ISSN 0125-796X

THE RED ALGAE SUBCLASS BANGIOPHYCIDAE OF THAILAND

by

Hisao Ogawa

and

Khanjanapaj Lewmanomont

KASETSART UNIVERSITY FISHERY RESEARCH BULLETIN NUMBER 15

เอกสารวิชาการประมง มหาวิทยาลัยเกษตรศาสตร์ ฉบับที่ ๑๕

June 15, 1984 – ๑๕ มิถุนายน ๒๕๒๗

THE RED ALGAE SUBCLASS BANGIOPHYCIDAE OF THAILAND

Hisao Ogawa* and Khanjanapaj Lewmanomont**

ABSTRACT

Nine species of the red algae belonging to Subclass Bangiophycidae collected from the coasts of the Gulf of Thailand are described. Six of which are new records for Thailand: *Goniotrichum alsidii* (Zanardini) Howe, *Erythrocladia subintegra* Rosenvinge, *Erythrotrichia carnea* (Dillwyn) J. Agardh, *Erythrotrichia parietaris* Tanaka, *Bangia fusco-purpurea* (Dillwyn) Lyngbye and *Compsopogon aerugiosus* (J. Agardh) Kützing.

*Department of Fishery Science, Faculty of Agriculture, Tohoku University, Sendai 980, Japan.

**Faculty of Fisheries, Kasetsart University, Bangkok 10903, Thailand.

INTRODUCTION

Previous works on marine algal flora of Thailand were done mostly by foreign scientists. The earliest work was known in 1866 by Martens in "Die Preussische Expedition nach Ost-Asien". Followed by Schmidt (1900–1916) in "Flora of Koh Chang" and Weber van Bosse (1913–1928) in "List des algues du Siboga". Until 1935, the study of marine algae was reported by a Thai scientist, Boon-nag, "On the agar obtained from the marine algae of Siam". In 1954, Dawson had a short visit to Thailand and published a paper "Notes on tropical Pacific marine algae". Since then phycological works in Thai waters have been continued. In 1959, the Department of Science, Ministry of Industry, reported "On the survey of marine algae in the southern part of Thailand"; Thiemmedh (1960), Brohmanonda and Sahavacharin (1968) made the reports on *Porphyra* sp.; Egerod published three papers in 1971, 1974 and 1975. Other works were done by Maneerat (1974); Velasquez and Lewmanomont (1975); Lewmanomont (1976 and 1978); Christensen and Wium-Andersen (1977); Lewmanomont and Ogawa (1978), Ogawa and Lewmanomont (1978, 1979 and 1982); and Edwards et al (1982).

As the results of these works, the floral characteristics along the coasts of Thailand have been reported, From these reports only two genera and three species belonging to Subclass Bangiophycidae were found. They are : *Erythrocladia ceramicola* (Lyng.) Aresch. (Schmidt, 1900–1916), *Porphyra crispata* Kjellman and *P. vietnamensis* Tanaka et Pham-Hoang Ho (Lewmanomont and Ogawa 1978).

Although the species of *Porphyra* in the Bangiophycidae are important as economic seaweeds of Thailand, our knowledge on this group growing in Thai waters has not been satisfied until now. Therefore, taxonomy and distribution of the species found in Thai waters must be emphasized and carried out. The knowledges gained from this study will contribute not only to phycological science, but also to the culture of this group along the coasts of Thailand.

MATERIALS AND METHODS

Collections of algal specimens were done during December 1982 to April 1983 along the coasts of the following Provinces; Pattani, Songkhla, Prachuab Khiri Khan, and Chon Buri on the coasts of the Gulf of Thailand, and Phuket on the Andaman Sea. Some of the specimens used for the present study showed epiphytic growth on other algae, especially on *Padina* growing

between tide-marks. After collection, the specimens were put temporarily in plastic bags with 5-10% formalin-seawater and finally sorted out in the laboratory, Faculty of Fisheries, Kasetsart University, Bangkok. All illustrations were drawn under the camera lucida.

RESULTS AND DISCUSSIONS

A total of 9 species of the red algae belonging to Subclass Bangiophycidae are reported. Six of which are new records for Thailand.

SYSTEMATIC LIST OF SUBCLASS BANGIOPHYCIDAE OF THAILAND

SUBCLASS : BANGIOPHYCIDAE

ORDER I : GONIOTRICHALES

FAMILY 1 : GONIOTRICHACEAE

Goniotrichum alsidii (Zanardini) Howe

ORDER II : BANGIALES

FAMILY 1 : ERYTHROPELTIDACEAE

Erythrocladia subintegra Rosenvinge

Erythrocladia sp.

