armata, Gelidiella acerosa, Gelidium* spp., *Hypnea* spp., *Jania pumila, Lophosiphonia reptabunda, Neosiphonia ferulacea*.

Collection sites in Hainan. Meixia, Xian Hai, Qukou, Nanmai, Shalao, Xincun, Lingchang, Dadong Hai, Xiadong Hai, Yalongwan, Ximao Zhou, Tian Ya Hai Jiao.

***Erythrocladia irregularis*** Rosenvinge ( ♣ )

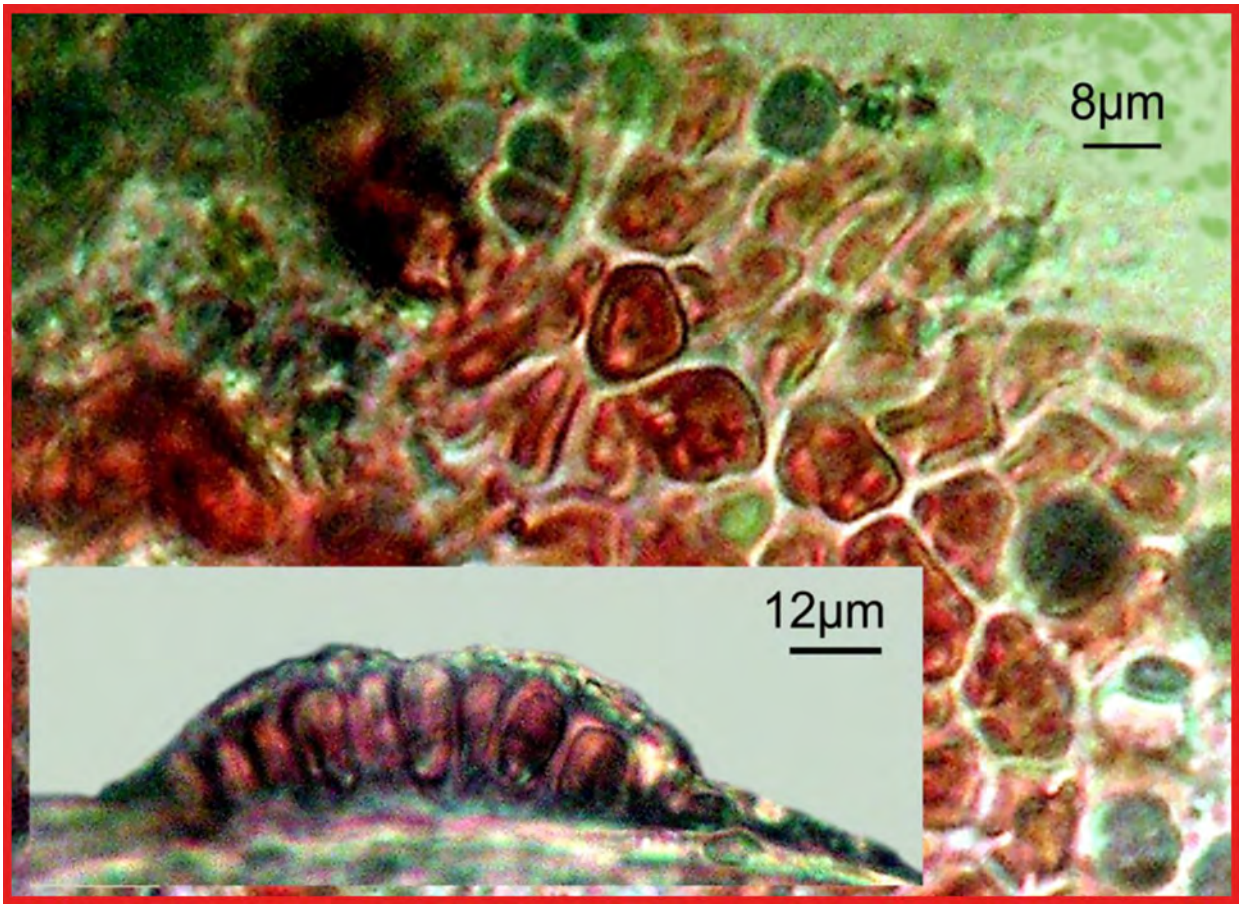


**Fig. 5** ***Erythrotrichia irregularis.*** Cells in surface view. Inset: Transverse section of young disc. Hainan Island, Yalongwan, March 2012.

Characteristics: Thallus microscopic, forming an irregular disc (50-300 μm in diameter), consisting of branched filaments, tightly arranged in the inner portion and loose at the periphery. The disc monostromatic becoming of 2-3 cells thick in central portion. Cells irregular in shape, polygonal in surface view, 1.5-6(-.5)×10-12.5 μm, 1-2.5 μm diameters long. Chloroplast blade-like, parietal with one pyrenoid. Reproduction by monospores (-5 μm in diameter) formed in sporangia cut off from inner cells of polystromatic portion of the disc. Growing epiphytic on Anadyomene wrightii, *Caulerpa serrulata, Cladophora catenata, Phyllodictyon anastomosans* stalk, *Siphonocladus rigidus, Valoniopsis pachynema*.

Collection sites in Hainan. Xian Hai, Wenchang, Yalongwan, Luhuitou, Xiaodong Hai, Tian Ya Hai Jiao.

***Sahlingia subintegra* (Rosenvinge) Kornmann** (♣)

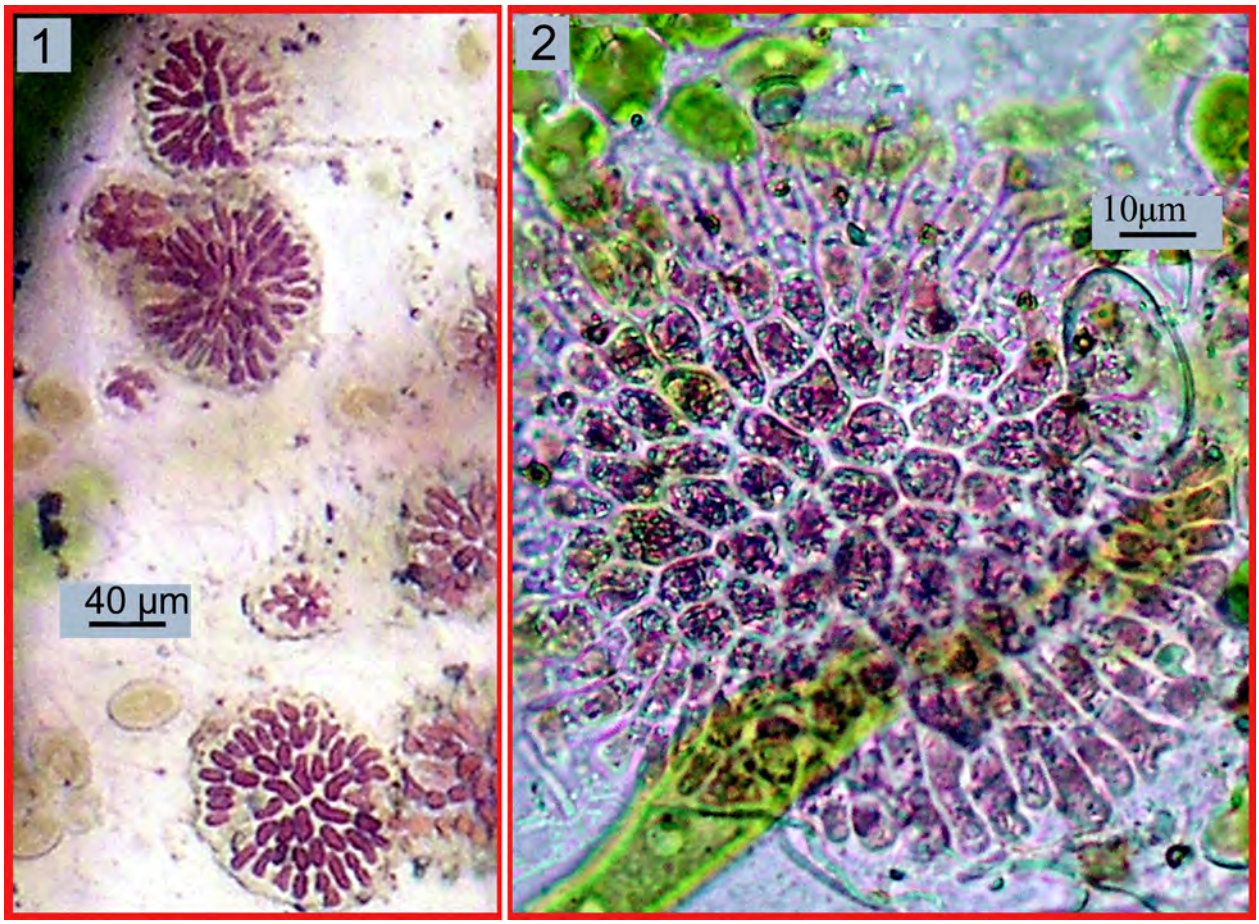


**Fig. 6** ***Sahlingia subintegra.*** 1. Young crusts. 2. Adult alga epiphytic on *Phyllodictyon anastomosans* stalk. Hainan Island, Luhuitou, November 2010.

Characteristics: Thallus forms monostromatic, prostrate disc with entire margins, 45-60(-300) µm across, becoming 2-3 cells thick in central portion. The disc consists of irregularly to subdichotomously branched filaments, dark rose-red to violet. Cells oblong rectangular, irregular in young discs; polygonal, isodiametric in central portion, (2.5-)3.5-5 µm in diameter, 6-12.5 µm long in adult discs. Marginal cells bifurcate, to 17.5 µm long. Chloroplast band- or bowl-shaped, with a single pyrenoid. Reproduction by globose monospores (to 6 µm in diameter) forming in the middle (inner portion of the disc) by oblique divisions of vegetative cells. The alga was found epiphytic on *Bryopsis australis, B. pennata, Chaetomorpha linum, Cladophora catenata, C. vagabunda, Parvocaulis clavatus* stalk*, Phyllodictyon anastomosans* stalk*, Siphonocladus rigidus, Valoniopsis pachynema, Canistrocarpus cervicornis, Hypnea spinella, Jania pumila, Neosiphonia ferulacea, Polysiphonia scopulorum, Pterocladiella capillacea*.

Collection sites in Hainan. Meixia, Xian Hai, Wenchang, Shalao, Xincun, Yalongwan, Luhuitou, Xiadong Hai, Tian Ya Hai Jiao.

**Order HILDENBRANDIALES**

**Family HILDENBRANDIACEAE**

***Hildenbrandia rubra* (Sommerfelt) Meneghini** ( ♦ )

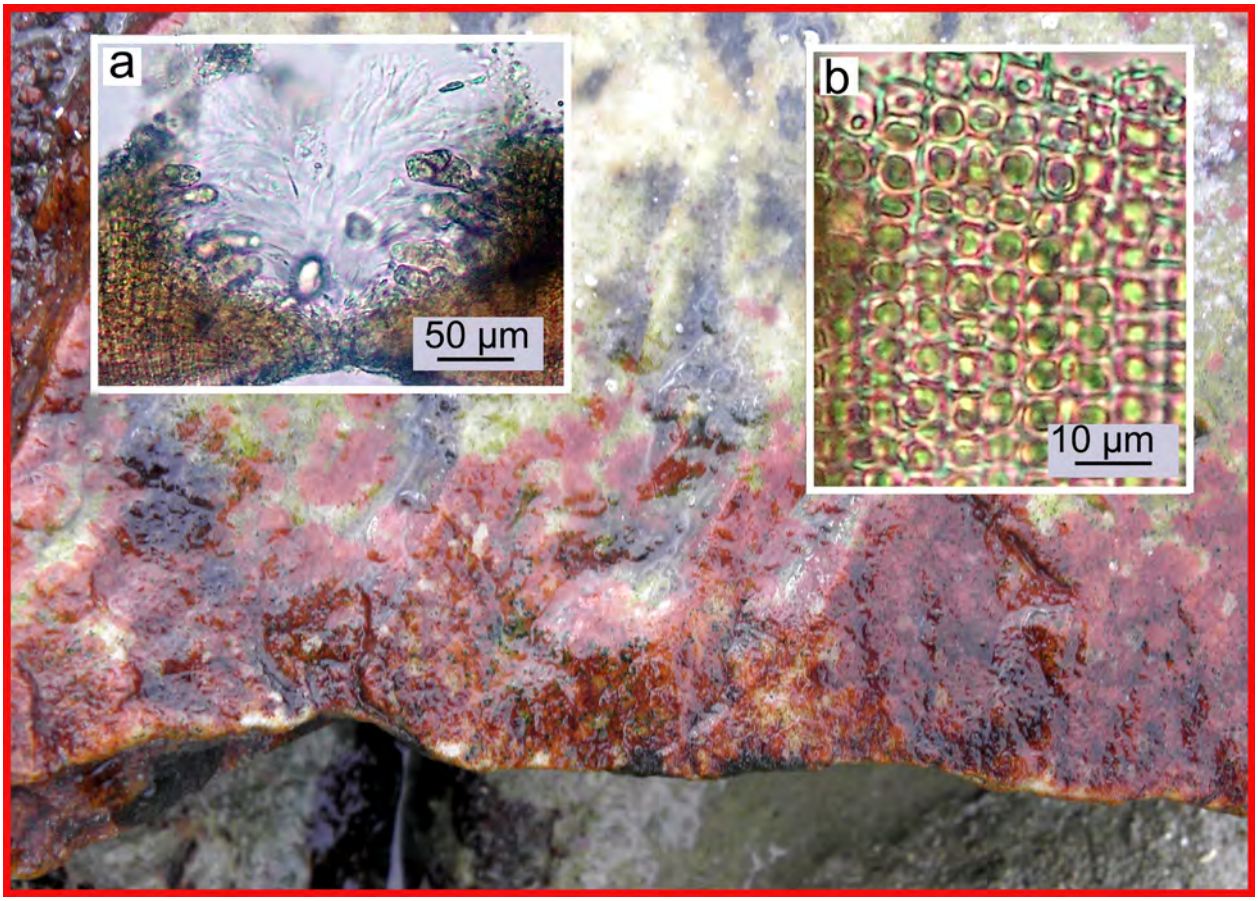


**Fig. 7** ***Hildenbrandia rubra.*** Insets: a, cross section of thallus through conceptacle with released tetrasporangia; b, cross section of thallus showing cells of perithallic layer. Hainan Island, Dadong Hai, October 2008.

Characteristics: Thallus form non-calcified crusts with smooth surface, tightly adherent to the substratum, irregular in outline, 1-5(-20) cm across, 80-240(-500) µm thick, light red, orange-red, or brown- red color. Thallus consists of hypothallus with horizontal radially branched filaments and perithallus with erect filaments. In cross section, thallus consists of compact erect filaments, 3-5 µm in diameter, 12-40 cells long. Cells rectangular, 4-5 µm wide, to 7 µm high, or quadrangular, 4 µm wide, decreasing to 3 µm in the upper part. Tetrasporangial conceptacles 70-100 µm in diameter with wide pore. Tetrasporangia ellipsoidal-lanceolate, pear-like to ovoid with mucronate lower end, 8-15(-17.5) µm in diameter, 27-35 µm long, obliquely or irregularly divided. Growing on intertidal rocks, stones, pebbles and shells.

Collection sites in Hainan. Meixia, Luhuitou, Dadong Hai, Xiadong Hai, Tian Ya Hai Jiao.

**Order NEMALIALES**

**Family GALAXAURACEAE**

***Tricleocarpa cylindrica*** (J. Ellis & Solander) Huisman & Borowitzka ( ♦ )

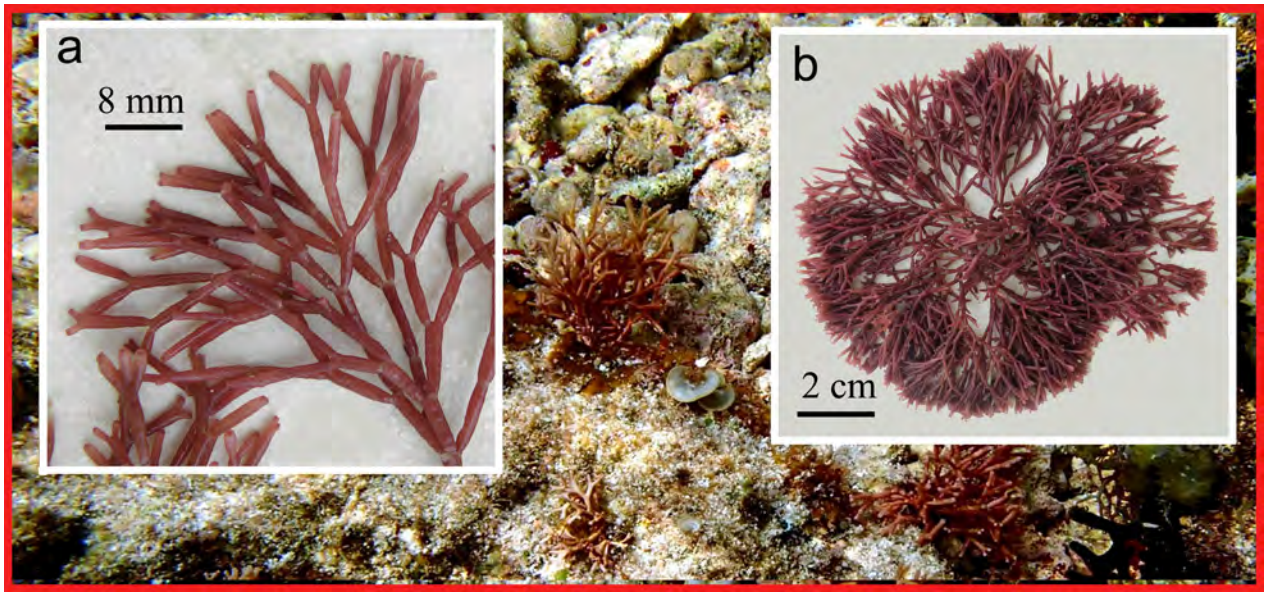


**Fig. 8** ***Tricleocarpa cylindrica*** on dead coral block in the upper subtidal zone. Hainan Island, Luhuitou, April 2012. Insets: a, detail showing branching pattern; b, Overall morphology..

Characteristics: Thalli stiff, bushy, pinkish-purple, dull red, forming dense clumps, (2)-6-15 cm high. Branching regularly repeatedly dichotomous, sometimes with proliferations. Branches consist of heavily calcified, firm segments. Segments cylindrical, smooth, of the same diameter throughout, 0.5-0.8(-1.0) mm in diameter, (3.0)-5-10 mm long, constricted at dichotomies. In transverse section, cortex consists of 3-4 layers: one layer of superficial small pigmented cells, 8 µm high, 10-15 µm in diameter, subsurface subspherical to ovoid cells, 20-30 µm in diameter and inner large, colorless cells 20-50 µm in diameter; medulla of loosely arranged branched fine filaments, 10 µm in diameter with thick cell walls. Joints flexible, non-calcified. Apices truncate. Holdfast small, discoid, inconspicuous. Cystocarps spherical, 250-400 µm in diameter. Growing in shallow pools on rocks covered with sand, on dead coral blocks and shells in the intertidal zone to 15 m deep at sites with moderate wave action and in protected areas.

Collection sites in Hainan. Dadong Hai, Xiadong Hai, Luhuitou.

**Order ACROCHAETIALES**

**Family ACROCHAETIACEAE**

***Acrochaetium secundatum* (Lyngbye) Nägeli** (♣)

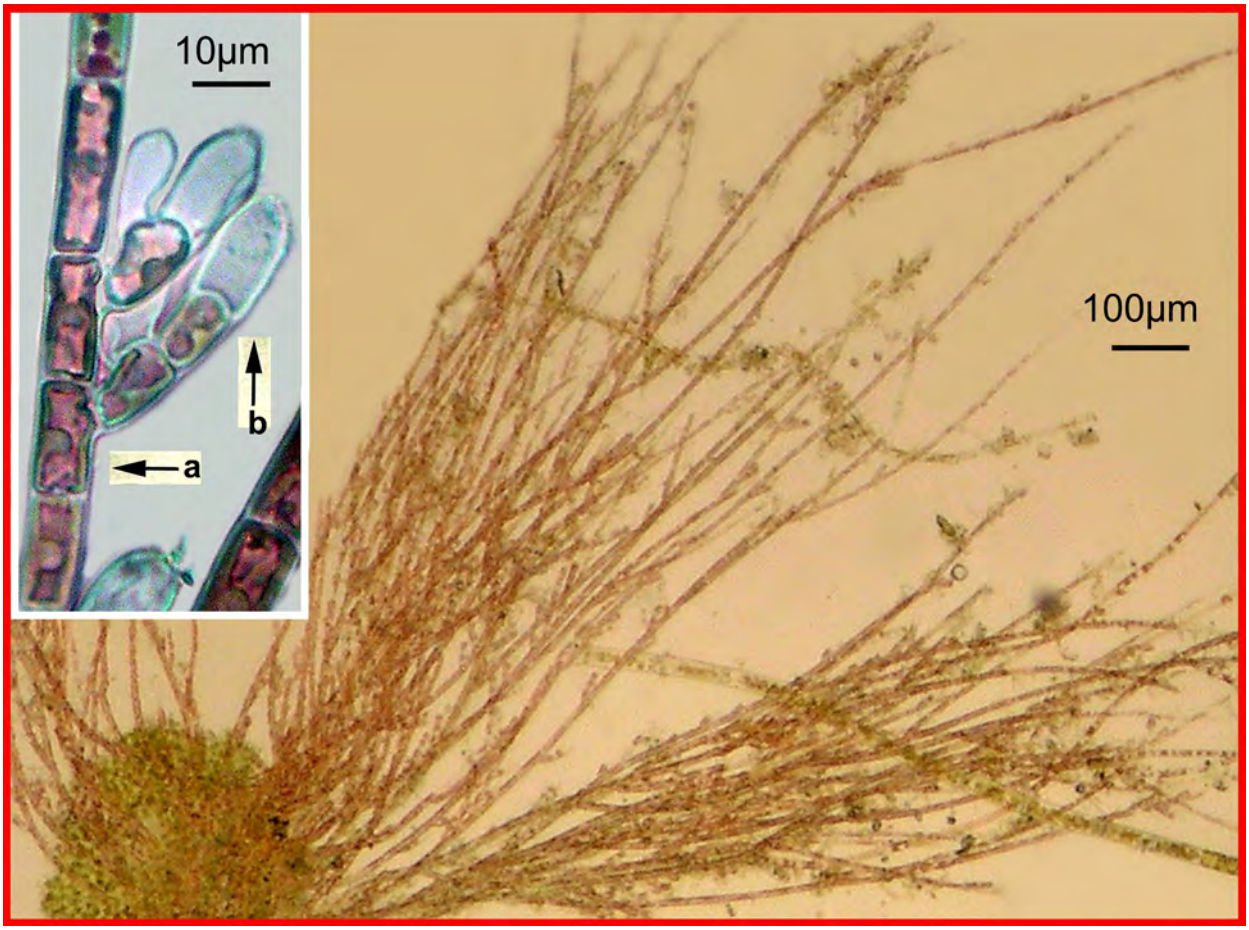


**Fig. 9** ***Acrochaetium secundatum.*** Overall morphology. Inset: Details showing parietal chloroplasts (arrow a) and monosporangia (arrow b). Hainan Island, Luhuitou, March 2012.

Characteristics: Thallus epiphytic, in small tufts, 1-2(-3) mm high, consists of prostrate axes (6 µm in diameter) bearing erect filaments (4)-6-8.5(-11) µm in diameter, slightly tapering towards the apices and commonly terminating into slender colorless unicellular hair, 2.5 µm in diameter. Branching sparse, irregular, mostly unilateral, alternate or sometimes opposite. Lateral branchlets one-three-celled. Cells cylindrical or barrel-shaped, often widened at upper end, 2.5-3 diameters long. Chloroplast parietal laminate with one pyrenoid. Monosporangia ovoid, sessile or stalked, 6-9 µm in diameter, 10-12.5(-18) µm long, develop on lateral branchlets apically or laterally, single or in pairs. Epiphytic on various algae *Amphiroa fragilissima, Ceramium marshallense, Ceratodictyon intricatum, Gelidium pusillum, Hypnea pannosa, H. spinella, Padina australis, Sargassum polycystum*.

Collection sites in Hainan. Nanmai, Yalongwan, Xiadong Hai, Luhuitou.

**ORDER COLACONEMATALES**

**Family COLACONEMATACEAE**

***Colaconema daviesii* (Dillwyn) Stegenga** (♣)

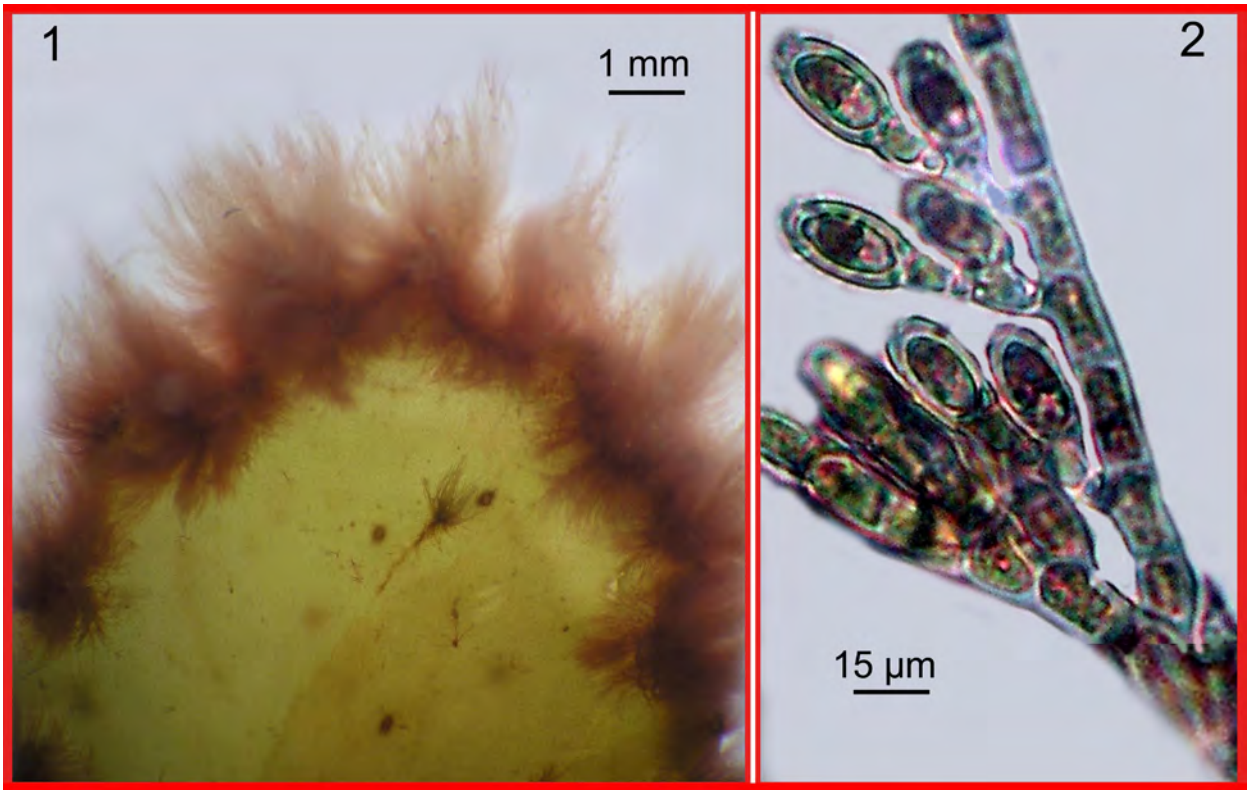


**Fig. 10** ***Colaconema daviesii.*** 1. Epiphytic on *Sargassum phylloid* margin. 2. Detail showing monosporangia. Hainan Island, Luhuitou, February 2012

Characteristics: Thallus 0.7-1.3(-4) mm high. Erect branches arising from monostromatic disc consisting of prostrate filaments. Erect filaments 8.2-10(-13) µm in diameter. Branching dense, irregular, lateral or alternate. Cells cylindrical, 7-8(-11) µm in diameter, 1.5-4(-5.5) diameters long. Chloroplast occupy all body of cell, sometimes lobed, with one large pyrenoid. Determinate branchlets in tufts, develop laterally, alternate and in axils of indeterminate branches. Monosporangia ovoid, sessile or stalked, 8-12 µm in diameter, 14-20 µm long, develop at the base of branches or terminally on short 1-5 celled lateral (adaxial) branchlets. Colorless multicellular hairs occur on branchlets bearing sporangial clusters in axils of the branches. Growing epiphytically on *Padina australis, Sargassum sanyaense* and *S. henslowianum* phylloids.

Collection sites in Hainan. Luhuitou, Xiadong Hai.

**Order CORALLINALES**

**Family CORALLINACEAE**

***Amphiroa foliacea* J.V. Lamouroux** (♣)

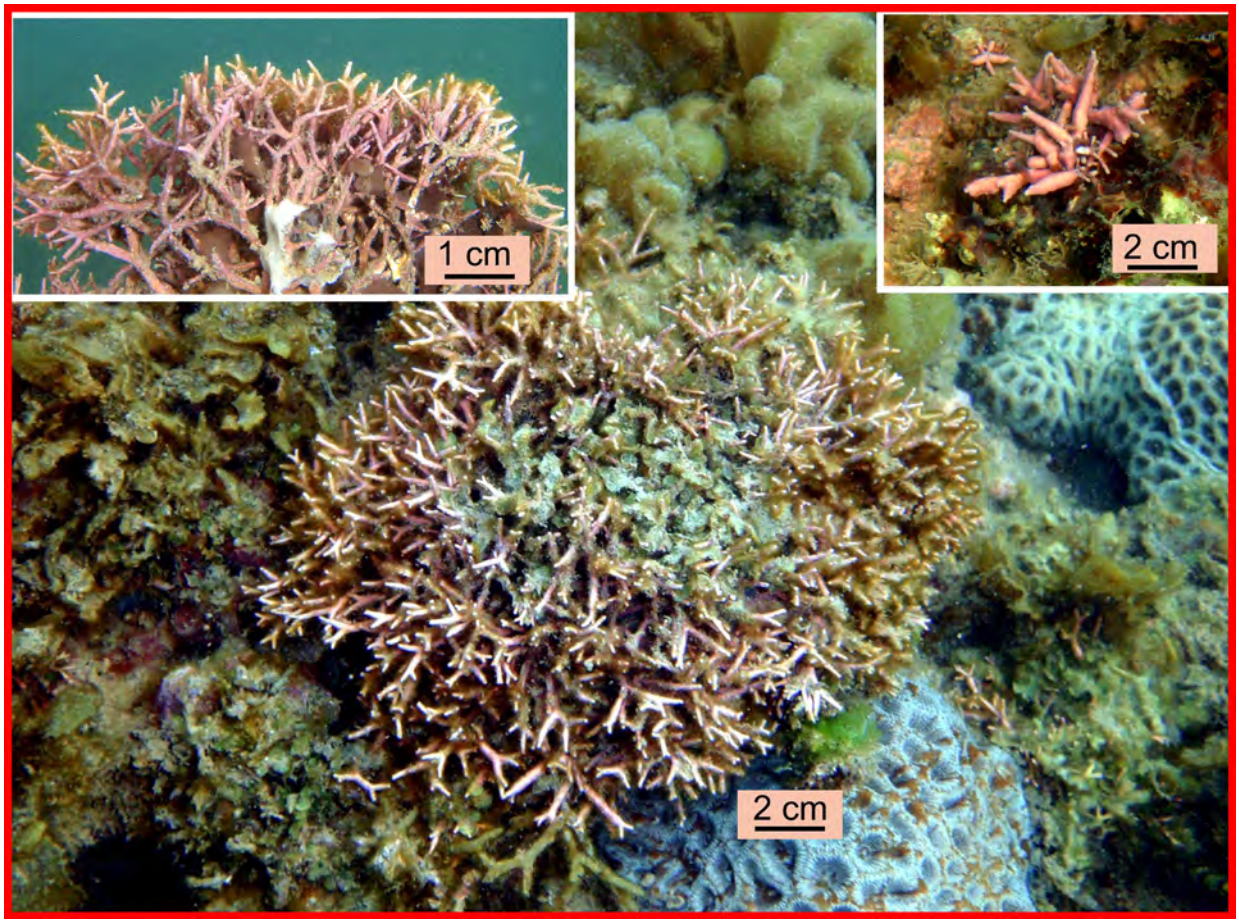


**Fig. 11** ***Amphiroa foliacea.*** Colonizing a damaged live coral at 2 m depth. Hainan Island, Luhuitou, March 2012. Insets: Left - lower side of a clump; Right - young plant.

Characteristics: Thalli articulated, rigid, heavily calcified, decumbent or erect in dense, intricate clumps, 1-3(-6) cm high, grayish, rose-purple or whitish color. Branching di-trichotomously, irregularly dichotomously, frequently with adventitious branches in one plane. Branches composed of segments with tapering whitish-rose tips. Segments subcylindrical to flat with a distinct midrib, broadly winged to 2(-3) mm in width. Joints short, flexible, non-calcified. Tetrasporangial conceptacles lateral, scattered over the surfaces of segments, 250-300(-450) µm in diameter, hemispherical, not very prominent; tetrasporangia zonately divided. Cystocarpic conceptacles 300-350 µm in diameter. Growing on rocks, stones, dead coral colonies, intertidal to subtidal in protected to moderate wave exposed sites.

Collection sites in Hainan.Wenchang, Shalao, Dadong Hai, Xiadong Hai, Luhuitou.

***Hydrolithon boreale* (Foslie) Y.M. Chamberlain** ( ♣ )

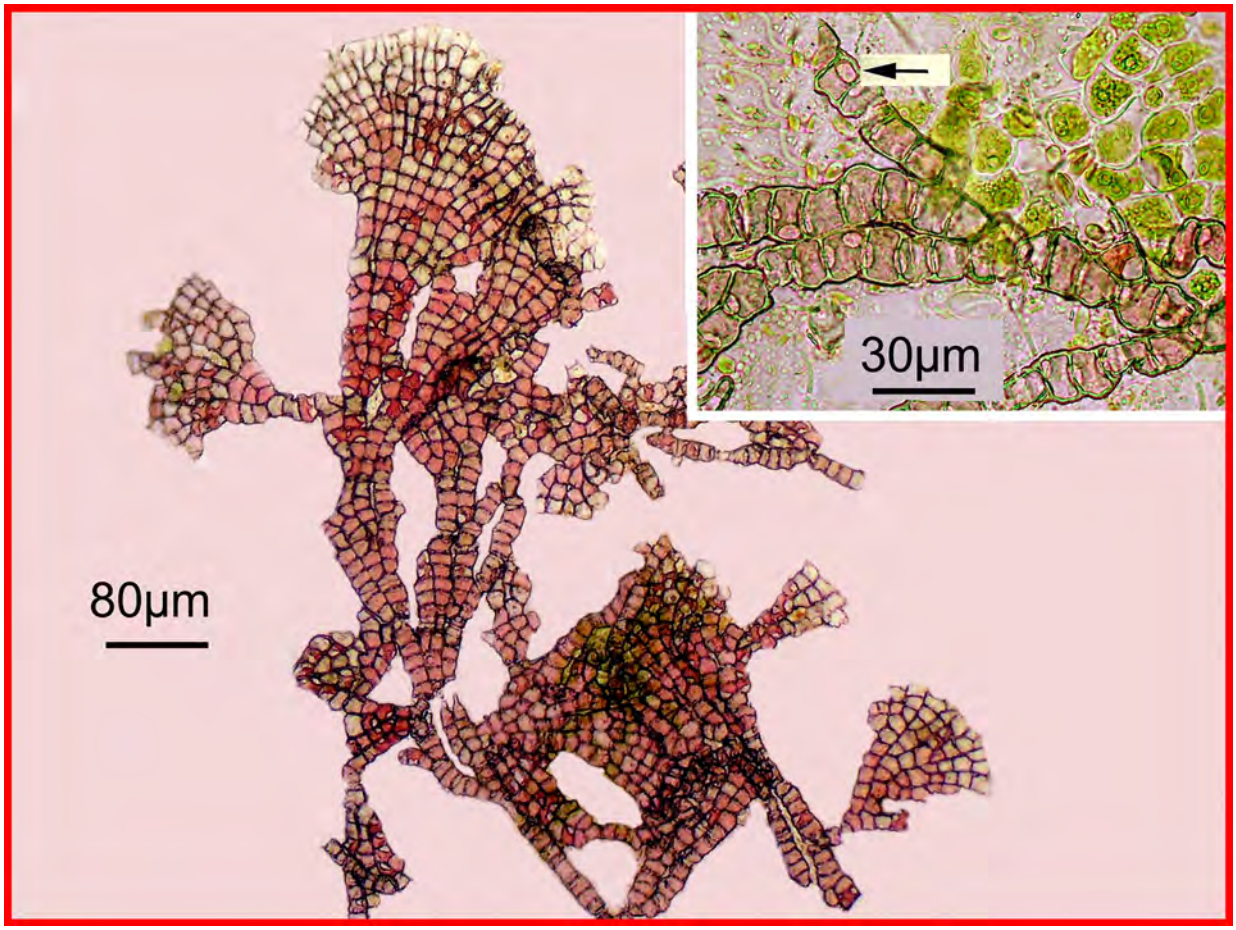


**Fig. 12** ***Hydrolithon boreale.*** Overall morphology Inset: Detail showing vegetative cells with cap cells in close view (arrow). Hainan Island, Luhuitou, February 2012.

Characteristics: Thallus flat, adherent, consists of prostrate irregularly branched filaments often consolidating into small calcareous crusts (to 3-5 mm across) irregular in shape, not forming regular disc, pink or grayish green in colour. Crust consists of 2 layers: prostrate basal filaments and surface (epithallial) cells. Vegetative crusts consist of a single layer of branched meandering filaments which form from initial four-celled disc surrounded by 4 lateral cells (bilateral symmetry) and 4 atrophic cells. Cells in surface view subrectangular, oblong, 7.5-17 μm in diameter, 12-20 μm long; cap cells present at distal ends of surface cells. Trichocytes colorless, terminal on basal cells. Tetrasporangial conceptacles hemispherical, (65-)90-150(-200) μm in diameter with a single ostiole. Tetrasporangia 20-40×35-65 μm, zonately divided. Bisporangia 25-40 × 55-75 μm. Growing on rocks, stones, shells and on larger algae (*Phyllodictyon anastomosans, Valonia ventricosa, V. aegagropila, Colpomenia sinuosa*).

Collection sites in Hainan. Shalao, Yalongwan, Luhuitou.

***Hydrolithon farinosum*** **(J.V. Lamouroux) D. Penrose & Y.M. Chamberlain** ( ♣ )

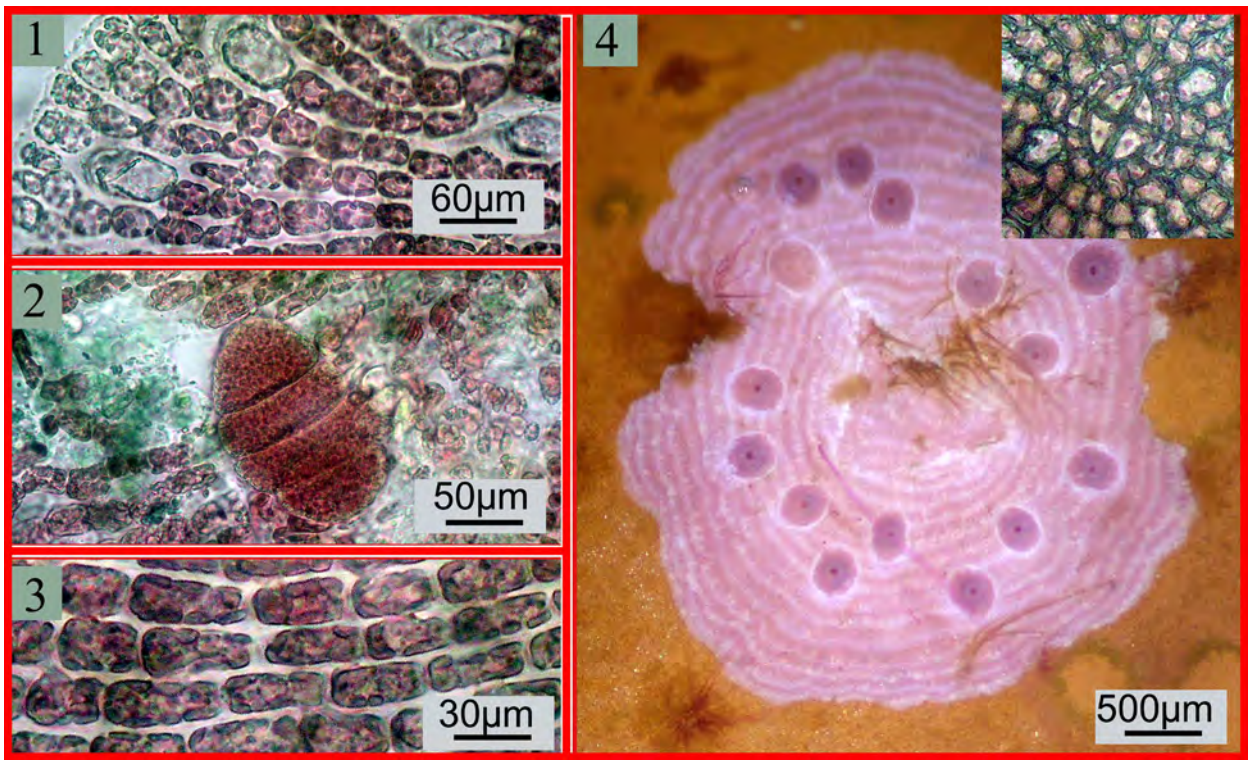


**Fig. 13** ***Hydrolithon farinosum.*** 1. Detail showing trichocytes. 2. Zonately divided tetrasporangium (after decalcification). 3. Cells from surface view. 4. Overall morphology with conceptacles. Inset: Initial four-celled structure. Hainan Island, Luhuitou, February 2012.

Characteristics: Thallus forms calcareous fragile lightly calcified small crust to 5 mm in diameter, pink or whitish. Vegetative crusts consist of a single layer of branched filaments which form from initial four-celled disc (with cells 20-35 µm) surrounded by 12 pericentral cells. Cells in the surface view irregularly shaped, subrectangular 7.5-12(-20) µm wide and 20-37(-45) µm long, radially arranged. Cap cells roundish (10 µm in diameter) or oval (6-10 µm). Trichocytes colorless, oval, ovoid, 10-30×22-40 µm. Tetrasporangial conceptacles hemispherical, (100-)140×250(-280) µm in diameter with a single ostiole. Tetrasporangia 20-50×35-85 µm, zonately divided. Growing epiphytically on *Acetabularia calyculus, Anadyomene wrightii, Borgesenia forbesii, Bryopsis pennata, Caulerpa racemosa stolons, C. serrulata, Cladophora catenata, Dictyosphaeria cavernosa, Phyllodictyon anastomosans stalk, Valonia ventricosa, Valoniopsis pachynema, Canistrocarpus cervicornis, Colpomenia sinuosa, Hydroclathrus clathratus, Padina boryana, Sargassum polycystum, Turbinaria ornata, Actinotrichia fragilis, Ceratodictyon intricatum, Chondria repens, Palisada parvipapillata*.

Collection sites in Hainan. Wenchang, Qukou, Qinglan Gang, Shalao, Xincun, Yalongwan, Dadong Hai, Xiadong Hai, Luhuitou, Ximao Zhou, Tian Ya Hai.

