

Contribution to The Study of *Gracilaria* and relative genera (Gracilariales, Rhodophyta) from Vietnam

Nhu Hau LE¹ and Huu Dai NGUYEN²

¹Institute of Material Science, Nha Trang Branch, Vietnam

²Institute of Oceanography, Nha Trang, Vietnam

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Abstract—More than 1500 specimens of *Gracilaria sensu lato* (*Gracilaria*, *Gracilariopsis*, and *Hydropuntia*) collecting by previous authors along the coast of Vietnam and our new material, which are deposited in the herbaria of the Institute of Oceanography, Nha Trang (ION), Institute of Material Science, Nha Trang Branch (IMS) and Institute of Oceanology, Hai Phong Branch (IOH), have been studied. We re-examined almost herbarium specimens of 33 *Gracilaria* taxa had been published by Dawson (1954); Pham Hoang Ho (1969), Nguyen Huu Dinh (1992), Nguyen Huu Dinh et al (1993) and Nguyen Van Tien (1994). Some of them were misidentified or misapplied names. In this paper, 19 Vietnamese species of *Gracilaria sensu lato* were discussed and critically adjusted. The structure of male and female reproductive organs, particularly the formation of spermatangia has been studied carefully. Five of the nineteen were added for the flora: *Gracilaria rubra*, *G. cuneifolia*, *G. longirostris*, *G. yamamotoi*, and *Hydropuntia divergens*

Key words: *Gracilaria*, *Gracilariopsis*, *Hydropuntia*, Seaweed, Taxonomy, Vietnam

Introduction

The genus *Gracilaria* and relative genera (Gracilariales, Rhodophyta) include many species with taxonomic difficulties, primarily due to incomplete knowledge of their reproductive features and a high degree of morphological variability. Currently, some authors agree with the opinion of the segregation from *Gracilaria* Greville of *Gracilariopsis* Dawson and *Hydropuntia* Montagne (= *Polycavernosa* Chang et Xia) (Fredericq and Hommersand 1989, Gurgel and Fredericq 2004, Terada et al. 2004). *Hydropuntia* is characterized by nutritive filaments that connect the lower gonimoplast cells with the cells of the cystocarpic floor, and spermatangial conceptacles with several cavities. This separation was supported by Gurgel and Fredericq (2004) on the basis of plastid rbcL DNA sequence analyses. *Gracilariopsis* has no nutritive filaments in cystocarps and Fredericq & Hommersand (1989) had added a character of spermatangia on the surface of plant. All the remained species have shallow or pot-shaped spermatangial conceptacles belonging to the *Gracilaria* genus.

In Vietnam, 33 taxa of *Gracilaria*, *Gracilariopsis*, and *Polycavernosa* had been published by previous authors: Dawson (1954), Pham Hoang Ho (1969), Nguyen Huu Dinh (1992), Nguyen Huu Dinh et al. (1993) and Nguyen Van Tien (1994). Some of them were misidentified and their reproduc-

tive features were unknown. In this paper we report the results of the re-examination of these species. However, this paper was not concerned with *Gracilariopsis nganii* Phamhoang and *Gracilariopsis phanthietensis* Phamhoang, the two isotype specimens deposited in ION were only female, and we have not yet found new material from these type localities.

Materials and Methods

More than 1500 herbarium specimens of previous authors and our recently collected material which are deposited in the herbaria of Institute of Oceanography Nha Trang (ION), Institute of Oceanography, Haiphong Branch (IOH), and Institute of Materials Science, Nha Trang Branch (IMS) have been studied. Sections were cut by hand with single-edged razor blades. Microscope slide materials, rehydrated, and then stained with a mixture of about 0.3% aniline blue in glucose syrup to which a drop of 1% HCl was added when used. Sections were mounted in about 35% glucose syrup with phenol crystals added. Drawings were made by using a camera OLYMPUS DP12 attached to Leica DMLB compound microscope. Photographs were done by photoshop 7.0.

Results and Discussion

Gracilariopsis Dawson, 1949

1. *Gracilariopsis bailinae* Zhang et Xia, 1991: 290 (Fig. 5a)

— *Gracilaria bailinae* (Zhang et Xia) Zhang et Xia, 1999: 31
— *Gracilaria heteroclada* Zhang et Xia, 1988: 132; Nguyen Huu Dinh 1992: 207; Ohno et al. 1999: 107.

Specimens examined: Phu Yen (Song Cau), Dai00601–00610 (ION); Khanh Hoa, Hau 03528–03550, 04610–615; Ninh Thuan, Dinh 94215, 97312, 98529, 0211–02119, Hau 03511–27; Phan Thiet (Thanh Hai), Hau 03622–630 (IMS).

