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Studies on Chinese species of *Gelidiella* and *Pterocladiella* (Gelidiales, Rhodophyta)

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Key words: seaweed, *Gelidiella*, *Pterocladiella*, taxonomy, China

Abstract

A detailed study of materials from our herbarium shows the presence of two species of *Gelidiella* and three species of *Pterocladiella*, including two new records and a new species. Previously recorded species include *G. acerosa* and *P. capillacea*. *G. bornetii* and *P. caerulescens* are new records for China and *P. yinggehaiensis* is believed to be a new species. This new species is characterized by its small thalli, 1.5–2 cm high, that are more densely branched on the middle to upper parts for one half their lengths. These characteristics are so distinctive that they can be used to separate this species readily from other species now reported in this genus.

Introduction

Gelidiella was proposed by Feldmann & Hamel (1934) and *Pterocladiella* by Santelices & Hommersand (1997). Recently, we studied the Gelidiales from the herbarium of the Institute of Oceanology, Academia Sinica (AST) and found two species of *Gelidiella* and three species of *Pterocladiella*. Previously recorded species included *Gelidiella acerosa* (Forsskål) Feldmann *et* Hamel and *Pterocladiella capillacea* (Gmelin) Santelices *et* Hommersand. *Gelidiella bornetii* (Weber–van Bosse) Feldmann et Hamel and *Pterocladiella caerulescens* (Kützing) Santelices are new records for China, and *P. yinggehaiensis* sp. nov. is described here for the first time. These materials are important economic seaweeds, and together with *Gelidium* are used as raw materials for industrial or domestic production of agar in China.

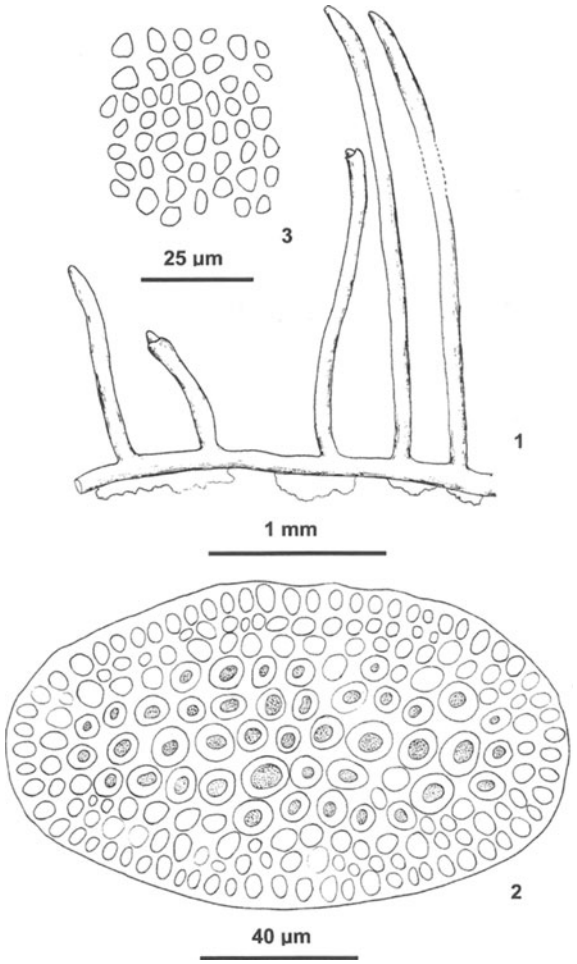
Key to the Chinese species of *Gelidiella* and *Pterocladiella*

1. Thallus with rhizoidal filaments within medullary tissue 3
1. Thallus lacking rhizoidal filaments within medullary tissue 2
2. Thallus small, erect parts 2–5 mm high, 139–158 μm broad, 83–86 μm thick ... *G. bornetii*
2. Thallus large, erect parts 5–7 cm high, about 1 mm broad, 797–930 μm thick ... *G. acerosa*
3. Thallus large, 5–15 cm high, consisting of one to several distichously, pinnately branched percurrent axes rising from a holdfast of entangled stolons, with pyramidal outlook ..... *P. capillacea*
3. Thallus small, less than 4 cm high, consisting of creeping parts and erect axes 4
4. Thallus blackish, 2–3.6 cm high, erect axes subcylindrical below, flattened or ligulate above, branching from pinnate to alternate ..... *P. caerulescens*
4. Thallus purple red, 1.5–2 cm high, compressed lower axes often naked, and dense palmate branches on the middle to upper parts of axes ..... *P. yinggehaeiensis*