***Jania capillacea*** **Harvey** (♣)

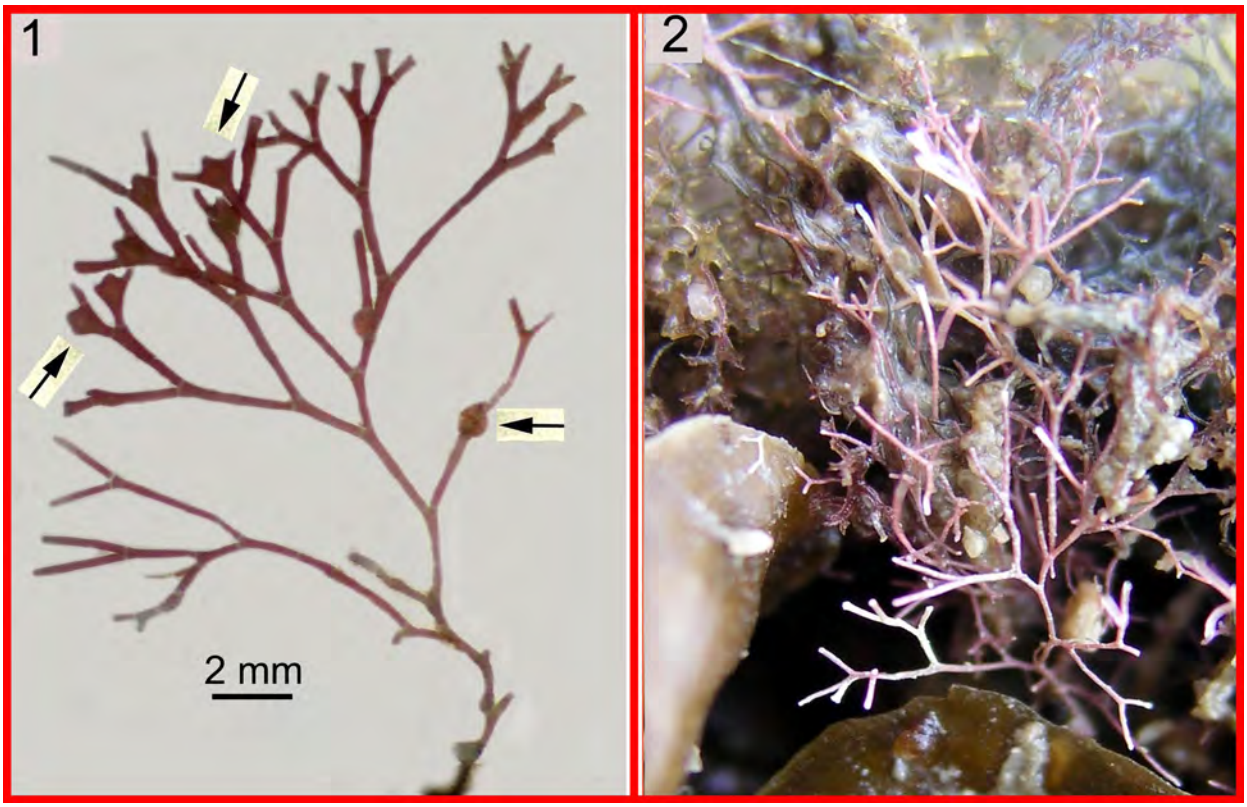


**Fig. 14** ***Jania capillacea.*** 1. Branch with conceptacles (arrows). 2. Occurring on dead coral (Hainan Island, China). April 2012.

Characteristics: Thallus bushy, delicate, calcareous, forming small, dense tufts or cushions, 3–15 mm high, pinkish-red or grayish-violet. Branching widely dichotomous, angles (45°–)60°–90°. Branches terete, slender, 100(–130) µm in diameter at the basal portion, upwards becoming thinner to 60(–40) µm in diameter, often recurved, mainly with pointed apices. Segments 4–6(–10) diameters long. Joints flexible, non-calcified, at regular intervals between segments. Conceptacles (Fig. 1, arrows) form in swollen terminal segments, vase-shaped, with apical pore, frequently bearing two long, horn-like branchlets on both upper sides of the conceptacles. Tetrasporangia oval, 25–40×80–140 µm, zonately divided. Attachment by crust-like holdfast. Growing in calm places in intertidal to upper subtidal zones on dead corals, rocks among other turf algae and epiphytically upon larger algae (*Amphiroa foliacea, A. beauvoisii, Dichotomaria marginata, Gelidiella acerosa, Lithophyllum pygmaeum, Palisada papillosa, Tolypiocladia condensata, Chnoospora implexa, Colpomenia sinuosa, Hydroclathrus clathratus, Lobophora variegata, Dictyota implexa, Padina* spp., *Sargassum* spp., *Turbinaria ornata, Anadyomene wrightii, Boergesenia forbesii, Boodlea composita, Caulerpa racemosa, C. serrulata, Dictyosphaeria cavernosa, Valoniopsis pachynema*).

Collection sites in Hainan. Nanmai, Meixia, Shalao, Xincun, Yalongwan, Dadong Hai, Xiaodong Hai, Luhuitou, Ximao Zhou, Tian Ya Hai Jiao, Ying Ge Hai.

***Jania pumila* J.V. Lamouroux** (♣)

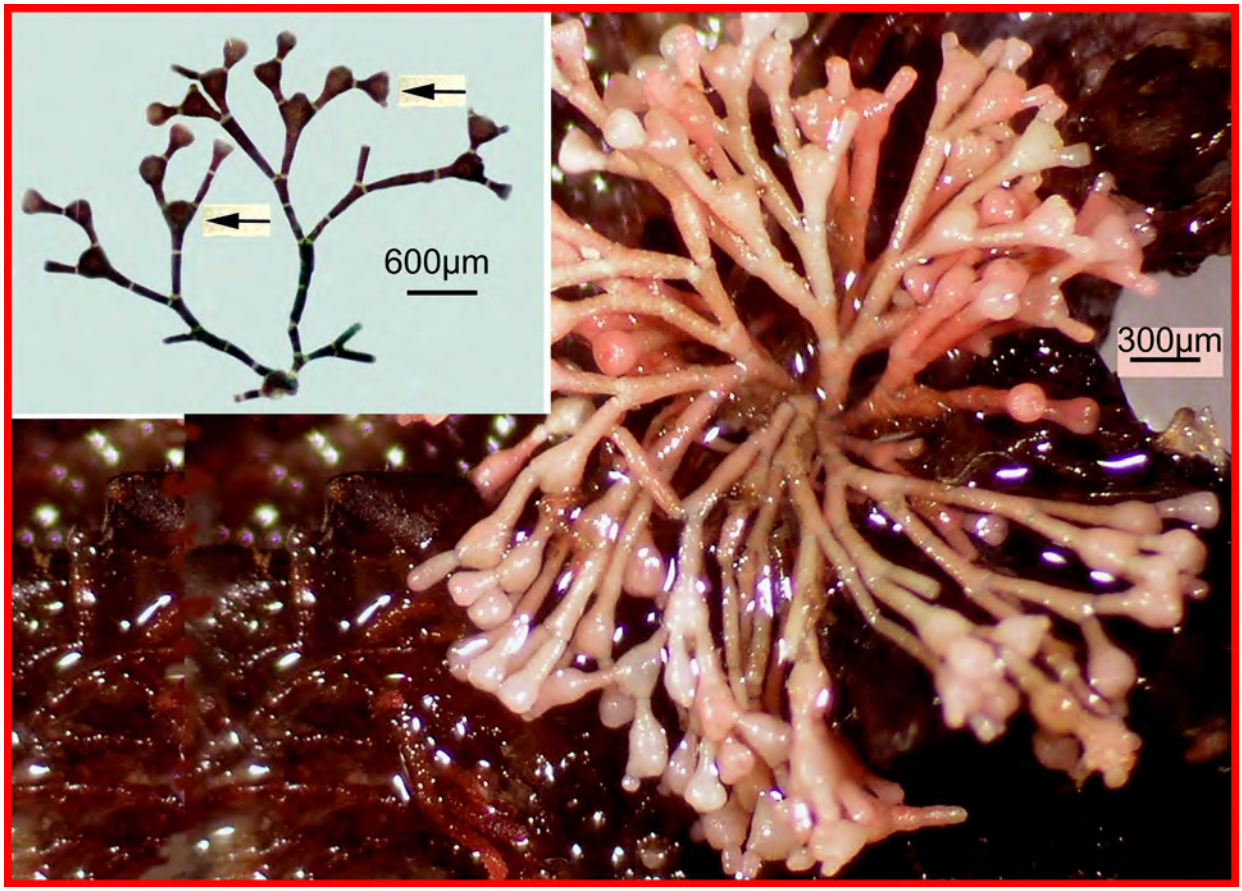


**Fig. 15** ***Jania pumila.*** Overall morphology with carposporangial conceptacles (arrows). Hainan Island, Luhuitou, March 2012.

Characteristics: Thallus bushy, very small, erect or partially prostrate, forming small tufts, to 1 cm in diameter, of several (8–10) erect branches arising from disc, pinkish-red or whitish-pink. Branching dichotomously (a few dichotomies). Segments subcylindrical, (60–)80–150 µm in diameter, calcified, short, 2–3 diameters long with rounded or clavate apices. Joints flexible, non-calcified, at regular intervals between segments. Conceptacles (Fig. 1, arrows) 230–325 µm wide, 300–465 µm long. Tetrasporangial conceptacles triangular with two horn-like segments and apical pore. Tetrasporangia elongated oval, zonately divided, 40-50 µm wide and 150-180 µm long. Carposporangial conceptacles obovate. Attachment by small roundish disk-like holdfast, to 400 µm in diameter. Growing commonly epiphytic on *Lithophyllum pygmaeum, Hydroclathrus clathratus, Padina boryana, Sargassum* spp., *Turbinaria ornata* phylloids; the alga was also found on small shells.

Collection sites in Hainan. Xincun, Yalongwan, Dadong Hai, Xiaodong Hai, Luhuitou, Ximao Zhou.

***Jania ungulata* f. *brevior* (Yendo) Yendo** (♣)

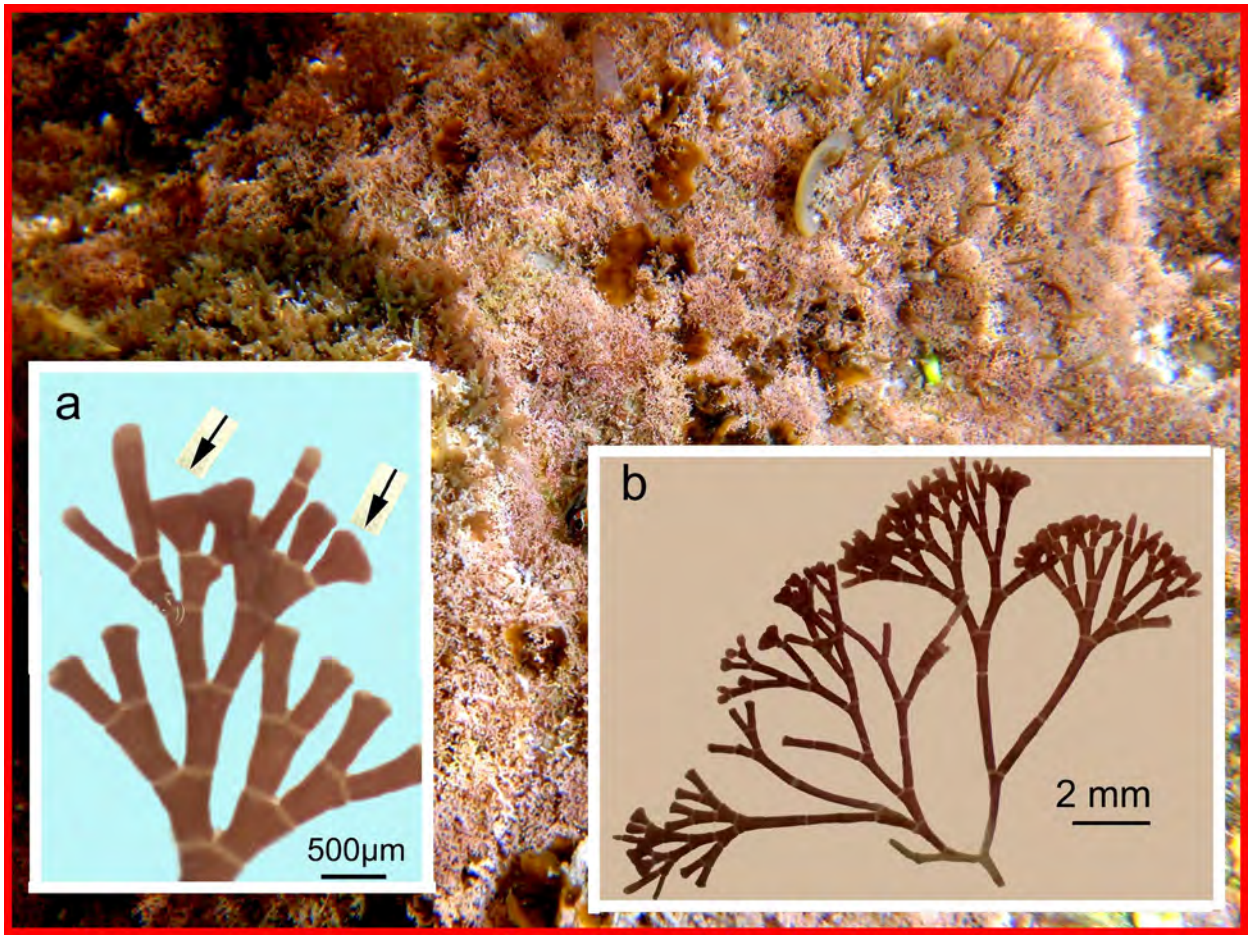


**Fig. 16** ***Jania ungulata.*** On intertidal dead coral block. Insets: 1. Fragment showing branching pattern and expanded ungulate segments 2. The alga among turf algae. Hainan Island, Luhuitou, April 2012.

Characteristics: Thallus erect, bushy, forming dense tufts or cushions, to 1.0–2(–3) cm high, arising from calcified crusts, pinkish-purple, repeatedly dichotomously branched and rarely trichotomously. Segments cylindrical at lower part, (75–)100–120(–130) μm in diameter, usually 2–4(–6) diameters long. Upper segments compressed, shorter, branching in one plane (Fig. 1, arrows), 170–220(–250) μm broad, terminal segments usually ungulate, compressed, broad (300–400 μm) at the apical margins, occasionally globose or cylindrical. Conceptacles are oval-shaped, Up to 250 μm in diameter, slightly compressed, axial with lateral horn-like branchlets. Tetrasporangia zonately divided, (35–)40–60 μm broad and 90–120(–130) μm long. Attachment by disk-like holdfast. Growing in the low intertidal zone on rocks, dead corals or epiphytic on *Acanthophora spicifera, Chondria armata, Hydroclathrus clathratus, Sargassum* spp.*, Padina australis, Turbinaria ornata*.

Collection sites in Hainan. Wenchang, Xincun, Yalongwan, Dadong Hai, Xiaodong Hai, Luhuitou.

***Neogoniolithon megalocystum*** **(Foslie) Setchell & L.R. Mason** ( ♦ )

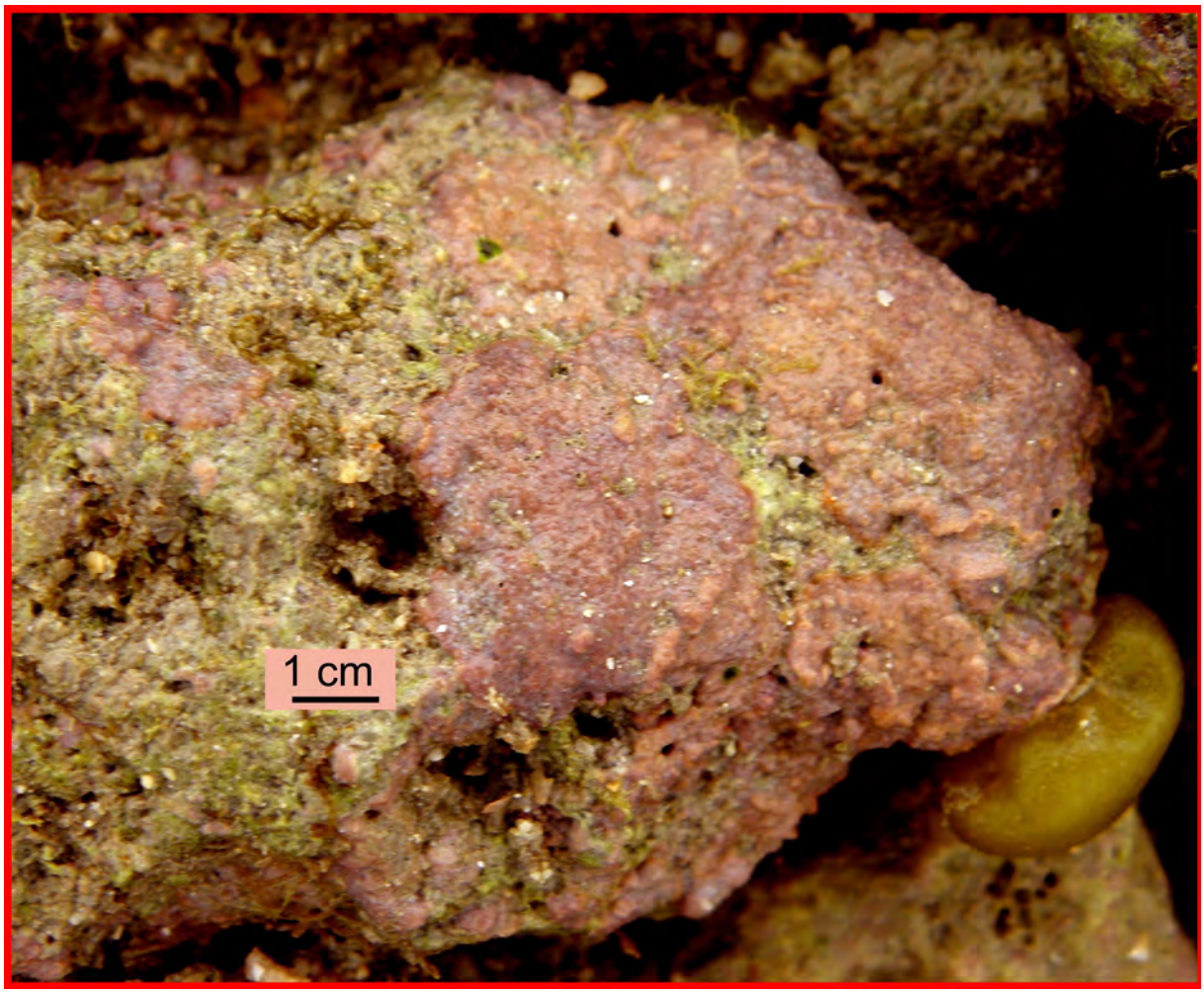


**Fig. 17** ***Neogoniolithon megalocystum.*** Crusts overgrowing dead coral. Hainan Island, Luhuitou, March 2012.

Characteristics: Thallus stony, heavily calcified, crustaceous, chalky, forming crusts 600–1000 µm thick, pinkish-violet, grayish-pink. Cells from surface view 6–7 µm across. In vertical section, hypothallus consists of dense rows of subquadrate cells, 5–7(–10) µm or subrectangular cells 6–8×7–15 µm (several to 10 layers). Perithallus consists of erect filaments arising from the hypothallus; intercellular fusion present in hypothallus and perithallus. Epithallus consists of single layer of flattened cells. Terasporangial conceptacles prominent, 550–750 µm in diameter, opening by a single central pore. Tetrasporangia zonately divided, 30–37 µm in diameter, 60–75 µm long, arranged over the floor of the tetrasporangial conceptacles. Growing on dead corals, shells and carbonate substrates in the lower intertidal to upper subtidal zones.

Collection sites in Hainan. Yalongwan, Luhuitou.

***Pneophyllum confervicola*** **(Kützing) Y.M. Chamberlain ( ♦♦ )**

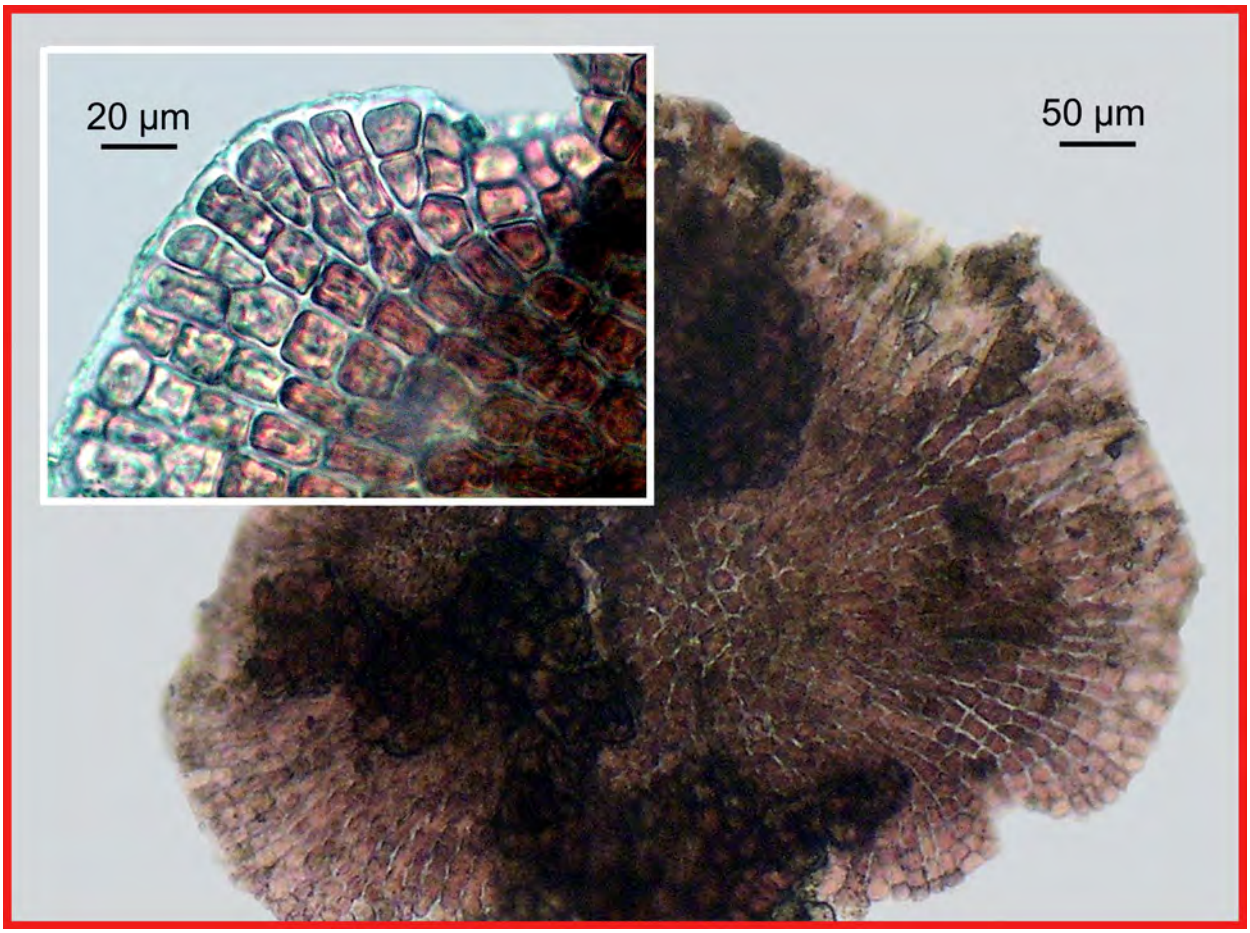


**Fig. 18** ***Pneophyllum confervicola.*** Overall morphology. Inset: A portion, showing cells arrangement. Hainan Island, the vicinity of Wenchang City, March 2012.

Characteristics: Thallus prostrate, thin, forming lightly calcified crusts of irregular shape, roundish with lobed margins, 500×400 μm, pale pink to dark red color. Crusts composed of one layer of cells except narrow part (2–3 cell layers thick) around conceptacles. Cells from surface view quadrate or slightly elongated (5–)7.5–10(–15) μm broad, (7.5–)10–12.5(–17.5) μm long. Cap cells small, inconspicuous. Trichocytes rare, small, intercalary. Tetrasporangial conceptacles hemispherical, 45–120 μm in diameter, uniporate. Tetrasporangia zonately divided, 14 μm in diameter, 30 μm long. Growing epiphyticy on *Chondria pygmaea, Jania ungulata* f. *brevior*.

Collection sites in Hainan. The vicinity of Wenchang City, Luhuitou.

***Pneophyllum fragile* Kützing (♣)**

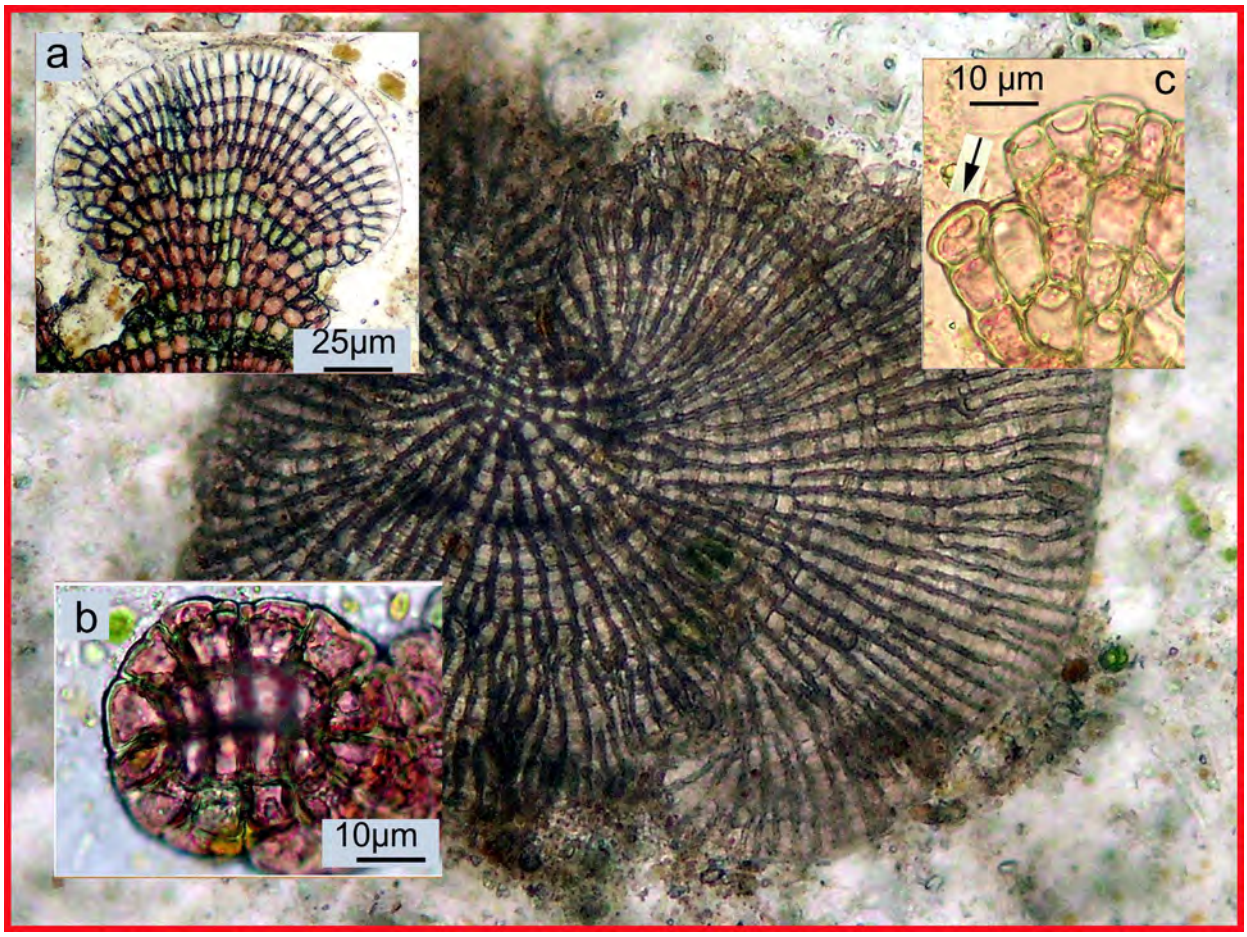


**Fig. 19** ***Pneophyllum fragile.*** Overall morphology. Insets: a, marginal blade; b, germinating disc with eight initial cells; c, detail showing cap cells (arrow). Hainan, Luhuitou, 2009.

Characteristics: Thallus forms roundish or irregularly fan-shaped, fragile, thin calcified crusts 0.1-2 mm in diameter, dark or pale pink. Vegetative crusts consist of a single layer of branched filaments, which form from initial eight-celled structure. Older crusts consist of two-four cells thick, often merging together and overlapping each other. Cells in the surface view square, rectangular 5-10 μm wide and 6-20 μm long, radially arranged. Cap cells (insert, arrow) broader than long (3.5-8 μm wide, 1.5-3.5 μm long). Trichocytes rare, intercalary in cell rows, 6-10(-13.5) μm in diameter, 11-20 μm long, colorless. Sporangial and cystocarpic conceptacles slightly elevated or hemispherical, (70-)150-180(-280) μm in diameter, with central pore. Tetrasporangia elongate, 18-50 μm in diameter, 33-80 μm long, zonately divided. Growing epiphytically on *Anadyomene wrightii*, *Bryopsis pennata* stalk, *Cladophora catenata, Phyllodictyon anastomosans* stalk, *Ulva clathrata, Valoniopsis pachynema, Colpomenia sinuosa, Dictyota friabilis, Padina* spp., *Sargassum* spp., *Actinotrichia fragilis, Ceratodictyon intricatum, Chondria repens, Gracilaria Salicornia, Jania pumila, Parviphucus pannosus, Cymodocea serrulata*.

Collection sites in Hainan. Meixia, Nanmai, Wenchang, Shalao, Yalongwan, Dadong Hai, Xiaodong Hai, Luhuitou, Ximao Zhou, Tian Ya Hai Jiao.

**Family HAPALIDIACEAE**

***Lithothamnion intermedium*** **Kjellman ( ♦ )**

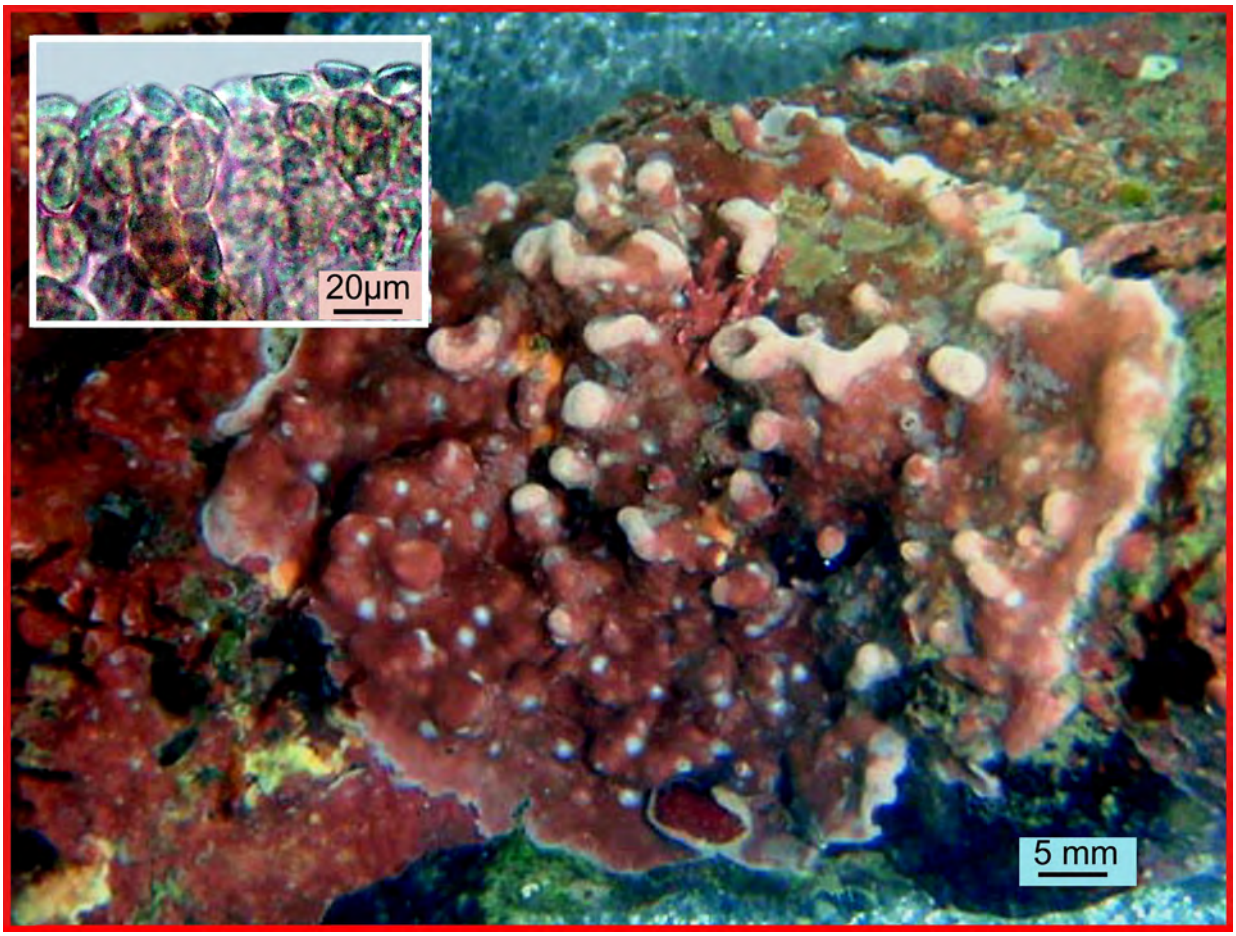


**Fig. 20** ***Lithothamnion intermedium.*** Attached to dead coral in the upper subtidal zone. Yalongwan, Hainan Island, March 2012. Inset: Radial section showing lens-shaped cells of the surface layer.

Characteristics: Thallus form stony heavily calcified crust (500–550 µm thick), tightly attached to the substratum, purple-red, with wavy whitish margins and projections, (1)-2–5 mm high, 1–2 mm in diameter, simple or subdichotomously branched, frequently fusing with adjoining projections. In radial section, hypothallium (bottom cells) consists of several layers of rectangular elongated cells, (7.5-)10-12.5 µm in diameter, 12.5–15 µm long. Perithallium consist of vertically elongated cells, 7.5-12.5 µm in diameter, 10–25 µm long. Cells of the surface layer lens-shaped or oval, 2.5-5 x 5-7.5(-10) µm, lateral pit connections present. Tetrasporangial conceptacles develop on the basal crust and projections, slightly convex, with age becoming whitish, 225–500 µm in diameter. Tetrasporangia 50–65 µm in diameter, 120–145 µm long. Growing in the low intertidal and upper subtidal zones, on stones, boulders and on shells in semi-sheltered and open areas.

Collection sites in Hainan. Yalongwan.

***Lithothamnion phymatodeum*** **Foslie ( ♦ )**

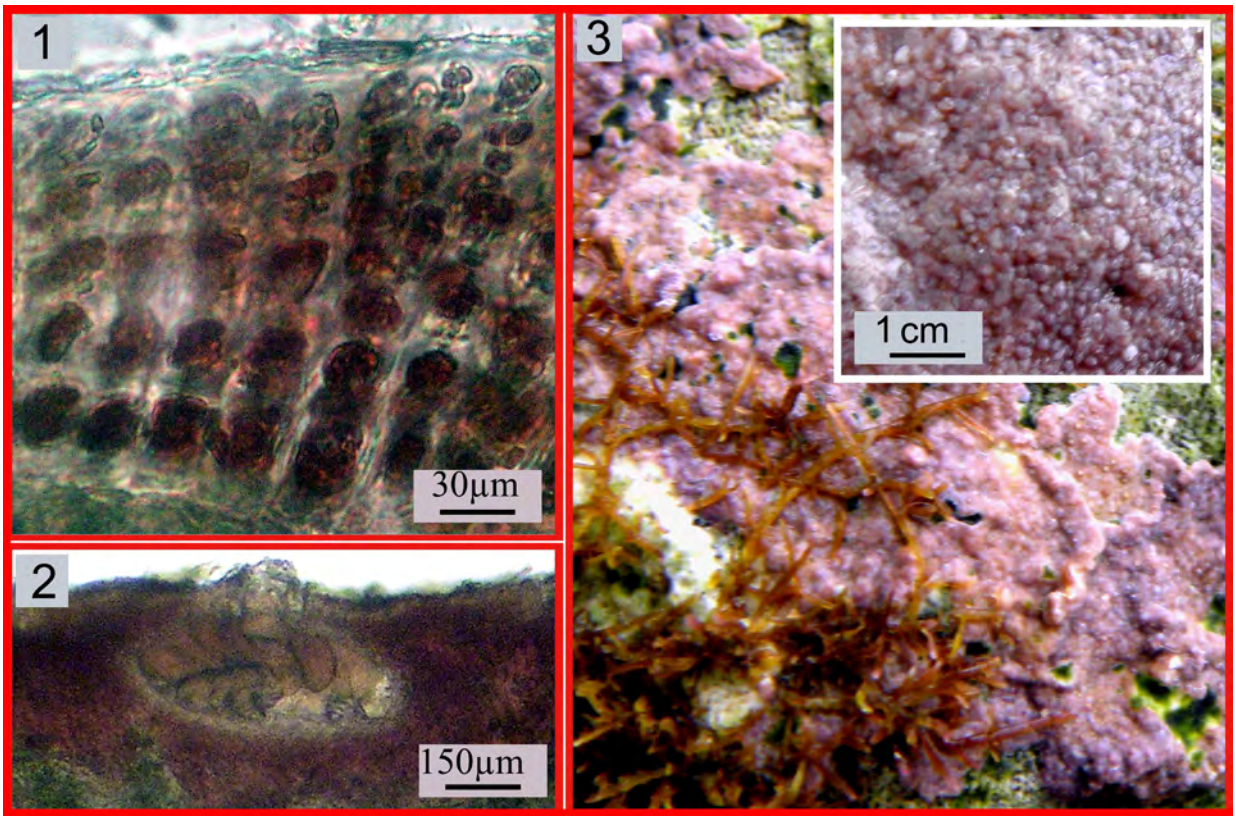


**Fig. 21** ***Lithothamnion phymatodeum.*** 1. Radial section. 2. Section through uniporate carposporangial conceptacle. In habitat, Hainan Island, Luhuitou, March 2012.

Characteristics: Thallus as thick calcareous crusts, roundish or irregular shape, 3.5-8 cm across, tightly adhering to the substrate, pinkish-purple, violet or whitish-pink with narrow or broadly cylindrical protuberances, 2-6 mm high and 2-4 mm in diameter, covering the surface of the crust and giving them a “verrucose” appearance. The protuberances simple or subdichotomously branched, not fusing together, with rounded tops. Margins of the crust uneven, wavy or lobed, with white border, raised above the substrate. Conceptacles protruding, to 500 μm across, with age turn whitish, usually develop on the protuberances. The roof of tetrasporangial conceptacle with (25-)30-40 pores. Carposporangial conceptacles with cone-shaped roof bearing one pore on the top. Growing in the intertidal and upper subtidal zones, on dead coral blocks, stones, boulders and shells in semi-sheltered and open areas.

Collection sites in Hainan. Luhuitou.

**Order CERAMIALES**

**Family CERAMIACEAE**

***Antithamnion antillanum* Børgesen (♣)**

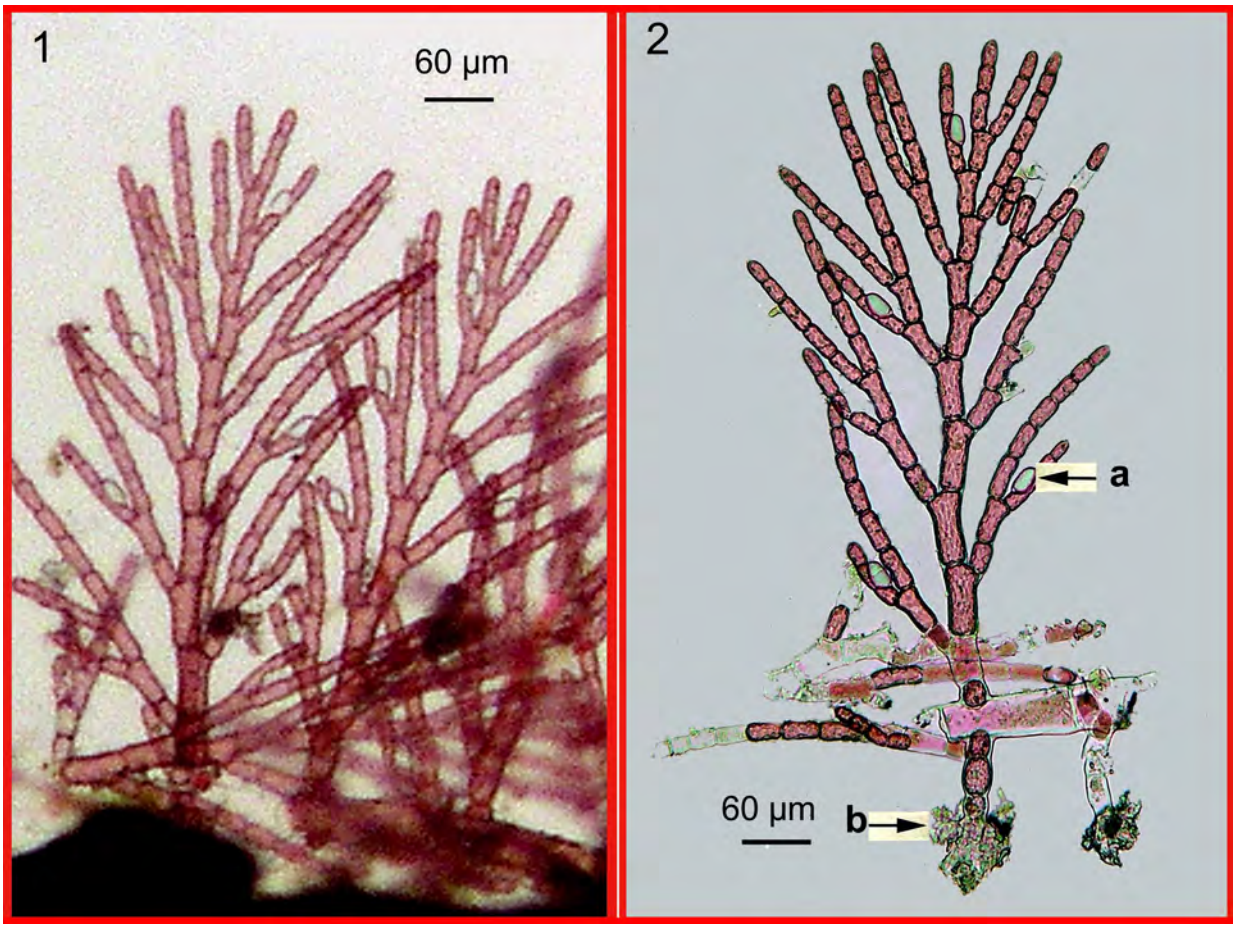


**Fig. 22** ***Antithamnion antillanum.*** 1. Overall morphology. 2. Plant showing branching pattern, gland cells (arrow a) and rhizoids (arrow b), Hainan Island, Luhuitou, October 2008.

Characteristics: Thalli consist of creeping axes and erect branches, 0.5-2.5 mm high, rose-red in color. Creeping axes (40-50 µm in diameter) consist of cells 70-200 µm long. Erect branches fine filamentous, 25-40 µm in diameter; cells 50-75(-120) µm long, basal cell shorter, spherical, -20 µm in diameter. Branching alternate, branches of the first order develop from every cell, in one plane; branchlets of the second order 1(-2) per branchlet, 3-5 cells long and bearing gland cells. Gland cells solitary, borne on inner side of branchlets, in contact with the first and second cells from base of the branchlets, 13-18 µm in diameter, 20-25 µm long. Attachment by rhizoids issuing from distal end of cells of creeping axes, opposite erect branches. Rhizoids consist of uniseriate moniliform cells, terminating in digitate holdfast. Tetrasporangia oval, 20-40 µm in diameter, 45-90 µm long, cruciately divided, in axils of branchlets. Growing epiphytic on *Cladophora vagabunda, Padina jonesii, Bryocladia cervicornis, Mastophora rosea, Portieria hornemannii, Yonagunia formosana*.

Collection sites in Hainan. Shalao, Dadong Hai, Luhuitou.