Local distribution: common in central Vietnam, from Binh Dinh to Vung Tau, cultured in lagoons and shrimp ponds.

Remarks: This species was described by Zhang and Xia (1991) from China. Later, it was transferred to *Gracilaria bailinae* by Zhang and Xia (1999). They have spermatangia on the surface of plant and the absence of nutritive filaments. In Vietnam, It was first listed by Dinh (1992) as *Gracilaria heteroclada*.

Gracilaria Greville, 1830

2. *Gracilaria arcuata* Zanardini, 1858: 265 (Fig. 5b)

Nguyen Huu Dinh et al. 1993: 246

Specimens examined: Quang Ngai (Ly Son Island), Hau 203382–23400 (IMS), Dai 21019–21029 (ION); Khanh Hoa (Nha Trang), Dai 99160 (ION); Khanh Hoa (Pratley archipelago), Hau 20034–20040; Ninh Thuan, Hau 81526–29, 78231, 86210, 99205–217 (IMS).

Local distribution: common in littoral coasts from Quang Ninh to Vung Tau

Remarks: Plant usually solitary, cylindrical, spermatangial conceptacles is *verrucosa*-type, with nutrient filaments in cystocarps. This species was first reported by Pham Hoang Ho (1969), But this was a misidentified from the material collected in Phu Quoc Island (fig. 2. 115).

3. *Gracilaria blodgettii* Harvey, 1853: 111 (Fig. 5c)

Fredericq and Norris, 1992: 211; Zhang and Xia, 1999: 35.

— *Gracilariopsis rhodotricha* sensu Dawson, 1954: 439; and sensu Pham Hoang Ho, 1969: 182 (Non *G. rhodotricha* Dawson, 1949).

Specimens examined: Khanh Hoa (NhaTrang), Dawson 11216a, 11090 (ION), Hau 02015, 04501–04515 (IMS),

Local distribution: Khanh Hoa (Nha Trang, Cua Be)

Remarks: This species is similar to *G. firma* in external appearance. However, the latter has the *verrucosa*-type spermatangial conceptacles (Chang et Xia, 1976), while the former belong to the *textorii*-type. Dawson (1954), identified the specimens which were collected in Khanh Hoa (Nhatrang, Cua Be) as *Gracilariopsis rhodotricha* Dawson on the basis of cystocarpic materials. We examined Dawson's

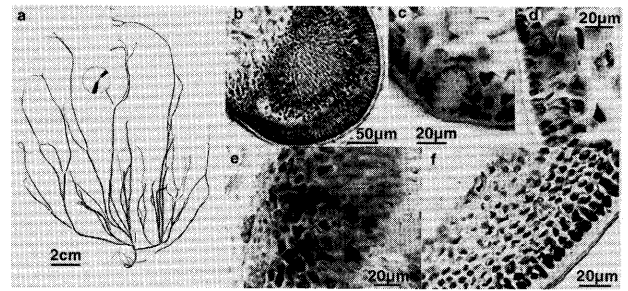


Fig 1. *Gracilaria firma* (a) Habit of plant (specimens IMS 670319). (b) Longitudinal section of cystocarp. (c) Transverse section of spermatangial conceptacle, showing *verrucosa*-type. (d) Transverse section of tetrasporangia, showing cruciately divided. (e) Gonimoblast of small cells in longitudinal section of cystocarp. (f) Longitudinal section of pericarp.

materials (ION) and our new materials were also collected at the same locality of Dawson's herbarium materials, we saw that some cystocarps of the same plants having the distinctive nutritive filaments running from gonimoblast to pericarp but the others lack nutritive filaments, and cup-shaped *textorii*-type spermatangial conceptacles. So, *Gracilariopsis rhodotricha* were misapplied for Vietnamese specimens by Dawson (1954), and should be changed to *Gracilaria blodgettii* Harvey.

4. *Gracilaria cuneifolia* (Okamura) Lee et Kurogi, 1977: 113 (Fig. 5d)

Zhang and Xia, 1994: 103; Xia and Zhang, 1999: 44; Le Nhu Hau, 2004: 82

— *Rhodymenia cuneifolia* Okamura, 1934: 16

Specimens examined: Khanh Hoa (Nha Trang), Hau 201102–105, 202105–109, 204361–375 (IMS)

Local distribution: Khanh Hoa (NhaTrang, Cua Be)

Remarks: Cystocarps with nutrient filaments, in external appearance, this species resembles to *G. sublittoralis*, but it is different from the latter in *Verrucosa*-type spermatangial conceptacles (Yamamoto 1978) instead of the *Textorii*-type. It was first reported in Vietnam by Hau (2004).