Description of the species

Gelidiella bornetii **(Weber -van Bosse) Feldmann** *et* **Hamel** (Figs 1–3)

Feldmann & Hamel, Rev. Gen. Bot. 46: 535, 1934.
Basionym: *Gelidium bornetii* Weber–van Bosse, Vidensk. Medd. Dan. Naturhish. Foren. Kobenhavn 81: 107, 1926.



Figures 1–3. Gelidiella bornetii (Weber–van Bosse) Feldmann *et* Hamel (**AST** I Ph-99). **1.** Habit sketch of frond; **2.** Transection of erect branch; **3.** Surface view of part of cortex cells of frond.

Thallus is very small, purple red, the decumbent creeping filaments with vigorous rhizoids fixed to the substratum, from the basal part the erect filaments arise reaching a height of about 2–5 mm. The filaments are about 139–158 μm broad, erect axes usually unbranched, apices obtuse. In transverse section of erect filaments, they are more or less oval, showing that the thallus is cartilaginous and somewhat compressed, consisting of a medulla of roundish cells, 7–10 μm diam., one to two layers of smaller cortical cells, filaments 83–86 μm thick.

Only a few sterile specimens were found which agree well in size, manner of growth, general habit and transverse section of frond with Børgesen's description (1938: 210).

Habitat: Creeping on a piece of dead coral. Xiaodonghai, Hainan province, China.

Distribution: India, Indonesia (Type locality).

Remarks: Transverse sections of the thallii of Hainan and South Indian materials are more or less oval or somewhat compressed. This differs from the original description of Weber –van Bosse (1926:107) and more recent listing by Kraft & Abbott (1998:53), which indicate that axis symmetry is flattened throughout.

A new record for China.

Gelidiella acerosa **(Forsskål) Feldmann** *et* **Hamel** (Figs 4–8)

Feldmann & Hamel, Rev. Gen. Bot. 46: 533, 1934; Zhang & Xia, Studia Marina Sinica, 15: 21, Figure 1, Pl. I: 9, 1979; Xia, Xia & Zhang, In Tseng C. K. (ed.), Comm. Seaweeds China: 64, Pl. 35, Figure 4, 1983.

Basionym: Fucus acerosus Forsskål, Flor a Aegyptiaco-arabica: Post mortem auctoris edidit Carsten Niebuhr: 190, 1775.

Thallus 5–7 cm high, with several tufted, entangled, cylindrical, erect axes rising from creeping axes that are decumbent and arcuate, attached to the substratum by stoloniferous rhizoids; erect axes cylindrical, 3–6 cm long, about 1 mm broad, frequently incurved abaxially, normally with opposite or subopposite pinnate branch sometimes secondly branched, up to 15 mm long, generally shorter apically. Thallus in transverse section consisting of medulla of irregular roundish cells, 22–26 μm in diam., surrounded by small cortex cells, 6–8 μm × 3–5 μm; dull purplish, cartilaginous.