***Antithamnion elegans*** **(Berthold) J.H. Price & D.M. John ( ♦ )**

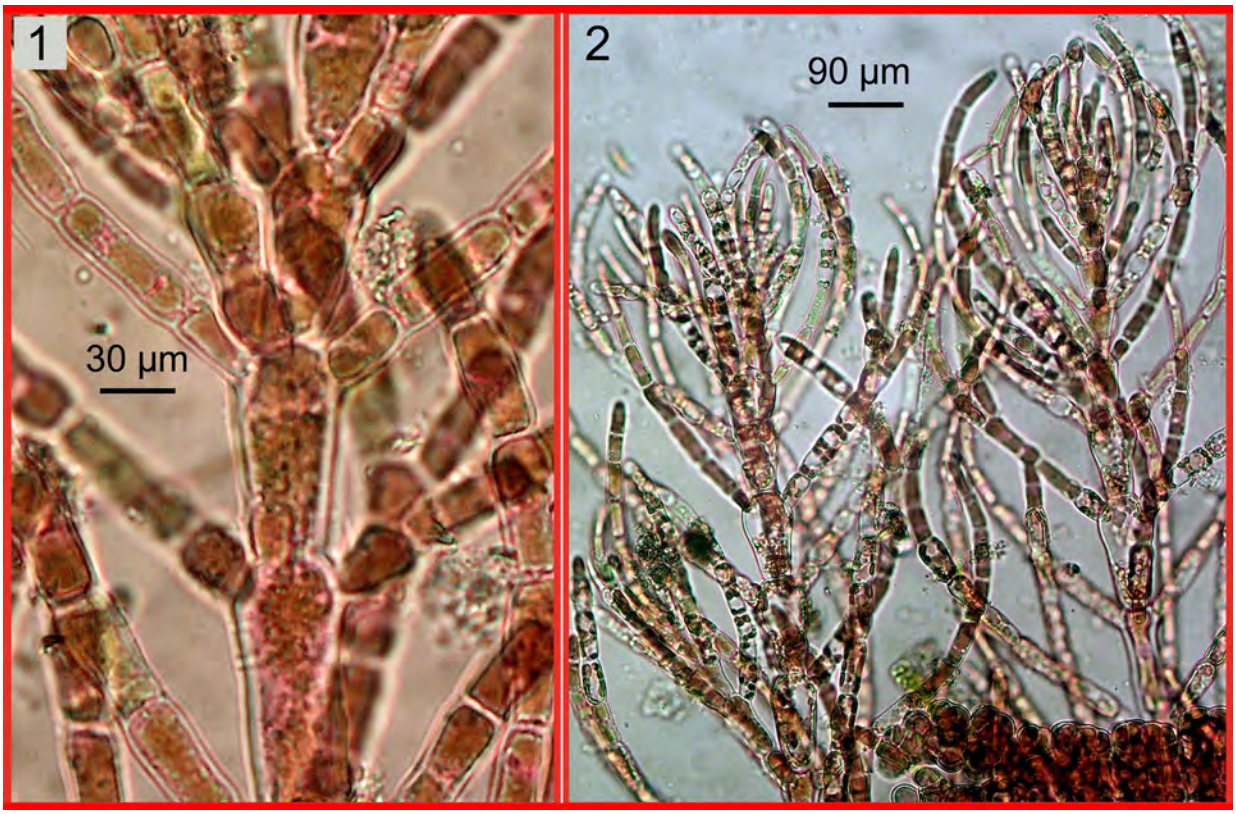


**Fig. 23** ***Antithamnion elegans.*** 1. Detail showing axial cells and branchlets. 2. Overall morphology. Hainan Island, Luhuitou, November 2010.

Characteristics: Thallus consists of creeping axes (25-50 µm in diameter) bearing erect, fine, filamentous branches, 1.1-2(-5 mm) high, rose-red to dark red color. Main axis of erect branches 25-36 µm in diameter, with cells 50-120(-135) µm long, bearing whorls of three branchlets at their distal ends. Branchlets of the second order, 8-15 µm in diameter and 20-25 µm long, gradually tapering towards apices, arranged laterally, alternately and slightly curved toward the main axis. Gland cells oval, 8-10×15-20 µm, borne on basal cell of lateral branchlets. Tetrasporangia borne on basal cells of the lateral branchlets, they are oval, 35-41 µm in diameter, 64-76 µm long, sessile, tetrahedrally, cruciately or irregularly divided. Attachment by rhizoids originating distally on cells on ventral side of creeping axes, opposite erect branches. The alga was found growing at 2-3 m depth, epiphytically on *Champia vieillardii, Parviphycus pannosus, Polysiphonia japonica* var. *savatieri*

Collection sites in Hainan. Xian Hai, Yalongwan, Luhuitou.

***Centroceras japonicum*** **Itono ( ♦ )**

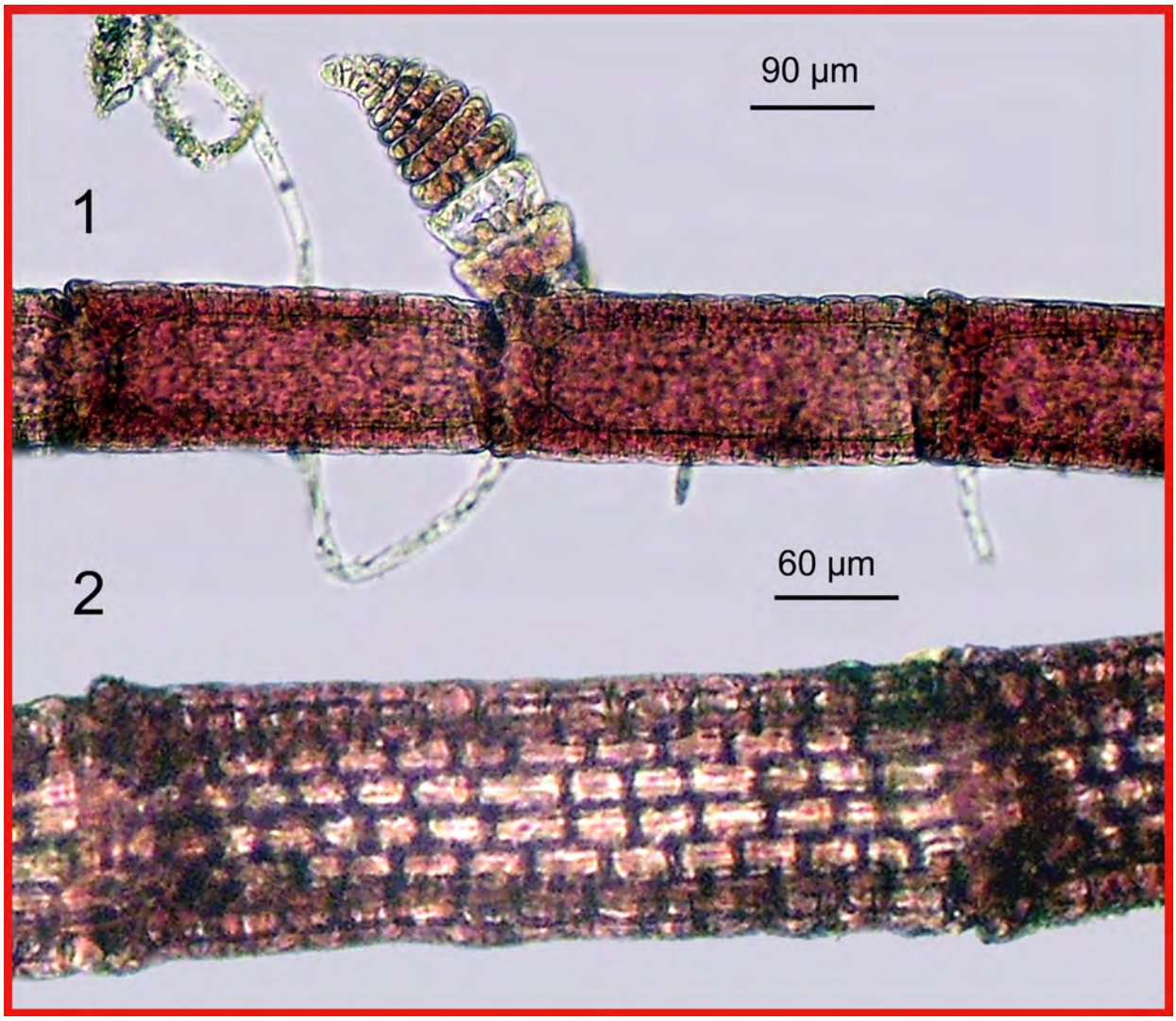


**Fig. 24** ***Centroceras japonicum.*** 1. Fragment of main axis with lateral branchlet. 2. Detail, showing cells in parallel longitudinal rows. Hainan Island, Luhuitou, November 2010.

Characteristics: Thallus minute, filamentous, sparsely irregularly branched, rarely subdishotomously. Branch apices non-forcipate, apical cell 10–12.5 in diameter, 7 µm long. Filaments consist of corticated segments, 75–80 µm in diameter, 3–4 diameters long (to 200 µm long at lower half and 50–100 µm long in the upper portion). Surface cortical cells arranged in parallel longitudinal rows, but not in transverse rows. These cells are of two kinds: short almost quadrate (12.5–15 µm broad, 12.5 µm long); and long rectangular (12.5–15 µm broad and 20–30 µm long). Spines absent at nodal joints, but protrudions present. Tetrasporangia in whorls at nodes, spherical, -35 µm in diameter, not involucrate. Rhizoids sparse, unicellular, simple, 15 µm in diameter and 100–500 µm long. Growing in the upper subtidal zone (1.5–2 m depth), on dead coral fragments, underneath *Lobophora variegata* thalli, among *Griffithsia metcalfii*, epiphytic on *Chnoospora implexa, Colpomenia sinuosa*.

Collection sites in Hainan. Yalongwan, Luhuitou.

***Centroceras minutum*** **Yamada (♣)**

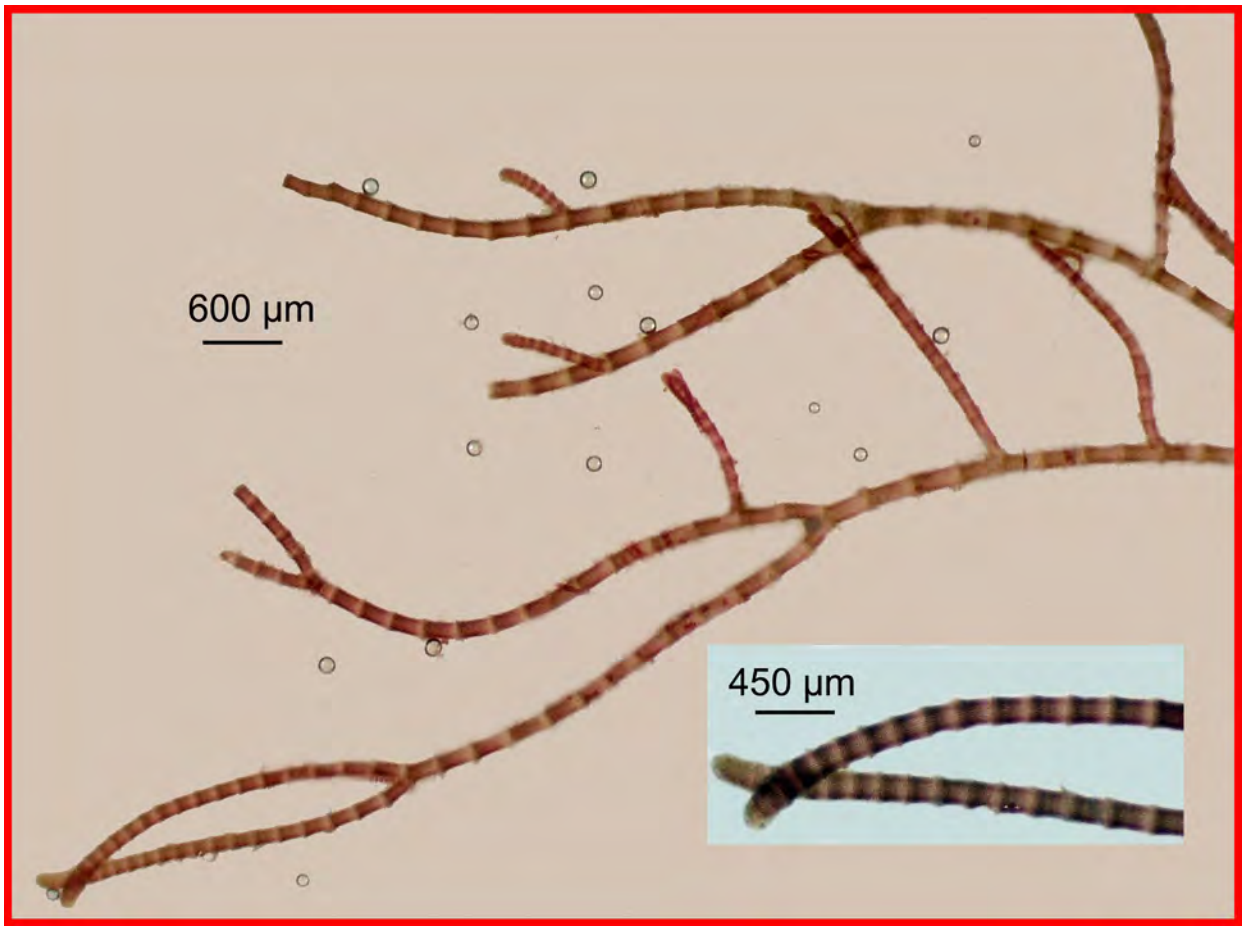


**Fig. 25** ***Centroceras minutum.*** Overall morphology. Inset: non-forcipate tips. Hainan Island, Luhuitou, March 2012. 1

Characteristics: Thallus consists of creeping axes bearing erect filaments, 8–10 mm high, light reddish-, to dark reddish-brown color. Branching sparse, irregular, subdichotomous. Filaments 70–110(–130) µm in diameter, darkly pigmented at joints, with non-forcipate, blunt tips. Axial cells surrounded by periaxial cells (6–8 per axial cell). Segments 3–5 diameters long completely corticated. Cortical cells square to rectangular, longitudinally elongate in surface view, 7–10 µm in diameter and 20–40 µm long and arranged in 14–20 longitudinal rows and at times in transverse rows. Colorless multicellular (2–3-celled) spines 8(–10) borne at the nodes. Tetrasporangia spherical, 23–25 µm in diameter or obovate, 25–26 µm across and 33–35 µm long, tetrahedrally divided, shortly stalked, prominent, covered with involucral, 3–4-celled filament, in whorls at nodes. Rhizoids multicellular, 10–30 µm in diameter, to 3 mm long ending into multicellular discoid holdfast. Growing in association with *Gayliella flaccida, Hypnea spinella* and *Spyridia filamentosa*, epiphytic on *Anadyomene wrightii, Caulerpa racemosa, C. serrulata, Dictyosphaeria cavernosa, Valoniopsis pachynema, Colpomenia sinuosa, Dictyota friabilis, Hydroclathrus clathratus, Padina australis, Acanthophora spicifera, Gelidiella acerosa, Gelidium pusillum, Hypnea spinella, Palisada papillosa, Spyridia filamentosa, Tolypiocladia condensata.*

Collection sites in Hainan. Shalao, Xiaodong Hai, Luhuitou, Ximao Zhou.

***Ceramium aduncum*** **Nakamura ( ♣ )**

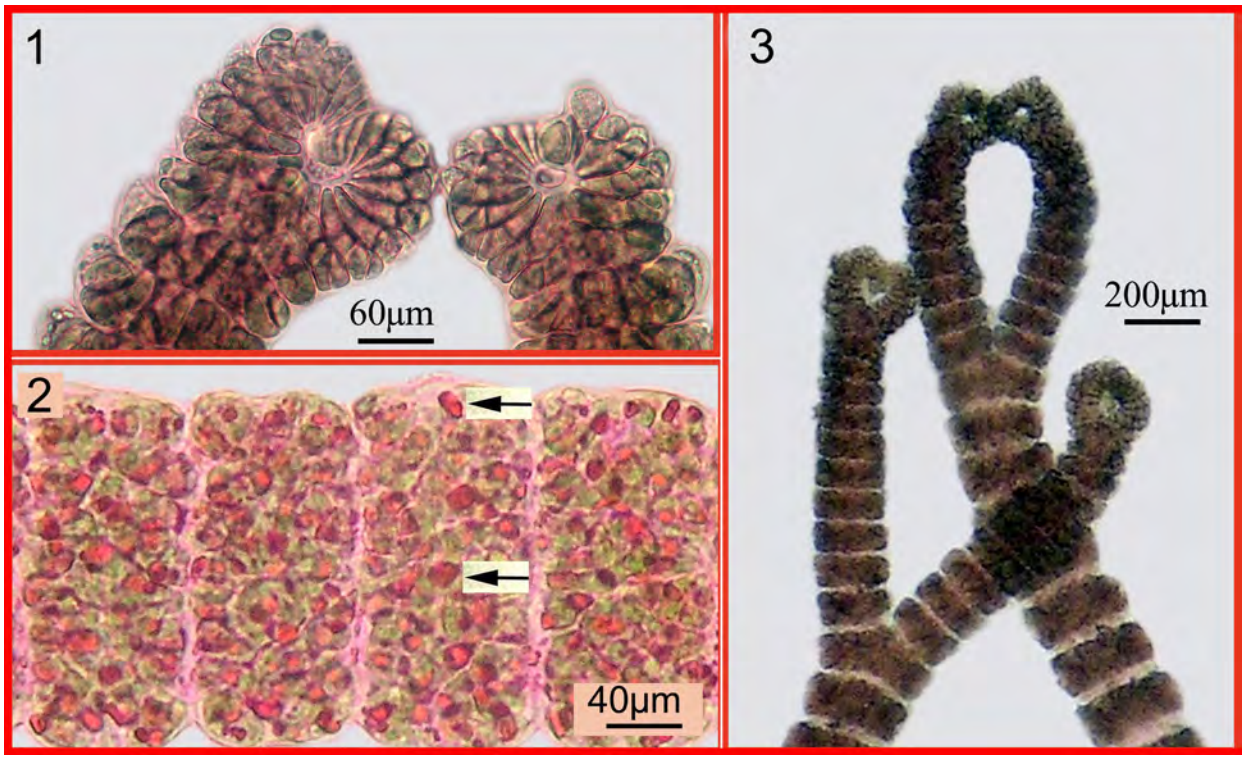


**Fig. 26** ***Ceramium aduncum.*** 1. Detail showing strongly inrolled tips. 2. Cortical bands with numerous gland cells (arrows). 3. Upper parts of branches showing heart-shaped tips. Hainan Island, Luhuitou, April 2012.

Characteristics: Thallus 2.5-5(-10) mm high, consist of creeping axes and erect branches. Erect branches to 250 µm in diameter at base, gradually decreasing towards apices. Apices of erect axes strongly inrolled (circinate) or form heart-shaped overlapping. Branching regularly dichotomous. Periaxial cells 6-11 per axial cell. Cortical bands composed of central ring of large roundish slightly longer than broad cells and outer small irregularly shaped angular cells, 6-10-10-15 µm, irregularly arranged; gland cells scattered over cortical bands. Tetrasporangia protruding, spherical, 60-90 µm in diameter, including thick envelope, naked (without involucral filaments), numerous, borne adaxially at each cortical band in the upper portion of erect branches. Attachment by multicellular rhizoids issuing from nodes of creeping axes. Growing epiphytically on *Chondria armata, Lobophora variegata*.

Collection sites in Hainan. Nanmai, Xiaodng Hai, Luhuitou.

***Ceramium borneense*** **Weber-van Bosse ( ♣ )**

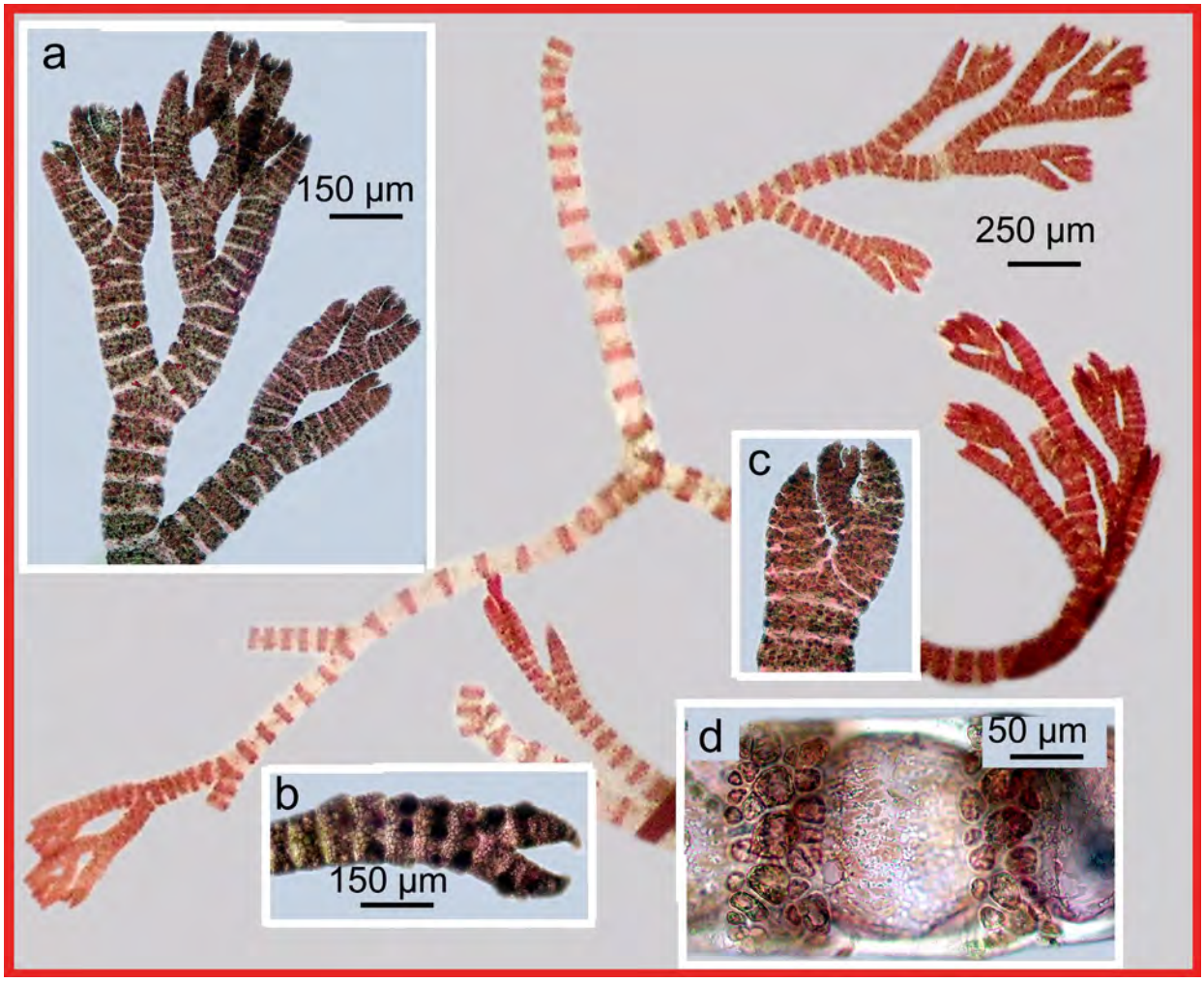


**Fig. 27** ***Ceramium borneense.*** Overall morphology. Insets: a, detail showing branching pattern; b, branch with tetrasporangia; c, apical portion; d, internode and cortical bands. Hainan Island, Yalongwan, March 2012.

Characteristics: Thallus consists of prostrate axis bearing erect branches. Prostrate axes Erect branches stiff, 1.8-3.5 mm high, 220 µm broad at base and 120 µm broad above. Branch tips pointed, slightly incurved and forcipate. Branching regular sympodial or subdistichous, in one plane. Cortical bands shorter than broad (30-52 µm long) composed of central ring of large polygonal to roundish cells (12.5-17.5×22.5-25 µm) and smaller angular to roundish cells (12.5-15×12.5-15 µm) on both sides of the central ring. Internodes 70 µm long at basal part becoming shorter towards apices to 25 µm. Attachment by simple rhizoids from prostrate axes to 300 µm long. Tetrasporangia subspherical, 30-45 µm in diameter, tetrahedrally divided, borne on cortical bands, non-involucrate. Growing on dead corals, epiphytic on *Grateloupia filicina, Hypnea pannosa, Leveillea jungermannioides, Palisada papillosa, Sargassum polycystum*.

Collection sites in Hainan. Yalongwan, Luhuitou, Xiadong Hai, Dadong Hai, Tian Ya Hai Jiao,

***Ceramium cimbricum*** **H.E. Petersen (♣)**

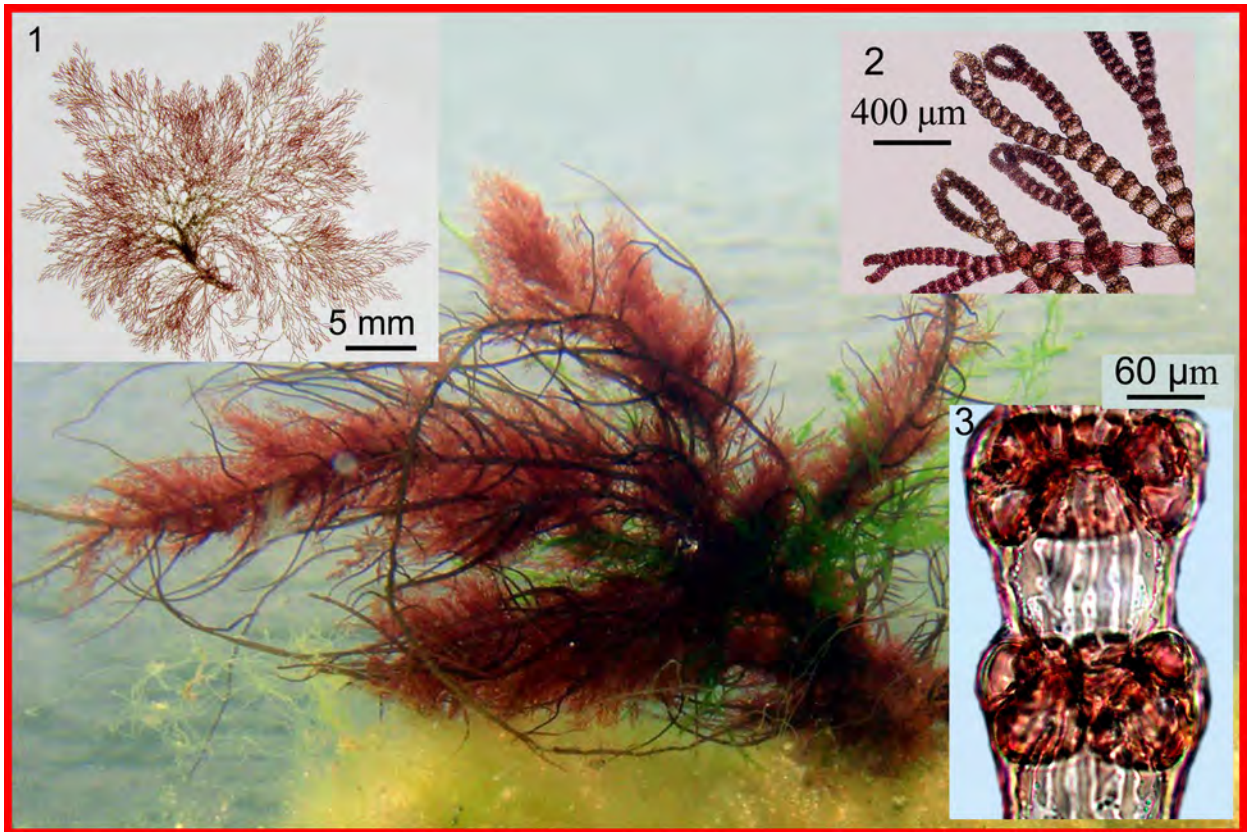


**Fig. 28** ***Ceramium cimbricum.*** Epiphytic on *Grateloupia filicina*. Hainan Island, Luhuitou, April 2012. Insets: 1. Overall morphology. 2. Branching pattern. 3. Fragment showing cortical nodes.

Characteristics: Thalli fine filamentous, bushy, 0.5–3.5(–10) cm high, purple to dark red. Branching irregularly dichotomous, with straight or slightly incurved apices. Internodes 50–160 µm in diameter, 150–250(–500) µm long, striated, lightly pigmented. Cortical nodes 50–170 µm in diameter, 30–60 µm long., swollen, heavily pigmented, composed of two cell layers in young plants: upper layer of small cells, -7.5 µm in diameter, lower layer of large cells, 17–20 x 25 µm; and 4–6 rows in old thalli with small upper cells and larger ones in lower rows. Tetrasporangia prominent, spherical, tetrahedrally divided, to 65 µm in diameter, solitary or in rows at nodes. Attachment by unicellular rhizoids issuing from cortical nodes of creeping axes. Growing on hard substrate, epiphytic on larger algae (*Centroceras clavulatum, Gelidiella acerosa, Hypnea* spp., *Jania capillacea, Canistrocarpus cervicornis, Chnoospora implexa, Colpomenia sinuosa, Padina australis, Rosenvingea intricata, Sargassum polycystum, Turbinaria ornata* phylloids), in low intertidal, upper subtidal, in sheltered and semi-protected coasts.

Collection sites in Hainan. Wenchang, Xincun, Xiaodong Hai, Luhuitou, Ying Ge Hai.

***Ceramium cingulatum*** **Weber-van Bosse (♣♣)**

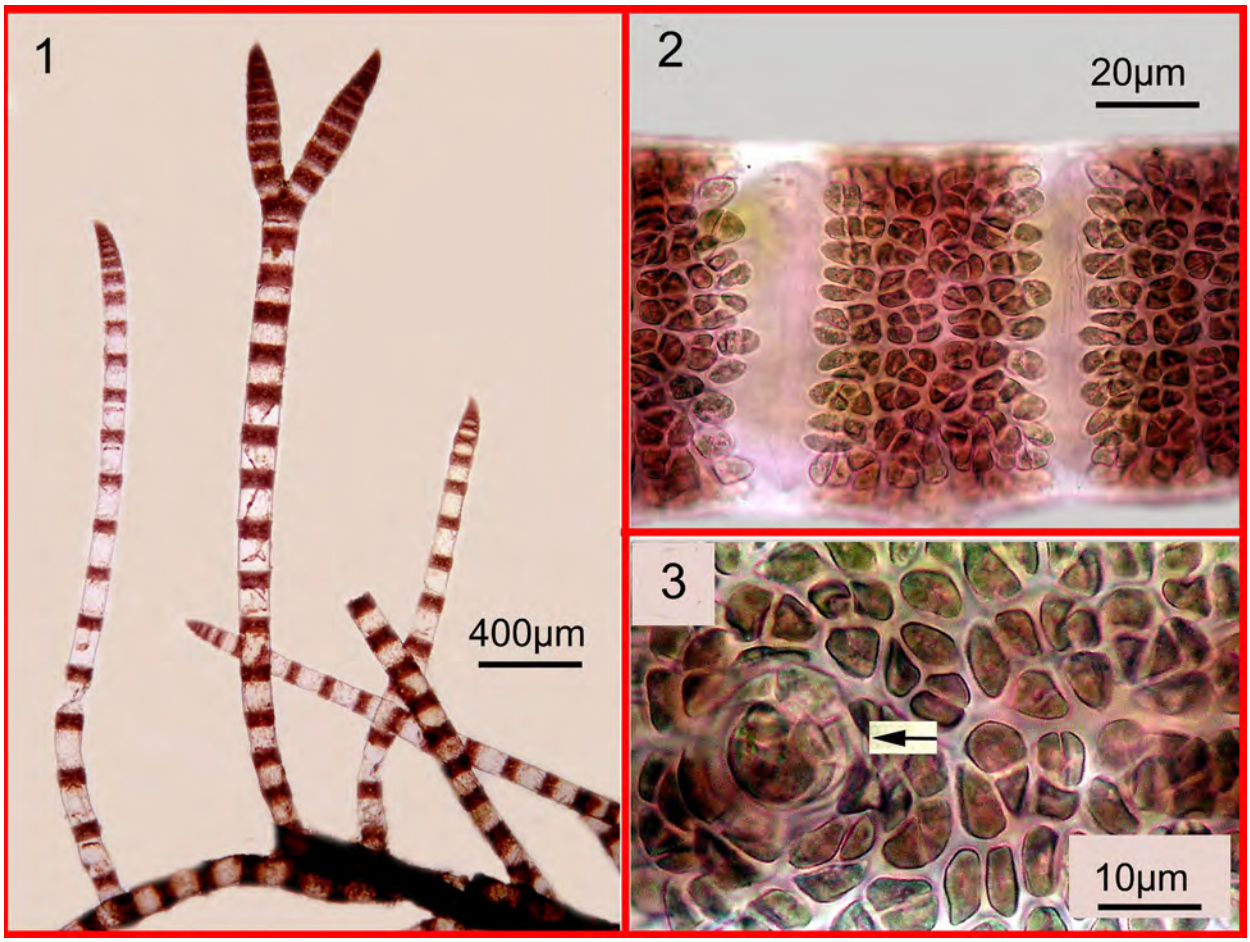


**Fig. 29** ***Ceramium cingulatum.*** 1. Overall morphology. 2. Cortical nodes. 3. Detail showing tetrasporangium (arrow). Hainan Island, Luhuitou, December 2010.

Characteristics: Thallus consists of creeping axes, semi-erect and erect filaments, and light pink color. Erect filaments commonly simple, non-forcipate, rarely sparsely branched, 1-3.3 mm high, to 145-200 μm diam., tapering to the basal portion and with apices slightly incurved. Cortical bands (-50 μm long) consist of eight periaxial cells and 5-6 rows of cortical cells composed of basipetal small cells (8-10 x 8-10 μm) and acropetal (5x 5-10 μm). Internodes striate, 90-200 μm long in creeping axes, in erect branches internodes shorter, to 70 μm long. The structure of cortical bands in sterile, tetrasporophytic and male plants is very variable. Rhizoids borne at every cortical band of creeping axes, 25-35 μm diam., 125-130 μm long, ending into branched (finger-like) attachment. Tetrasporangia whorled, imbedded in cortical layer, spherical (35 μm diam.) to oval (35-60 μm), cruciately, irregularly cruciately divided. Growing epiphytic on *Boodlea composita, Cladophora catenata, C. laetevirens, Cladophoropsis sundanensis, Dictyosphaeria versluysii, Colpomenia sinuosa, Hydroclathrus clathratus, Padina boryana, P. minor, Turbinaria ornata, Actinotrichia fragilis, Ceratodictyon intricatum, Gelidium pusillum, Gelidiella acerosa, Ganonema farinosum, Gracilaria salicornia, Palisada parvipapillata*.

Collection sites in Hainan. Linchang, Nanmai, Shalao, Yalongwan, Dadong Hai, Xiadong Hai, Luhuitou, Ximao Zhou, Tian Ya Hai Jiao, Ying Ge Hai.

***Ceramium comptum*** **Børgesen ( ♦ )**

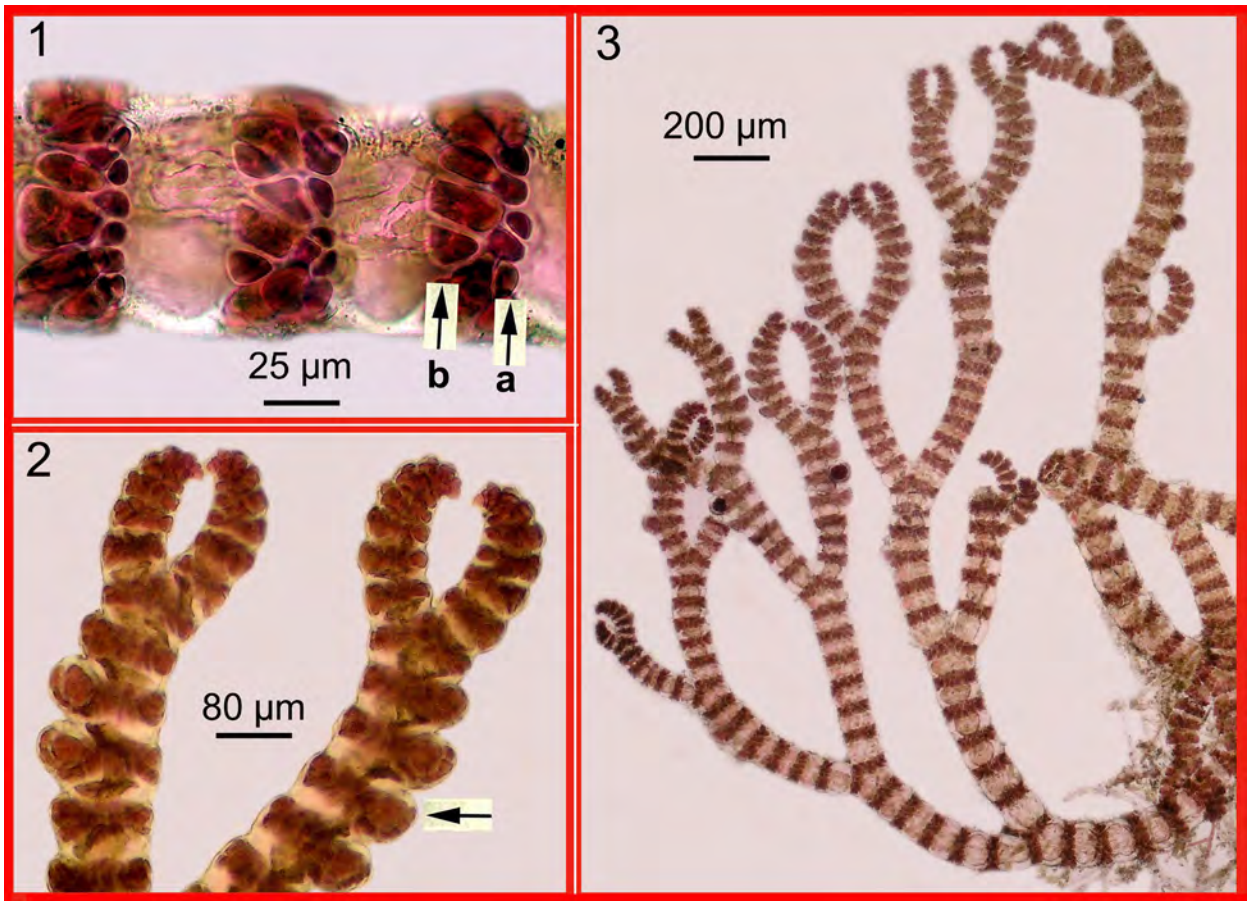


**Fig. 30** ***Ceramium comptum.*** 1. Detail showing cortical bands: a, upper row of cells; b, lower row of cells. 2. Upper portion of branches with tetrasporangia (arrow). 3. Overall morphology. Hainan Island, Luhuitou, April 2009.

Characteristics: Thallus consists of loosely creeping axes and erect branches to 2 mm high. Branching regularly pseudodichotomous. Cortical nodes composed of two rows of densely pigmented cells. The upper row consists of small cells (5-10 ×7.5 µm) (Fig 1, arrow a), the lower row of large, angular, longitudinally elongated cells (7-12.5 ×15-20 µm) (Fig. 1, arrow b). At the basal portion, cortical nodes 130 µm in diameter, to 50 µm long, internodes 45 µm long. In the middle portion, cortical bands 100-75 µm in diameter, 30–32 µm long, internodes 25–45 µm long. In the upper portion, cortical bands 60 µm in diameter, 10–20 µm long, internodes 10–25 µm long. Sporangia arranged unilaterally, spherical (50 µm in diameter) or occasionally oval (25×50 µm), tetrahedrally divided, partially covered by involucral branchlets arising from the lower row of cells. Attachment by rhizoids (17 µm in diameter, ~50 µm long) originating from cortical nodes on ventral side of creeping axes. Growing epiphytically on *Hypnea esperi, Sargassum polycystum* phylloides.

Collection sites in Hainan. Shalao, Dadong Hai, Xiadong Hai, Luhuitou.

***Ceramium macilentum*** **J. Agardh ( ♣ )**

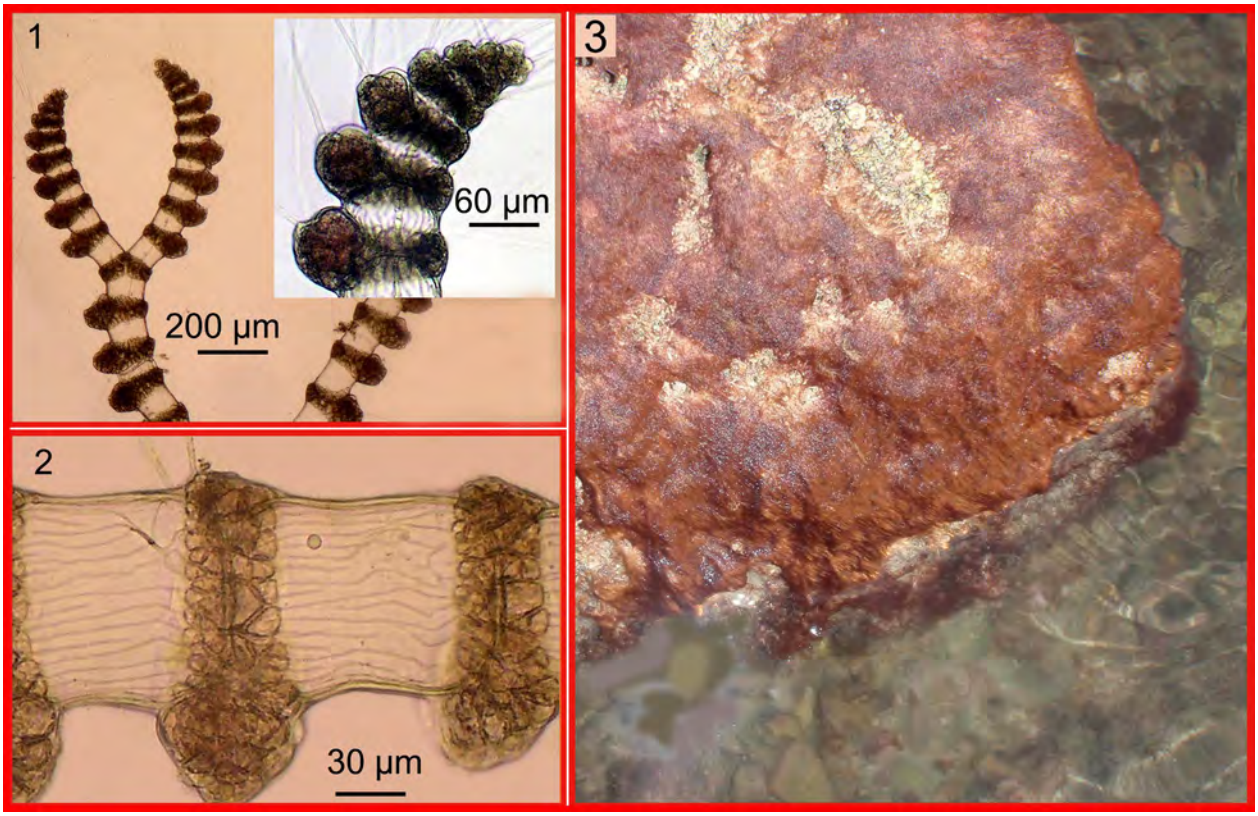


**Fig. 31** ***Ceramium macilentum.*** 1. Upper portion of branch with tetrasporangia and hairs. 2. Cortical bands with immature tetrasporangia. 3. In habitat, the middle intertidal zone at low tide. Hainan Island, Luhuitou, April 2012.

Characteristics: Thallus filamentous, 2-4 cm high, dark red-brown, initially creeping, giving rise to erect branches. Erect filaments 90-100(-150) µm in diameter. Branching regular dichotomous, pseudo-dichotomous. Cortical nodes, 25-30(-45) µm long, 75-90(-100) µm in diameter) consist of three bands: large polygonal cells 20-25(-30)×15-17.5(-20) µm in the middle (central ring) and small (7 µm) angular cells above and below the central ring. Internodes 75 µm in diameter 100-150 µm long at the lower portion and shortening to 30-45 µm long at the upper one. Branch tips forcipate, sometimes circinate, inwardly curved. Rhizoids issuing from the nodes on ventral side of creeping axes, 1-3 rhizoids from each node, 12-15 µm in diameter, two-celled, ending into blunt or disc-like attachment. Tetrasporangia prominently projecting, abaxial, 1-2(-3) per node, tetrahedrally divided, spherical or subspherical 35-40(-50) µm in diameter, partially surrounded by cortical involucre. Growing on rocks, epiphytically on larger algae (*Dictyosphaeria versluysii, Lobophora variegata, Padina boryana, P. minor, Sargassum crassifolium, Gelidiophycus divaricatus, Portieria hornemannii*) in the middle intertidal to shallow subtidal zones.

Collection sites in Hainan. Xian Hai, Shalao, Xiadong Hai, Luhuitou, Ximao Zhou.