5. *Gracilaria firma* Chang et Xia, 1976: 143. (Fig. 1)

Lewmanomont, 1994: 139; Xia et Zhang, 1999: 49; Ohno et al. 1999: 104.

— *Gracilaria hainanensis* sensu Nguyen Huu Dinh, 1969: 44 and Nguyen Huu Dinh et al. 1993: 248 (Non *G. hainanensis* Chang et Xia),

— *Gracilaria blodgettii* sensu Nguyen Huu Dinh, 1969: 33 and Nguyen Huu Dinh et al. 1993: 248 (Non *G. blodgettii* Harv.)

— *Gracilaria articulata* sensu Nguyen Huu Dinh, 1992: 208 (Non *G. articulata* Chang et Xia)

Specimens examined: Hai Phong, Tien 65831, 67019 (IOH); Quang Ninh, Dinh 670032, 670036, 670319; 670305, 690635 (ION), Hau 03290–299 (IMS).

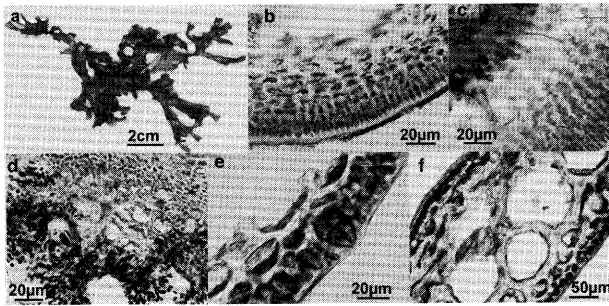


Fig. 2. *Gracilaria mammillaris* (a) Habit of plant (specimens IMS 03812), (b) Longitudinal section of pericarp, (c) Nutrient filaments connecting to pericarpic cells, (d) Longitudinal section of gonimoblast, consisting of large-sized cells, (e) Transverse section of tetrasporangia, (f) Transverse section of blade.

Local distribution: common in Vietnam, cultured in lagoons and shrimp ponds.

Remarks: This species has been characterized by firm in texture, gradual transition from cortex to medulla, small gonimoblast cells, without nutritive filaments in cystocarp and deep pot-shaped *Verrucosa*-type spermatangial conceptacles. We re-examined herbarium specimens (identified under the name *G. hainanensis*, *G. blodgettii* and *G. articulata*) (ION) and new materials collected in the north Vietnam, they have the characters of *G. firma*. We proposed to rename these herbarium specimens to *G. firma*. This species was first reported in Vietnam by Ohno et al. (1999) from Kien Giang (Hatien).

6. *Gracilaria longirostris* Zhang et Wang, 1995: 197 (Fig. 5e)

Xia and Zhang, 1999: 58; Le Nhu Hau, 2004: 84

Specimens examined: Hue (Thuan An), Hau 203601–203606(IMS).

Local distribution: Thua thien-Hue (Thuan An)

Remarks: This species may have the nutritive filaments in cystocarps or not, and cup-shaped *textorii*-type spermatangial conceptacles. It is characterized by the long rostrate ostiole on top of cystocarp. This species was first reported in Vietnam by Hau (2004).

7. *Gracilaria mammillaris* (Montagne) Howe, 1918: 515 (Fig. 2)

Taylor, 1960: 447; Pham Hoang Ho, 1985: 138.

Specimens examined: Kien Giang (Phu Quoc Island, Duong Dong), Ho 61005 (ION), Hau 20105–136, 03500–03510, 03812–831 (IMS).

Local distribution: Kien Giang (Phu Quoc Island, Duong Dong)

Remark: Plant flattened, 250 mm thick, membranaceous, medulla consisting 7–10 layers of large cells up to 125 (µm in diam.), more or less regularly dichotomously branched, three to five times in same plane, margins entire, undulate or

twisted, nutritive filaments in cystocarps. Our materials closely resembles to *G. dawsonii* (Hoyle, 1994, fig. 7) in external appearance, but it differs from the latter which has medulla consisting 10–13 layers of large cells up to 250 (µm in diam). Although a large number of materials of this species had been collected in September 19, 2003 from Phu Quoc Island; but we did not find any spermatangial plant yet. It was first reported in Vietnam by Ho (1985).