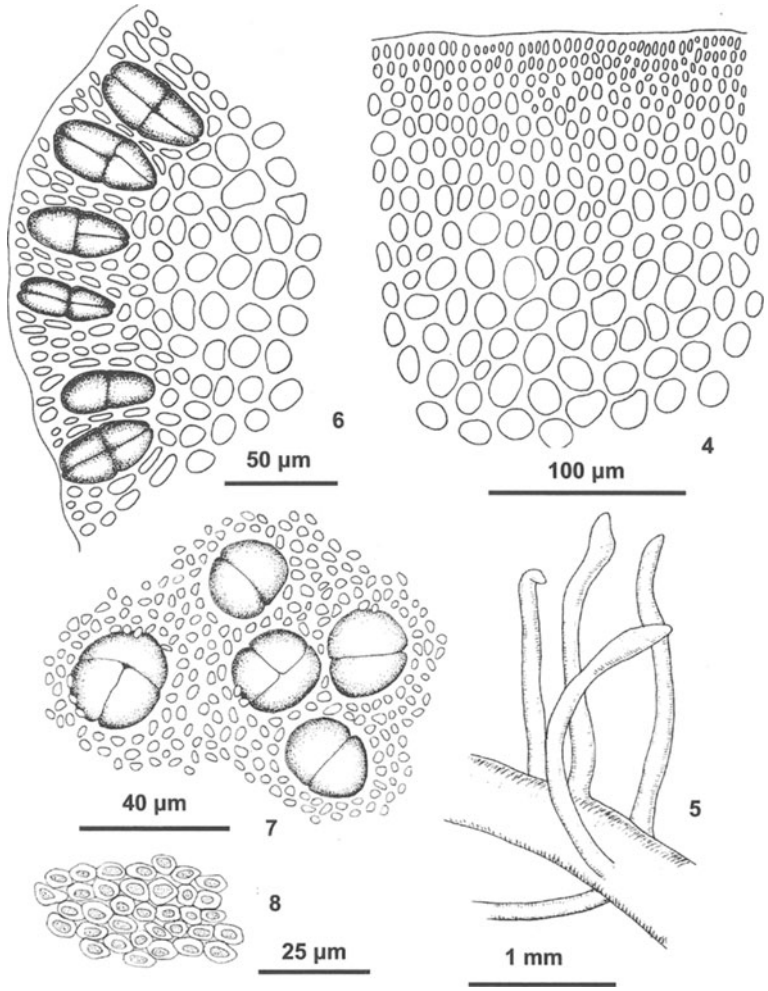
Tetrasporangia borne around the apical swollen part of the branchlets, in surface view, roundish, 23–30 μm × 17–26 μm, in transverse section, obovate, 48–70 μm × 26–32 μm, surrounded by slightly modified cortical cells, cruciately divided. Cystocarp and spermatangia unknown.

Habitat: Growing on intertidal or subtidal dead coral. Hainan and Taiwan Provinces.

Distribution: Common in the tropics, Red Sea (Type locality).

Pterocladiella caerulescens **(Kützing) Santelices** *et* **Hommersand** (Figs 9–16)

Santelices & Hommersand, Phycologia 36: 118, 1997.



Figures 4–8. Gelidiella acerosa (Forsskål) Feldmann *et* Hamel. **4.** Transection of part of frond (**AST** 76-1364); **5.** Tetrasporangial branchlet (**AST** 76-1364); **6.** Transection of tetrasporangia (**AST** 76-1364); **7.** Surface view of tetrasporangia (**AST** 54-4545); **8.** Surface view of part of cortex cells of frond (**AST** 54-4545).

Basionym: *Gelidium caerulescens* Kützing, Tab. Phyc. 18(1): 19, Pl. 56c, d, 1868.

Synonyms: *Pterocladia tropica* Dawson, Pac. Natur. I: 40, Figures 21 A–D, Figure 22 B, 1959.

Gelidium irregulare Loomis, Allan Hancock Found. Occas. Pap. 24: 6, Pl. 9, Figure 1, Pl. 10, Figures 1–2, Pl. 11, 2–3, 1960.