***Ceramium marshallense*** **E.Y. Dawson ( ♣♣ )**

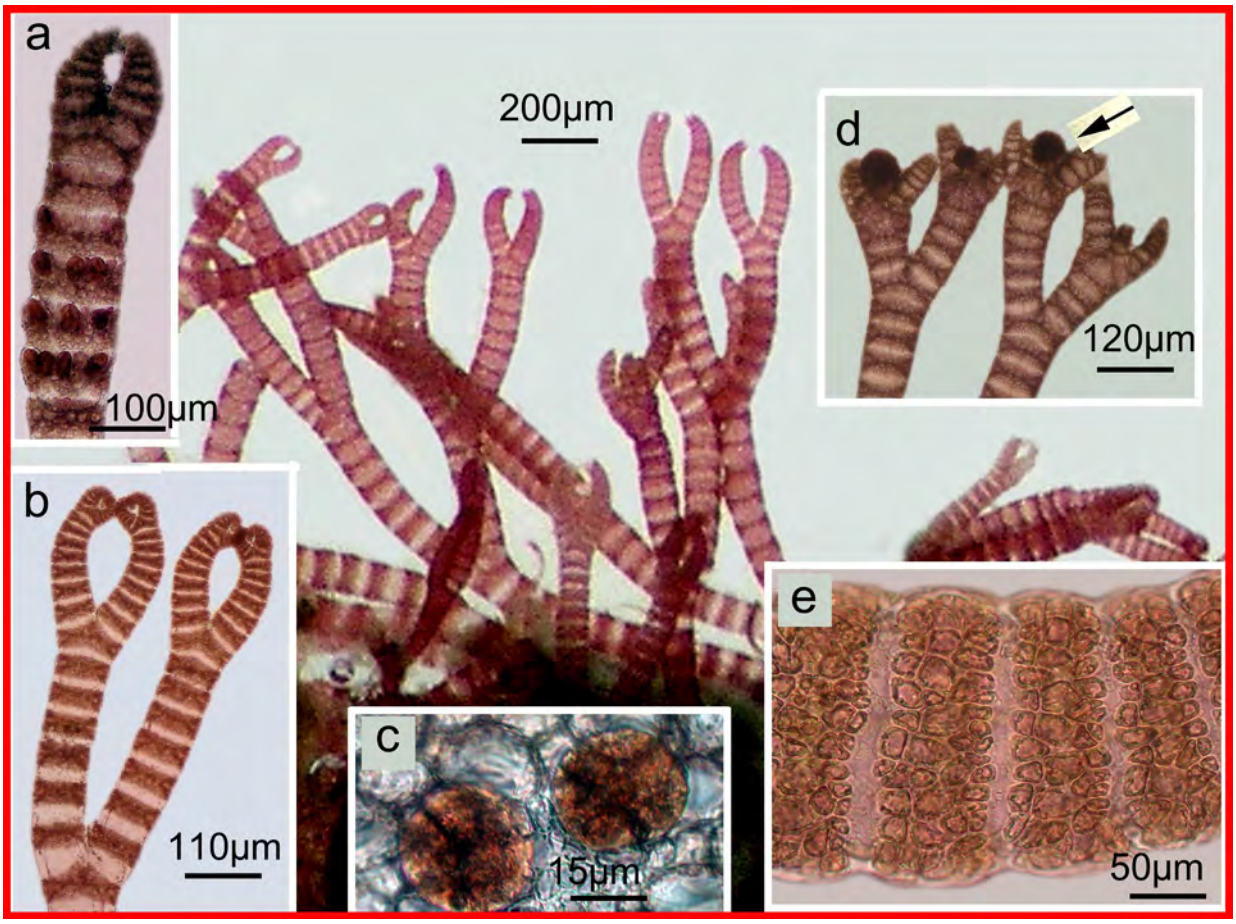


**Fig. 32** ***Ceramium marshallense.*** Overall morphology. Insets: a, branch with tetrasporangia; b, detail showing branching pattern; c, tetrasporangia; d, branches with cystocarps (arrow); e, cortical nodes. Hainan Island, Luhuitou, February 2012.

Characteristics: Thallus filamentous, 2.2-20 mm high, dark red, initially creeping. Creeping axes 165 μm in diameter. Erect filaments 90-100(-180) μm in diameter. Branching regularly dichotomous, pseudo-dichotomous. Cortical nodes (25-75 μm long) consist of three bands of large angular cells (22.5-27×22-32 μm) in the middle (central ring of 5-6 cells) and small angular (7-15×17 μm) cells above and below. Internodes 60-150 μm long at the lower portion and shortening to 45 μm long at upper. Branch tips circinate, inwardly curved. Tetrasporangia borne abaxially, 1-3 per node, tetrahedrally divided, spherical or subspherical 35-40(-50) μm in diameter, surrounded by involucres. Cystocarps 125×150 μm. Rhizoids on ventral side of creeping axes, 2-4 rhizoids from each node, 75-150 μm long, 7.5-15(-25) μm in diameter, 1-2-celled, ending into blunt or disc-like attachment. Growing on upper intertidal to shallow subtidal rocks, epiphytic on Dictyota friabilis, *Chnoospora implexa, Padina australis, Rosenvingea intricata, Turbinaria ornata, Amphiroa foliacea, Gelidium pusillum, Hypnea pannosa*.

Collection sites in Hainan. Yalongwan, Xiadong Hai, Luhuitou, Ximao Zhou, Ying Ge Hai.

***Ceramium procumbens*** **Setchell & N.L. Gardner ( ♦♦ )**

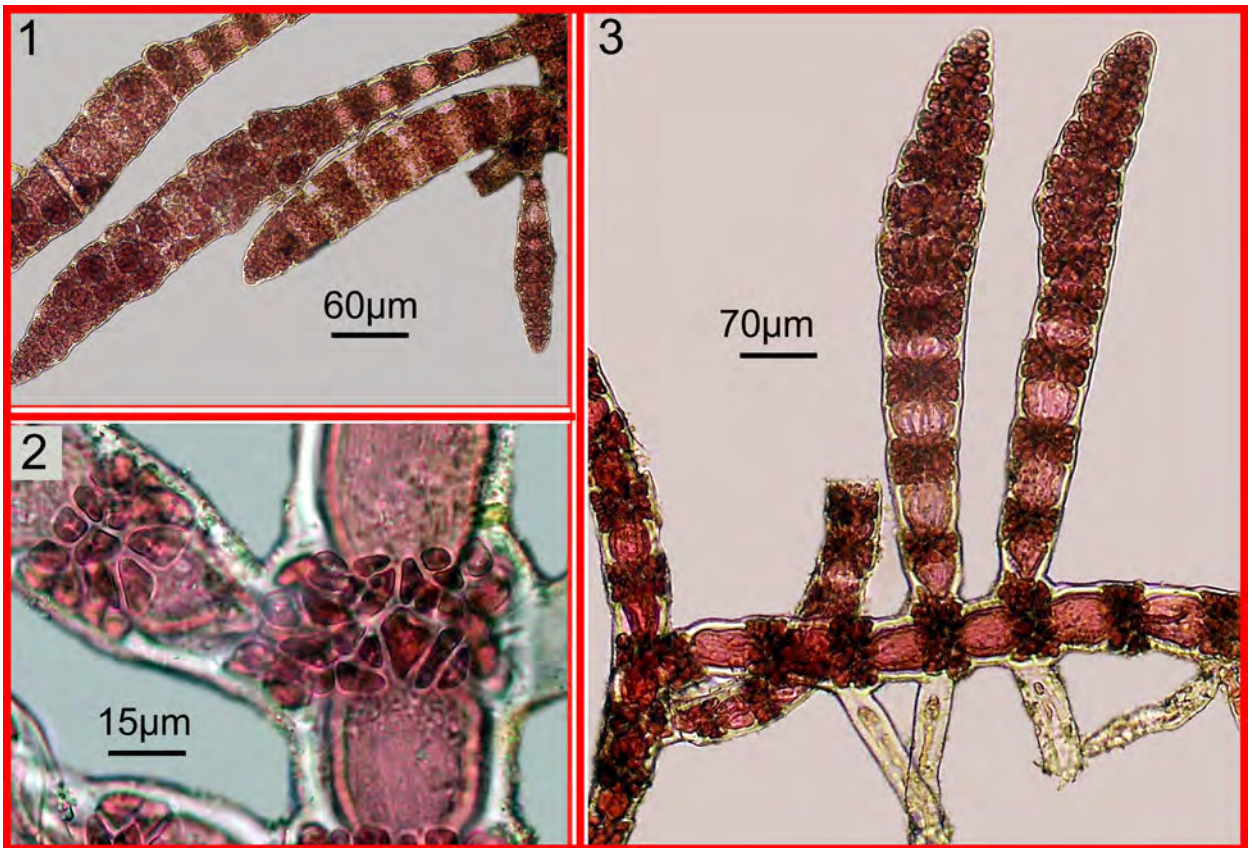


**Fig. 33** ***Ceramium procumbens.*** 1. Fragment showing branches with tetrasporangia. 2. Detail showing cortical nodes. 3. Creeping axis bearing rhizoids and erect branches with tetrasporangia. Hainan Island, Luhuitou, November 2010.

Characteristics: Thallus microscopic, consists of creeping axes and erect branches, (27-)37-50(-90) μm in diameter, dark red in color. Cortical nodes in creeping axes 50-60 μm long, consisting of irregularly shaped cells. Internodes 17-65 μm long, striated. Branching distichous. Erect branches simple, non-forcipate, straight with nodal bands 40 μm in diameter, 17.5-37 μm long, and internodes 25-35 μm long. Tetrasporangia spherical, 25-35 μm in diameter, subspherical, cruciately divided, 25(-45)x27(-50) μm, immersed, borne in swollen upper portions of erect branches. Rhizoids develop from nodal bands opposite erect branches, (7.5-)17.5-25 μm in diameter, 35-75(-125) μm long, simple or ending into disc-like holdfast. Growing epiphytically on *Codium repens, Pterocladiella caerulescens.*

Collection sites in Hainan. Yalongwan, Xiadong Hai, Luhuitou.

***Ceramium tenerrimum*** **(G. Martens) Okamura ( ♣ )**

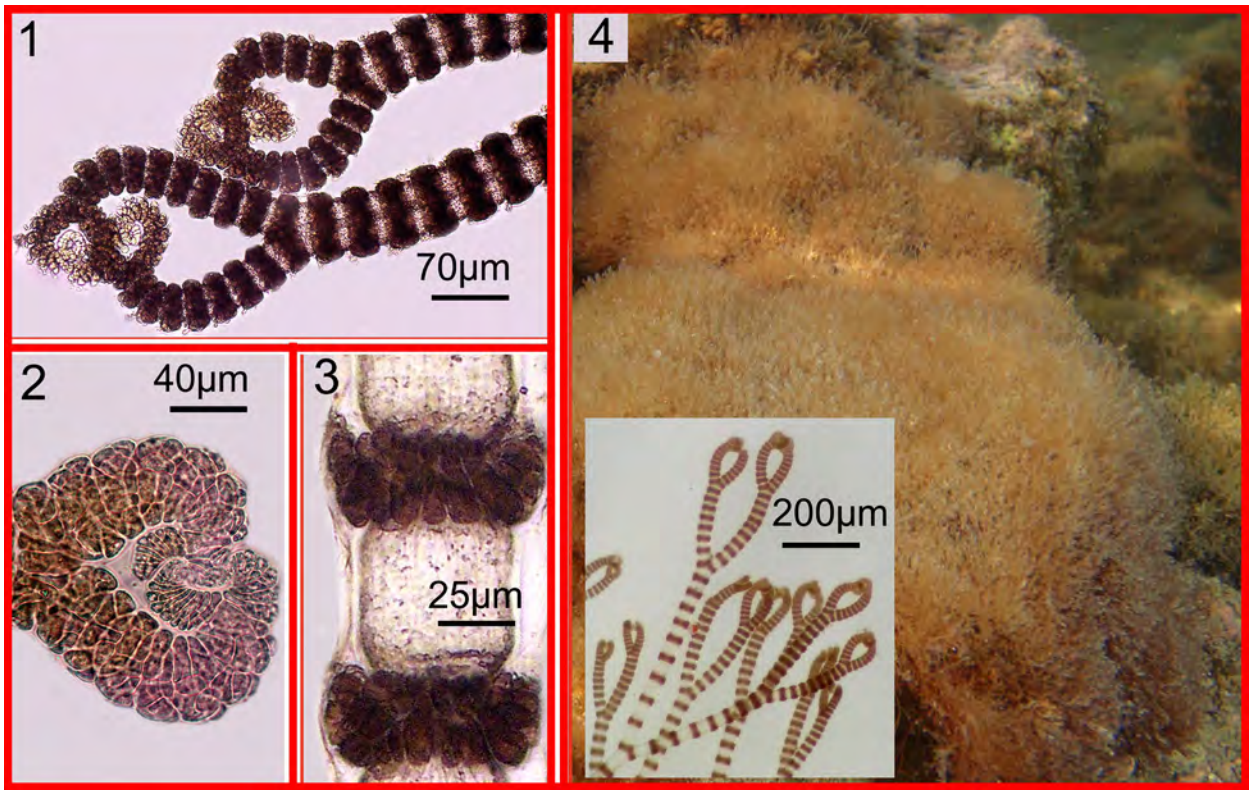


**Fig. 34** ***Ceramium tenerrimum.*** 1, 2. Details showing strongly enrolled apices. 3. Cortical nodes. 4. In habitat, on midintertidal rocks. Hainan Island, Luhuitou, March 2012. Inset: Detail showing branching pattern.

Characteristics: Thallus flaccid, tuft-like, consists of creeping axes (90-132 μm in diameter) and erect fine filaments, light pinkish red to dark reddish-brown, 1-6(-10) cm high. Branching dichotomous, fastigiate, the apices forcipate, strongly enrolled. Filaments corticated at nodes, the nodes, 60-85(-110) μm in diameter, (35-)47-50 μm long, composed of 3-4 transverse rows of cells. Cortical cells angular, smaller in the upper row of the cortical node. Internodes (92-)110-220 μm long at lower part of thallus (5-10 diameters long), gradually becoming shorter to apices, to 15-17.5 μm, 70-100 μm in diameter. Tetrasporangia spherical or ovate, 40-50(-65) μm in diameter, tetrahedrally or cruciately divided and borne on lateral branchlets, verticillate. Cystocarps surrounded by 2-3 involucral cells, develop on the upper portions of branches. Rhizoids originating from cortical nodes (by 3-4 rhizoids from node) on ventral side of creeping axes, simple, 2-3-celled or more, with blunt or disc-like holdfast, 400-850 μm long. Growing on intertidal and upper subtidal rocks covered with sand, in association with Centroceras clavulatum and epiphytic on larger algae (*Codium repens, Phyllodictyon anastomosans, Valonia aegagropila, V. ventricosa, Sargassum polycystum, Sphacelaria tribuloides, Turbinaria ornata, Champia vieillardii, Ganonema farinosum, Gracilaria salicornia, Hypnea* spp., *Izziella orientalis, Liagora ceranoides, Polysiphonia scopulorum*).

Collection sites in Hainan. Xian Hai, Nanmai, Shalao, Yalongwan, Xiadong Hai, Luhuitou, Ximao Zhou, Tian Ya Hai Jiao.

***Ceramium vagans*** **P.C. Silva ( ♣ )**

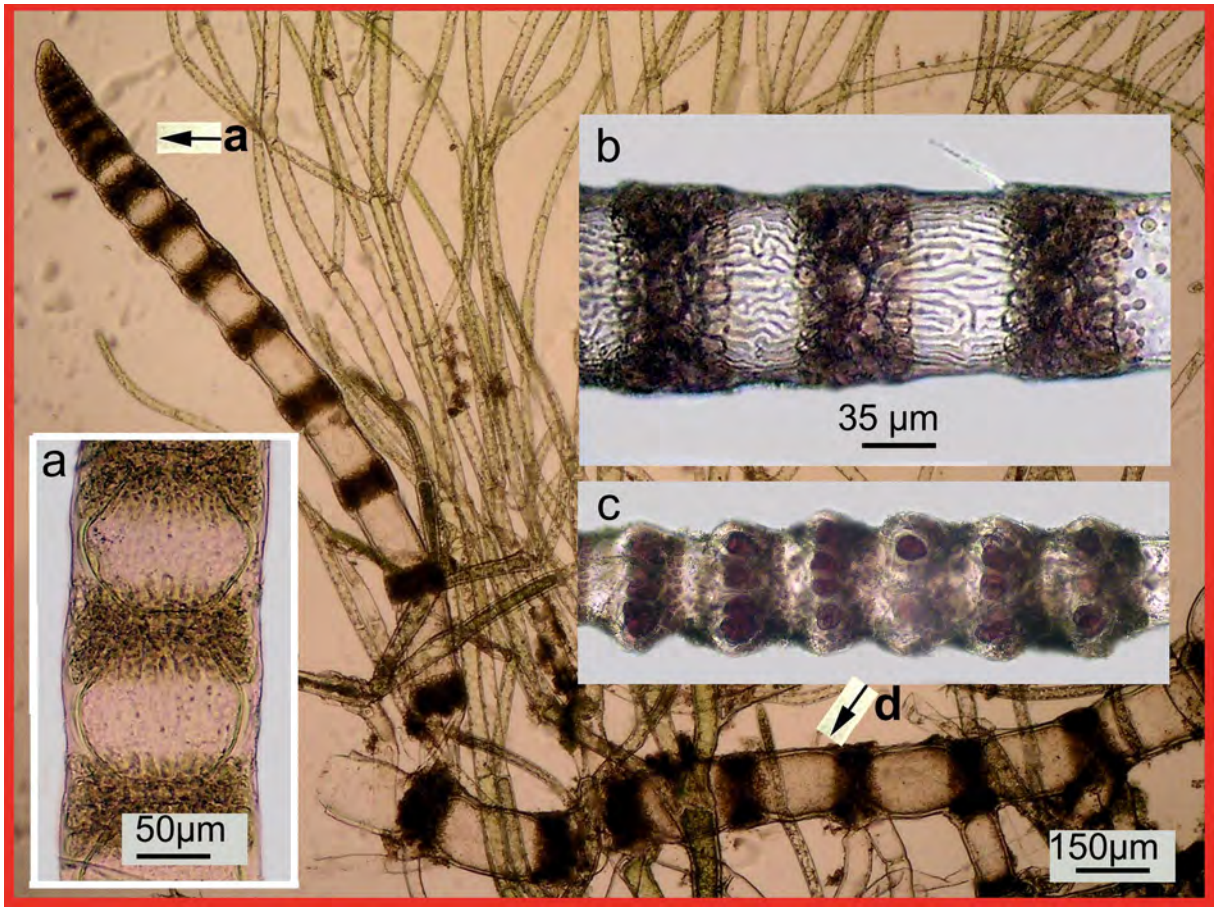


**Fig. 35** ***Ceramium vagans.*** Creeping axis (arrow a) and erect non-forcipate branch (arrow d). Insets: a, portion of older branch; b, portion of erect young branch; c, tetrasporangia. Hainan Island, Luhuitou, April 2012.

Characteristics: Thallus consists of creeping axis bearing erect branches 1.5-2.5 mm high. Erect branches (80-)140-180 μm in diameter, simple, sparse or irregularly branched. Branch tips non-forcipate, with prominent apical cell, 7.5-10×8-17 μm. Cortical bands 30-40 μm long, with even margins. Bands consist of inner ring of large (15-20×25-30 μm) and small angular cortical cells on both sides of the ring, 5-6 μm across. Internodes to 170 μm long at the basal part of erect branches becoming shorter towards apices to 20 μm long. Tetrasporangia subspherical (30-40 μm in diameter), ovate (35-42×40-45 μm), cruciately divided, verticillate, in whorls of 4-6, protruding at distal nodal bands of the erect axes. Rhizoids numerous, multicellular, originating from nodes on ventral side, 25-40(-60) μm in diameter, to 700 μm long, ending into branched, finger-like holdfast. Growing on hard substrate and epiphytically on *Hypnea pannosa, Dictyota friabilis, D. bartayresiana, Lobophora variegata, Padina australis, P. minor* (Vaughaniella stage), *Sargassum polycystum* phylloids.

Collection sites in Hainan. Wenchang, Shalao, Yalongwan, Dadong Hai, Xiadong Hai, Luhuitou, Ximao Zhou, Tian Ya Hai Jiao.

***Corallophila kleiwegii*** **Weber-van Bosse ( ♣ )**

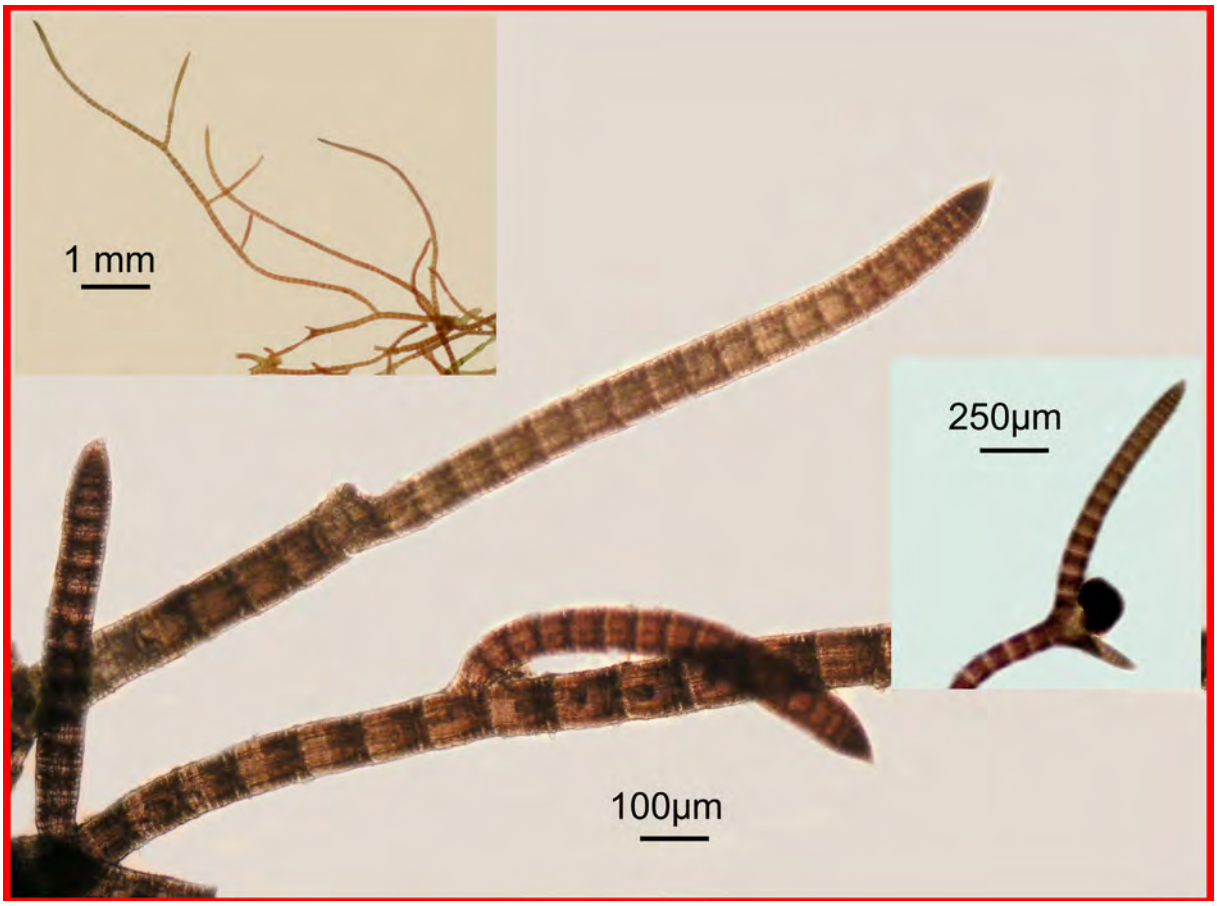


**Fig. 36** ***Corallophila kleiwegii.*** Fragment. Insets: upper left, Overall morphology; lower right, portion with cystocarp. Hainan Island, Luhuitou, November 2010.

Characteristics: Thallus consists of prostrate and erect axes 110-160(-170) μm diam., composed of axial cells (30-)70-100(-155) μm diam., surrounded by 6-10 pericentral cells, 20-25 μm in diameter. Branching irregular, alternate. Apices apiculate, non-forcipate, apical cell protruding (to 12-18 μm) with transverse segmentation below. Surface cortical cells arranged in 18-24(-32) parallel longitudinal rows, composed of elongate cells, 12.5-20 μm in diameter. Rhizoids single or abundant, issuing from corticating cells of prostrate axes 12-17(-30) μm in diameter, to 400-500 μm long, simple or ending into finger-like outgrowth or multicellular lobed disc. Tetrasporangia spherical, (25-)30-35(-40) μm in diameter, cruciately divided, borne within corticated segments near apices of erect axes. Growing on dead corals among turf algae, epiphytic on *Caulerpa racemosa, Dictyosphaeria cavernosa, Colpomenia sinuosa, Lobophora variegata, Sargassum polycystum, Ceratodictyon intricatum, Gelidium pusillum, Hypnea pannosa, Jania ungulata f. brevior, Peyssonnelia rubra*, at low intertidal to upper subtidal.

Collection sites in Hainan. Wenchang, Yalongwan, Dadong Hai, Xiadong Hai, Luhuitou, Ximao Zhou.

***Gayliella fimbriata*** **(Setchell & N.L. Gardner) T.O. Cho & S.M. Boo ( ♦ )**

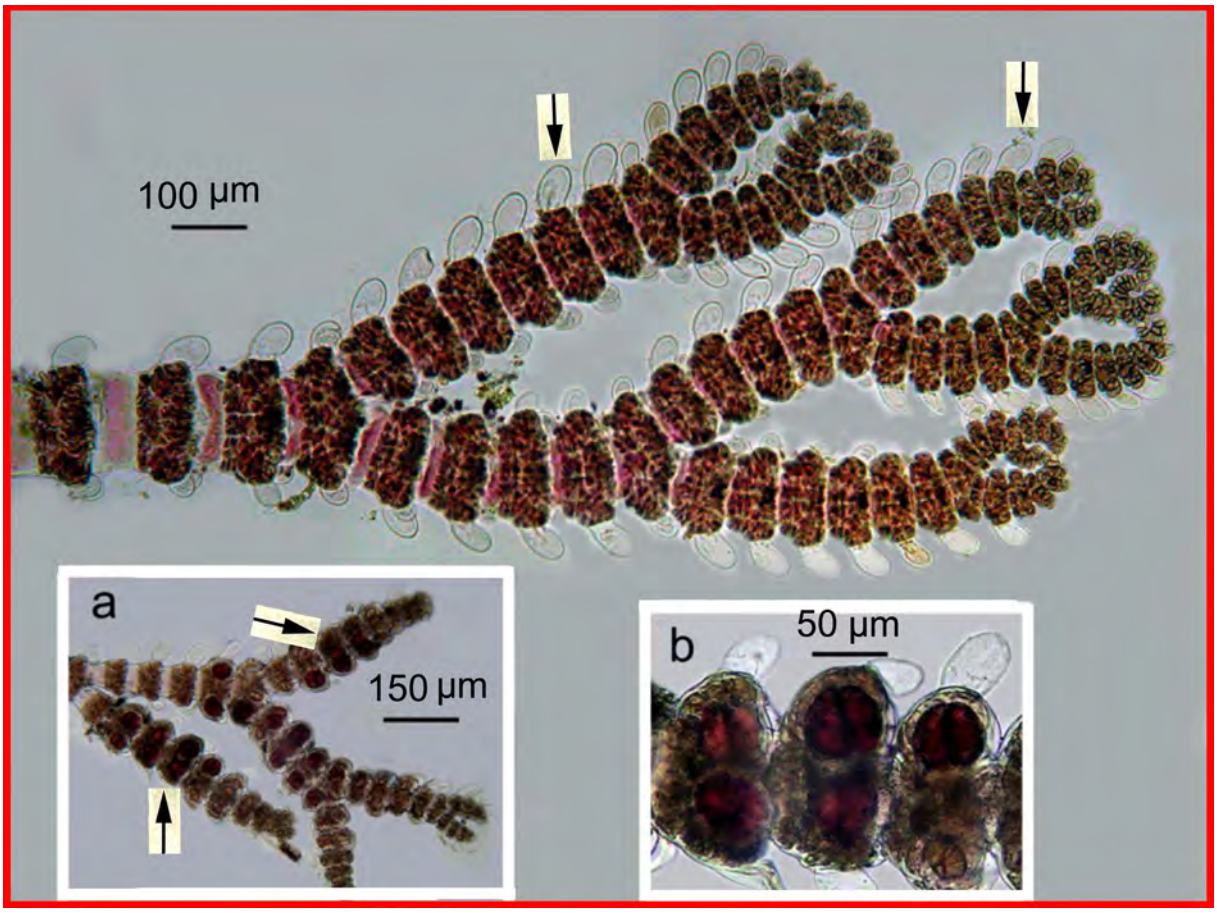


**Fig. 37** ***Gayliella fimbriata.*** Part of thallus showing branching pattern and ear-like hairs (arrows). Insets: a, upper portion with tetrasporangia (arrows); b, portion with tetrasporangia in close view. Hainan Island, Luhuitou, November 2010.

Characteristics: Thallus delicate, fine, forming small tufts to about 1 cm high, pinkish to rose-red, consists of prostrate axes giving rise to erect axes, 75-100 µm in diameter. Branching dichotomous, alternate, in one plane, corticated at nodes. Cortical bands about ½ as long as wide and composed of transversely elongated cells at lower part. Axial cells spherical to cylindrical, 50-60(-80) µm in diameter. Apices incurved, often forcipate. Hairs thick, ear-like, clavate, strongly protruding, develop on abaxial side or whorled from distal edges of cortical bands, 40-50 µm long, 20-25 µm in diameter. Rhizoids numerous, unicellular issuing from periaxial cells of prostrate axes, ending in digitate pad. Tetrasporangia spherical, 55-60(-70) µm in diameter, tetrahedrally divided, 1-2 per node, protruding, partly covered by involucre, borne within corticated bands near apices of erect axes. Growing on dead corals among turf algae or epiphytic on larger algae at low intertidal to upper subtidal.

Collection sites in Hainan. Luhuitou.

***Gayliella mazoyerae*** **T.O. Cho, Fredericq & Hommersand ( ♣ )**

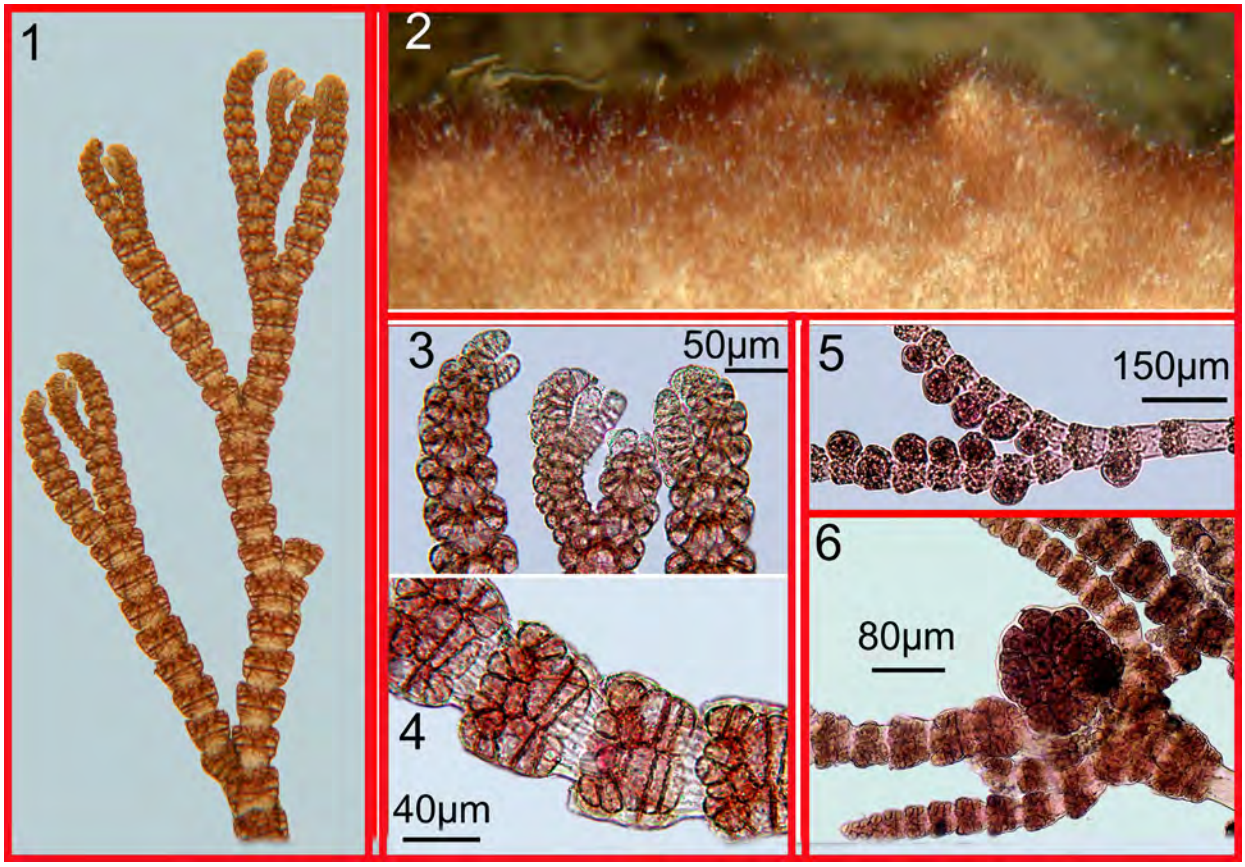


**Fig. 38** ***Gayliella mazoyerae.*** 1. Fragment showing branching pattern. 2. In habitat. 3. Branch tips. 4. Nodal bands. 5. Detail showing tetrasporangia. 6. Cystocarp. Hainan Island, Luhuitou. November 2011.

Characteristics: Thallus fine filamentous, to 2 cm high, pinkish-red, to reddish-brown, forming loose or dense tufts. Branching pseudodichotomous. Cortical nodes 50-120(-250) µm in diameter, (20-)50-60 µm long consisting of basipetal transversely elongate cells and acropetal (1-2 rows) of small roundish to angular cells. Internodes 100-150(-300) µm long at the lower portion and shortening to apices. Branch tips inwardly curved, often forcipate. Tetrasporangia tetrahedrally divided, spherical, 30-45 µm in diameter, unilateral, 1(-2) per node, partially covered by involucre. Cystocarps terminal, spherical, to 150 µm in diameter. Rhizoids unicellular with simple or digitate tips, 1(-3) per node of creeping axis. Growing on rocks, epiphytic on larger algae (*Anadyomene wrightii, Boergesenia forbesii, Caulerpa serrulata* stolons, *Canistrocarpus cervicornis, Colpomenia sinuosa, Dictyota friabilis, Lobophora variegata, Padina australis, P. boryana, Sargassum polycystum, S. sanyaense, Turbinaria ornata, Acanthophora spicifera, Actinotrichia fragilis, Amphiroa beauvoisii, Ceratodictyon intricatum, Dichotomaria marginata, Ganonema farinosum, Jania adhaerens, Pterocladiella caerulescens, Tricleocarpa fragilis*) in the upper intertidal to shallow subtidal zones.

Collection sites in Hainan. Meixia, Xian Hai, Wenchang, Qukou, Shalao, Yalongwan, Dadong Hai, Xiadong Hai, Luhuitou, Ximao Zhou, Tian Ya Hai Jiao, Ying Ge Hai.

**Family Callithamniaceae**

***Crouania attenuata*** **(C. Agardh) J. Agardh ( ♣ )**

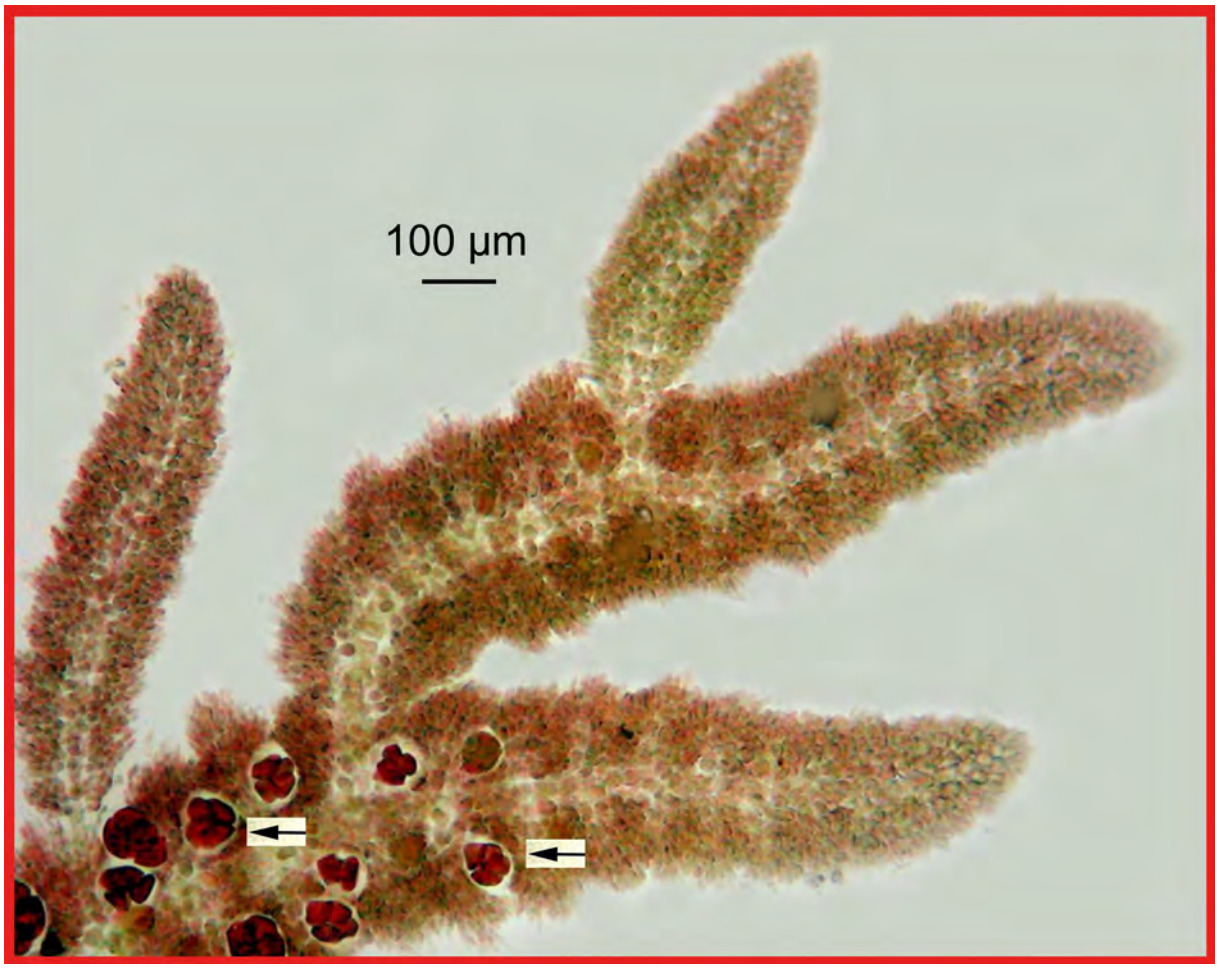


**Fig. 39** ***Crouania attenuata.*** Overall morphology of tetrasporangial plant. Hainan Island, Luhuitou, April 2012.

Characteristics: Thallus minute, consists of creeping axis giving rise to erect branches, 2-4 mm high, soft because of gelatinous cover, lightly calcified, bright red color. Branching irregular. Axial cells cylindrical to 100 µm in diameter, 180 µm long; each cell bears a whorl of 4 branchlets below the upper end of the axial cell. Branchlets 100-130 µm long with cells 25-30 µm in diameter and 2-4 diameters long, tapering to apices to 6-8 µm in diameter. Tetrasporangia (arrows) spherical, 70-75 µm in diameter, to oval, 50-60 × 70-85 µm, tetrahedrally divided, borne singly on the basal cell of lateral branchlets. Growing on dead coral fragments, epiphytic on *Bryopsis auastralis, Turbinaria ornata* phylloids.

Collection sites in Hainan. Nanmai, Shalao, Yalongwan, Dadong Hai, Xiadong Hai, Luhuitou, Ximao Zhou, Tian Ya Hai Jiao.

**Family Delesseriaceae**

***Taenioma perpusillum* (J. Agardh) J. Agardh ( ♣ )**


**Fig. 40** ***Taenioma perpusillum.*** Overall morphology. Hainan Island, Luhuitou, March 2012.

Characteristics: Thallus consists of creeping axes bearing erect branches. Creeping axes cylindrical, 90-100 µm in diameter. Erect branches cylindrical bearing alternate fastigiated branchlets (blades), 0.3-1 mm long (20-30 segments), 85 µm broad. These blades stalked (3-4 segments long), flattened and with a midrib, to 70 µm in diameter and bearing three hairs on the top. Hairs colorless, 10-12.5(-17.5) µm in diameter and 200-275 µm long. Axial cells of four pericentral cells of equal length, 25 µm long and 10 µm in diameter. Lateral cells of the blades each bear two marginal cells. Stichidial branchlets to 110 µm broad. Tetrasporangia tetrahedrally divided and arranged in two rows on both sides of the midrib; each row contains 8-14 tetrasporangia. Cystocarps urceolate. Spermatangia borne on both surfaces of the fertile blades. Attachment by rhizoids originating from the creeping axes. The rhizoids 55-70 µm in diameter, 0.35-1.5 mm long, are terminating in digitate holdfast. Growing on low intertidal rocks, in association with Centroceras clavulatum, epiphytic on *Caulerpa racemosa stolons, Colpomenia sinuosa, Padina australis, Sargassum polycystum, Ganonema farinosum*.

Collection sites in Hainan. Meixia, Xiaodong Hai, Ximao Zhou.

**Family Rhodomelaceae**

***Bryocladia cervicornis*** **(Kützing) F. Schmitz ( ♦♦ )**

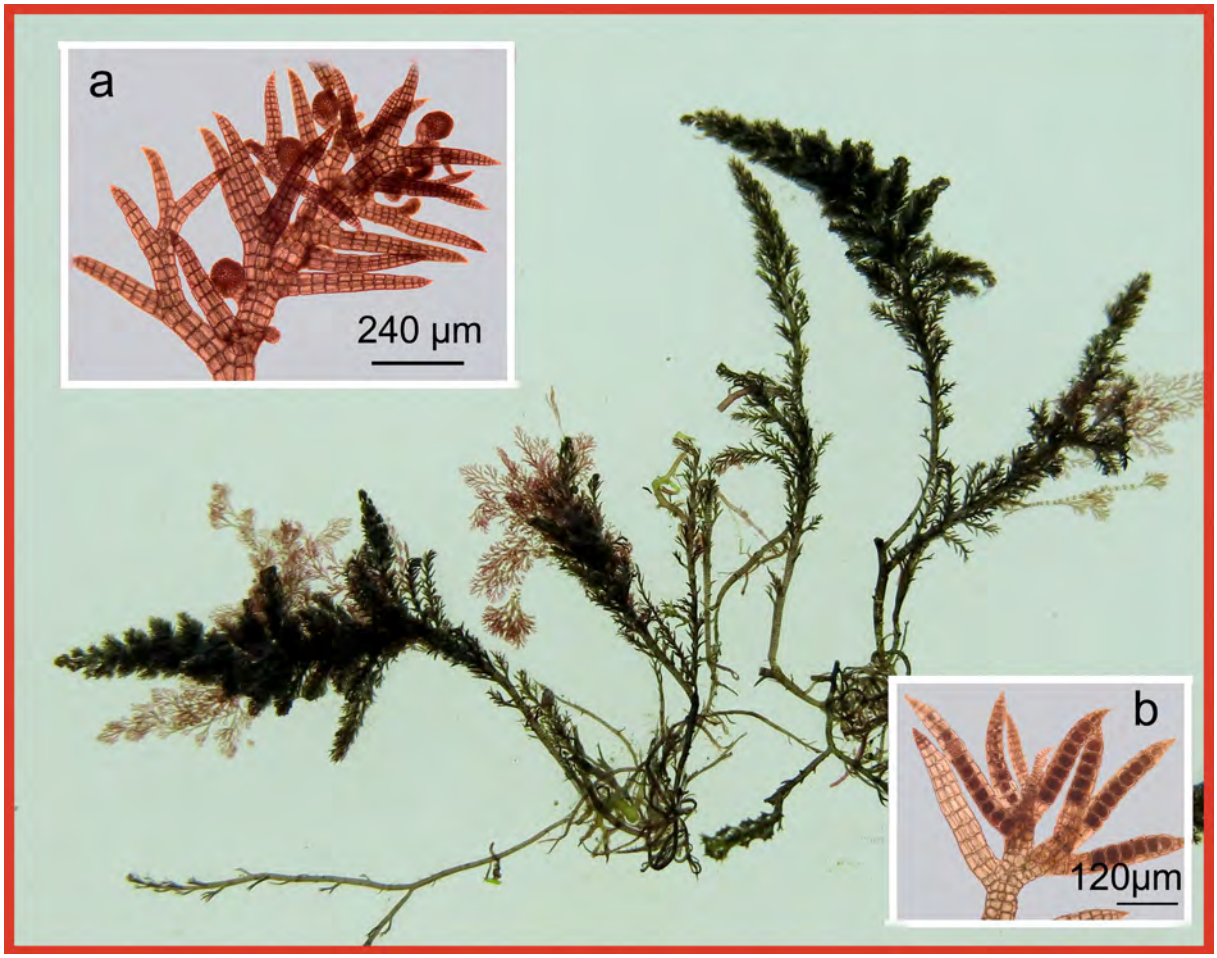


**Fig. 41** ***Bryocladia cervicornis.*** Overall morphology. Insets: a, upper portion of plant with cystocarps; b, detail showing branchlets with tetrasporangia in straight series. Hainan Island, Ying Ge Hai, April 2014.