8. *Gracilaria rubra* Chang et Xia, 1976: 100 (Fig. 5f)

Xia and Zhang, 1999: 65; Le Nhu Hau, 2004: 85

Specimens examined: Khanh Hoa (Nha Trang, Cua Be), Hau 02041–065, 04102–122 (IMS)

Local distribution: Khanh Hoa (Nha Trang, Cua Be)

Remark: This species was originally described by Zhang and Wang (1995) from Hainan Island, Guangdong province, China. Plant is terete throughout and abruptly constricted at branch bases, pot-shaped *verrucosa*-type spermatangial conceptacles. It is distinguished from *G. rhodotricha* (Dawson) Papenf. by having abundant nutritive filaments in cystocarps. It was first reported in Vietnam by Hau (2004).

9. *Gracilaria salicornia* (C. Agardh) Dawson, 1954: 4 (Fig. 5g)

Ohmi, 1958, 27; Yamamoto, 1978: 135; Nguyen Huu Dinh, 1969: 36; Nguyen Huu Dinh et al. 1993: 244.

— *Sphaerococcus salicornia* C. Agardh, 1820: 302.

— *Gracilaria crassa* Harvey ex J. Agardh, 1876: 417; Dawson, 1954: 438; Pham Hoang Ho, 1969: 186; Nguyen Huu Dinh, 1969: 43

— *Gracilaria cacalia* (J. Ag.) Dawson, 1954: 2; Nguyen Huu Dinh, 1969: 38 Nguyen Huu Dinh et al. 1993: 245.

Specimens examined: Quang Ninh (Tien Yen), Dinh 69644 (ION); Quang Ngai (Ba Lang An) 99220–231 (IMS); Khanh Hoa, Dai 5112, 81023, 81024, 76002, 81023, 80024, 99620 (ION), Hau 01100–150, 97110–115; Ninh Thuan, Hau 97230–246, 02110–115, 02160–169; Kien Giang, Hau 93231, 79184–189 (IMS).

Local distribution: Common in Vietnam

Remarks: Plant has nutritive filaments in cystocarps and pot-shaped spermatangia conceptacles. Xia (1986) merged 4 related species *G. crassa*, *G. cacalia*, *G. minor*, *G. opuntia* into *G. salicornia* due to the degree of constrictions at the branch bases was not distinguishable among them. The articulated and constricted segments of this species are very distinctive with other species of *Gracilaria*. This species was reported in Vietnam as *G. crassa* by Dawson (1954), Ho (1969), and as *G. cacalia* by Dinh (1969).

10. *Gracilaria spinulosa* (Okam.) Chang et Xia, 1976: 148 (Fig. 5h)

Nguyen Huu Dinh, 1992: 208; Xia and Zhang, 1999: 69.

— *Rhodymenia spinulosa* Okamura, 1934: 33.

— *Gracilaria purpurascens* J. Ag., 1885: 63

— *Gracilaria purpurascens* (Harv.) J. Ag. f. *spinulosa* (Okam.) Yamada, 1941: 204; *Gracilaria denticulata* Okam., 1931: 113 (non *G. denticulata* Schmitz),

— *Gracilaria puntata* sensu Nguyen Huu Dinh et al. 1993: 237 (Non *G. puntata* (Okam.) Yamada

Specimens examined: Nghe An (Quynh Tien), Dinh 64027 (4 sheets) (ION); Hau 03315–03317 (IMS)

Local distribution: Nghe An (Quynh Tien)

Remark: This species was first listed by Nguyen Huu Dinh (1992). The plant was distinguished from *G. puntata* which has entire margins, stipe expanding abruptly into broad blade, dark brown spots of hairs over the surfaces, several nutritive filaments in cystocarps, cells of pericarp arranged in vertical rows. Examination of the specimens Dinh 64027 (4 sheets) (ION) collected April, 26th 1964 at Nghe An (Quynh Tien) (under the name *G. puntata*), and also new materials on May, 30th 2003 (in the same place), they have dentate margin, many cystocarps as black spots on surfaces, stipe expanding gradually into broad blade, no nutritive filaments in cystocarps, cup-shaped *Textorii*-type spermatangial conceptacles, cells of pericarp not arranged in vertical rows. So we proposed to rename the herbarium specimens of *G. puntata* (ION) to *G. spinulosa*.

11. *Gracilaria tenuistipitata* Chang et Xia, 1976: 161 (Fig. 5i)

Nguyen Huu Dinh, 1992: 207; Nguyen Van Tien, 1994: 107; Ohno et al. 1999: 109

— *G. asiatica* sensu Nguyen Huu Dinh, 1992: 207 (Non *G. asiatica* Chang et Xia)

— *G. bursa-pastoris* sensu Nguyen Huu Dinh, 1993: 241 [Non *G. bursa-pastoris* (Gmel.) Silva]

— *G. gigas* sensu Nguyen Huu Dinh, 1969: 45 and Nguyen Huu Dinh, 1993: 242 (Non *G. gigas* Harv.)