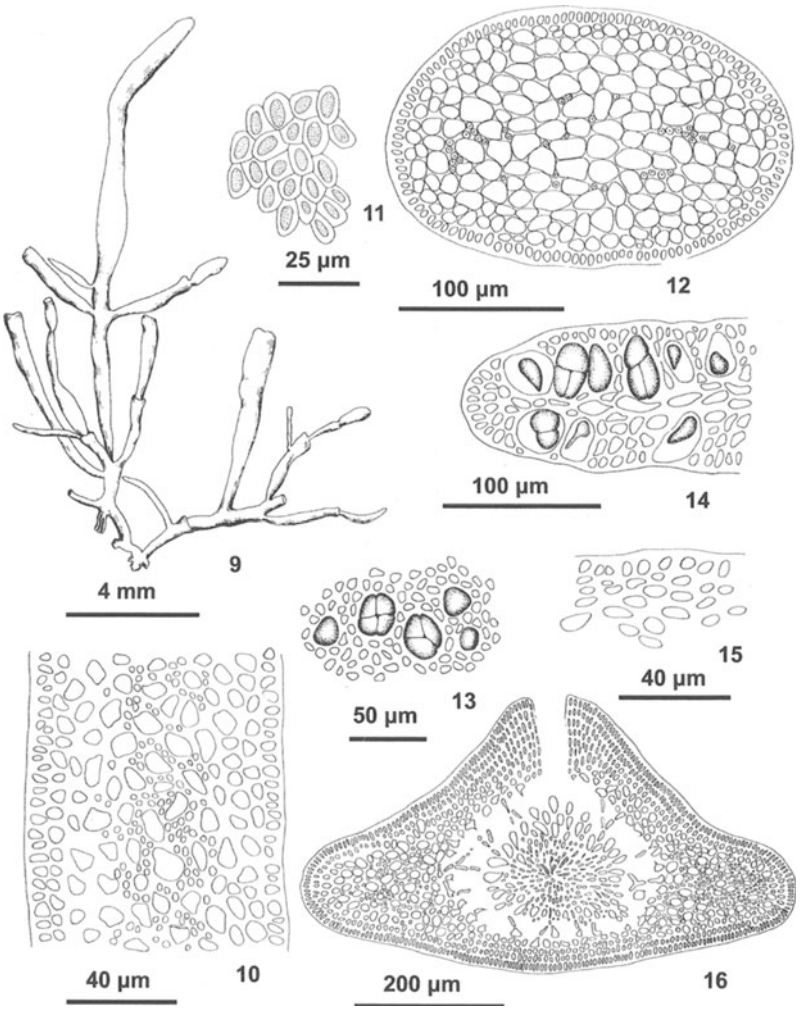
Pterocladia rigida Loomis, Allan Hancock Found. Occas. Pap. 24: 8, Pl. 12, Figs 1–4, 1960.

Pterocladiella caloglossoides sensu Xia *et* Wang *non P. caloglossoides* (Howe) Santelices. Tax. Econ. Seaweeds 7: 81–86, Figures 1–8, 1999.

Thallus erect, 2–3.6 cm high, flattened axes rising from subcylindrical or compressed creeping axes, attached to the substratum by peg-like holdfasts. Erect axes subcylindrical below, flattened above, 813–868 μm (up to 1 mm) broad, 76–79 μm thick; branching extremely irregular, from simple to alternate, pinnate or secund slightly constricted at base, with acute tips. Blackish, subcartilaginous, adhering slightly to paper on drying.

Transverse section showing numerous rhizoidal filaments aggregated within medullary tissue, medullary cells irregularly ovate or oblong, 13–17 μm × 7–12 μm, cortical cells 1–2 layers, 5–8 μm × 3.3–5 μm.

Tetrasporangia disposed in sori at apex of branches, with sterile margins; in surface view, tetrasporangia irregularly arranged, roundish, 26–33 μm in diam., in transverse section, ovate or obovate, 26–50 μm × 20–26 μm, cruciate. Cystocarps unilateral,



Figures 9–16. Pterocladiella caerulescens (Kützing) Santelices. **9.** Habit sketch of frond (**AST** 60-4586); **10.** Transection of erect branch (**AST** 60-4586); **11.** Surface view of part of cortex cells of frond (**AST** 93-0674); **12.** Transection of basal creeping axes (**AST** 93-0674); **13.** Surface view of tetrasporangia (**AST** 93-0674); **14.** Transection of tetrasporangia (**AST** 93-0674); **15.** Longitudinal section of pericarp (**AST** 93-0674); **16.** Longitudinal section of a cystocarp (**AST** 60-4586).

elongate swellings at the apex of branches, with a single ostiole on one surface of the frond and with sterile margins around the cystocarps. In longitudinal section of cystocarp, gonimoblast is usually attached on one side to the cystocarp floor, and produces chains of carposporangia on the remaining three sides. Spermatangia unknown.