Characteristics: Thallus consists of creeping, matted base, bearing erect filaments, 350-400 µm in diameter, 2-4(-5 cm high), dark red to blackish color. Branching alternate, from all sides, ecorticate; branches approximately of equal length (1.5 mm), 150 µm in diameter, stiff, straight or slightly recurved; branchlets, 60-100 µm in diameter, 400-600 µm long, with apiculate tips. In transverse section, branch consists of axis, surrounded by 8-12 pericentral cells. Segments 85-100 µm long. Trichoblasts numerous, 300-400 µm long, 2-3 times dichotomously branches. Tetrasporangia spherical, (50-)75-100 µm in diameter, cruciately divided, borne in branchlets, 1 per segment, in straight series of 8-12. Cystocarps urn-shaped, 500 µm long, 370 µm in diameter and with wide ostiole, about 200 µm broad. Growing on rocky substratum in the middle intertidal zone.

(Note: The plants do not adhere to paper.)

Collection sites in Hainan. Xian Hai, Ying Ge Hai.

***Chondria minutula*** **Weber-van Bosse ( ♦♦ )**

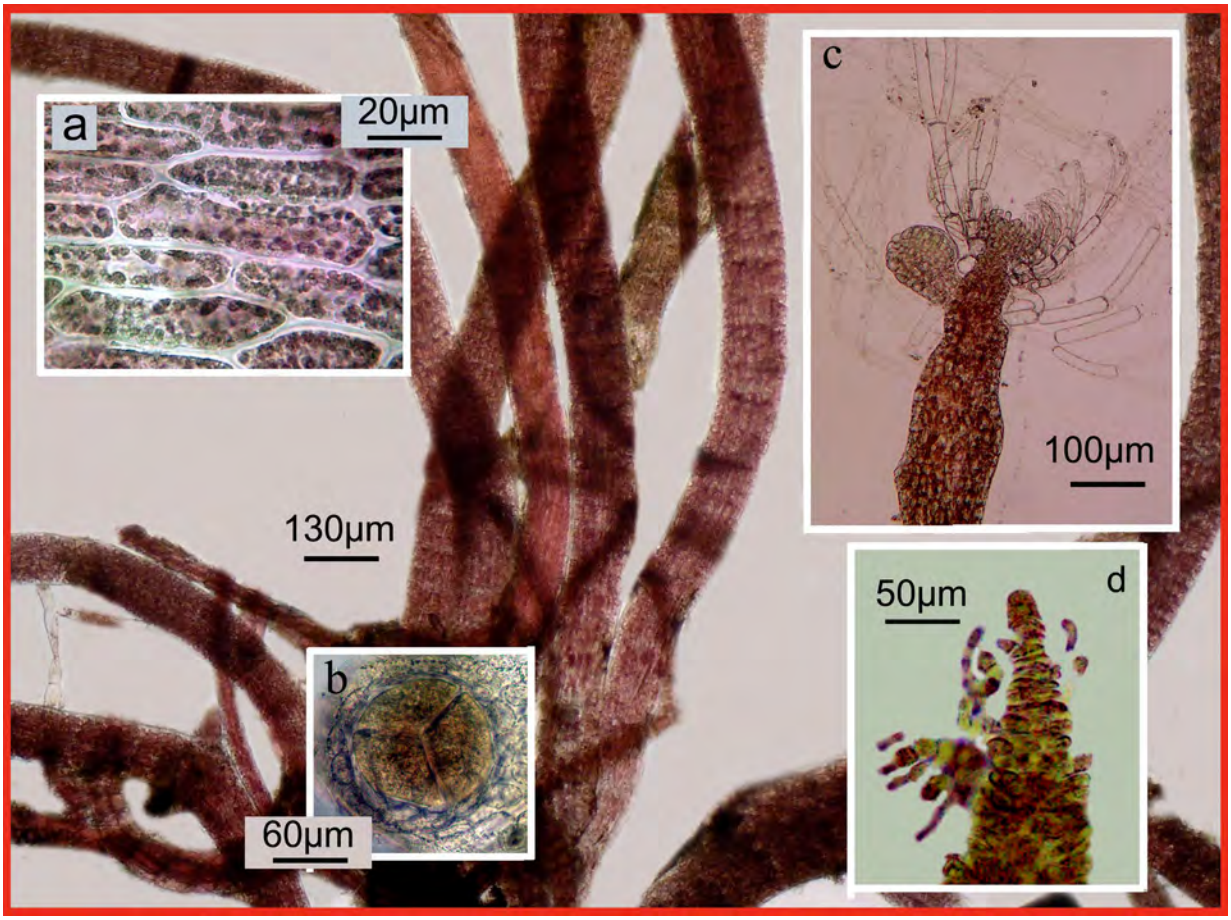


**Fig. 42** ***Chondria minutula.*** Detail showing erect simple filaments arising in a group. Insets: a, cortical cells in surface view; b, tetrasporangium; c, upper portion of erect branch bearing trichoblasts and immature spermatangial disc; d, upper portion showing apical cell. Hainan Island, Yalongwan, March 2012.

Characteristics: Thallus consists of creeping axes bearing erect branches (single or in groups), up to 3.5 mm high, reddish-brown in color. Creeping axes cylindrical, 200 μm in diameter, to 8 mm long. Erect branches cylindrical, subcylindrical at lower part and compressed to flattened above, (90-)110-125(-140) μm broad (7-9 cell rows) slightly taper towards apices. Surface cells subcylindrical to ellipsoidal, arranged in longitudinal rows, 10-15(-20) μm in diameter, 45-60(-80) μm long. Subsurface cells subcylindrical, ellipsoidal, 15 μm in diameter, 50 μm long. Branch apices projecting, 17.5 μm wide, 10 μm long. Spermatangial discs 400-450 μm in diameter. Tetrasporangia spherical, 120-140 μm in diameter, tetrahedrally divided, borne in broadened upper parts of the erect branches. Attachment by compact tufts of rhizoids. Growing on *Lithophyllum pygmaeum* in association with *Sphacelaria novae-hollandiae*.

Collection sites in Hainan. Yalongwan, Luhuitou.

***Chondria pygmaea*** **Garbary & Vandermeulen ( ♦♦ )**

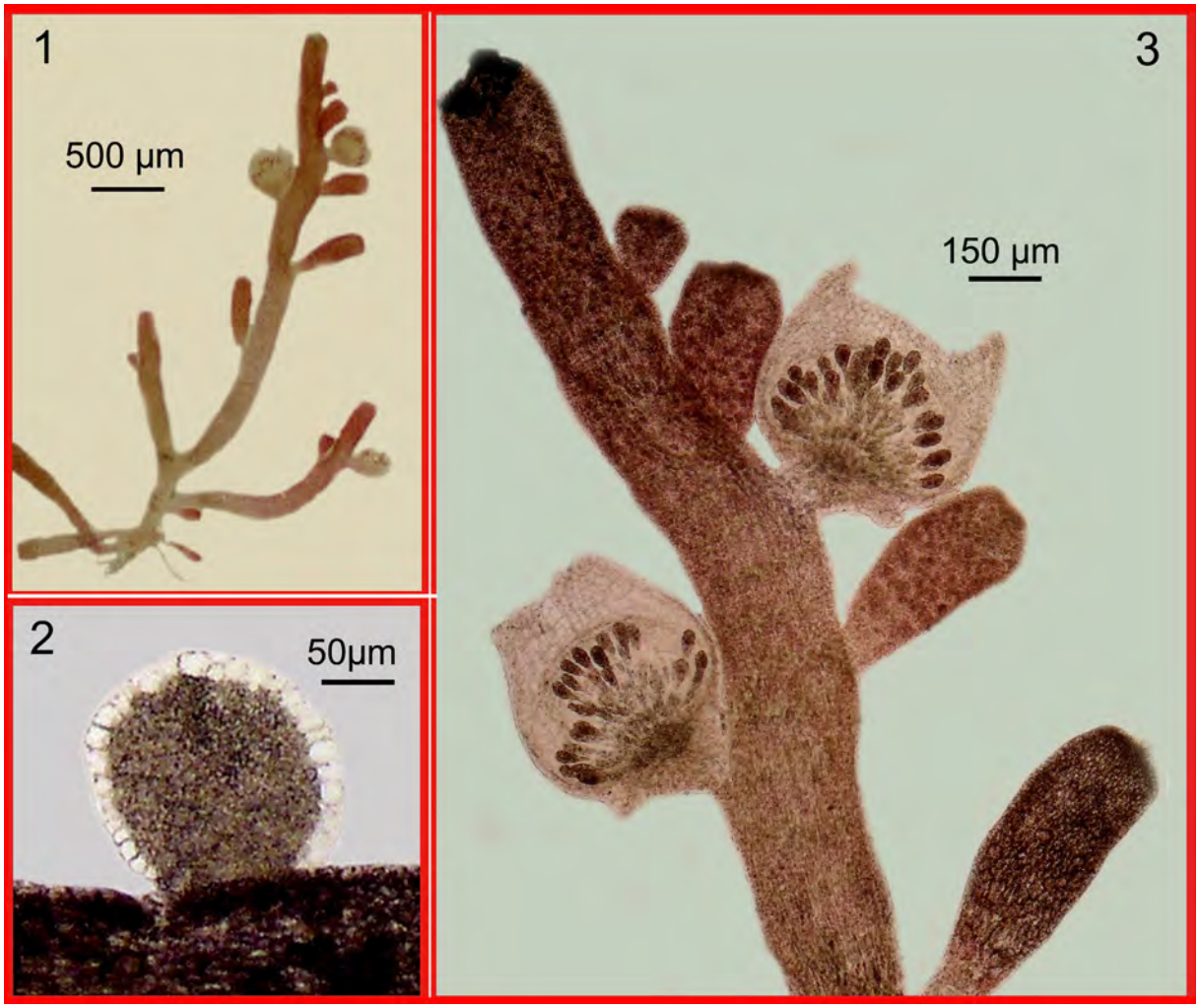


**Fig. 43** ***Chondria pygmaea.*** 1. Overall morphology of cystocarpic plant. 2. Spermatangial plate. 3. Fragment with cystocarps. Hainan Island, Luhuitou, April 2014.

Characteristics: Male plants small, 2.25-5.5 mm high. Branching irregular. Main axis 105 μm in diameter at base and 195 μm below the apex. Cells from surface view mainly in longitudinal (at times in transverse) rows, roundish to polygonal, oval near apices, 12.5 μm in diameter, to 12.5-17×22.5-35 μm. In the middle part, (12.5-)17.5-20×42.5-75 μm and at base oval, elongated cylindrical, 17.5-2×55-65(-100) μm. Spermatangial plates on the top of main axes and branches, 220×250-280 μm, with a single marginal row of sterile cells, to 22.5-30×20-22.5 μm. Cystocarpic thalli 5.5 mm high. Cystocarps 425-490 μm in diameter, 510-680 μm long. Tetrasporophyte 3 mm high, main axis 350 μm in diameter, spores tetrahedrally divided, 90-98 μm in diameter. Attachment by small discoid holdfast, 500-520 μm in diameter. Growing epiphytically on *Padiana australis, Sargassum polycystum*, in the low intertidal zone.

Collection sites in Hainan. Luhuitou.

***Chondria repens* Børgesen ( ♣ )**

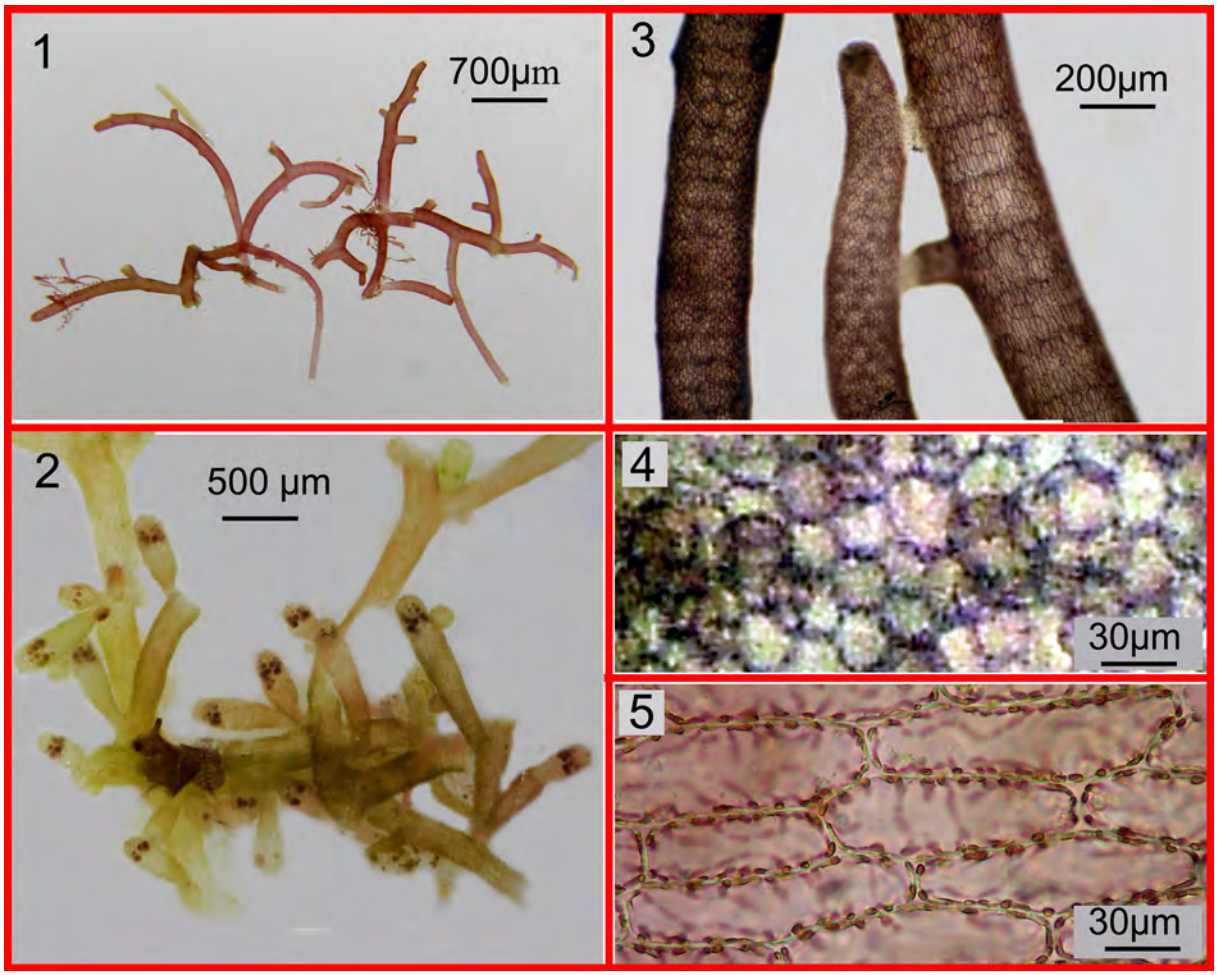


**Fig. 44** ***Chondria repens.*** 1. Overall morphology. 2. Tetrasporangial plant. 3. Fragment with anastomoses.4. Cells in surface view near apices. 5. Cells in surface view in the middle portion. Hainan Island, Luhuitou, February 2012.

Characteristics: Thallus creeping with short erect branches 0.9-4 mm high. Creeping axes to 300 μm in diameter. Branching irregular, sparse. Erect branches cylindrical 160-280 μm in diameter, arched, slightly constricted at base. Branchlets short, spindle-like with blunt tips and terminal cavities. Cells in surface view rounded polygonal to elongated, longitudinally arranged, 20-48x50-90 μm, becoming smaller to apices. In transverse section, thallus consist of central axis, 15-25 μm, surrounded by six pericentral cells, 22x42-52 μm, cortical cells roundish to oval 15x22-25 μm. Rhizoids short, ~100 μm in diameter, tightly bundled of unicellular filaments 15-17 μm in diameter. Tetrasporangia embedded near branch tips, spherical, tetrahedrally divided, to 100 μm in diameter. Growing on dead coral fragments and epiphytically on other algae (*Boodlea composita, Dictyosphaeria cavernosa, D. versluysii, Canistrocarpus cervicornis, Dictyota implexa, Lobophora variegata, Rosenvingea intricata, Actinotrichia fragilis, Gelidiella acerosa, Gelidium pusillum*).

Collection sites in Hainan. Nanmai, Meixia, Yalong Wan, Dadong Hai, Xiadong Hai, Luhuitou, Ximao Zhou.

***Herposiphonia insidiosa*** **(Greville ex J. Agardh) Falkenberg ( ♦ )**

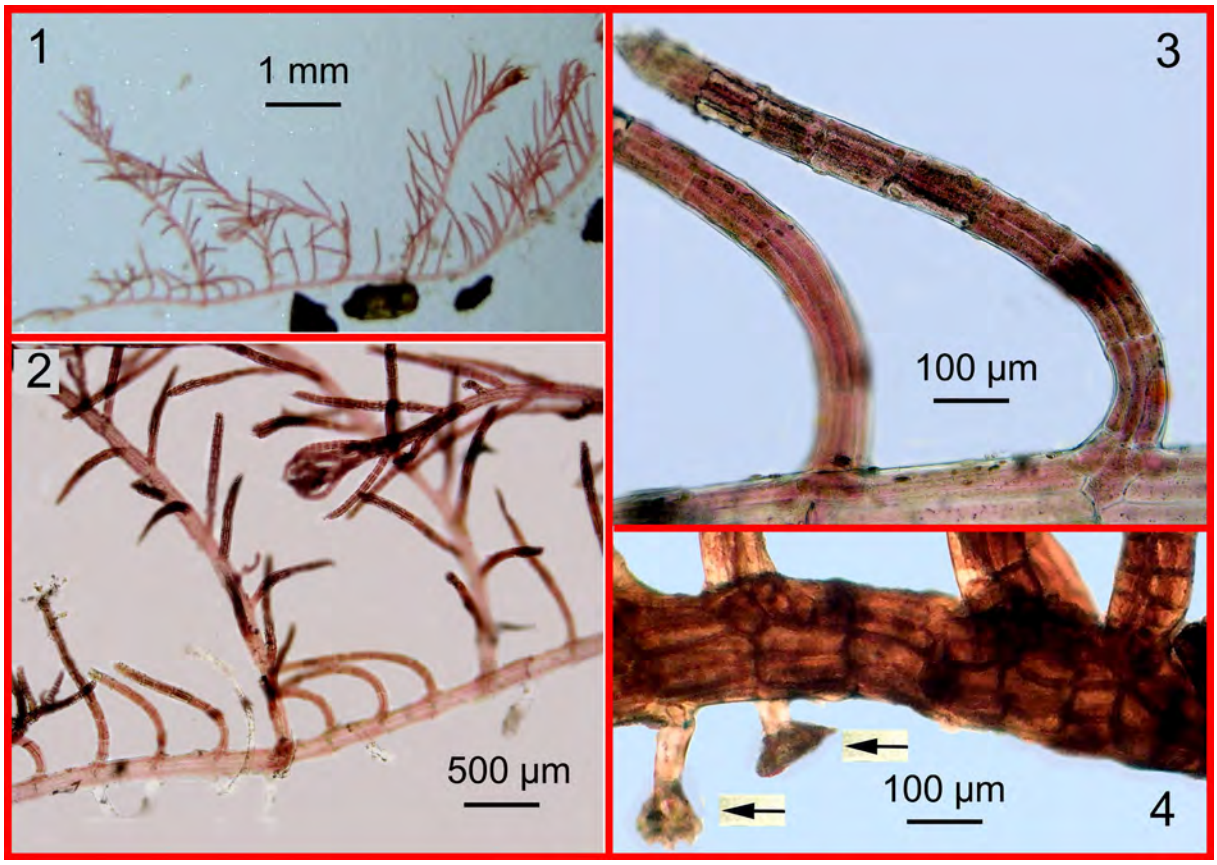


**Fig. 45** ***Herposiphonia insidiosa.*** 1. Overall morphology (dried specimen). 2. Portion of thalls showing branching pattern. 3. Basal part of erect branches. 4. Detail showing rhizoids (arrows). Hainan Island, Ying Ge Hai, April 2014.

Characteristics: Thallus consists of creeping axes bearing erect filaments to 1 cm high almost from each segment of the axes, dark reddish-brown. Creeping axes polysiphonous, 8 pericentral cells, 120-135(-145) µm in diameter with segments (58-)85-135 µm long. Erect filaments curved, simple or branched, 80-100 µm in diameter, with segments (40-)95-125(-175) µm long (8-12 pericentral cells). Branches alternate or second, gradually tapering to apices. Tetrasporangia tetrahedrally divided, spherical, to 60 µm in diameter, one per segment, in straight series of up to 10 sporangia in branches. Attachment by rhizoids originating from cells on ventral side of the creeping axes. Rhizoids 35-64 µm in diameter and 85-300 µm long, simple or ending into digitate holdfast. Found growing epiphytically on *Valonia aegagropila.*

Collection sites in Hainan. Ying Ge Hai.

***Herposiphonia parca*** **Setchell ( ♣ )**

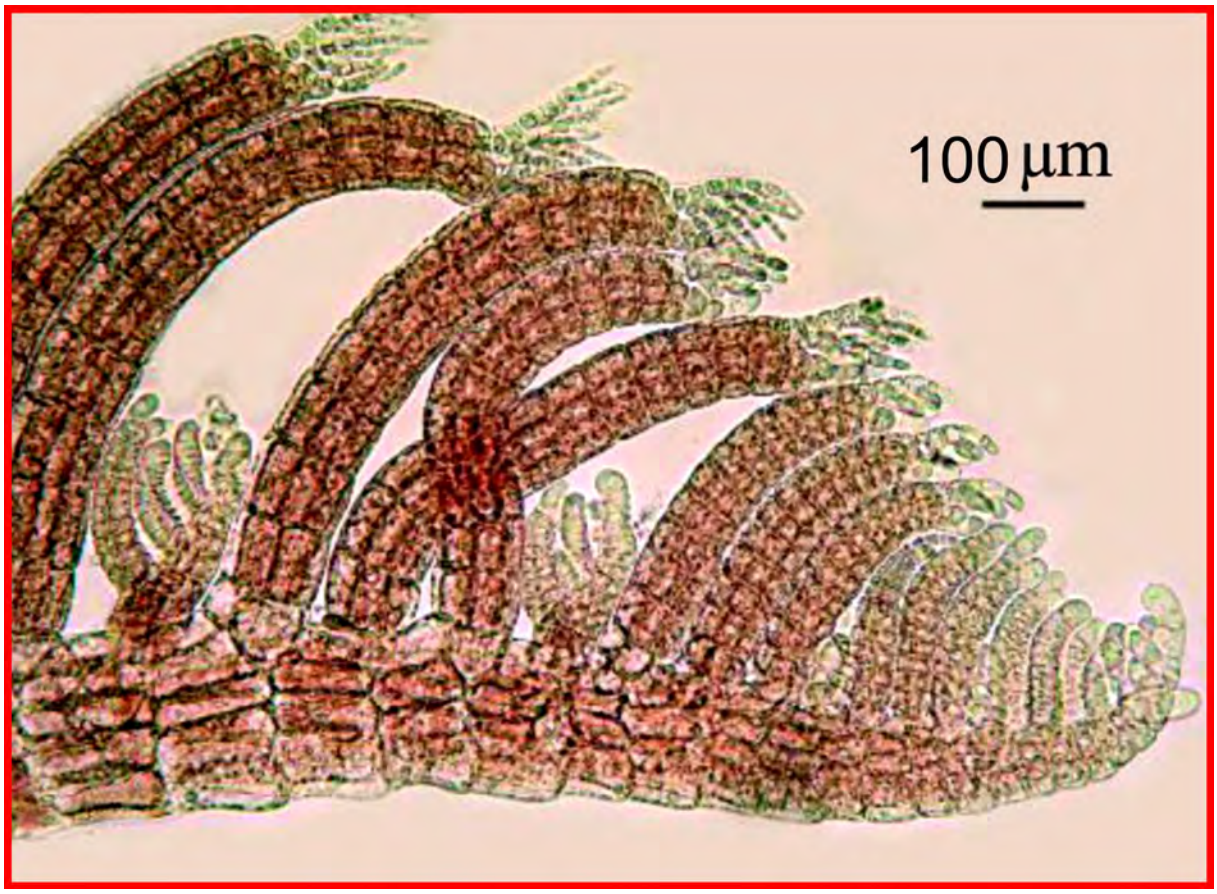


**Fig. 46** ***Herposiphonia parca.*** Portion of creeping axis with determinate and indeterminate branches. Hainan Island, Yalongwan, March 2012.

Characteristics: Thallus consists of creeping axes bearing erect filaments from each segment in regular pattern of three determinate branches alternated with one indeterminate branchlet, dark orange-brown or purplish, small, about 0.6-10 mm high. Creeping axes polysiphonous, 8-9 pericentral cells, 90-150 µm in diameter, with upcurved tips. The determinate branches arching distally, simple, unbranched, 40-90 µm in diameter, 11-12 segments long with blunt truncated tips. Segments consist of 8-11 pericentral cells. Trichoblasts in clusters of 2-3 at branch tips. Tetrasporangia develop in the mid portion of determinate branches in spiral series. Tetrasporangia tetrahedrally divided, spherical, subspherical, 40-80(-120) µm in diameter, borne in the upper half of determinate branches. Attachment by rhizoids on ventral side of creeping axes. Rhizoids simple or ending in digitate holdfast. Growing on intertidal rocks and epiphytically on various algae (*Dictyosphaeria cavernosa, Phyllodictyon anastomosans* stalk, *Valonia fastigiata, Dictyota cervicornis, Hydroclathrus clathratus, Turbinaria ornata, Actinotrichia fragilis, Amphiroa fragilissima*).

Collection sites in Hainan. Yalongwan, Xiaodong Hai, Luhuitou, Ximao Zhou.

***Herposiphonia secunda* f. *tenella*** **Setchell ( ♣♣ )**

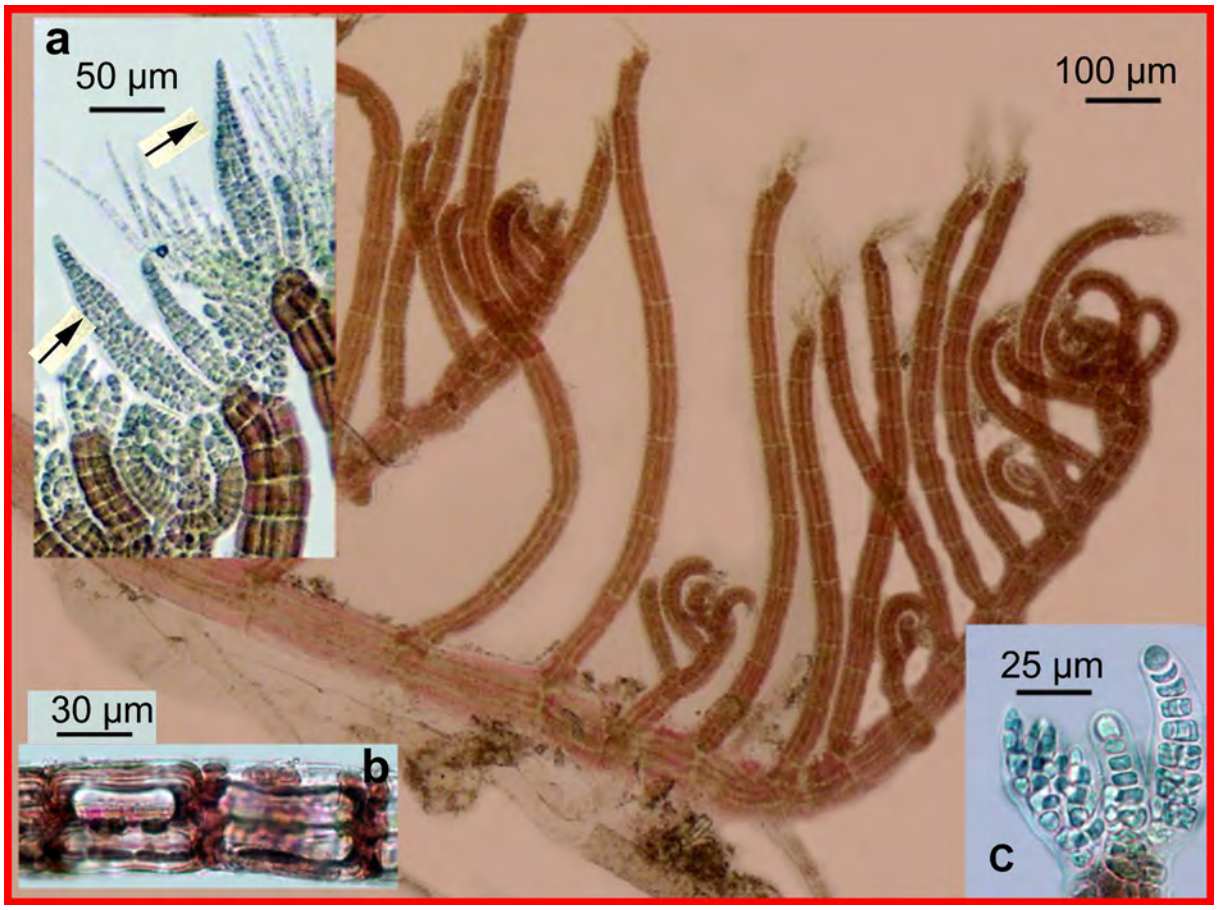


**Fig. 47** ***Herposiphonia secunda* f. *tenella*.** Overall morphology. Insets: a, branch tips with spermatangial branchlets and trichoblasts (arrows); b, segments of erect filament; c, apical portion with trichoblasts. Hainan Island, Luhuitou, November 2012.

Characteristics: Thallus consists of creeping axes bearing erect filaments from each segment in regular pattern of three determinate branches alternated with one indeterminate branchlet, dark reddish-brown. Creeping axes polysiphonous, 8-9 pericentral cells, 100-135 µm in diameter with segments (40-)60-195 µm long. Erect filaments 65-100 µm in diameter, 18-22 segments long (-1.1 mm high) with segments 35-55-70 µm long and terminating into tips with trichoblasts. Tetrasporangia tetrahedrally divides, spherical, subspherical, 60×70-75(-80) µm, one per segment, in straight series in the upper portion of erect branches. Attachment by rhizoids originating almost from every distal end of periaxials cells on ventral side of the creeping axes. Rhizoids (12-)25-60 µm in diameter and 30-100(-200) µm long, simple or ending into branched discoid or digitate holdfast. Growing epiphytic on various algae (*Cladophora vagabunda, Dictyosphaeria cavernosa, Phyllodictyon anastomosans, Canistrocarpus cervicornis, Dictyota friabilis, Lobophora variegata, Padina boryana, Sargassum polycystum, Amphiroa foliacea, Griffithsia metcalfii*).

Collection sites in Hainan. Yalong Wan, Dadong Hai, Xiadong Hai, Luhuitou.

***Lophosiphonia cristata*** **Falkenberg ( ♦♦ )**

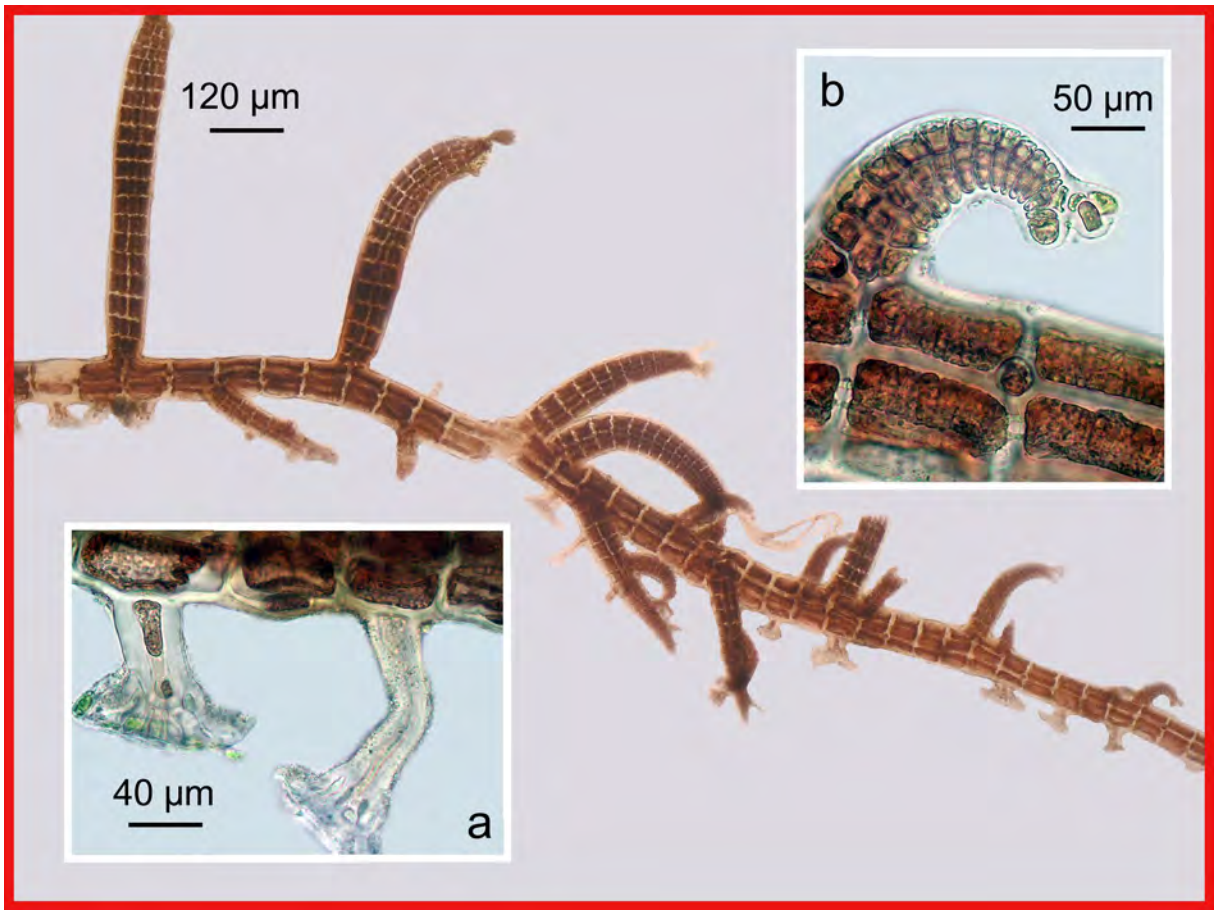


**Fig. 48** ***Lophosiphonia cristata.*** Overall morphology. Insets: a, rhizoids; b, downturned apex. Hainan Island, Luhuitou, November 2010.

Characteristics: Thallus consists of creeping axes bearing erect branches (0.7-2.7 mm high) at more or less regular intervals (at each 6 segment), dark reddish-brown color. Creeping axes to 15 mm long, 65-90 µm in diameter, of 4-6 pericentral cells. Segments (-55)-75-80 µm long becoming shorter towards tips (to 10 µm). The erect branches of 16-18 segments long, slightly narrowed at the basal portion (60-65 µm in diameter) and near apices (45-55 µm in diameter). The segments 80-95 µm in diameter at the broadest part, 35-40 µm long with 8-12 pericentral cells. Trichoblasts at distal parts of the erect branches, deciduous (scar cells present), of two kinds: long to 400 µm, dichotomously divided 4 times and shorter (to 60 µm long, branching 2-3 times). Rhizoids issuing at irregular intervals of 1-4 segments or at each segment, single-celled, cut off parent cells (with pit connections), 30-40 µm in diameter, short (20-30 µm long), ending into digitate (finger-like) attachment pads. Found epiphytic on *Lobophora variegata*, in association with *Jania adhaerens.*

Collection sites in Hainan. Luhuitou.

***Lophosiphonia reptabunda*** **(Suhr) Kylin ( ♣ )**

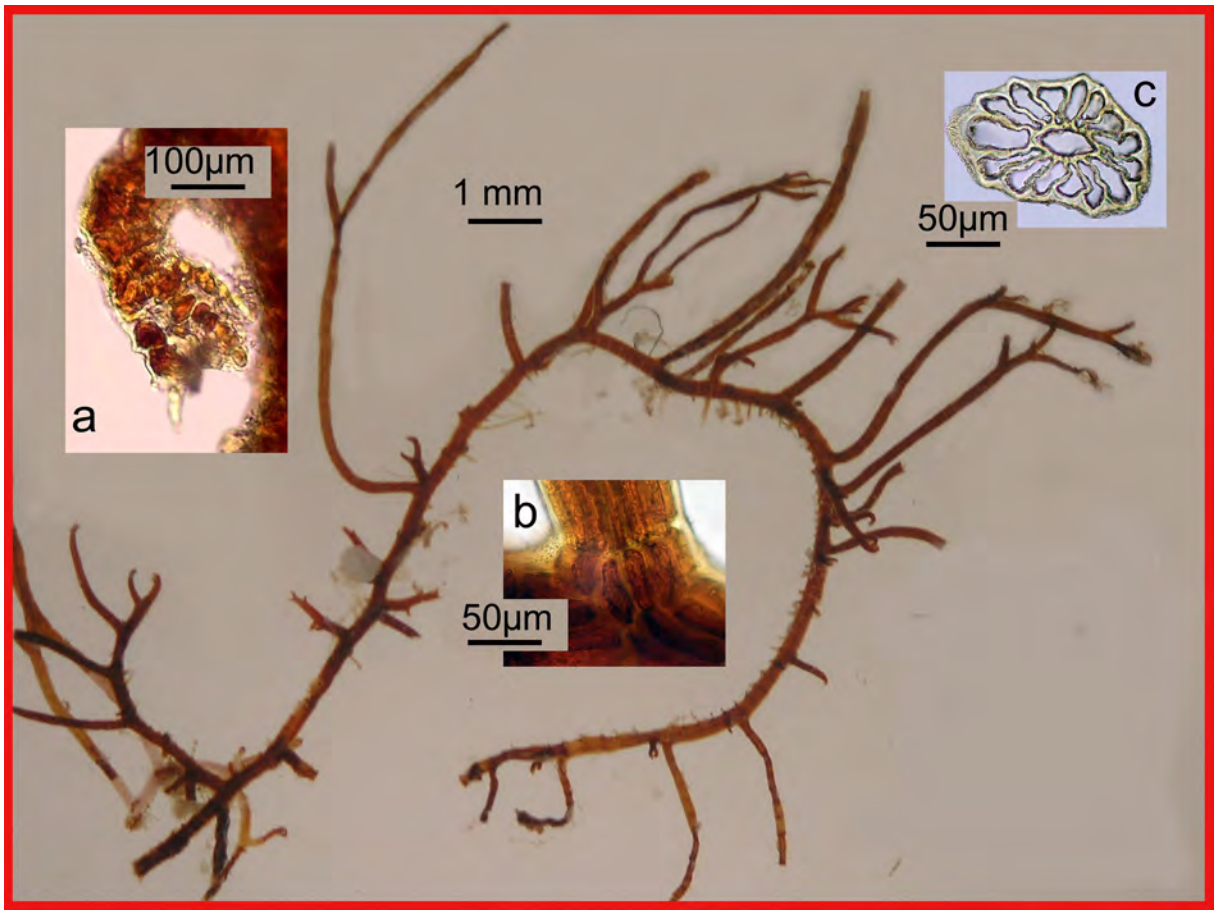


**Fig. 49** ***Lophosiphonia reptabunda.*** Overall morphology (dried specimen). Insets: a, down-curved apex; b, basal cells of erect branch; c, transverse section of erect branch. Hainan Island, Luhuitou, November 2010.

Characteristics: Thallus creeping, giving rise to erect branches, forming densely intertwined mat, dark reddish-brown color. Prostrate axes 125-135(-200) µm in diameter, consisting of central, axial cell and 10-18 periaxial cells. Segments 65-120 µm long. Erect axes to 6.5 mm high, simple or unilaterally branched, 100 µm in diameter at base, 130 µm in diameter above, slightly tapering to apices, consisting of 12-14(-20) periaxial cells. The apices are straight or down-curved. Segments in erect axes 160-185 µm long in the middle portion and becoming shorter (to 80 µm) near apices. Rhizoids develop almost from each segment, pit-connected with mother cell, 200-250 µm long, simple or terminating into branched disc-like hapteron. Trichoblasts dichotomously branched, deciduous, to 600 µm long. Growing on rocks, epiphytically on *Padina australis* (Tian Ya Hai Jiao locality).

Collection sites in Hainan. Luhuitou, Tian Ya Hai Jiao.

***Neosiphonia ferulacea*** **(Suhr ex J. Agardh) S.M. Guimarães & M.T. Fujii ( ♣ )**

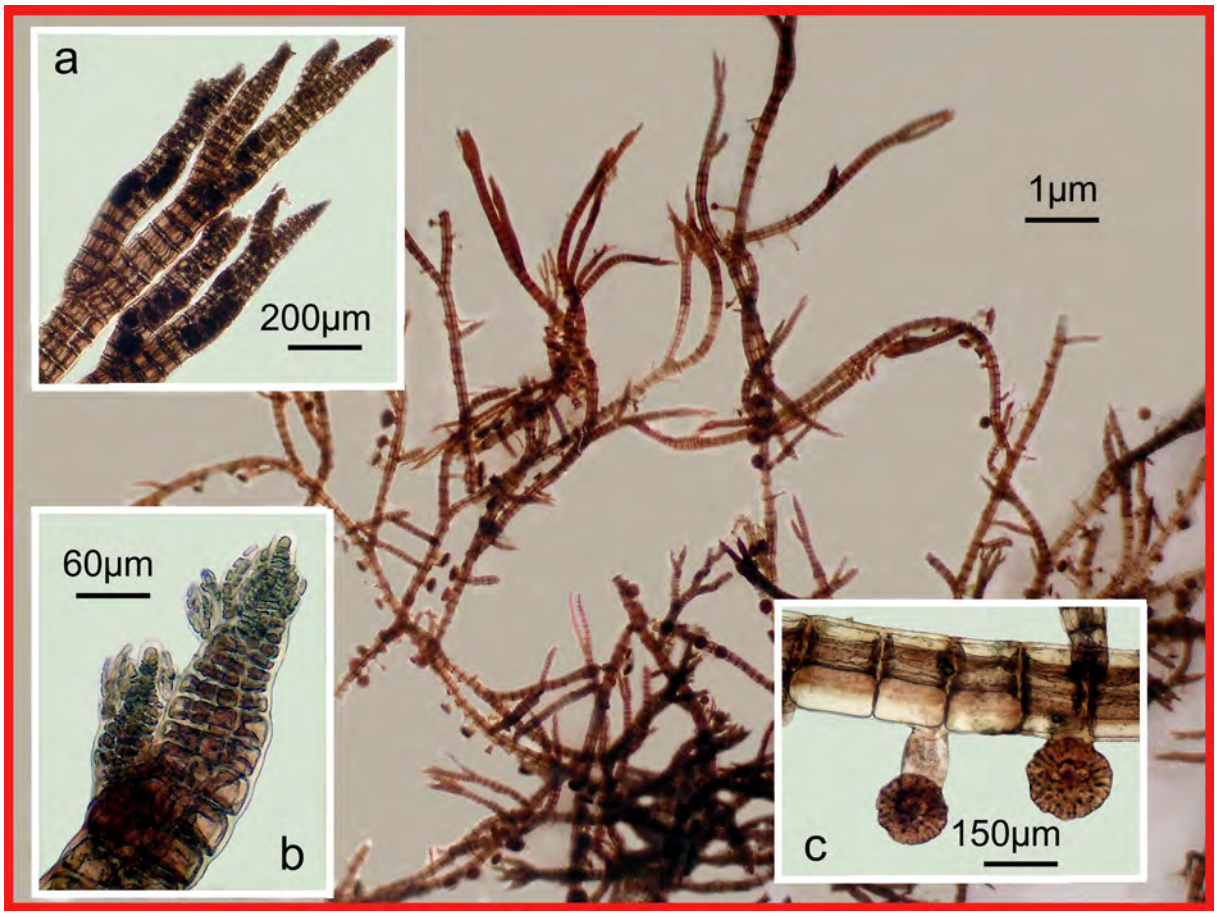


**Fig. 50** ***Neosiphonia ferulacea.*** Overall morphology. Insets: a, upper part of plant with tetrasporangia; b, apical part; c, portion with rhizoids. Hainan Island, Yalong Wan, March 2012.