— *Gracilaria confervoides* f. *ecorticata* sensu Pham Hoang Ho, 1969: 183. (Non *G. confervoides* f. *ecorticata* Valerie)

— *G. chorda* sensu Nguyen Huu Dinh, 1969: 45 and Nguyen Huu Dinh, 1993: 249. (Non *G. chorda* Holm.)

— *G. verrucosa* sensu Nguyen Huu Dinh, 1993: 249 and sensu Pham Hoang Ho, 1969: 182. [Non *G. verrucosa* (Huds.) Papenf.]

Specimens examined: Quang Ninh, Dinh 69648, 69684, 69648 (9 sheets) (ION), 69638, 69648 (IMS), 64131 (IOH). (misidentified name *G. bursa-pastoris*); Quang Ninh, Dinh 67304 (ION), 69641, 67304 (IMS), Tien 670304 (IOH); Hai Phong, Dinh 66499, 66494, 69641 (ION), 66501 (IMS) (misidentified name *G. gigas*). Hai Phong, Tien 93625, 93642 (IOH), Dinh 94252 (IMS) (misidentified name *G. asiatica*). Quang Ninh, Dinh 69192, 68362, 69347, 68363, 691127 (IMS) (misidentified name *G. chorda*). Hai Phong, Dinh 65271, 65272, 65256 (ION), 65272 (IMS) (misidentified name *G. verrucosa*).

Hue, Hau 98100–119, 03250–03260, 03401–03407 (IMS) (*G. tenuistipitata*).

Local distribution: Common in Vietnam, cultured in lagoons and shrimp ponds.

Remarks: Although the habit of plants of these *Gracilaria* specimens showing extreme morphological variation, but their anatomy of vegetative and reproductive organs was the same, cystocarps with or without nutritive filaments, cup-shaped *textorii*-type spermatangial conceptacles. So, we proposed to change these misapplied names to *G. tenuistipitata*. A variety was recognized as *G. tenuistipitata* var. *liui* Zhang et Xia, which was reported from Vietnam by Ohno et al. (1999) and Abbott et al. (2002). Re-examination of herbarium specimens: Phu Yen, Luong Cong Kinh 6100, 3129 (ION) (misidentified name *G. verrucosa*). Phu Yen, Luong Cong Kinh 61130 (ION) (misidentified name *Gracilaria confervoides* f. *ecorticata*). They resemble to *G. tenuistipitata* var. *liui* in the external morphology and *textorii*-type spermatangial conceptacles. So, we proposed to change these specimens to *G. tenuistipitata* var. *liui*.

12. *Gracilaria textorii* (Suringar) De Toni, 1895, 27 (Fig. 5j)

Nguyen Huu Dinh, 1969: 49; Nguyen Huu Dinh et al. 1993: 236.

— *Gracilaria foliifera* (Forsk.) Boerg. sensu Nguyen Huu Dinh et al. 1993: 238 [non *G. foliifera* (Forsk.) Boerg]

Specimens examined: Hai Phong (Do Son), Dinh 67429, 67527, 670013, 670014, 670076, 670077, 670067b (ION); Tien 93024 (IOH)

Local Distribution: Hai Phong (Do Son)

Remark: This species is easy to distinguish from the other flattened species by irregularly dichotomous branches and nutritive filaments absence in cystocarps. Herbarium specimens Dinh 670076, 670013, 670013b, 670067b (ION) collected in Hai Phong (Do Son) assigned to the name *G. foliifera*, but fortunately, one of them is male plant with spermatangial conceptacles of *textorii*-type, so it must not be *G. foliifera* (with spermatangial conceptacles of *Polycavernosa*-type). So we proposed to change these specimens to *G. textorii*. This species was first reported in Vietnam by Dinh (1969).

13. *Gracilaria yamamotoi* Zhang et Xia, 1994: 106 (Fig. 5k)

Xia and Zhang, 1999: 76; Le Nhu Hau, 2004: 83

Specimens examined: Nghe An (Quynh Tien), Hau 03342–351 (IMS)

Local distribution: Nghe An (Quynh Tien)

Remarks: Plant caespitose, flattened, purplish red, 5–6 cm high, 3–4 (5) mm wide, branches somewhat undulate, blunt apices, with entire margins, cup-shaped, *Textorii*-type spermatangial conceptacles, with nutritive filaments in cysto-

carps. This species closely resembles with *G. textorii* (Suringar) De Toni in di-subdichotomous branching in one plane and cup-shaped *textorii*-type spermatangial conceptacles, but easily distinguished from the latter by having a branched tuft at the upper parts, construction of pericarp with small gonimoblast cells. It also resembles *G. glomerata* Zhang et Xia in external appearance, but differ from the latter which has only one kind of pericarpic cells and only five layers of medulla cells. This species was first reported in Vietnam by Hau (2004).