Habitat: Growing in intertidal rock pools. Guangdong and Hainan Provinces.

Distribution: Hawaiian Islands, Guam, Vietnam, New Caledonia (Type locality).

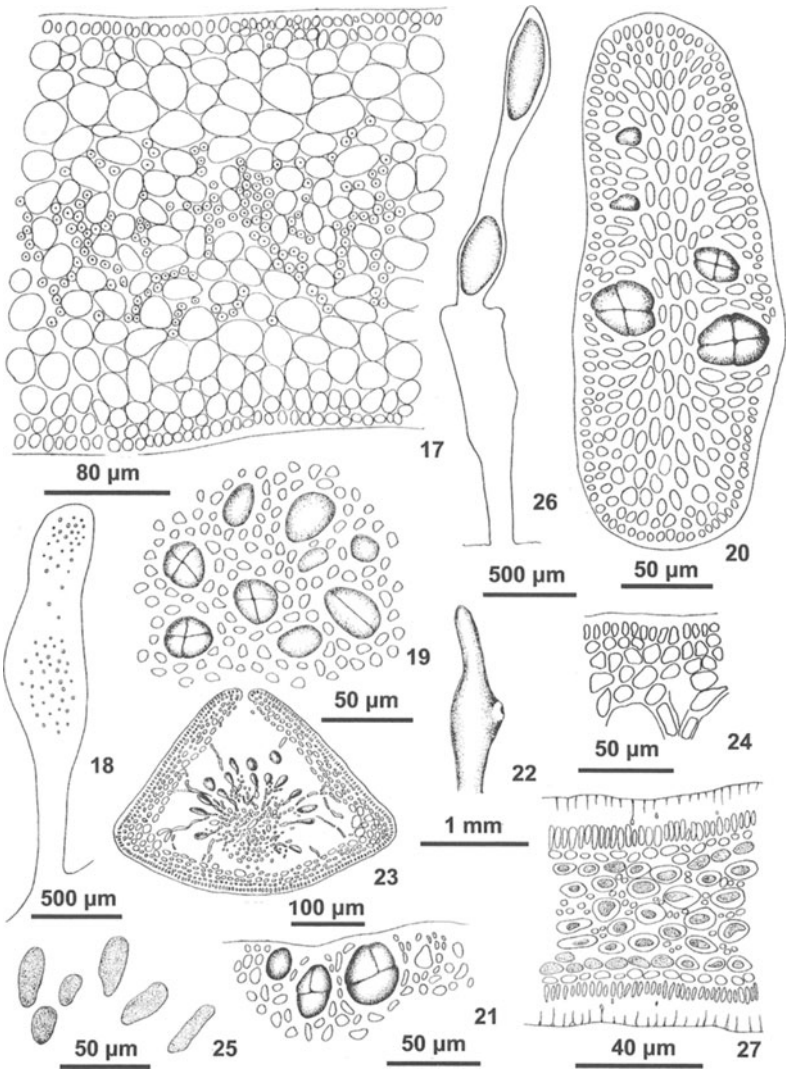
Remarks: Santelices (1976) demonstrated extensive morphological variation in Hawaiian populations of *Pterocladiella caerulescens*. This extensive morphological variation was also observed in Chinese materials.

Pterocladiella capillacea **(Gmelin) Santelices** *et* **Hommersand** (Figs 17–27)

Santelices & Hommersand, Phycologia 36: 118, 1997.

Basionym: *Fucus capillaceus* Gmelin, Historia fucorum: 146, Pl. 15, Figure 1, 1768.