Characteristics: Thallus filamentous consists of creeping axes bearing erect branches, dark red-brown. Creeping axes to 300 μm in diameter. Branching lateral, alternate. Erect branches of four pericentral cells, 8-10 mm high, to 300 μm in diameter below, gradually tapering to acute tips. Apical cell prominent, 10-10 μm. Trichoblasts to 300 μm long, pale brown in color, branching 1-2(-4) times, with segments at base 25 μm in diameter, 60 μm long, gradually tapering to apices (to 5-8 μm in diameter). Scar cells present in every segment. Rhizoids borne single or in pairs from proximal ends of segments, cut off pericentral cells, unicellular, 55 μm in diameter, terminating into lobed or digitate holdfast. Tetrasporangia 75-85 μm in diameter, in spiral series. Cystocarps 275-280 μm. Growing epiphytically on *Anadyomene wrightii, Caulerpa serrulata, Canistrocarpus cervicornis, Chnoospora implexa, Colpomenia sinuosa, Hydroclathrus clathratus, Padina* spp., *Sargassum* spp., *Turbinaria ornata, Betaphycus gelatinum*.

Collection sites in Hainan. Shalao, Yalong Wan, Dadong Hai, Xiaodong Hai, Luhuitou.

***Palisada concreta*** **(A.B. Cribb) K.W. Nam ( ♦ )**

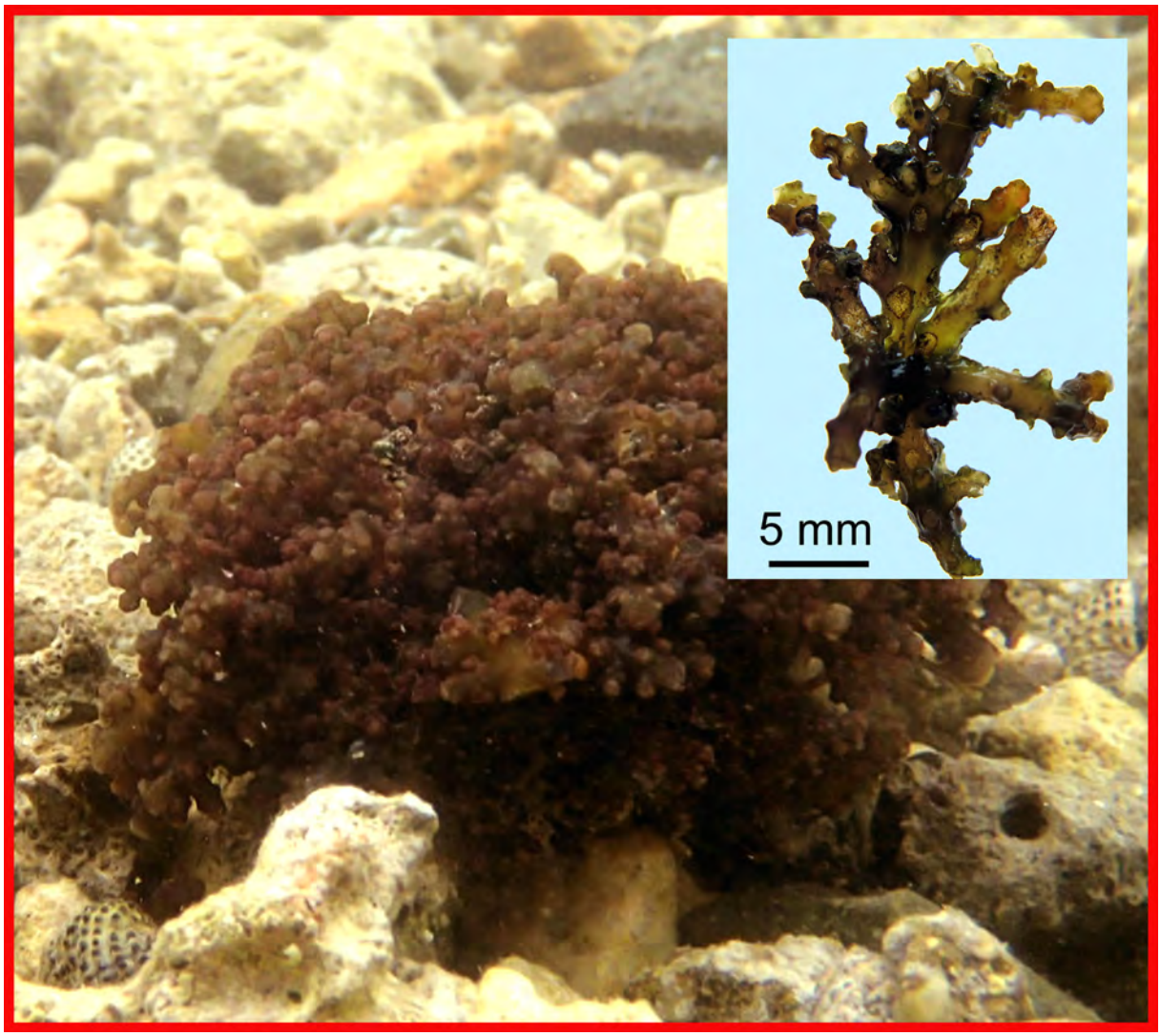


**Fig. 51** ***Palisada concreta.*** Overall morphology. Hainan Island, Xiaodong Hai, April 2016. Inset: Isolated branch.

Characteristics: Thallus rigid, cartilaginous, greenish-brown to dark purple or almost black, forming prostrate, strongly adherent to the substratum at several points compact cushions (rather brittle), to 25 cm in diam., 1-3 cm thick, consisting of densely coalesced branches. Branches thick, cylindrical, 2-3 mm in diam. Branching irregular, alternate, opposite or subverticillate. Branchlets short, wart-like, with blunt tips, develop from all sides. Growing on rocks, dead corals in the low intertidal and upper subtidal zones, at coastal localities exposed to moderate and strong wave action..

Collection sites in Hainan. Xiaodong Hai.

***Palisada papillosa*** **(C. Agardh) K.W. Nam ( ♦ )**

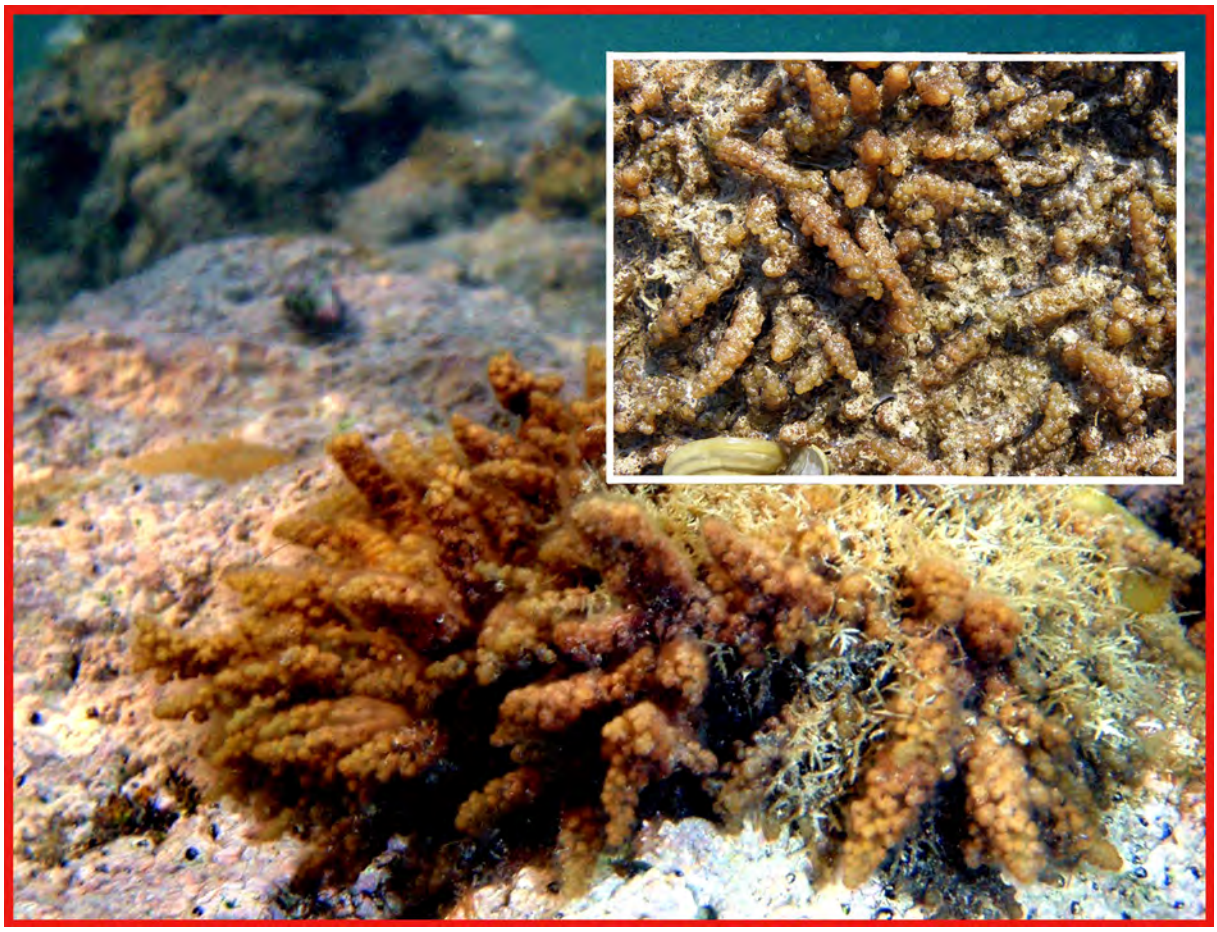

**Fig. 52** ***Palisada papillosa.*** In the middle intertidal zone, Hainan Island, Luhuitou, March 2012. Inset: Plants at low tide.

Characteristics: Thallus solitary or grouped, cartilaginous, tough, 3.5-6(-10) cm high, consisting of prostrate and erect branches, light brown, olive-brown to dark reddish-brown. Branching irregular, or alternate. Branches terete, 1-2 mm in diameter, naked at basal portion and densely covered by ultimate papilliform branchlets from all sides in the middle and upper portions, often in longitudinal rows. The branchlets short, wart-like, knobby, or club-shaped, perpendicular to branches, 0.5-0.7 mm in diameter, 0.5-2.5 mm long, terminating in apical pits. Tetrasporangia spherical, to 100 μm in diameter, tetrahedrally divided, near the top of branchlets. Holdfast discoid or pad-like. Growing on hard substrates, exposed to moderate wave action, intertidal, often covered by sand, exposed to air during low tide.

Collection sites in Hainan. Xiaodong Hai, Luhuitou.

***Polysiphonia exilis*** **Harvey ( ♦♦ )**

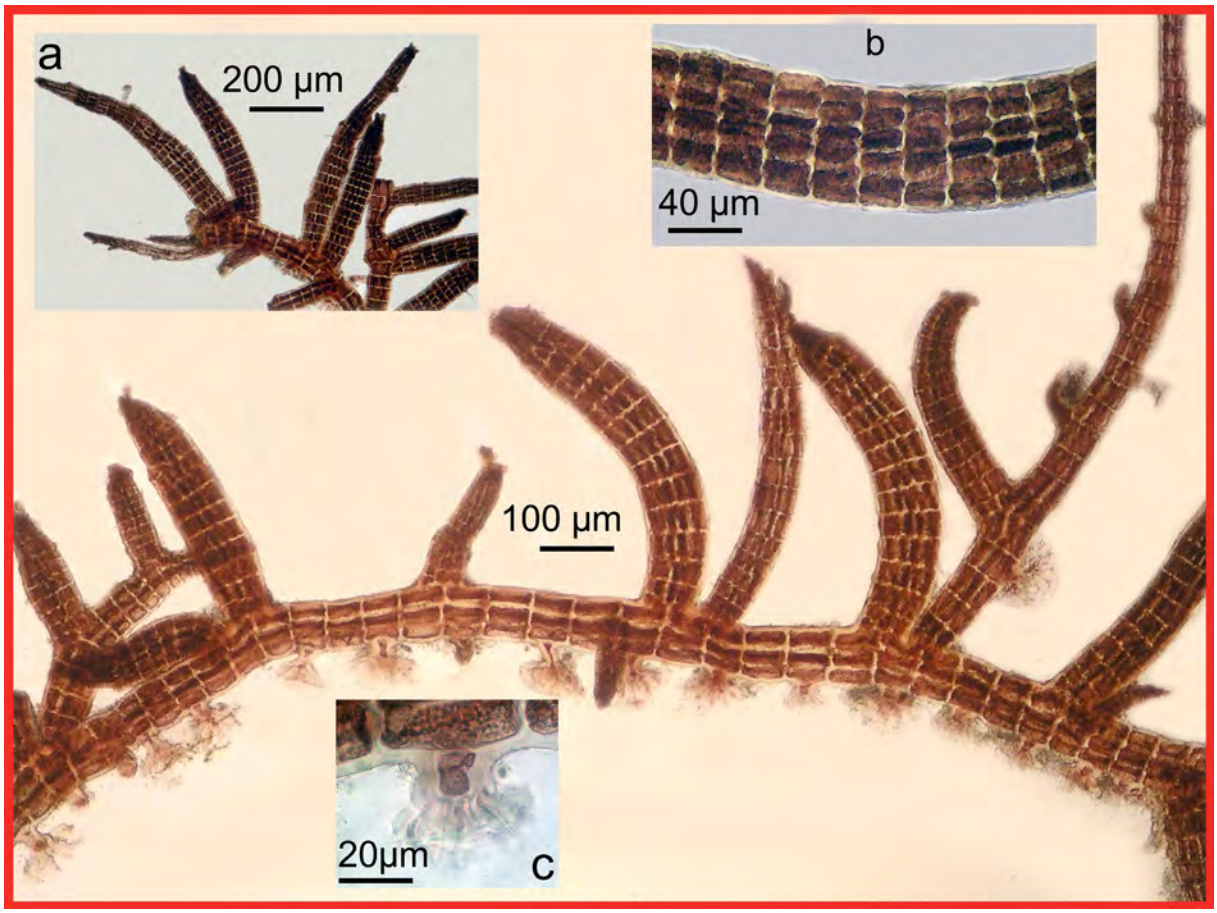


**Fig. 53** ***Polysiphonia exilis.*** Overall morphology. Insets: a, fragment; b, detail showing segments of erect branch in surface view; c, rhizoid. Hainan Island, Luhuitou, February 2012.

Characteristics: Thallus filamentous, densely entangled, consists of well-developed creeping axes (2-3 mm long) bearing erect simple branches (0.8 cm high) at irregular intervals (1-)5-6 segments along the prostrate axes, purplish to dark reddish brown. Prostrate axes to 95 µm in diameter with segments (6 pericentral cells) 50-60 µm long, in longitudinal rows. Attachment by unicellular rhizoids issuing from the middle of pericentral cells (cut off the parent cell), ending into lobed (with protoplasts) digitate holdfast. Erect branches simple, borne cicatrigenously, consist of 9-12 pericentral cells. The branches slightly taper (or commonly not taper) to their base, 100 µm in diameter near the base, 80 µm in diameter near apices, with segments 15-25 µm long at the basal portion, 35-50 µm long in the middle and 12-20 µm long towards the apices. Apical cells well visible in young branches, 10×12.5 µm. Scar cells present, in ¼ spiral divergence (counterclockwise) at each segment. The alga was found epiphytic on *Lobophora variegata*.

Collection sites in Hainan. Luhuitou.

***Polysiphonia japonica* var. *savatieri* (Hariot) Yoon ( ♦♦ )**

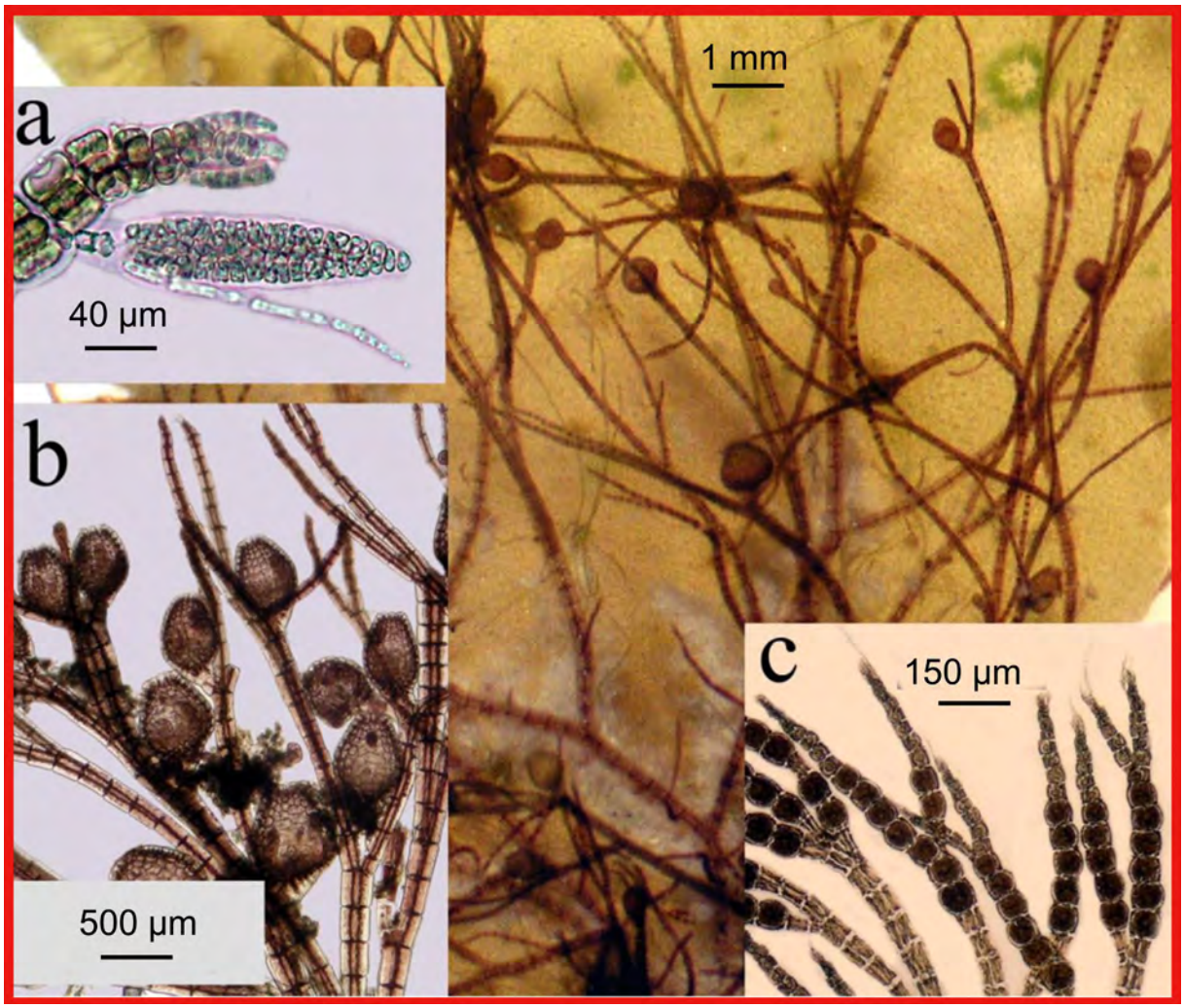


**Fig. 54** ***Polysiphonia japonica* var. *savatieri*.** Plant epiphytic on *Sargassum polycystum* phylloid. Insets: a, spermatangial branch; b, cystocarps; c, tetrasporangia in straight series. Hainan Island, Luhuitou, April 2009

Characteristics: Thallus erect, filamentous, fine, ecorticate, of four pericentral cells, 0.47-1 cm high, light brown, reddish-brown color. Branching dichotomous. Main axes 275-320 µm in diameter at the base, 210-220 µm in the middle and -60 µm in the upper part; segments 125-175 µm long at lower part and 210 µm above. Tetrasporangia spherical, (55-)67-70 µm in diameter, tetrahedrally divided, in straight series. Cystocarps globose, 200-290×220-350 µm with a wide ostiole (to 100 µm). Scar cells common. Trichoblasts borne at each segment. Rhizoids cut off from pericentral cells, unicellular, to 600 µm long, ending into lobed (branched) discs and form dense aggregations at the base of main axes. Growing epiphytic on *Colpomenia sinuosa, Dictyota friabilis*, on phylloids of *Sargassum sanyaense, S. polycystum* and *Turbinaria ornata*.

Collection sites in Hainan. Luhuitou, Ying Ge Hai.

***Polysiphonia pseudovillum*** **Hollenberg ( ♦♦ )**

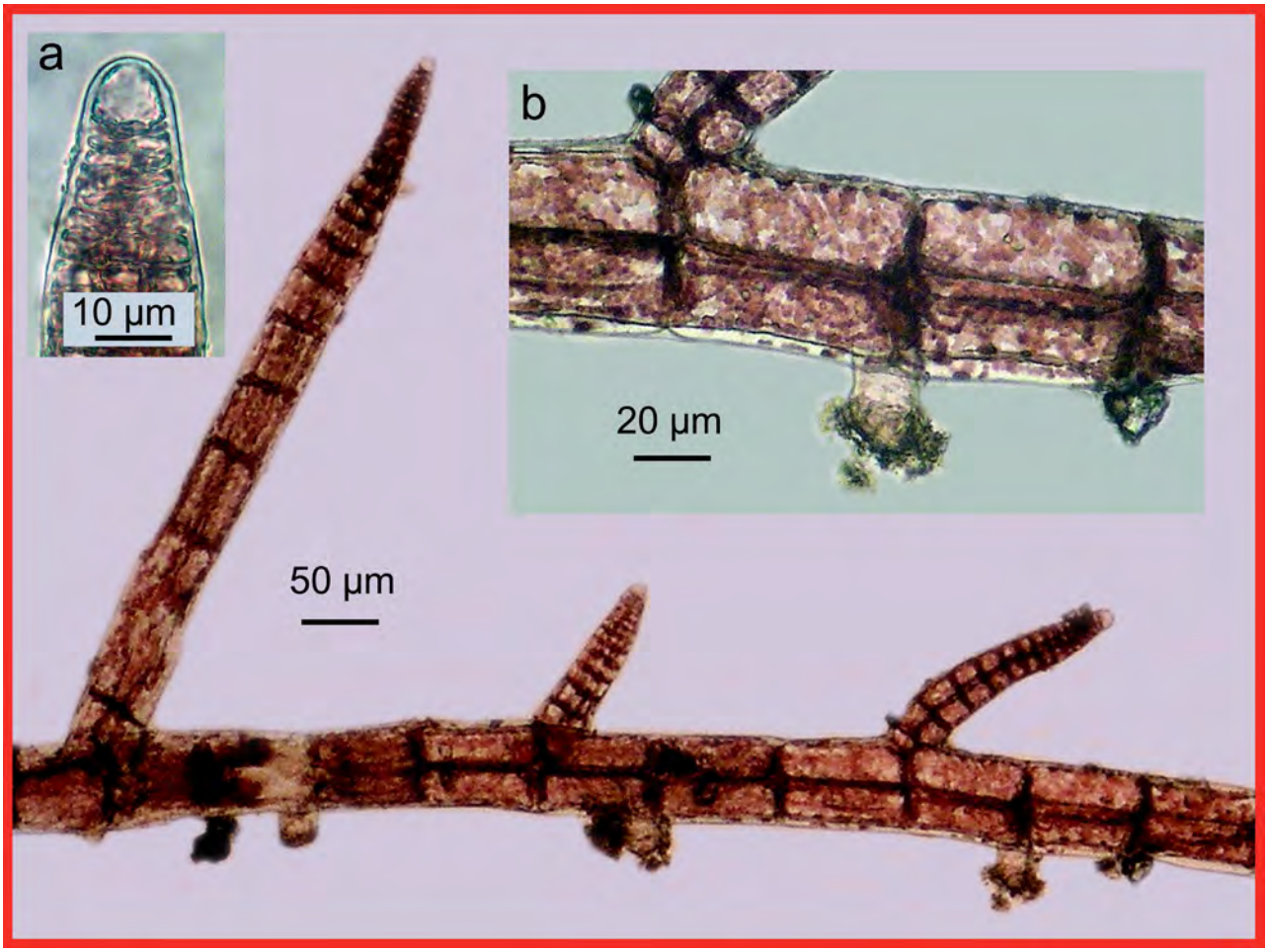


**Fig. 55** ***Polysiphonia pseudovillum.*** Insets: a, apical portion of erect branch; b, detail showing rhizoids proximal on pericentral cells. Hainan Island, Luhuitou, February 2012.

Characteristics: Thallus filamentous, consists of prostrate and erect branches arising at intervals of 3-4 segments. Prostrate axes to 2 mm long, (45-)75-80 µm in diameter, with segments (35-)115-135 µm long (1.0-1.5 diameters long). Erect branches arising cicatrigenously at frequent intervals of 4-5 segments, simple or sparsely branched, to 2 mm high, 30-60 µm in diameter, of four pericentral cells, ecorticate. Segments 1.2-1.5 diameters long at lower half becoming shorter towards apices. Apical cell prominent, 12.5-15×15-17 µm. Scar cells present, in ¼ spiral manner.Trichoblasts repeatedly branched, gradually decreasing in diameter and length towards apices. Cystocarps ovoid to slightly urceolate, Up to c.150 µm across. Spermatangial branchlets cylindrical. Tetrasporangia spherical, 45-50 µm in diameter, tetrahedrally divided, in swollen spiral series of the upper portions of erect branches. Rhizoids are cut off from the proximal end of pericentral cells by a cross-wall, unicellular, 17-32 µm in diameter, 50-80 µm long and terminating into simple or digitate holdfast. Growing epiphytically on lower side of *Lobophora variegata* thallus.

Collection sites in Hainan. Luhuitou.

***Polysiphonia scopulorum* var. *villum* (J. Agardh) Hollenberg ( ♣♣ )**

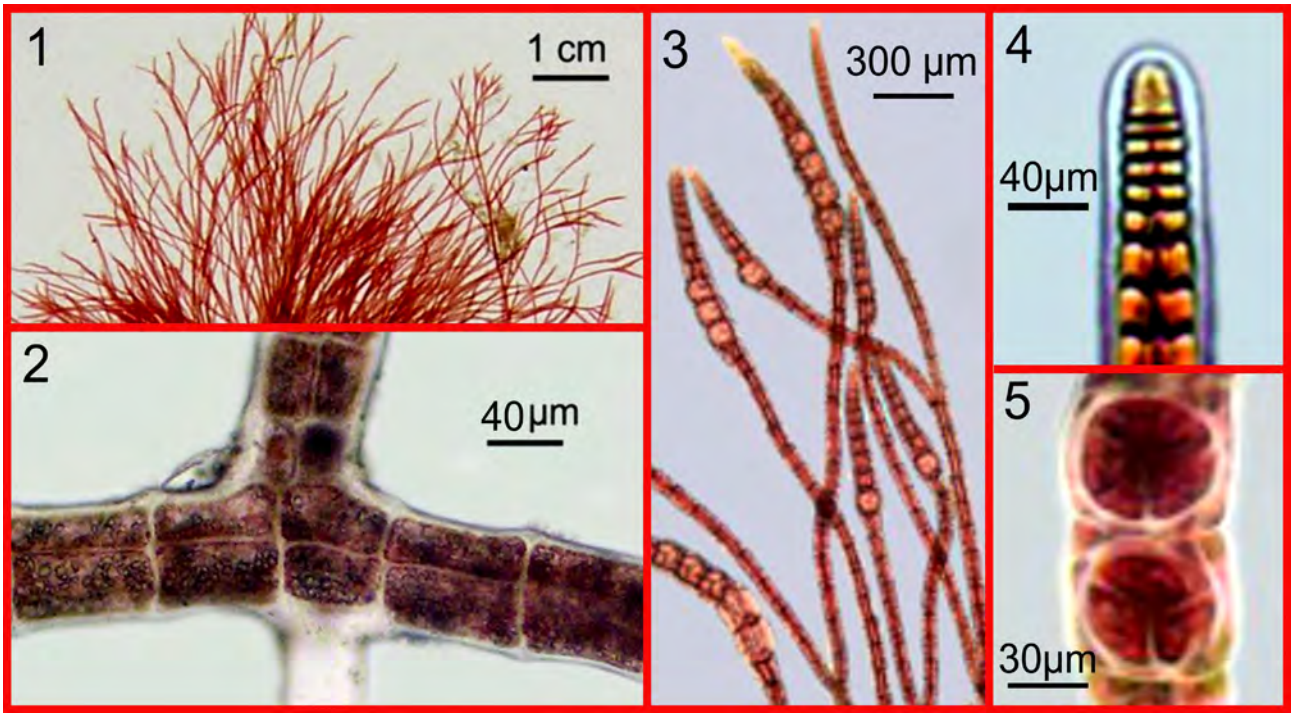


**Fig. 56** ***Polysiphonia scopulorum* var. *villum*.** 1. Overall morphology. 2. Detail showing creeping axis with central rhizoid on lower side of pericentral cell. 3. Erect branches with tetrasporangia. 4. Apical portion of erect branch. 5. Tetrasporangia. Hainan Island, Yalong Wan, March 2012.

Characteristics: Thallus filamentous, in tufts, consisting of prostrate and erect branches arising at intervals of 4-6 segments, pale red to dark red color. Prostrate axes 3-5 mm long, 60-100 µm in diameter, segments 70-75 µm long. Erect branches arise endogenously, simple or sparsely branched, 0.5-3.5(-8) mm high, (40-)65-80 µm in diameter, of four pericentral cells. Segments 55-62 µm long at lower half becoming shorter towards apices to 30 µm long. Apical cell prominent. Segments in the middle portion are commonly longer than broad. Trichoblasts to 0.75 mm long, dichotomously, subdichotomusly branched (5-7 times), gradually decreasing in diameter and length towards apices with every dichotomy. Tetrasporangia spherical, 45-50 µm in diameter, tetrahedrally divided, in straight series of the upper portions of erect branches. Rhizoids 25-65 µm in diameter, 35-600 µm long, in open cytoplasmic connection to pericentral cells, unicellular, terminating into digitate holdfast. Growing on dead coral fragments in association with *Sphacelaria novae-hollandiae*, epiphytic on *Dictyota implexa, Lobophora variegata, Padina minor, Sphacelaria rigidula, Champia parvula, Gracilaria salicornia*.

Collection sites in Hainan. Shalao, Yalong Wan, Dadong Hai, Xiaodong Hai, Luhuitou, Ximao Zhou.

***Polysiphonia subtilissima*** **Montagne ( ♣ )**

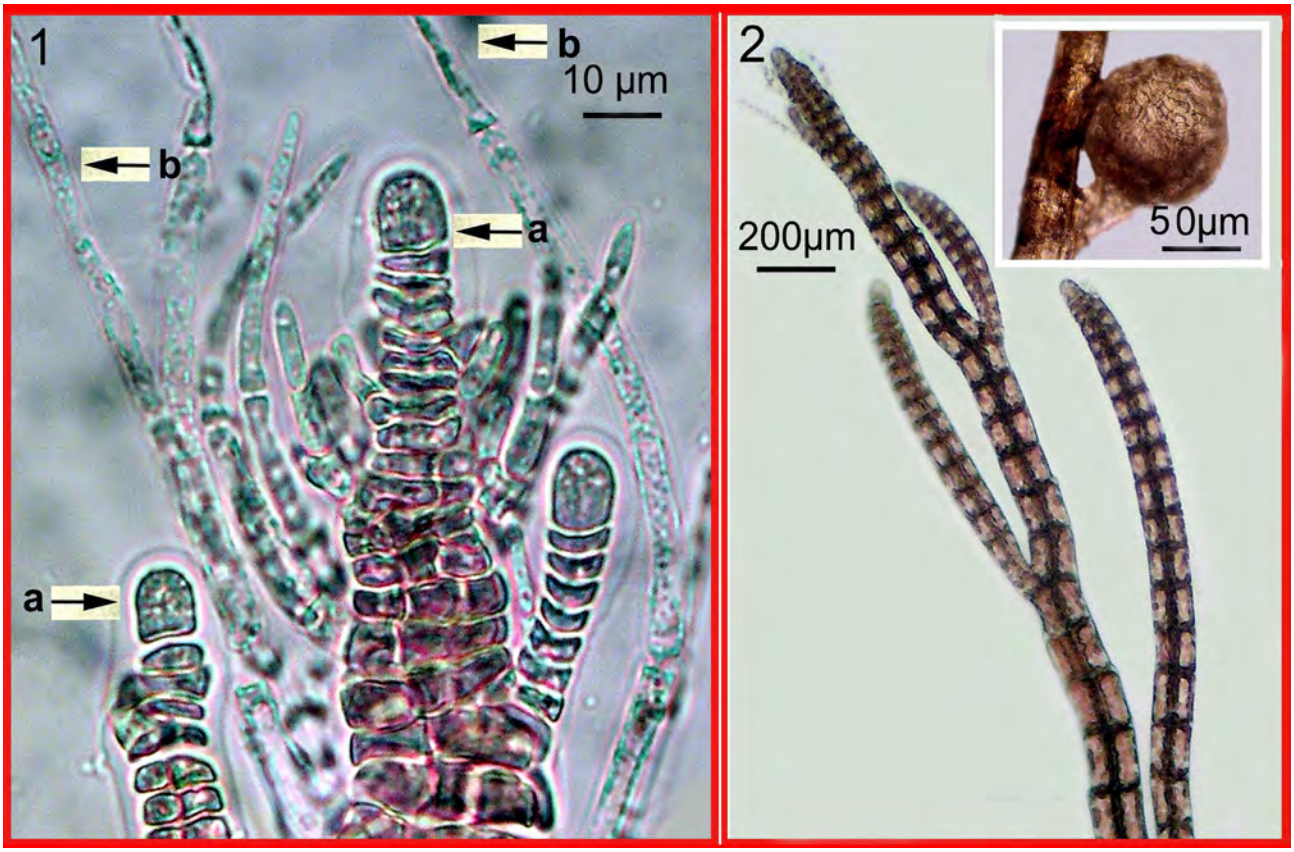


**Fig. 57** ***Polysiphonia subtilissima.*** 1. Upper part of thallus showing apical cells and trichoblasts. 2. Branch bearing branchlets from each sixth segment. Hainan Island, Luhuitou, November 2010.

Characteristics: Thallus filamentous, consisting of prostrate and erect axes, purplish-brown color. Main axes (70-)87-130 μm in diameter, of four pericentral cells, ecorticate. Segments in main axes 110-140(-275) μm long, gradually decreasing in length and diameters in branches from the first to third orders. Apical cell obvious, 10-12.5×10-12.5 μm. Trichoblasts poorly developed, tapering to delicate apices, to 400 μm long, 1-2 times dichotomously branched, deciduous. Scar cells present, inconspicuous. Branching alternate (from each sixth segment) with angles 15-30° (lateral branchlets replacing apical filament). Rhizoids numerous, unicellular, ending into lobed holdfast, 10-17.5 μm in diameter, in open connection with parent cells (without cell wall), proximal on pericentral cells. Tetrasporangia near to spherical, 50-70×50-75 μm, tetrahedrally divided, in straight series. Cystocarps globose, 80×100 μm. Growing on dead coral fragments epiphytically on *Acanthophora spicifera, Champia parvula, Chondria armata, Ganonema farinosum, Hypnea pannosa, Liagora ceranoides, Pterocladiella caerulescens, Spyridia filamentosa, Dictyota friabilis, Rosenvingea intricata, Turbinaria ornata, Boergesenia forbesii, Caulerpa serrulata, Codium repens, Dictyosphaeria cavernosa, Ulva compressa*.

Collection sites in Hainan. Linchang, Shalao, Yalong Wan, Dadong Hai, Xiaodong Hai, Luhuitou, Ximao Zhou, Tian Ya Hai Jiao.

**Family WRANGELIACEAE**

***Wrangelia argus*** **(Montagne) Montagne ( ♣ )**

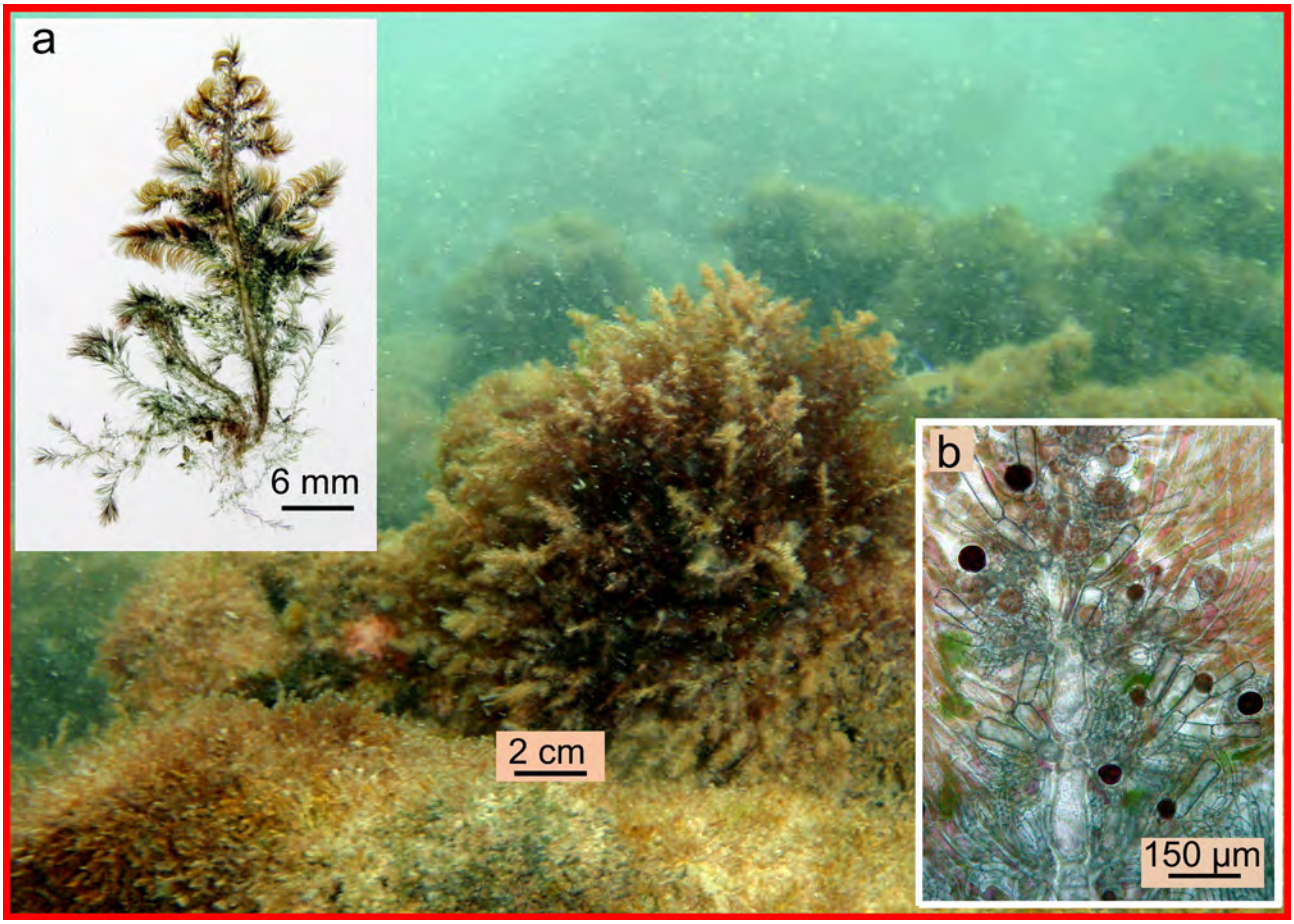


**Fig. 58** ***Wrangelia argus.*** Attached to rocky substrate, low intertidal. Hainan Island, Luhuitou, April 2012. Insets: a, overall morphology; b, squashed fragment showing axial cells and tetrasporangia.

Characteristics: Thallus forming soft loose tufts 1-2(-3) cm high, greenish-gray, dull green with pinkish tips, violet or purple-red, reddish-brown to bluish-green in color. Main axes ecorticate, bear whorls of lateral branchlets (4-5 times subdichotomously branched). Axial cells cylindrical 75-150 µm in diameter, 175-225 µm long. Basal cell of the branchlets spherical to oval 45-50 µm in diameter, 55-70 µm long. Cells of whorls 30 µm in diameter, 60-175 µm long. Apical cells conical (20-42 µm long) with acute apices. Cells in the branchlets gradually tapering to apices to 10-12.5 µm in diameter. Tetrasporangia spherical, tetrahedrally divided, (55-)75-90(-100) µm in diameter, borne on outer branchlets, surrounded by short, slender, incurved involucres. Attachment by numerous branched haptera issuing from basal cells of prostrate axes. Growing on middle intertidal rocks, dead coral debris, shells, often epiphytically on larger algae (*Acetabularia calyculus, Padina australis, Acanthophora muscoides, Jania capillacea, Lithophyllum pygmaeum*).

Collection sites in Hainan. Gukou, Yalong Wan, Luhuitou.

**Order GELIDIALES**

**Family GELIDIACEAE**

***Gelidium crinale*** **(Hare ex Turner) Gaillon ( ♣ )**

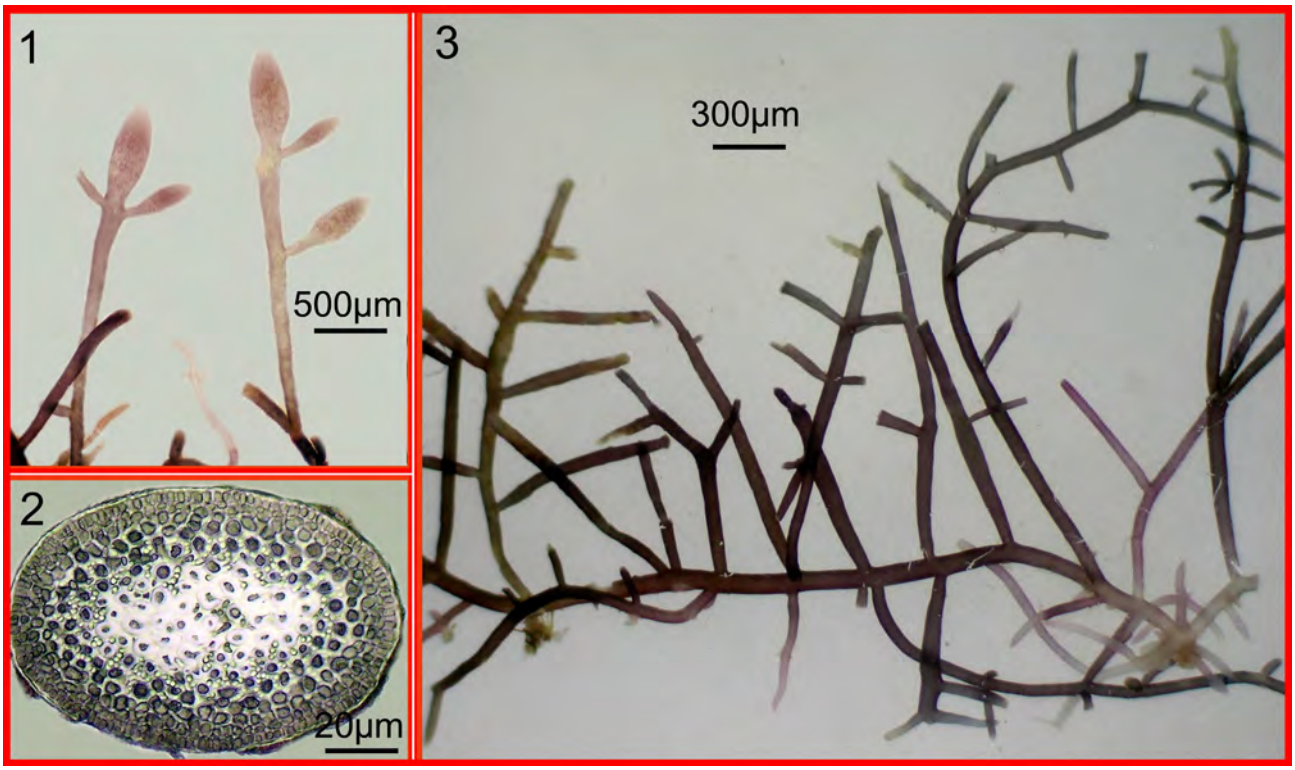


**Fig. 59** ***Gelidium crinale.*** 1. Fragment with tetrasporangial branchlets. 2. Transverse section. 3. Habit; photograph showing many branches grazed by herbivorous fish. Hainan Island, Wenchang, March 2012.