Hydropuntia Montagne, 1842

14. *Hydropuntia changii* (Xia et Abbott) Wynne, 1989: 476 (Fig. 5l)

— *Polycavernosa changii* Xia et Abbott, 1987: 407.

— *Gracilaria changii* (Xia et Abbott) Abbott, Zhang et Xia, 1991: 23. Ohno et al. 1999: 102.

Specimens examined: Kien Giang (Ha Tien), Dinh 93622–652, Hau, 98216–248 (IMS).

Local distribution: Kien Giang (Ha tien, Phu Quoc Island)

Remarks: Plant is terete with abruptly constricted at the base of branches, and multicavities, *Polycavernosa*-type spermatangial conceptacles. It resembles *G. blodgettii* Harvey in external appearance, but differs from the latter which has shallow *Textorii*-type spermatangial conceptacles. This species was first reported in Vietnam by Ohno et al. (1999).

15. *Hydropuntia divergens* (Xia et Abbott) Wynne, 1989: 477 (Fig. 3)

— *Polycavernosa divergens* Xia et Abbott, 1987: 408.

— *Gracilaria stellata* Abbott, Zhang et Xia, 1991: 22; Le Nhu Hau, 2004: 86

Specimens examined: Quang Ngai (Ly Son Island) Hau 03371–381; Ninh Thuan (My Hoa) Dinh 93527–565; Hau 03432–442, 03740–787 (IMS); Dai 80012–13 (ION).

Local distribution: Quang Ngai (Ly Son Island), Ninh Thuan (My Hoa)

Remark: This species was originally described by Xia and Abbott (1987) as *Polycavernosa divergens* from Bulusan, Sorsogon, Philippines. Later, Wynne (1989) transferred to *Hydropuntia* and Abbott et al. (1991) transferred again to *Gracilaria*. It is terete throughout with many branches, slightly constricted at the base of branches, and multicavities, *Polycavernosa*-type spermatangial conceptacles. It resembles *G. subtilis* in external appearance, but it differs from the latter by having subcortex cells in tetrasporangial plants and the pericarpic cells with star-shaped contents; medullary cells with thick walls (12–25 μm). This species was first reported in Vietnam by Hau (2004) as *Gracilaria stellata*.

16. *Hydropuntia edulis* (Gmelin) Gurgel et Fredericq, 2004: 155 (Fig. 5m)

— *Fucus edulis* Gmelin, 1768: 113.

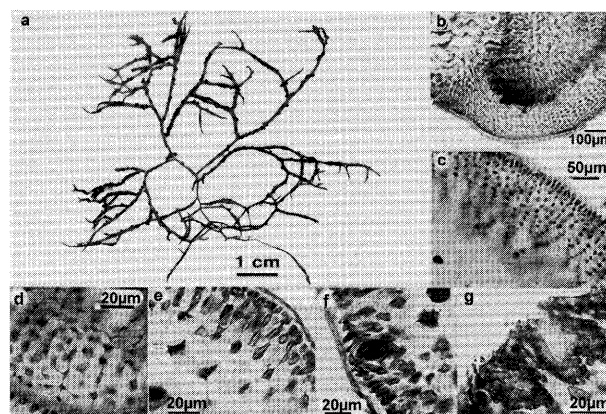


Fig. 3. *Hydropuntia divergens*. (a) Habit of plant (specimens IMS 02432). (b) Longitudinal section of cystocarp. (c, d) Longitudinal section of pericarp showing the cells consisting of star-shaped contents. (e) Transverse section of cortex showing the cells consisting of star-shaped contents. (f) Longitudinal section of tetrasporangium. (g) Longitudinal section of spermatangial conceptacles.

— *Gracilaria edulis* (Gmelin) Silva, 1952: 293; Nguyen Huu Dinh, 1992:

— *Polycavernosa fastigiata* Chang et Xia, 1963: 125; Nguyen Huu Dinh et al. 1993: 253.

— *Hydropuntia fastigiata* (Chang et Xia) Wynne, 1989: 477.

— *Gracilaria arcuata* sensu P. H. Ho, 1969: 185 (Non *G. arcuata* Zan.)