Synonyms: *Pterocladia tenuis* Okamura, Jour. Imp. Fish. Inst. (Tokyo) 29(2): 62, Pl. 29, Pl. 30, Figure 3, Pl. 33, Figures 1–3, 1934; Tseng et al. Econ. Seaweeds China: 122, Pl. III: 56, Figures



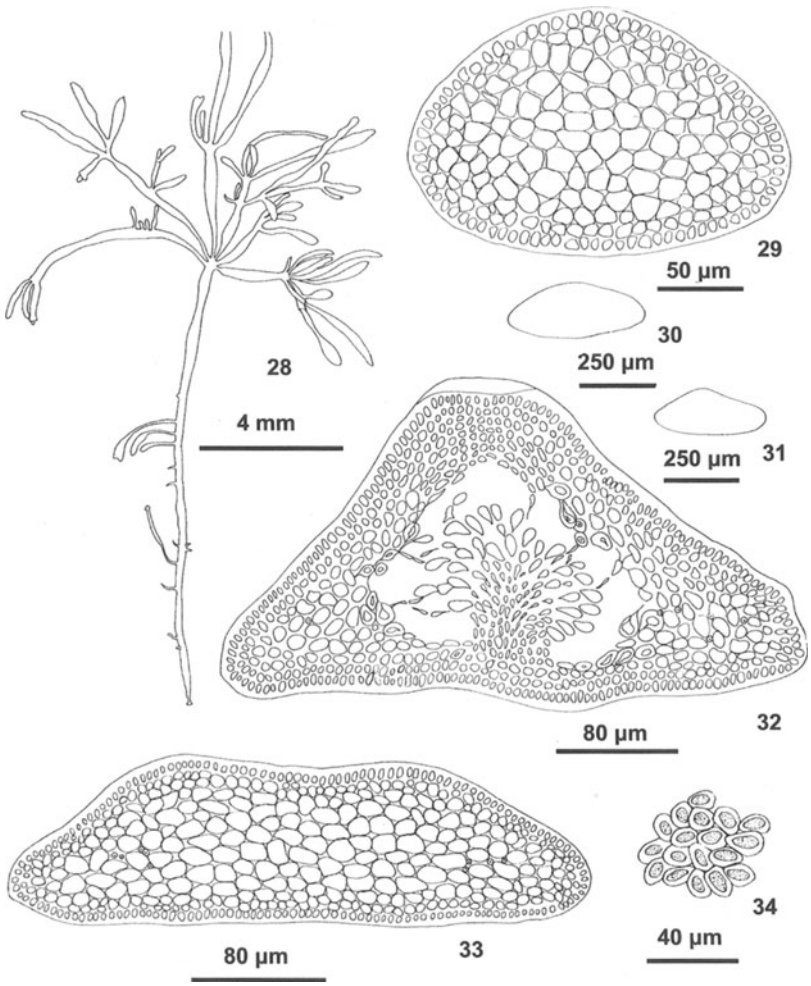
Figures 17–27. Pterocladiella capillacea (Gmelin) Santelices *et* Hommersand. **17.** Transection of part of frond 17 cm from apex (**AST** 64-99); **18.** Tetrasporangial branchlet (**AST** 57-531a); **19.** Surface view of tetrasporangia (**AST** 57-799); **20.** Transection of tetrasporangial branchlet (**AST** 57-799); **21.** Transection of tetrasporangia (**AST** 57-945); **22.** Cystocarpic branchlet (follows Tseng et al., 1962, Figure 28:4); **23.** Longitudinal section of a cystocarp (follows Tseng et al., 1962, Figure28:3); **24.** Longitudinal section of pericarp (**AST** 56-851); **25.** Carposporangia (**AST** 56-851); **26.** Spermatangial branchlet (**AST** 56-595); **27.** Transection of a spermatangial branchlet (**AST** 56-595).

27: 2, 28: 3–4, 1962; Xia, Xia & Zhang, In Tseng, C. K. (ed.), Comm. Seaweeds. China: 68, Pl. 37, Figure 3, 1983.

Thalli purplish red, compressed, 5–15 cm high, consisting of one to several distichously, pinnately branched percurrent axes rising from a holdfast of entangled stolons. The erect axes are slightly flattened below, strongly flattened above, with spatuliform or attenuated apices, up to 0.5 mm in diam. at their bases and up to 1.8 mm broad in the flat parts. Branching pinnately 2–3 times with pyramidal outline, with opposite or alternate pinnules, 1–2 mm broad, abruptly constricted at the base and with obtuse apices. Cartilaginous, adhering slightly to paper on drying.