Characteristics: Thallus bushy, cartilaginous, dark red-brown, forming dense turfs or masses, (0.5–)2–4(–6) cm high, composed of prostrate axes, bearing erect branches. Prostrate axes terete, 100–200 μm in diameter. Erect axes numerous, terete at base, slightly compressed above, 220-330 μm, with acute apices, branching pinnate, alternate, rarely opposite. Cells from the surface view roundish, - 8 μm across, with thin walls. In transverse section, cortex consists of 1–2 layers of small cells, 6–7.5x10 μm. Medullary cells 15–22.5 μm in diameter, thick-walled, surrounded by small cells (5–7.5 μm in diameter) of rhizoidal filaments, except outer cells of the medulla. Cystocarps develop at the ends of branches, 500–600 μm in diameter. Tetrasporangia ovoid, 22.5–30x27–35 μm, cruciately divided; develop in cortical layer of swollen apical portion of branches with lanceolate or spatulate appearance. Growing on intertidal shells and rocks.

Collection sites in Hainan. Meixia, Vicinity of Wenchang City, Gukou, Qingnan Gang, Yalong Wan, Xiaodong Hai, Luhuitou, Ximao Zhou.

***Gelidiophycus divaricatus* (G. Martens) G.H. Boo, J.K. Park & S.M. Boo ( ♣ )**

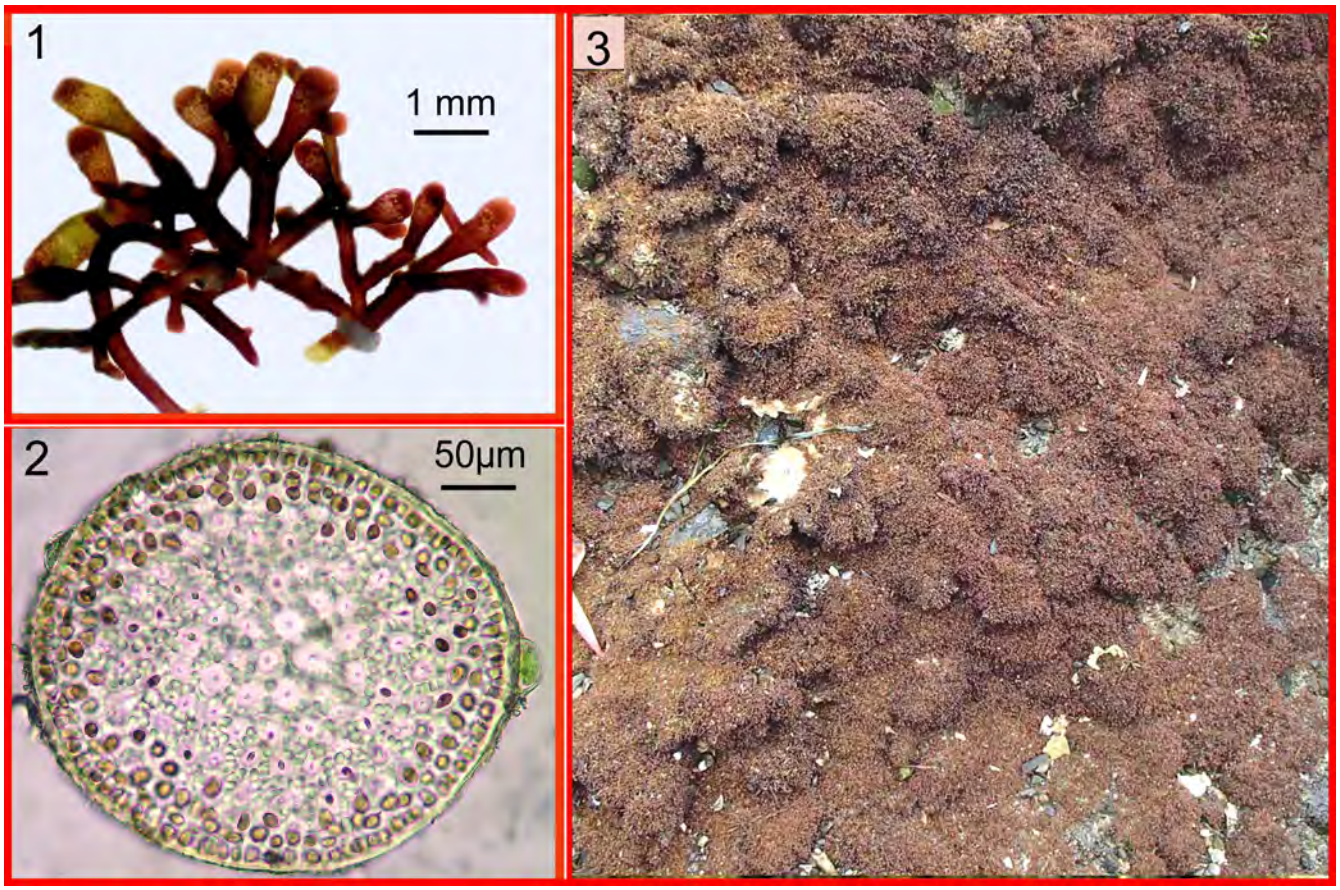


**Fig. 60** ***Gelidiophycus divaricatus.*** 1. Tetrasporangial plant. 2. Transverse section. 3. Attached to substrate, Hainan Island, Luhuitou, March 2012.

Characteristics: Thallus cartilaginous, densely caespitose, 0.25–2 cm high, composed of creeping terete or subterete axes, (150–)250–400(–700) µm wide, bearing erect branches. Branching bipinnate, with opposite-alternate ultimate branchlets at right angles. The branchlets 200–500 µm wide, 0.2–3 mm long, with blunt or acute slightly inflated apices. In transverse section, cortex consists of four layers of roundish cell gradually increasing in size toward the center. Medulla consists of colorless isodiametric cells, - 18 µm in diameter, the outer ones surrounded by small cells of rhizoidal filaments. Cystocarps near to spherical, 450–650 µm in diameter. Tetrasporangia elliptic (25–35x60 µm) or spherical, to 37 µm in diameter, cruciately divided, borne in rounded or expanded sori of terminal branchlets. Attachment by peg-like holdfast to rocks, shells in the intertidal zone.

Collection sites in Hainan. Meixia, Wenchang, Shalao, Luhuitou.

**Family GELIDIELLACEAE**

***Parviphycus adnatus* (E.Y. Dawson) B. Santelices ( ♣♣ )**

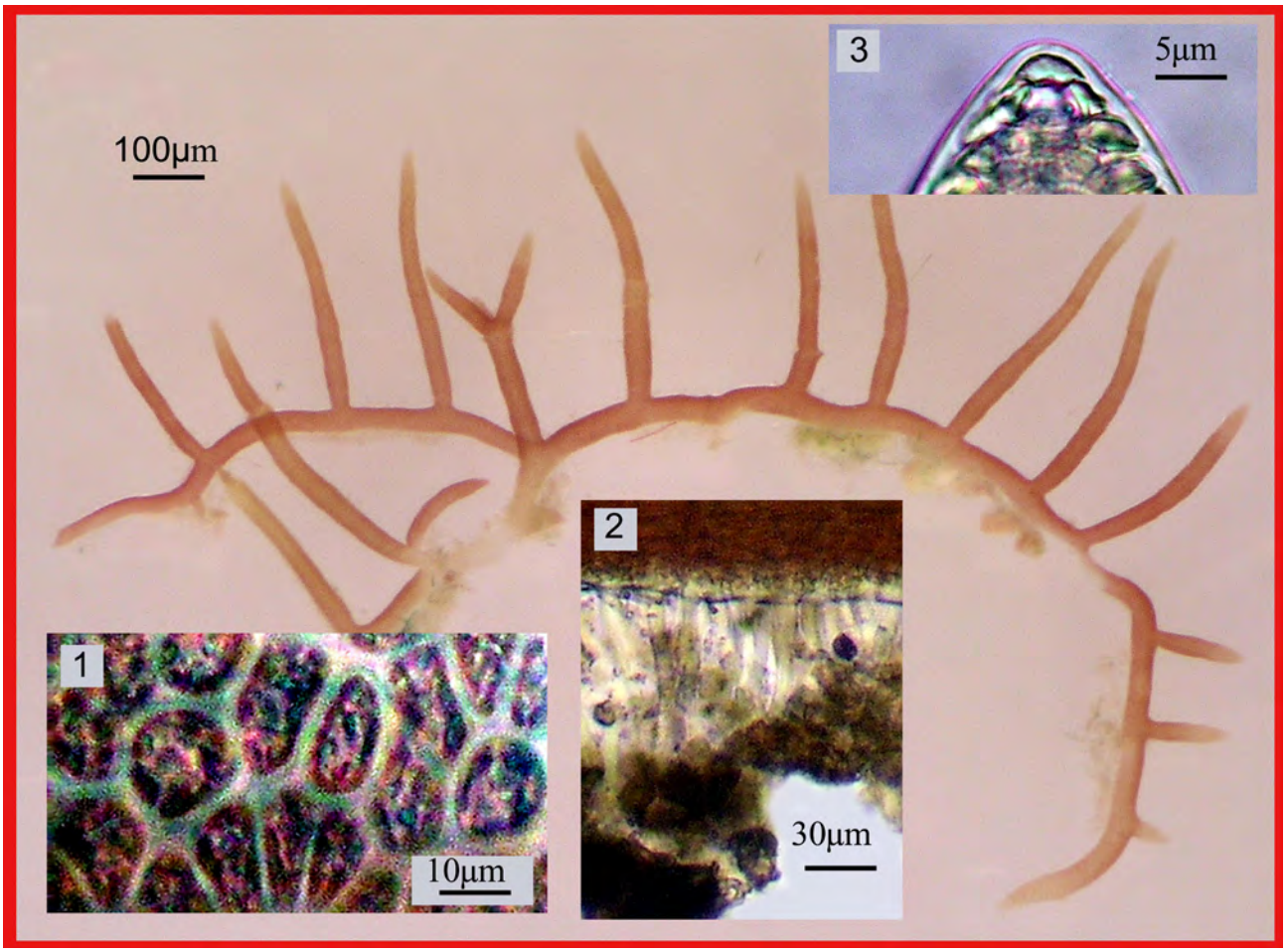


**Fig. 61** ***Parviphycus adnatus.*** Overall morphology. Insets: 1. Cells in surface view. 2. Rhizoids on ventral side of creeping axis. 3. Apex. Hainan Island, Luhuitou, April 2009.

Characteristics: Thallus small and delicate, consist of creeping axes and erect branches, pale-red color. The creeping axes cylindrical, 40-70(-100) μm in diameter, erect branches simple, unbranched, to 5 mm high, 75-95 μm in diameter at base, gradually tapering toward apices to (30-)35-45 μm in diameter. Apical cells prominent, 12.5x 7.5-12.5 μm. Surface cells (3.5-)5-10×7.5-15 μm, polygonal, sometimes transversely elongate arranged. In transverse section of erect branches, cortex composed of 1-2 layers of rounded cells (5-7.5 μm in diameter) and medulla consists of axial cell and two periaxial cells on both sides of the axial cell). Tetrasporangial stichidia lanceolate, 80-90 μm broad, 400-500 μm long, on short pedicel, to 50 μm long. Sporangia subspherical, 25-30x27-35 μm (including cell wall), tetrahedrally divided. Hairs c.2.5-3(-5) μm in diameter, 115-120 μm long) were found in apical parts of erect axes. Attachment to the substratum by a dense row of short unicellular rhizoids along ventral surface, originating from external cortical cells; rhizoids up to 100 μm long. Growing on intertidal dead coral blocks, rocks, in association with *Sphacelaria tribuloides* epiphytically on *Peyssonnelia boergesenii*.

Collection sites in Hainan. Shalao, Xiaodong Hai, Luhuitou.

***Parviphycus pannosus*** **(Feldmann) G. Furnari ( ♣♣ )**

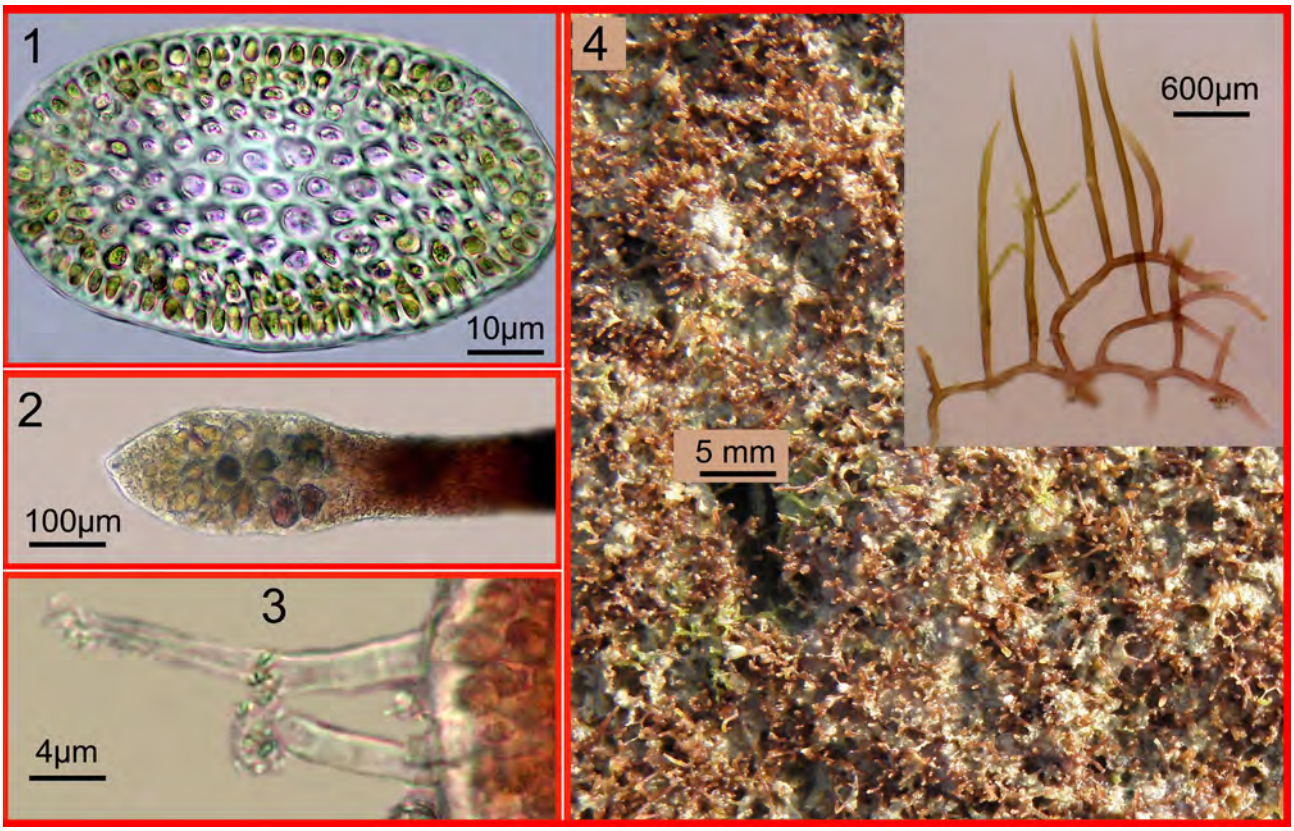


**Fig. 62** ***Parviphycus pannosus.*** 1. Transverse section. 2. Tetrasporangial stichidium. 3. Rhisoids originating from external cortical cells on ventral side of creeping axis. 4. In habitat, Hainan Island, Luhuitou, February 2012. Inset: Overall morphology.

Characteristics: Thallus small, consisting of creeping axes bearing simple erect axes, reddish-brown color. Creeping axes terete, 50–110(–175) μm in diameter. Erect axes terete to slightly compressed, simple (rarely branching), 1.5–4.7(–7) mm high, 50–135(–170) μm wide, tapering gradually to acute apices. Cells from surface in rows, quadrate, 12.5×12.5 μm, roundish-polygonal, 3.5–5x3–7.5 μm. In transverse section, cortex consists of two cell layers, medullary cells small, thick-walled. Tetrasporangial stichidia terminal, 80–150 μm wide, 200–400(–500) μm long. Tetrasporangia spherical, 22.5–27.5(–30) μm in diameter, tetrahedrally divided. Attachment by unicellular rhizoids originating from external cortical cells on ventral side of prostrate axes, 5(–7) μm in diameter, (25–)80–200 μm long, non-aggregated. Growing on stones, dead coral debris, in association with Centrtoceras clavulatum, epiphytically on *Caulerpa racemosa stolons, Lobophora variegata, Amphiroa foliacea, Palisada papillosa* in the intertidal to upper subtidal zones.

Collection sites in Hainan. Wenchang, Yalong Wan, Dadong Hai, Xiaodong Hai, Luhuitou, Ximao Zhou.

**Family PTEROCLADIACEAE**

***Pterocladiella capillacea*** **(S.G. Gmelin) Santelices & Hommersand** **( ♣ )**

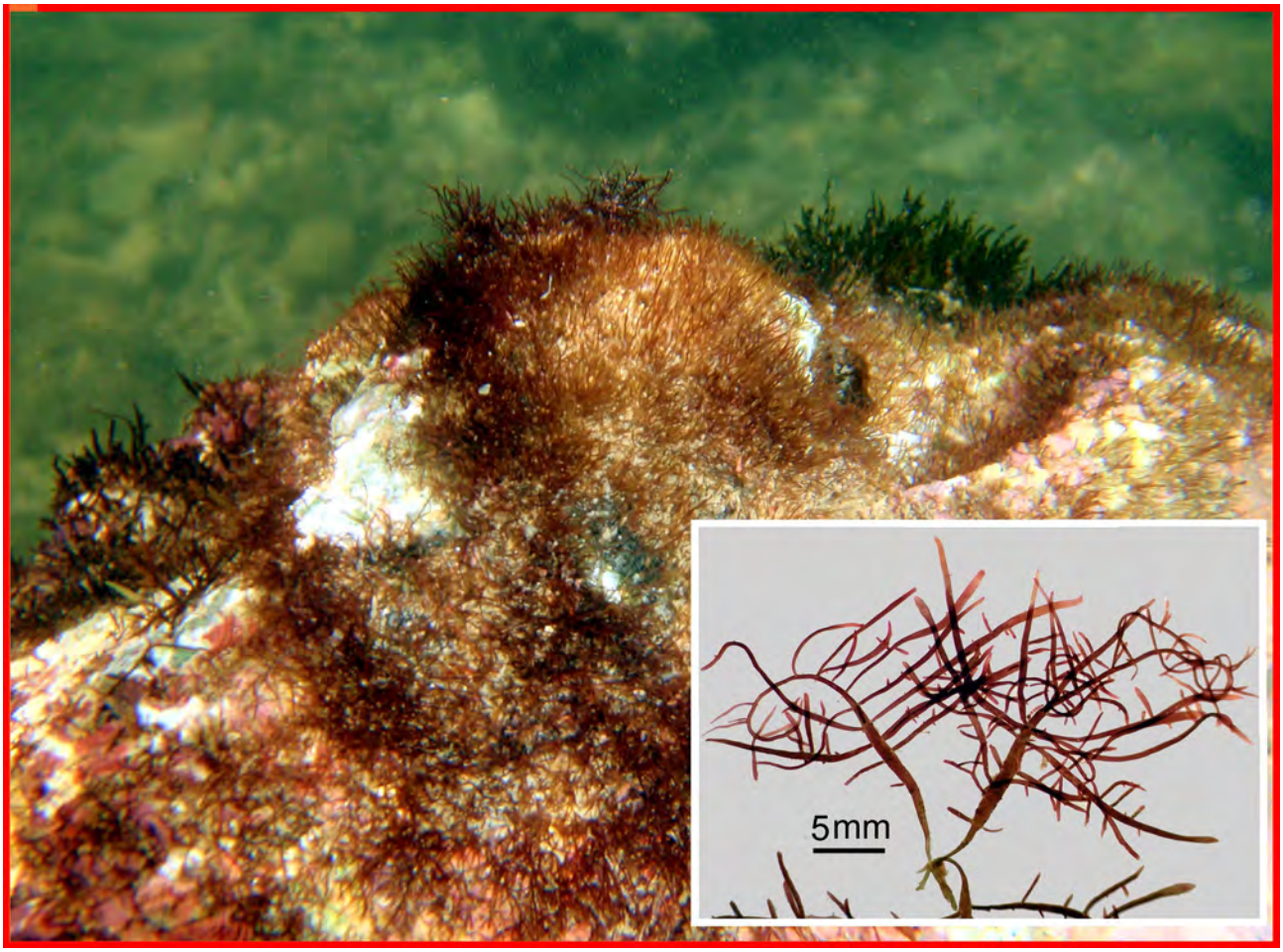


**Fig. 63** ***Pterocladiella capillacea.*** Attached to substrate, low intertidal. Hainan Island, April 2012. Inset: Overall morphology.

Characteristics: Thallus caespitose, cartilaginous forming dense tangled tufts, (1.5–)3–15 cm high, dark purplish-red. Creeping axes terete, give rise to erect, lanceolate flattened axes to 2 mm wide. Branching distichous, 2–3 times pinnate, pyramidal in outline, with opposite or alternate branchlets. In transverse section, cortex consists of 1–2 rows of roundish or square cells, to 10 µm across; medulla composed of roundish to oblong cells 22.5–30x17.5–25 µm surrounded by slender thick-walled cells of rhizoidal filaments in the inner medulla, 3.5–5 µm in diameter. Tetrasporangia spherical or ovoid, 20–30 µm in diameter, cruciately divided. Cystocarps 250–300 µm in diameter, formed in the middle of branchlets on one side. Attachment by pad-like rhizoids descending from creeping axes. Growing on intertidal to upper subtidal rocks, dead coral fragments.

Collection sites in Hainan. Xian Hai, Xiaodong Hai, Luhuitou.

**Order GIGARTINALES**

**Family CYSTOCLONIACEAE**

***Hypnea cenomyce* J. Agardh ( ♦ )**

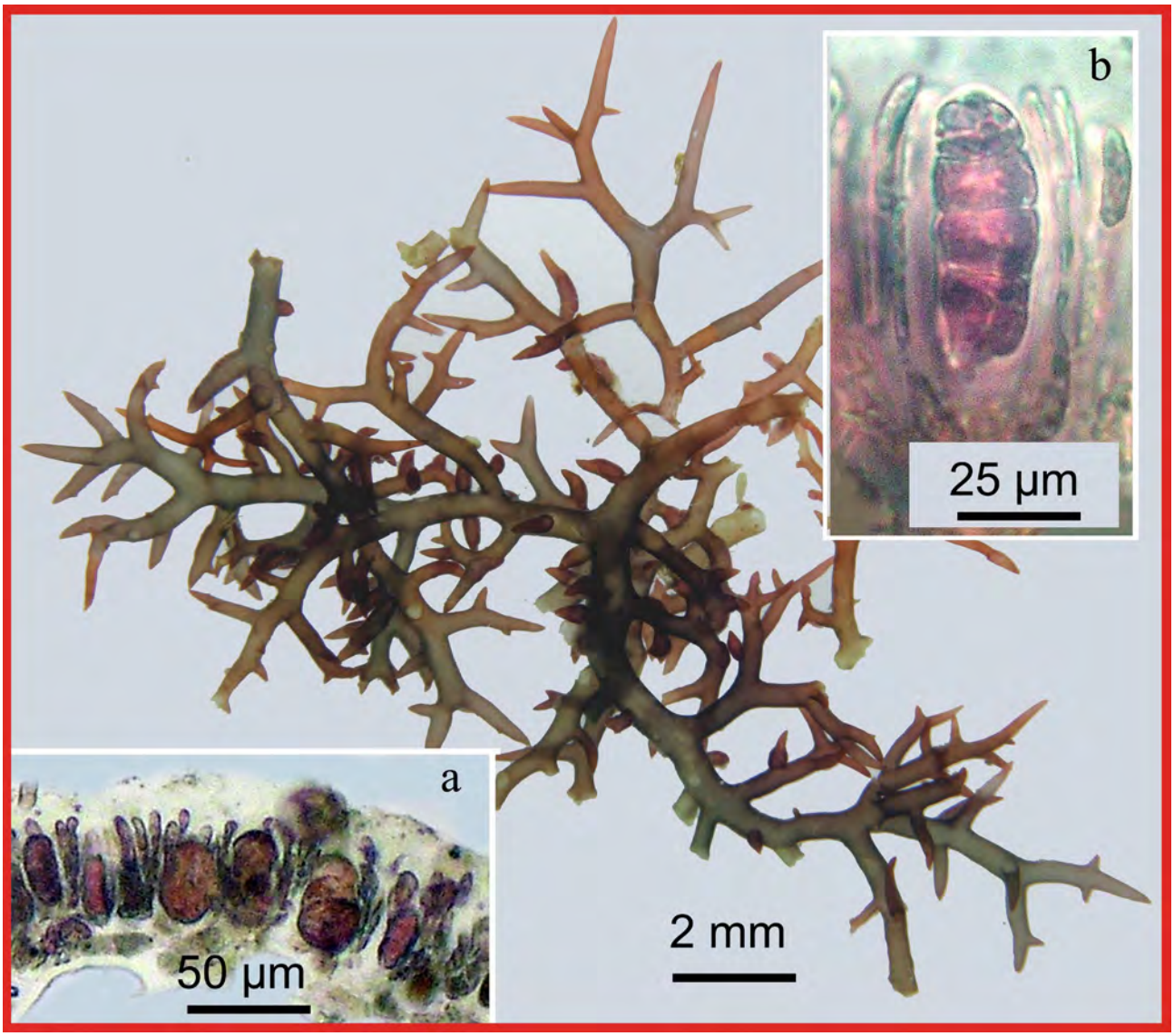


**Fig. 64** ***Hypnea cenomyce.*** Overall morphology of tetrasporophytic plant. Insets: a, part of cross section showing immature tetrasporangia; b, mature tetrasporangiun. Hainan Island, Yalong Wan. March 2012.

Characteristics: Thallus consists of densely intricate cushion-like basal portion and erect branches 2-3 cm high. Branches cylindrical, 0.5-1.0 mm in diameter, bearing branchlets. Branchlets not constricted at base and with acute apices.Tetrasporangia borne in basal swollen part of branchlets, zonately divided. Cystocarps subcylindrical, 0.6-1.0 mm in diameter, solitary or in groups of 2-3 on branches and branchlets. Growing on stones, pebbles, dead coral debris, in the upper subtidal zone, occasionally epiphytic on algae (e.g. on *Padina australis*).

Collection sites in Hainan. Meixia, Yalong Wan, Luhuitou.

***Hypnea esperi*** **Bory ( ♦ )**

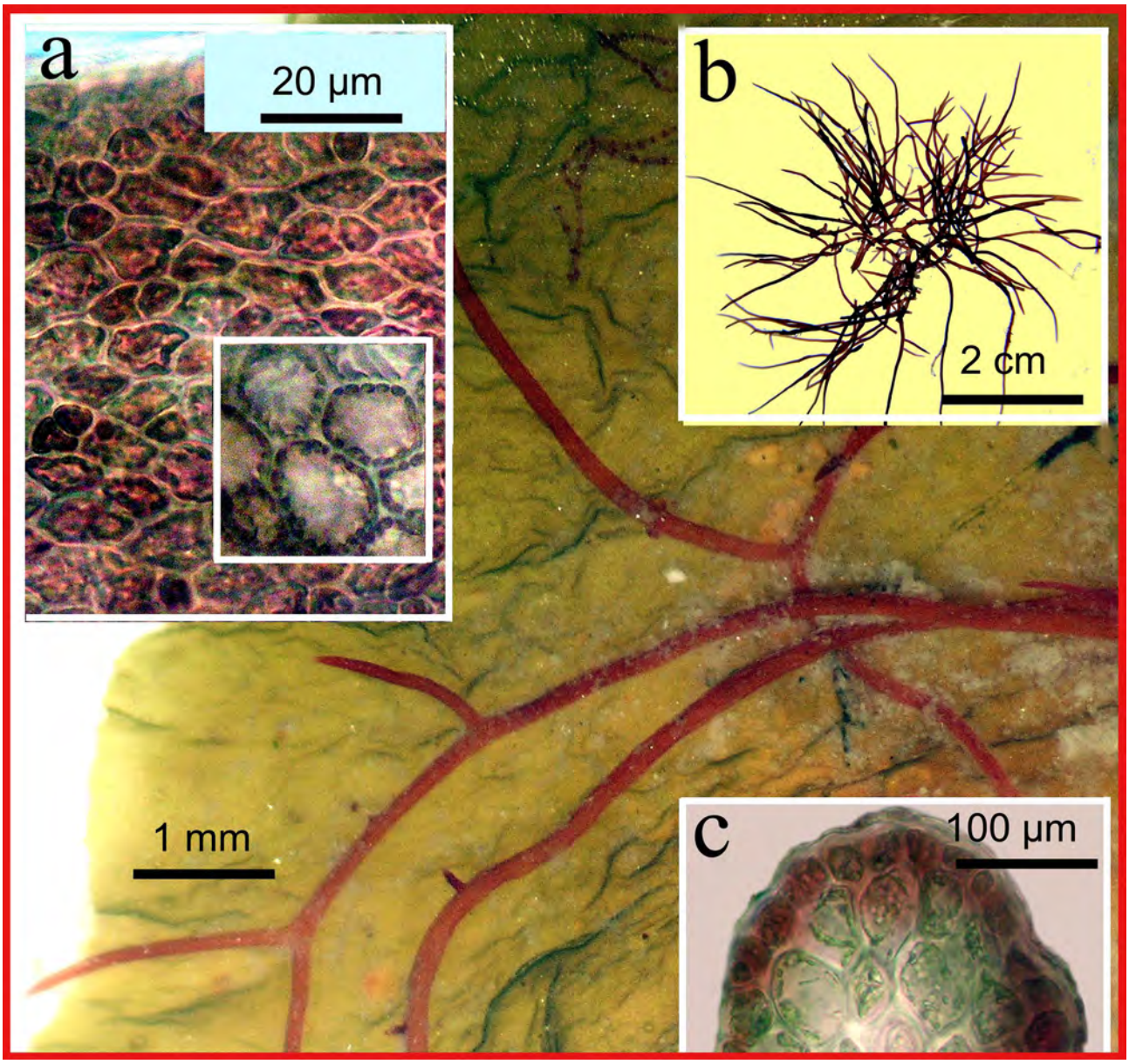


**Fig. 65** ***Hypnea esperi.*** In habitat, epiphytic on *Colpomenia sinuosa*. Hainan Island, Luhuitou, April 2012. a, cells in surface view; b, overall morphology; c– cross section.

Characteristics: Thallus subcartilaginous, in small loosely intricate, tufts, 1.5-2.4 mm long, tightly attached to host at many points, light purple-red. Branching sparse irregular, lateral or alternate, with wide angles. Branches cylindrical, slender, 185-350 µm in diameter, gradually tapering towards acute apices bearing short and long spinous determinate branchlets not constricted at the base. In cross section, axial cell distinct, surrounded by pericentral cells (80-100 µm across) and one-two layers of cortical cells. Cortical cells in surface view irregularly polygonal, 8-20×13-25 µm long. Tetrasporangia borne in swollen sori of basal and middle parts of the branchlets. Attachment by many small discoid haptera to hard substrates and to each other. Growing in the low intertidal to upper subtidal zones, often epiphytically.

Collection sites in Hainan. Yalong Wan, Xiaodong Hai, Luhuitou.

***Hypnea valentiae*** **(Turner) Montagne ( ♦♦ )**

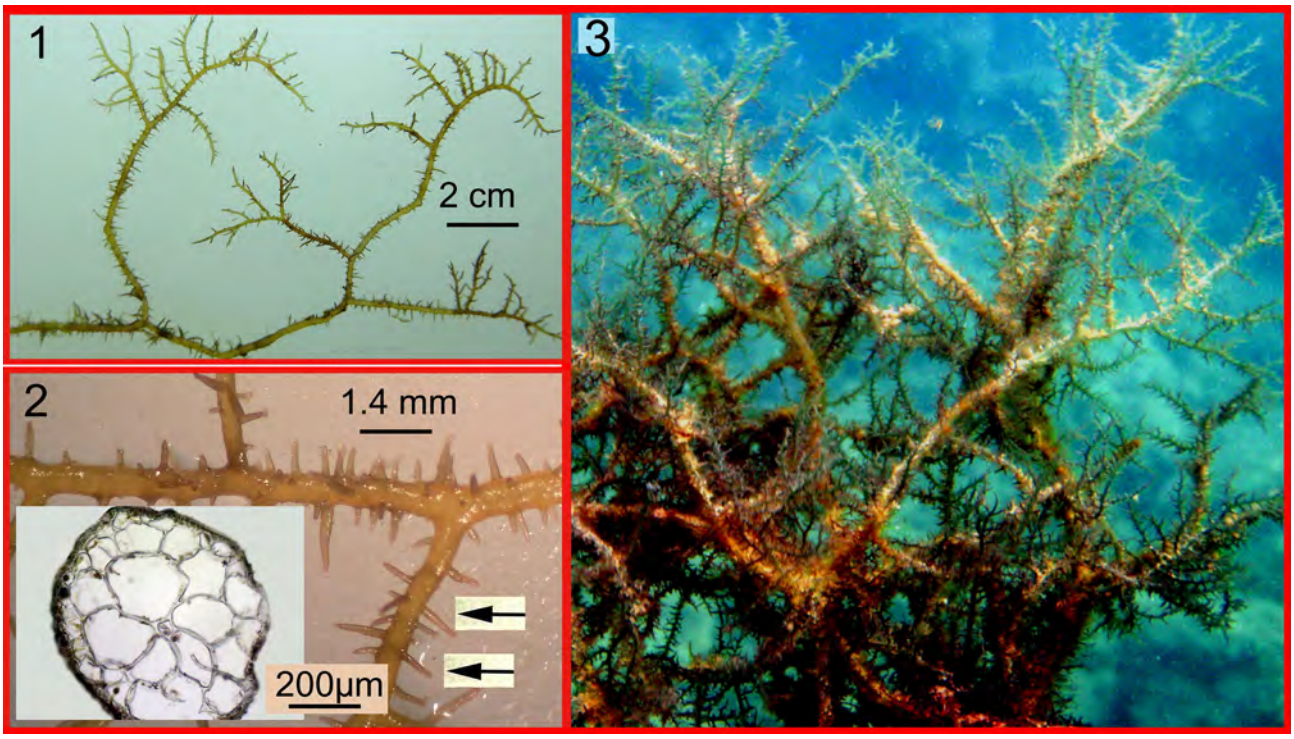


**Fig. 66** ***Hypnea valentiae.*** 1. Fragment showing branching pattern. 2. Detail showing lateral branchlets at right angle to the axis (arrows); Inset: Cross section of branch. 3. In habitat, the low intertidal zone, Hainan Island, Luhuitou, April 2012.

Characteristics: Thallus bushy, caespitose, wiry, erect or forming densely intricate mats or cushions, 6-15(-40) cm high, light greenish-brown to dark red. Branching dense, irregular. Branches cylindrical, 0.4-0.7(-1.5) mm in diameter, tapering towards the apices. Branches densely covered with short lateral branchlets at right angle to the branches. Branchlets numerous from all sides, simple or forked, spine or spur-like, 1-3 mm long, tapering to apices. Apices acute. In transverse section, axial cell (25 μm in diameter) surrounded by 5 pericentral cells (200 μm across); cortex 1-2 cells thick, cells rounded, densely pigmented, 10×12.5-15 μm. Tetrasporangia subcylindrical, oval 17-22-25-35 μm, zonately divided, develop in swollen sori at basal or middle portions of short branchlets, encircling the branchlets. Cystocarps spherical, 300-500 μm in diameter, sessile, develop laterally on branchlets, single or in groups of 2-3. Holdfast pad-like, inconspicuous. Growing on dead corals, rocks, in association with *Padina minor*, in the middle intertidal to upper subtidal zones in protected areas.

Collection sites in Hainan. Meixia, Xian Hai, Xiaodong Hai, Luhuitou, Ying Ge Hai.

**Family GIGARTINACEAE**

***Chondracanthus intermedius*** **(Suringar) Hommersand ( ♦ )**

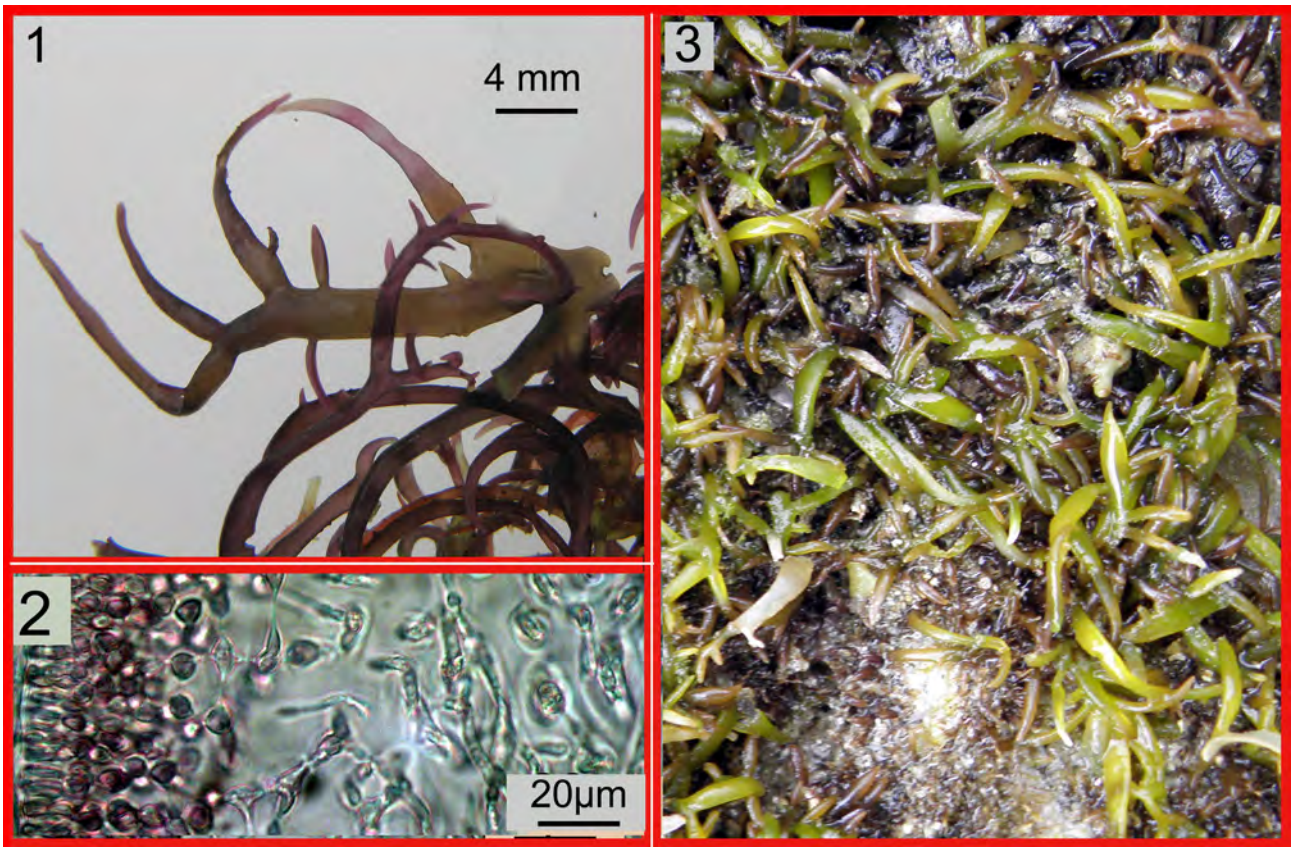


**Fig. 67** ***Chondracanthus intermedius.*** 1. Overall morphology. 2. Part of transverse section. 3. In habitat, Hainan Island, Xian Hai. April 2012.

Characteristics: Thallus small, creeping, (1)-2-5 cm long, forming pulvinate mat, 1-2 cm high with intertwined and overlapped each other branches bearing numerous secondary discoid holdfasts arising from apices and firmly attaching to the substratum. Plants firm in texture, leathery, cartilaginous, dark purplish-red with bluish iridescence (when submerged). Branching is sparse, irregular, opposite, alternate or unilateral. Stipe short, cylindrical. Branches compressed, flat, linear (0.5)-1.0-4.0 mm width, tapering to base and apices, distinctly recurvate. Apices often sharply pointed. Tetrasporangia spherical, to obovate, cruciately divided, borne within cortex of primary branches. Cystocarps spherical, prominent, 0.9-1.0 mm in diameter. Growing on middle and low intertidal rocks and also in the intertidal pools, in sheltered and moderately exposed localities.

Collection sites in Hainan. Meixia, Xian Hai.

**Order PEYSSONNELIALES**

**Family PEYSSONNELIACEAE**

***Peyssonnelia boergesenii*** **Weber-van Bosse ( ♦♦ )**

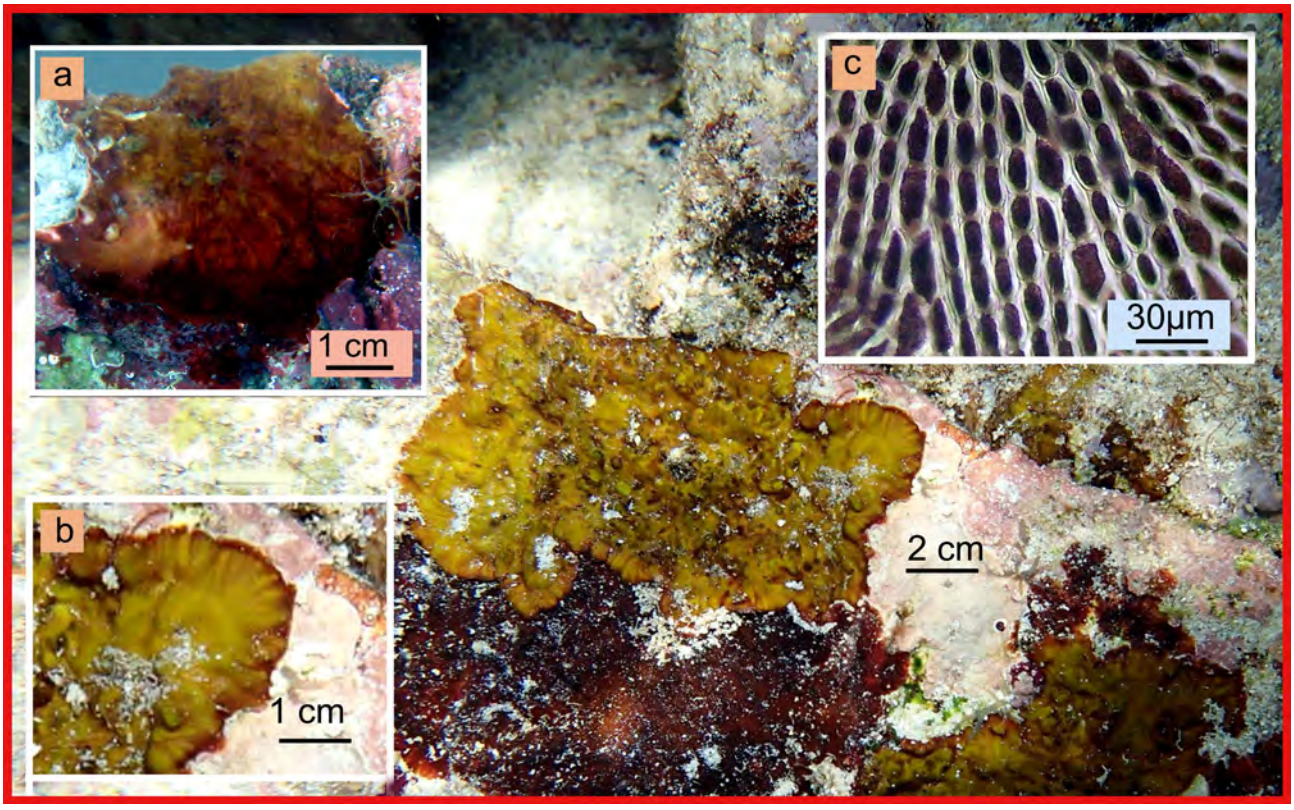


**Fig. 68** ***Peyssonnelia boergesenii.*** In habitat. Hainan Island, Yalong Wan, March 2012. Insets: a, plant from shaded site; b, plant in open site; c, cells on ventral side of crust.