— *Gracilaria coronopifolia* sensu P. H. Ho, 1969: 184 (Non *G. coronopifolia* J. Agardh)

Specimens examined: Ha Tien (Phu Quoc Island), Ho 2955, 2972 (ION), Hai Phong (Do Son), Dinh 65170–174, 67047–51, 67075–81, 67063–68, 67084, 67090, 67170; Ha Tinh (Ky Phong), Dinh 64164–84; Nghe An (Nghì Loc), Dinh 65068–78; Nghe An (Quynh Luu), Dinh 65167–170; Quang Tri (Vinh Linh), Dinh 64160–63, (ION); Nghe An (Quynh Tien), Hau 03321–03340, 03471–477; Quang Ngai (Ly Son Island), Hau 03365–369, 03352–03381; Ninh Thuan, Hau 93546–93575, Kien Giang (Phu Quoc Island), Hau 82135–140, 83243–248, 92110–112, 97244–97269, 99027–49, 20081–20092, 03473–477 (IMS).

Local distribution: Common in littoral coasts

Remarks: This species is terete throughout with dense and fastigiated branching in its upper part, multicavities, *Polycavernosa*-type spermatangial conceptacles. This species was first reported in Vietnam as *Polycavernosa fastigiata* by Nguyen Huu Dinh et al (1993). We re-examine herbarium materials as *G. coronopifolia* and *G. arcuata* by Pham Hoang Ho (1969, pp. 184–185, figs. 2.114–115), (specimens respectively 2972 and 2955) (ION), they have the same characters of *H. edulis*. So, the misapplied names of these specimens should be changed to *H. edulis*.

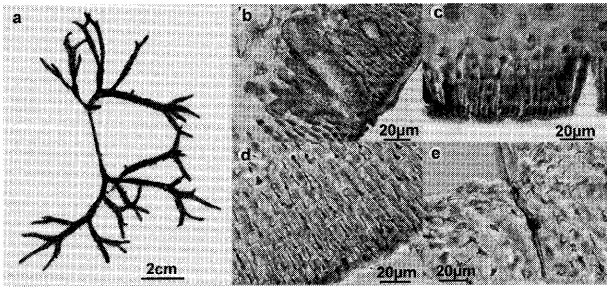


Fig. 4. *Hydropuntia eucheumatoides*. (a) Habit of plant (specimens IMS 03811). (b) Transverse section of *Polycavernosa*-type spermatangial conceptacle. (c) Transverse section of tetrasporic plant, showing oblong undivided tetrasporangia. (d, e) Longitudinal section of the outer and inner pericarp.

17. *Hydropuntia eucheumatoides* (Harvey) Gurgel et Fredericq, 2004: 155 (Fig. 4)

— *Gracilaria eucheumatoides* Harvey, 1860: 331; Dawson, 1954: 438; Pham Hoang Ho, 1969: 186; Ohno et al. 1999: 104.

Specimens examined: Ninh Thuan, Dai 99160–174 (ION), Dinh 99215–220, 97126–230; Khanh Hoa (Nha Trang), Dinh 94306, Quang Ngai (Ly Son Island), Hau 03811–03816 (IMS).

Local distribution: Common in littoral coasts

Remarks: This species was reported in Vietnam by several authors (Dawson 1954, Ho 1969, Ohno et al. 1999, Terada and Yamamoto 2002). Only female plant have been reported by Terada and Yamamoto (2002). In this paper, we have studied tetrasporangial, spermatangial, and cystocarpic plants. Male plants have multicavities, *Polycavernosa*-type spermatangial conceptacles, tetrasporangial plants with oblong undivided tetrasporangia.

18. *Hydropuntia fisheri* (Xia et Abbott) Wynne, 1989: 477 (Fig. 5n)

Lewmanomont K., 1991: 140; Ohno et al. 1999: 107.

— *Polycavernosa fisheri* Xia et Abbott, 1987: 411.

— *Gracilaria fisheri* (Xia et Abbott) Abbott, Zhang et Xia, 1991: 23.

Specimens examined: Kien Giang (Phu Quoc Island), Hau 02110–141, 03400–03432, Kien Giang (Ha Tien), Hau 03435–455 (IMS).

Local distribution: Kien Giang (Ha tien, Phu Quoc Island).

Remarks: Branches constricted at the base and multicavities, *Polycavernosa*-type spermatangial conceptacles. It resembles *G. changii* in external appearance, but differs from the latter by slender thallus, pale-green colour, pericarpic cells with star-shaped contents. This species was first reported in Vietnam by Ohno et al. (1999).