In transverse section, rhizoidal filaments scattered only in the middle portion of the central tissue, medullary cells irregularly oblong, 23–30 μm × 10–23 μm; cortical cells 1–2 layers, round or square, 3.3–5 μm.

Tetrasporangial sori in ultimate ramuli, scattered among the cortical layers of frond, circular or ovoid in surface view, 26–30 μm × 23–30 μm, ovoid or



Figures 28–34. Pterocladiella yinggehaiensis Xia *et* Tseng sp. nov. (**AST** 93-0768). **28.** Habit sketch of frond; **29.** Transection of basal creeping axes; **30.** Transection of upper part of erect branch; **31.** Transection of lower part of erect branch; **32.** Longitudinal section of a cystocarp; **33.** Transection of middle axes; **34.** Surface view of part of cortex cells of frond.

circular in transverse section, 33–40 μm × 23–33 μm, cruciately divided, surrounded by modified cortical cells. Cystocarps formed on the median axis of ramuli, swollen on one side, roundish, 249–300 μm × 300–332 μm, slightly rostrate, nonconstricted at base; in longitudinal section, gonimoblast consisting of very small cells, carposporangia oblong or ovoid, 26–40 μm × 13–20 μm; pericarp 33–53 μm thick, consisting of 4–5 cells layer. Spermatangial sori on slightly compressed ramuli, 498-697 μm long and 149 μm in diameter, spermatangia cut off directly from outer cortical cells.

Habitat: Growing on intertidal to subtidal rocks.

Distribution: Common on entire Chinese coast, Mediterranean (Type locality).

Pterocladiella yinggehaiensis **Xia** *et* **Tseng sp. nov.** (Figs 28–34)

Thallus parvus, 1–2 cm altus, dense caespitosus: rami erecti orientes ex axibus 132–145 μm diametro, compressis, repentibus, affixis ad substratum per haptera parva et obtusa. Rami erecti compressi, 316–389 μm lati, irregulariter 3–5(-9)-plo palmati in partibus superis. Fila rhizoidea rara intra medullam. Cystocarpia prope extrema ramorum liberorum.

Holotype: AST 93-0768, Cystocarpic, growing on lower intertidal rocks. Collected by Xia Bangmei, Kuang Mei and Wang Yongqiang at Yinggehai, Hainan Island, Hainan Province, China, September, 21, 1993.

Thallus small, 1–2 cm high, growing as a dense tuft, erect branches rising from compressed creeping axes, attached to the substratum by peg-like holdfasts. Erect axes compressed, 316–389 μm broad, 100–166 μm thick; more densely branched on the middle to upper parts (or rarely on branchlets) for one half their lengths, with branches 3–5 (-9) times palmate, apex obtuse and often broken, slightly constricted at base; rarely proliferous from surface; purple red, cartilaginous.

Transverse section creeping stem 132–145 μm broad, 165–224 μm thick, consisting of a medulla of irregularly angular parenchymatous cells, 11–20 μm × 8–13 μm, one layer of smaller cortical cells, 7–9 μm × 4–7 μm; transverse section erect axes consist of a medulla of irregularly angular parenchymatous cells, 10–17 μm × 7–13 μm, with one layer of smaller cortical cells, 7–10 μm × 4–6 μm, rare rhizoidal filaments found within two edges of compressed medullary tissue.

Cystocarps unilateral, prominently protruding, triangular, 290 μm high, 422 μm broad, rostrate, unconstricted at base; gonimoblast consisting of few small cells, chains of carposporangia radiating from a core of gonimoblast filaments surrounding the central axis, carposporangia obovate, 17–26 μm × 8–10 μm, pericarp 53–59 μm thick, consisting of 5-8 layers of cells, some inner cells elongated, extending to the placenta. Tetrasporangia and spermatangia unknown.

Remarks: Pterocladiella yinggehaiensis is characterized by its small thalli that are more densely branched on the middle to upper parts for one half their lengths. These characteristics are so distinctive that they can be used to separate this species readily from all other species now reported in this genus.

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