Characteristics: Thallus crust-like, irregularly rounded, conforming to substrate, slippery on the upper surface, lightly calcified on the lower one, pink, yellowish-olive-green with dark red margins, to dark maroon color (in shade), with pale irregular radial lines, tighly adhering to substrate, with margins often raised above its substrate. Crusts 3-5 cm across, 300-500 µm thick. Margins entire or lobed. Basal surface cells on ventral side ellipsoidal, 12-30 µm broad, 30-70 µm long, arranged pinnately. In transverse vertical section, hypothallus consists of large rectangular cells, 25-55 µm wide, 30-66 µm long; perithallus consists of 10-12 erect rows of roundish-rectangular cells, 8-10×5-15 µm. Tetrasporangial nemathecia elevated, 200-250 µm thick; tetrasporangia oblong obovate, cruciately divided, 30-50 µm in diameter, 100-160 µm long, borne on basal cells of paraphyses. Rhizoids multicellular, 25-30 µm in diameter, to 0.5 mm long. Growing on dead branched corals, carbonate rocks, in the intertidal to upper subtidal zone, at sites exposed to moderate wave action.

Collection sites in Hainan. Yalongwan, Luhuitou.

***Peyssonnelia inamoena*** **Pilger ( ♦♦ )**

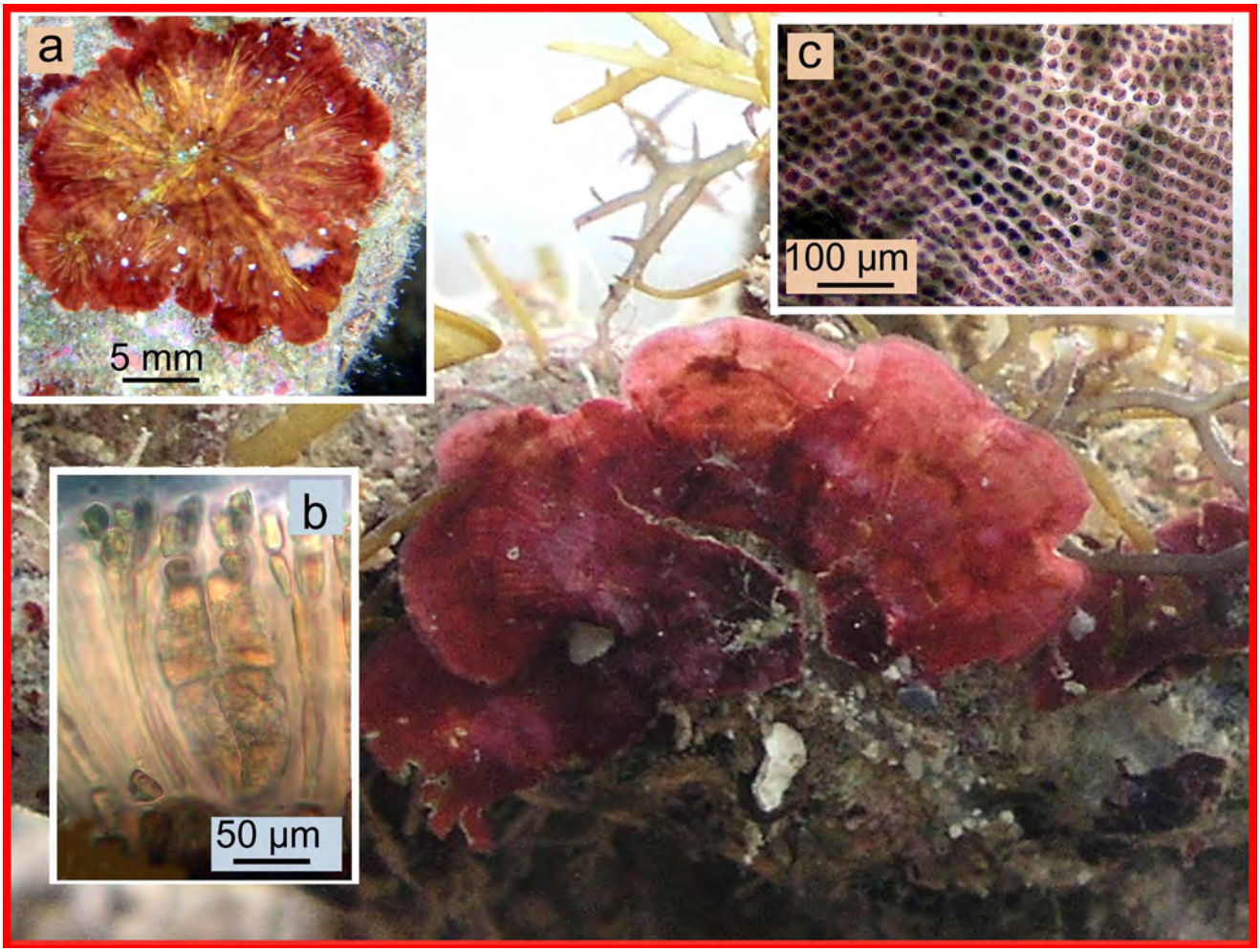


**Fig. 69** ***Peyssonnelia inamoena.*** In habitat, on dead coral, at low tide. Insets: a, overall morphology; b, vertical section of tetrasporangial tissue; c, cells in surface view. Hainan Island, Luhuitou, November 2010.

Characteristics: Thallus prostrate, irregularly rounded, fan-like, lobed, to 2.5 cm across, loosely attached and easily detached from its substratum, with margins raised above the substratum, rose-red with faint radial and concentric lines, lightly calcified on lower surface. Crusts 215 µm thick in vegetative thalli and to 380 µm thick in reproductive parts. Cells in surface view polygonal, isodiametric, 6-15 µm in diameter. Basal cells in surface view in parallel rows, rectangular with round corners and longitudinally elongate, 6-15 µm in diameter, 20-50 µm long. In radial vertical section, hypothallus of two layers of large cells and perithallus of 3-6 cell layers. Tetrasporangial nematecia elevated to 100 µm high. Tetrasporangia ovoid, 35-50 µm in diameter, 70-85 µm long, cruciately divided, on one-celled stalk, borne among simple or dichotomous paraphyses of 5-6 cells long. Rhizoids unicellular, to 15 µm in diameter, originating from center of hypothallial cells.

Collection sites in Hainan. Yalongwan, Xiaodong Hai, Luhuitou.

**Order GRACILARIALES**

**Family GRACILARIACEAE**

***Gracilaria textorii*** **(Suringar) De Toni ( ♦ )**


**Fig. 70** ***Gracilaria textorii.*** Overall morphology (dried specimen). Hainan Island, Ying Ge Hai, April 2014.

Characteristics: Thallus erect, flat, membranous to coriaceous, dull red or brownish red, 3.5-15 cm high. Branching irregularly di-, tri-, polychotomous in one plane. Blades flabellate, usually 3-6 mm wide (to 1.5 cm at broadest part), with round to attenuate apices. Margins commonly entire or at times proliferous. Terminal branches short, wedge-shaped and linear, or rather long and curved. In transverse section, blades 250-800 µm thick, cortex composed of 1-2 layers of small cells, 8-14 µm, medullary cells large, isodiametric, 200-250(-330) µm across. Cell transition from medulla to cortex abrupt. At the basal portion of the thallus, cortex multilayered. Tetrasporangia immersed in the cortical layer, ovate, roundish in surface view, cruciately divided, 15-24(-34) µm in diameter, scattered on both surfaces of the thallus. Cystocarps prominent, sessile, to 1.6 mm in diameter, subspherical, spherical, scattered on both surfaces of the blades. Attachment by small discoid holdfast. Growing on lower intertidal to upper subtidal rocks, dead coral blocks.

Collection sites in Hainan. Ying Ge Hai, Xian Hai.

**Order HALYMENIALES**

**Family HALYMENIACEAE**

***Grateloupia asiatica*** **S. Kawaguchi & H.W. Wang (♦)**

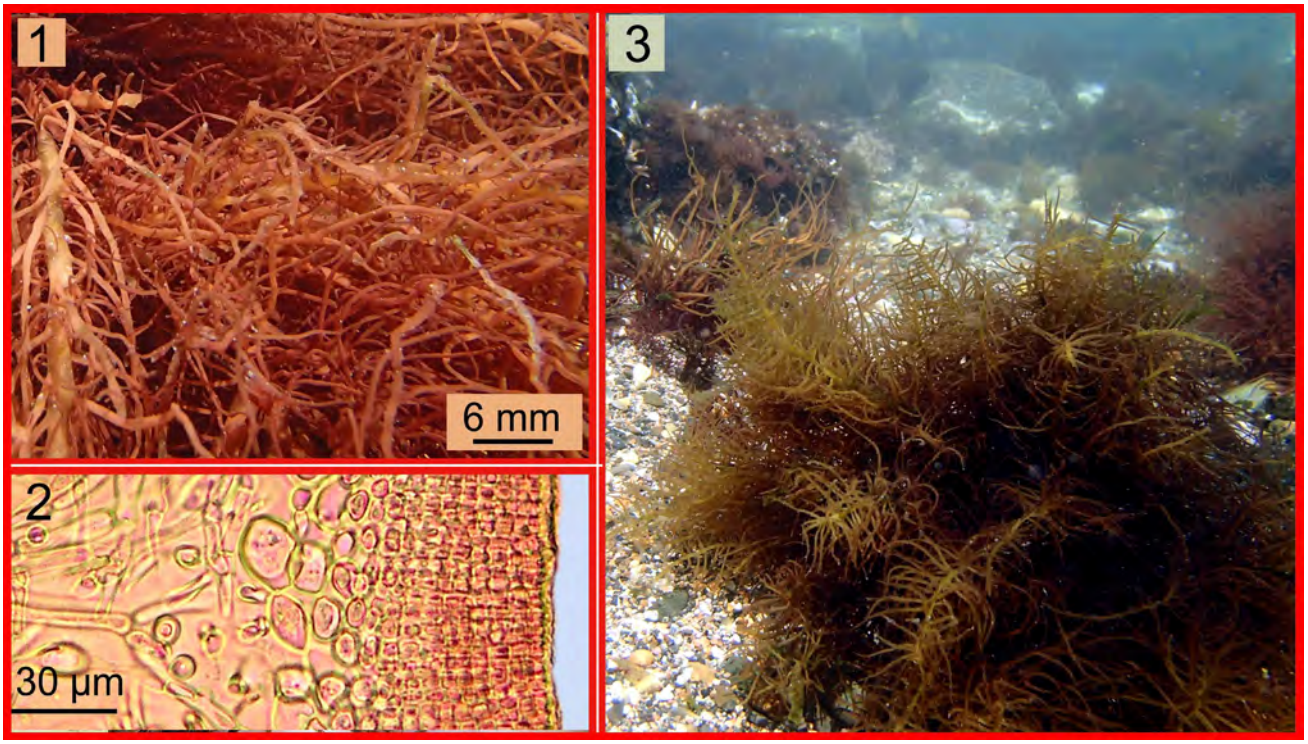


**Fig. 71** ***Grateloupia asiatica.*** 1, 3. In habitat, Hainan Island, Xian Hai, April 2012. 2. Part of transverse section of a branch.

Characteristics: Thallus cartilaginous, bushy, branched, 15–20 cm high, greenish to purplish red. Main axes, branches and branchlets are flat. Main axes linear, 1.2–3 mm broad, slightly twisted. Branching in lower portion of main axes from all sides, and above distichously from margins and often proliferating from the face of the main axes. Branches 5–6.5 cm long, 1–1.5 mm broad. Branchlets 0.5–1.4 cm long, 0.1–1.1 mm broad, pinnately arranged. The branchlets are flat, constricted at base and tapering to acute tips. Attachment by small discoid holdfast to 1 mm in diameter. Cystocarps immersed, 75–200 µm in diameter. Carpospores roundish to oval, 7–10 µm in diameter. Growing on middle to lower intertidal rocks, overgrowing artificial substrates exposed to moderate and strong wave action.

Collection sites in Hainan. Xian Hai, Ying Ge Hai.

***Grateloupia filicina*** **(J.V. Lamouroux) C. Agardh ( ♦ )**

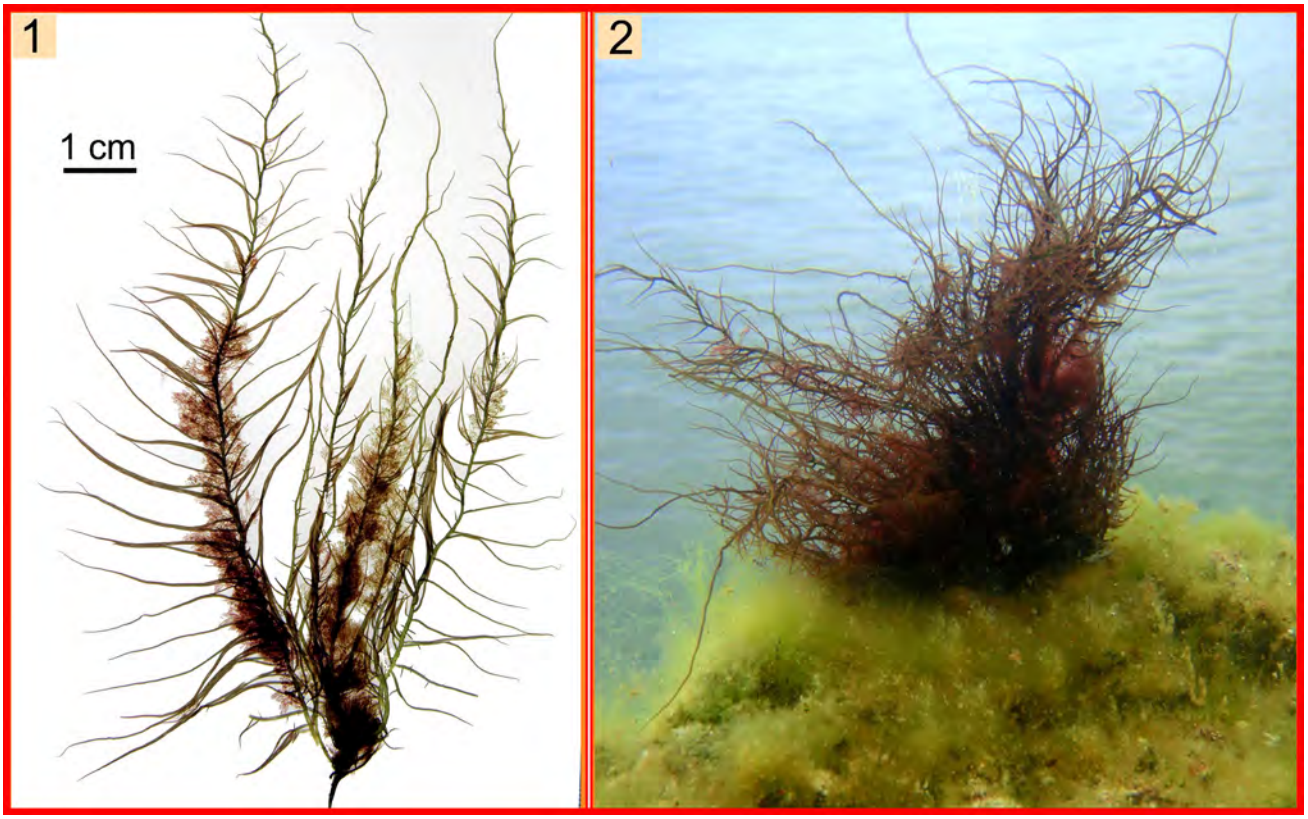


**Fig. 72** ***Grateloupia filicina.*** 1. Overall morphology, plant overgrown by the red alga *Ceramium cimbricum*. 2. Plant growing on artificial substratum. Hainan Island, Luhuitou, March 2012.

Characteristics: Thallus erect, caespitose, tufted, cartilaginous, slippery, 5–10(–20) cm high, linear, compressed to subcylindrical, shortly stipitate, purplish-red, dark purplish-brown to bluish-green. Main axes (1.5–2 to 4 mm broad) with numerous branches (1 mm broad and 3–10 cm long) tapering to base and apices. Branching multifarious, commonly marginally pinnate, bipinnate, sometimes proliferating from the face, or radially branched. Attachment by small disc-like holdfast. Tetrasporangia imbedded in the cortical layer, cruciately divided, near to oval, 18–20 µm in diameter, 35–40 µm long, scattered over all the thallus. Spermatangia develop in superficial patches. Cystocarps embedded in the cortex and reach far into the medullary tissue, partially prominent, to 180 µm in diameter. Attachment by disc-like holdfast. Growing on rocks in the middle intertidal zone, in the intertidal rocky pools and on artificial substrata.

Collection sites in Hainan. Xian Hai, Luhuitou, Ying Ge Hai.

**Order RHODYMENIALES**

**Family CHAMPIACEAE**

***Champia parvula*** **(C. Agardh) Harvey ( ♣ )**

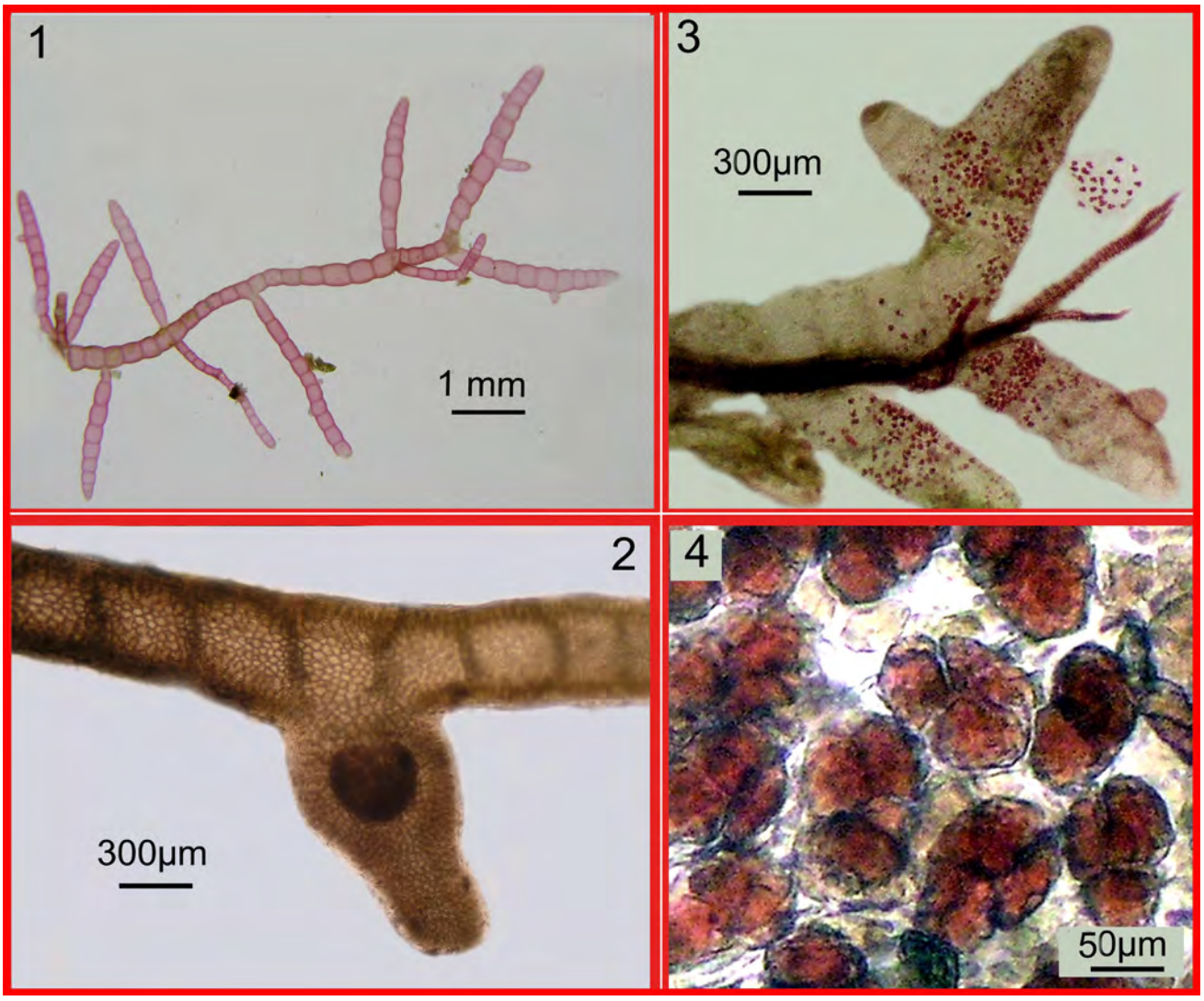


**Fig. 73** ***Champia parvula.*** 1. Young plant. 2. Cystocarp. 3. Tetrasporophyte. 4. Tetrasporangia in surface view. Hainan Island, Luhuitou, February 2012.

Characteristics: Thallus small, 2-3(-6) cm high, creeping, forming intertwined tufts or dense spherical clumps. Plants soft, gelatinous, translucent, pinkish to pale reddish or greenish, at times iridescent blue. Branching irregularly, opposite, alternate or verticillate. Branches cylindrical to slightly compressed 0.5-1.0(-2.0) mm in diameter, segmented, gradually tapering to base and apices. Segments hollow, swollen, barrel-shaped. Joints slightly constricted. Apices obtuse. Tetrasporangia spherical, 55-80(-100) µm in diameter, tetrahedrally divided, numerous, forming in the surface cortex. Cystocarps spherical, 500-800 µm in diameter, or urn-shaped, 300-500(-1500) µm high, to 800 µm in diameter, solitary, in pairs or sometimes in groups. Growing on low intertidal to subtidal rocks or epiphytic on larger algae (e.g. on *Amphiroa foliacea, Lobophora variegata*).

Collection sites in Hainan. Yalong Wan, Dadong Hai, Xiaodong Hai, Luhuitou, Ximao Zhoui.

***Champia vieillardii*** **Kützing (♣♣)**

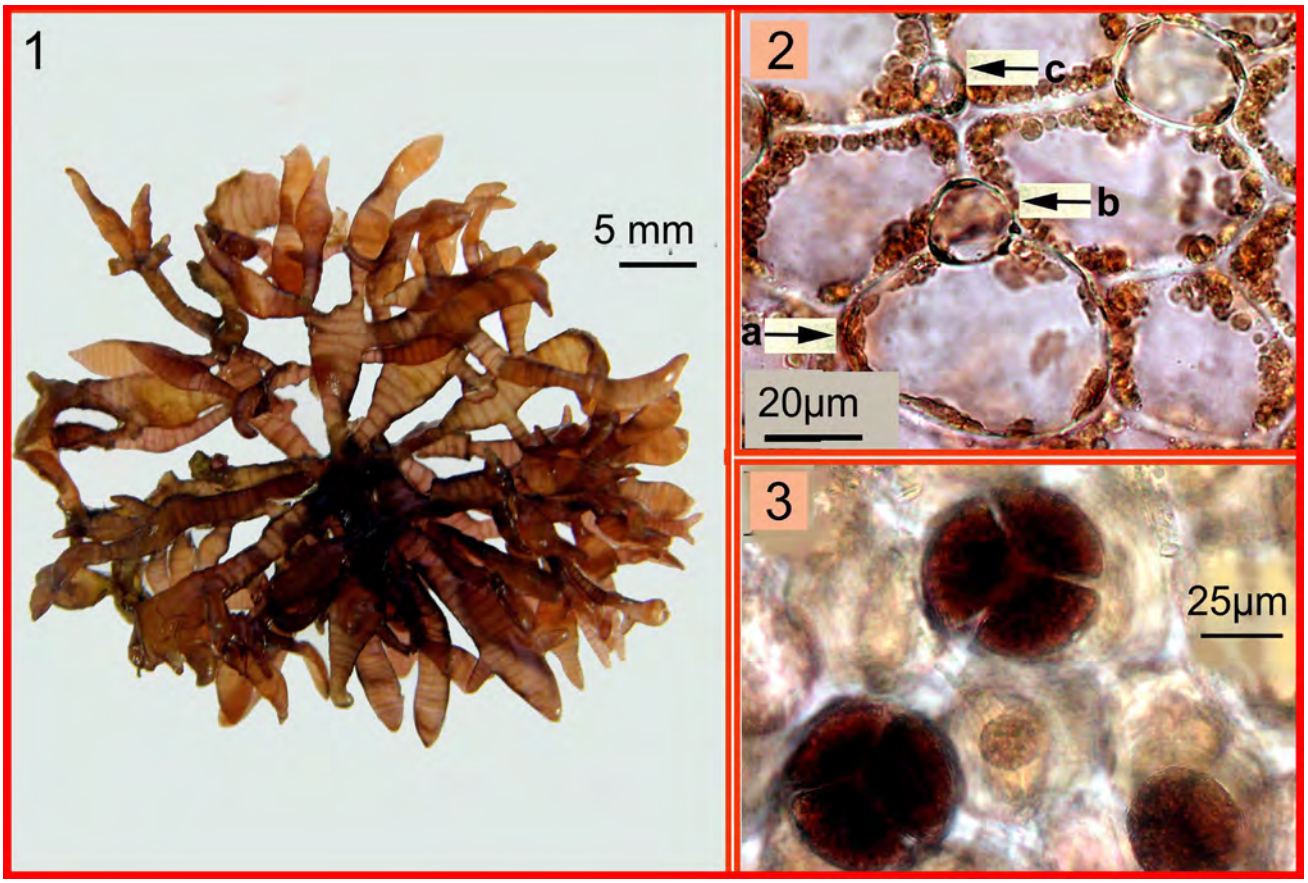


**Fig. 74** ***Champia vieillardii.*** 1. Overall morphology. 2. Cells in surface. 3. Surface view of tetrahedrally divided tetrasporangia. Hainan Island, Luhuitou, October 2012.

Characteristics: Plants gelatinous, soft, form tufts, 1-3 cm high, or small patches, reddish-purple to reddish-brown color. Branching pinnate, irregular and alternate to opposite. Axes and branches flat, with faint segmentation, 2-3 mm broad, tapering to blunt tips and bases. Segments 3.5-7 times broader than long. Superficial cells composed of large, polygonal, 40-45x37-60 μm, rarely of smaller cells, (17-)22.5-30x20-25 μm, interspersed between the large cells, and hair cells (-10 μm in diameter), which located at junctions between the large cells. The medullary cavity filled with a mucilaginous content and divided by numerous cellular partitions; the inner walls of the cortex are lined with longitudinal filaments, 8-10 μm in diameter, 200-250 μm long; gland cells oval, 7.5-8 μm in diameter, sparsely develop on these filaments. Tetrasporangia spherical, 60-100 μm in diameter, tetrahedrally divided, scattered between cortical cells. Cystocarps urn-shaped, -0.9 mm in diameter. Attachment by discoid holdfast. Growing in the intertidal to upper subtidal zones, on hard substrata, epiphytic on larger algae (*Actinotrichia fragilis, Amphiroa foliacea, Dichotomaria marginata, Pterocladiella caerulescens, Colpomenia sinuosa, Sargassum* spp.).

Collection sites in Hainan. Dadong Hai, Xiaodong Hai, Luhuitou.

**Family LOMENTARIACEAE**

***Ceratodictyon scoparium*** **(Montagne & Millardet) R.E. Norris ( ♦♦ )**

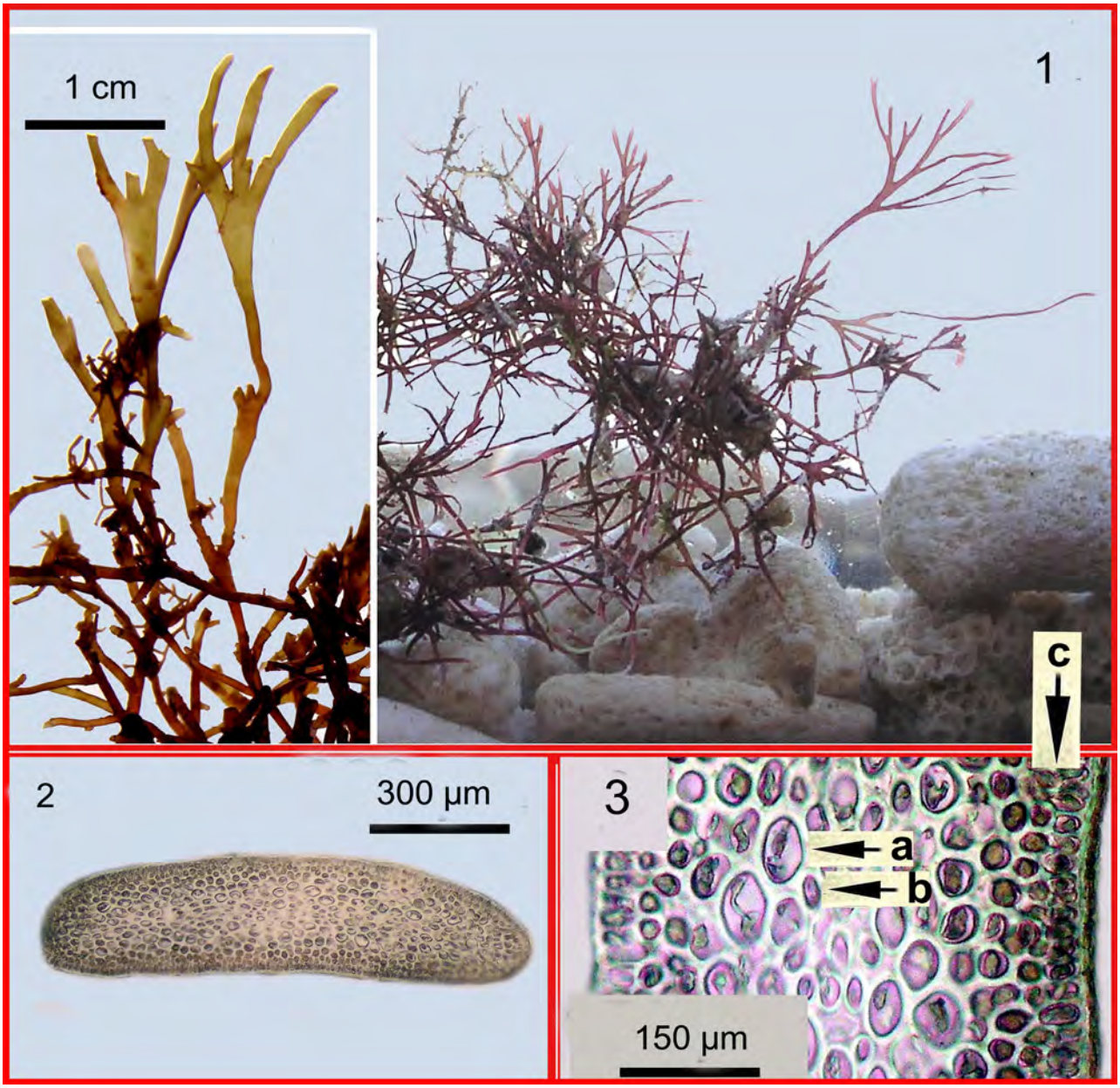


**Fig. 75** ***Ceratodictyon scoparium.*** 1. Plants in aquarium. Inset: Overall morphology (branches grazed by herbivorous fish). 2, 3. Cross section; a, larger cells, b, small thick-walled cells and c, cortical cells. Hainan, the vicinity of Wenchang City, March 2012.

Characteristics: Thallus erect, coarse, wiry, composed of prostrate stolons and erect branches forming sparse tufts to 5 cm high, various in color from reddish to dull purplish-red. Branching irregularly dichotomous, trichotomous, flabelliformis and in one plane in the upper portion of thalli. Branches linear, flattened, to 1.7 mm broad, 180-300 µm thick. In transverse section, medulla consists of small thick-walled cells (7-12 µm in diameter) surrounded by larger cells, 15-30 µm in diameter; cortex of two cell rows. Cells in surface view angular. Tetrasporangia spherical to oval, tetrahedrally divided. Attachment by rhizoids originating from prostrate axes. Growing on hard substratum in association with *Amphiroa foliacea*.

Collection sites in Hainan. The vicinity of Wenchang City, Dadong Hai, Xiaodong Hai, Luhuitou.

***Lomentaria corallicola*** **Børgesen (♣♣)**

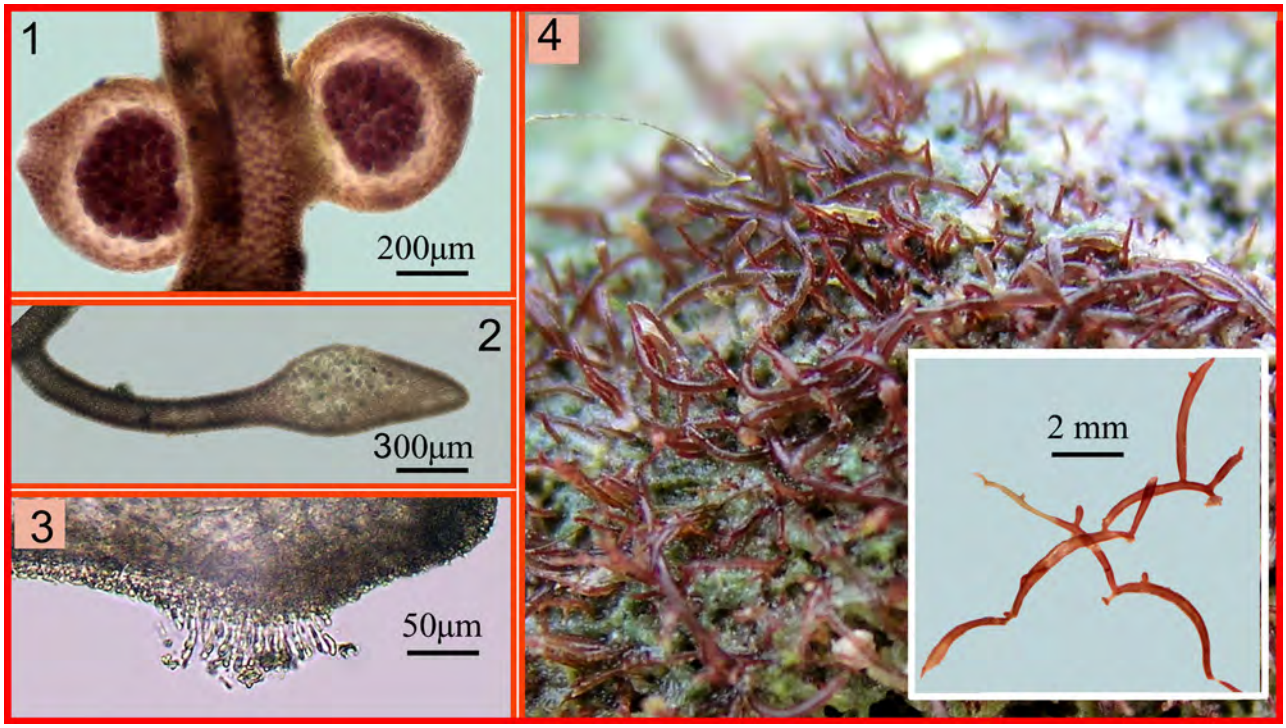


**Fig. 76** ***Lomentaria corallicola.*** 1. Fragment with cystocarps. 2. Tetrasporangial branch. 3. Tuft of uniseriate rhizoids from ventral side of branch. 4. In habitat, the low intertidal zone. (Hainan Island, Luhuitou), April 2009. Inset: overall morphology.

Characteristics: Thallus small, 3.8-5 mm high, forming turf-like small patches of connate plants consisting of arcuate creeping axes, 7-10 mm long, and rare erect branches, often attached to adjacent branches, reddish-purple, dark brownish-red color. Creeping axes 150-300(-400) µm in diameter. Axes and branches cylindrical, hollow. Erect branches slightly curved, (180-)300x500(-700) µm in diameter, constricted or not constricted at the base, with rounded apices. In surface view, cells large, roundish to oval, 17-60 µm long, (15-)17-30 µm in diameter, and small roundish cells, 5-12.5 µm in diameter, interspersed between the large cells. Tetrasporangia spherical, 35-50(-70) µm in diameter, tetrahedrally divided, develop in the middle or upper swollen portions of erect branches or branchlets. Cystocarps sessile, spherical, 340-460(-480) µm in diameter, lateral, on erect branches. Attachment by dense tufts of uniseriate rhizoids originating from surface cells on lower side of axes or from tips. Growing on rocks, coral blocks slightly covered with sediments or epiphytic on *Bryopsis australis, Dictyosphaeria cavernosa, Actinotrichia fragilis, Champia vieillardii*), in the lower intertidal to upper subtidal zones.

Collection sites in Hainan. Shalao, Dadong Hai, Xiaodong Hai, Luhuitou.

**Family RHODYMENIACEAE**

***Rhodymenia intricata*** **(Okamura) Okamura ( ♦ )**


**Fig. 77** ***Rhodymenia intricata.*** Overall morphology. Cast ashore, Hainan Island, Xian Hai, April 2012.

Characteristics: Thallus erect, solitary or gregarious forming intricate mass. Plants flabellate on short cylindrical stipe (1.5 mm long), subcartilaginous, bright to dark rose-red, to 5.5(-7) cm high. Branching irregularly repeatedly (3-5 times) dichotomous or subpalmate with roundish axils. Branches flat, strap-shaped, 2.5-6 mm wide with blunt, oblong or lingulate apices. In transverse section, blades120-150 µm thick, composed of 2-3 layers of cortex; outer layer of small roundish to oval densely pigmented cells, (3-)5-10 µm diameter, inner layer of slightly larger roundish to ovate cells, 7.5 µm high and 10-12.5 µm diameter; medullary cells large, roundish, axially elongated and becoming larger inwards to 40 µm across and 90 µm long. Surface cells roundish to oval, 3-8×5-10 µm. Tetrasporangia borne in roundish sori on both sides of the upper portions of blades, elliptical to oblong, 15-18 µm across and 35-40 µm long, cruciately divided. Tetrasporangia develop from inner cortical cells. Cystocarps prominent, sessile, to 0.7×0.8 mm, scarsely scattered on both surfaces of the upper portions of the blades. Attachment by means of small discoid holdfasts and stolons. Growing on lower intertidal to subtidal rocks, dead coral blocks.

Collection sites in Hainan. Xian Hai.

**Family HYMENOCLADIACEAE**

***Asteromenia anastomosans*** **(Weber-van Bosse) G.W. Saunders, C.E. Lane, C.W. Schneider & Kraft (♣)**

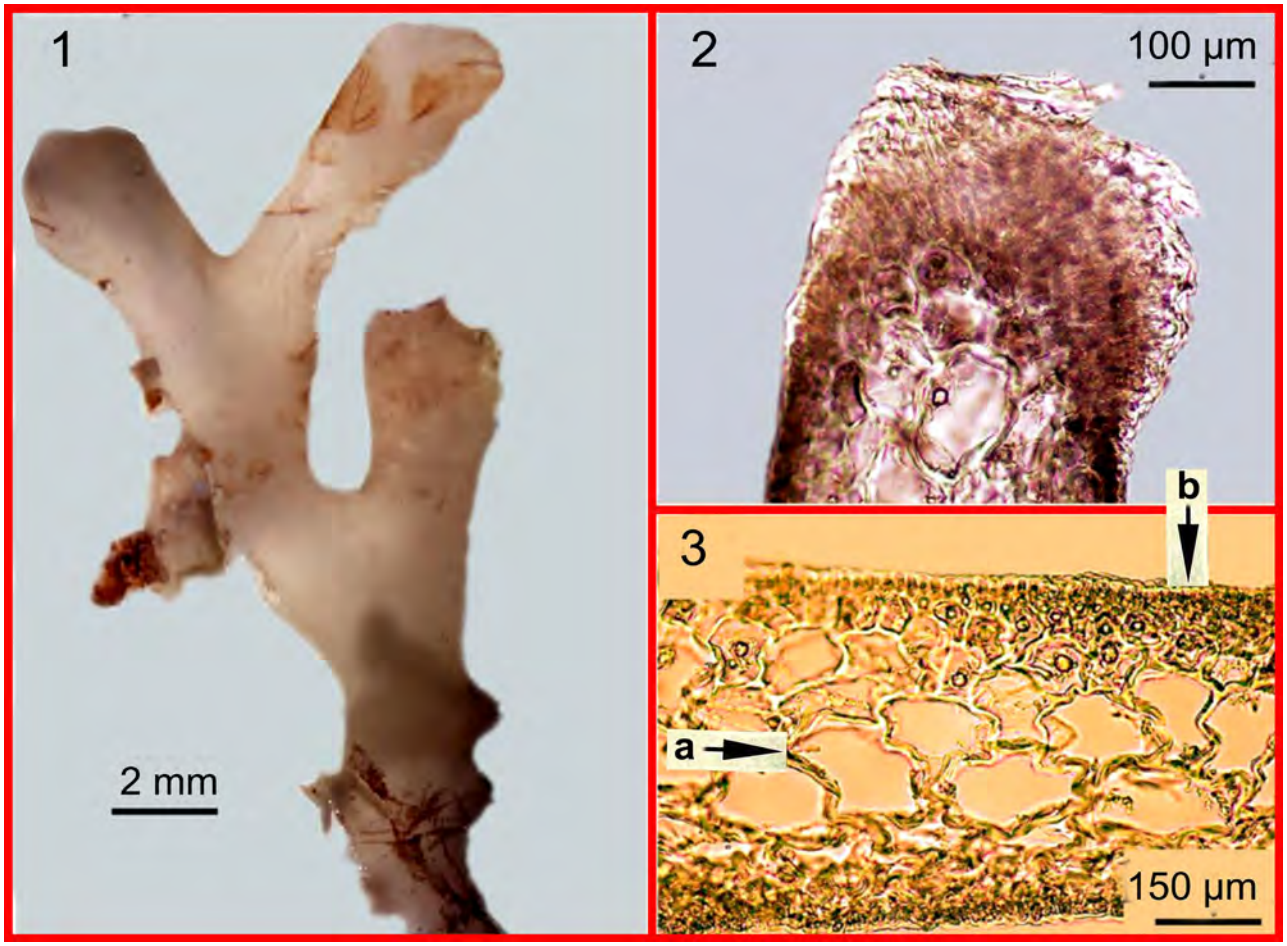


**Fig. 78** ***Asteromenia anastomosans.*** 1. Fragment of dried specimen. 2. Anastomosing branch tip. 3. Transverse section of dried thallus: a, medullary cells; b, cortical cells. Hainan Island, Xiaodong Hai, November 1990.

Characteristics: Thallus decumbent, 2.7 cm long. Branching irregular, pseudodichotomous. Blades strap-shaped, ligulate, 200-400(-600) µm thick, 2-3 mm wide, with numerous anastomosing outgrowths at margins and on the lower surface of blades (secondary attachments) with the other blades and the substratum. Attachment by stout, cartilaginous disc. In transverse section, medulla consists of 4-6 layers of large isodiametric or subrectangular cells, decreasing towards cortex. Cortex composed of 2-4 layers of cells small roundish to oval 6-7(-10) µm in diameter. Growing under corals, in shaded sites, in the uppermost subtidal zone. The alga was found on creeping stolons of *Sargassum polycystum*.

Collection sites in Hainan. Qingnan Gang, Xiaodong Hai.

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