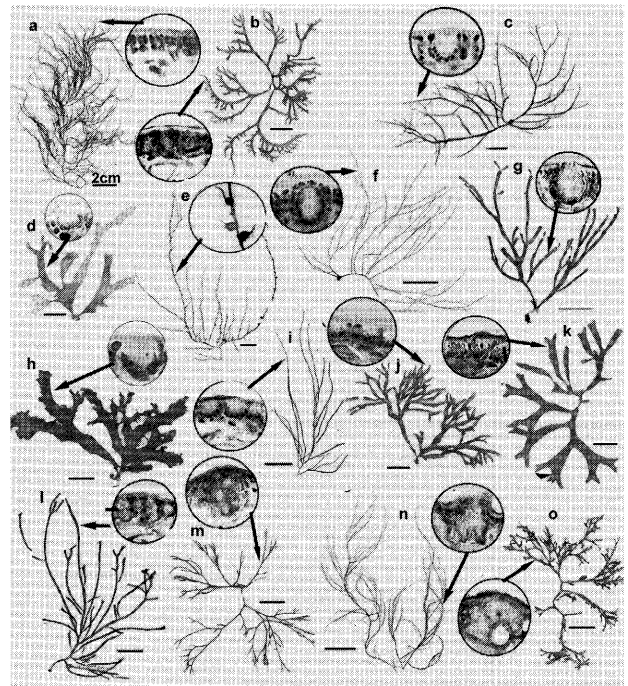


Fig. 5. Habit of plants and their spermatangial conceptacles: (a) *Gracilariopsis bailinae* (IMS 03615). (b) *Gracilaria arcuata* (IMS 03385). (c) *G. blodgettii* (IMS 04504). (d) *G. cuneifolia* (IMS 01102). (e) *G. longirostris* (IMS 03601). (f) *G. rubra* (IMS 02047). (g) *G. salicornia* (IMS 02110). (h) *G. spinulosa* (IMS 03315). (i) *G. tenuistipitata* (IMS 03201). (j) *G. textorii* (ION 67527). (k) *G. yamamotoi* (IMS 03342). (l) *Hydropuntia changii* (IMS 98216). (m) *H. edulis* (IMS 03477). (n) *H. fisheri* (IMS 03400). (o) *H. ramulosa* (IMS 03977).

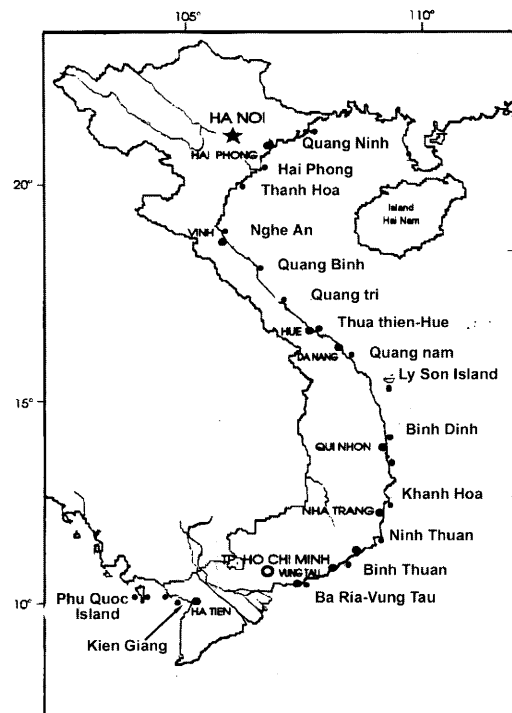


Fig. 6. The map of Vietnam showing coastal provinces where specimens were collected.

19. *Hydropuntia ramulosa* (Chang et Xia) Wynne, 1989: 477 [Fig. 5(o)]

—*Polycavernosa ramulosa* Chang et Xia, 1963: 122; Nguyen Huu Dinh et al. 1993: 252.

—*Gracilaria bangmeiana* Zhang et Abbott, in Abbott, Zhang et Xia, 1991: 23; Nguyen Huu Dinh, 1992: 207; Nguyen Huu Dai et al. 2001: 124

Specimens examined: Thanh Hoa (Bien Son), Dinh 65246–255, 67072–83; Quang Tri (Vinh Linh) Dinh 64210–64247 (ION); Hue (Lang Co), Hau 97616–919; Quang Ngai (Ly Son Island), Hau 01090–01095 (IMS); Khanh Hoa (Nha Trang), Dai 99145–9915 (ION), Hau 03113–118, 03961–977 (IMS)

Local distribution: Common in littoral coasts.

Remark: This species was first reported by Nguyen Huu Dinh et al. (1993) as *Polycavernosa ramulosa* and was transferred to *G. bangmeiana* (Nguyen Huu Dinh 1992, Nguyen Huu Dai et al. 2001). This species differs from *H. edulis* by having dense branching with short intervals in the upper part.

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