Erythrotrichia carnea (Dillwyn) J. Agardh

E. *parietalis* Tanaka

FAMILY 2 : BANGIACEAE

Bangia fusco-purpurea (Dillwyn) Lyngbye

Porphyra crispata Kjellman

P. vietnamensis Tanaka et Pham-Hoang Ho

ORDER III : COMPSOPOGONALES

FAMILY 1 : COMPSOPOGONACEAE

Compsopogon aeruginosus (J. Agardh) Kützing

KEY TO THE GENERA OF BANGIOPHYCIDAE

1. Thallus with elongated rhizoidal cells.....2
1. Thallus without elongated rhizoidal cells.....3
2. Thallus membranous, monostromatic.....*Porphyra*
2. Thallus filamentous, unbranched.....*Bangia*
3. Thallus creeping, forming a circumscribed disk.....*Erythrocladia*
3. Thallus filamentous.....4
4. Filament unbranched, uniseriate.....*Erythrotrichia*
4. Filament branched, uniseriate or multiseriate.....5
5. Filament multiseriate with corticated cells.....*Compsopogon*
5. Filament uniseriate without corticated cells.....*Goniotrichum*

DESCRIPTION OF THE SPECIES

Goniotrichum alsidii (Zanardini) Howe Pl. I, Figs. 1–5.

Tseng (1936) p. 32, Pl. IV, Fig. 15; Tanaka (1952) p. 5–7, Figs. 2, 3; Taylor (1960) p. 288; Lee (1965) p. 66, Pl. 1, Fig. D; Noda (1968) p. 76–77, Fig. 3; Pham-Hoang Ho (1969) p. 67-68, Fig. 2.1; Edwards (1970) p. 29–30, Fig. 94; Abbott and Hollenberg (1976) p. 280, Fig. 222; Islam (1976) p. 49, Pl. 49, Fig. 275.

Filaments uniseriate, minute, isolated, epiphytic on other algae, 0.2–11.0 mm long, pseudodichotomously branched, cells of the upper part 12–17 μ in diameter, of the basal part 25–30 μ in diameter; branches slightly attenuate; cells discoid to ellipsoid; monospores spherical 7–14 μ in diameter; containing a star-shaped chromatophore with a central pyrenoid; colour reddish pink or violet red.

The present specimens were found on the fronds of *Panida* which are very common in shallow waters along the coasts of the Gulf of Thailand and the Andaman Sea, monospores spherical in shape producing from ordinary vegetative cell without any cell division.

Place of collection: Chon Buri, Prachuab Khiri Khan, and Phuket.

This is a new record for Thailand.

Erythrocladia subintegra Rosenvinge Pl. I, Figs. 6–7.

Tseng (1936) p. 32–33, Pl. IV, Fig. 16; Tanaka (1952) p. 75–77, Figs. 35, 36; Taylor (1960) p. 290–291, Pl. 41, Fig. 1; Lee (1965) p. 67, Pl. 1, Fig, H; Noda (1968) p. 73–74, Fig. 3, 1–4; Pham–Hoang Ho (1969) p. 80, Fig. 2.12; Edwards (1970) p. 30, Fig. 95; Islam (1976) p. 49, Pl. 49, Fig. 276; Abbott and Hollenberg (1976) p. 284, Fig. 227.

Thalli microscopic, discoid or elliptical, monostromatic disk, 40–70 μ in diameter, with radiated growth by the division of terminal cells; cells often forked at the marginal part, 5–9μ broad and 9–20μ long; epiphytic on other algae; colour pinkish red.

The present specimens were found on the fronds of *Porphyra vietnamensis* collected from Gao Seng, Songkhla. Young thallus usually formed a circular margin, but sometimes showed an undulate margin. During the growth of thallus, it expanded radially and the disk form was irregularly in the old specimens. The plant attached closely to substratum and formed a monostromatic structure. A pyrenoid was not clearly found in central part of chromatophore. According to Tanaka (1952) and Taylor (1960), the reproduction of this species occurred by monospore formation, unfortunately monosporangia and monospore formation could not be observed in our specimens.

Place of collection; Pattani and Songkhla.

This is a new record for Thailand.

Erythrocladia sp. Pl. I, Fig.8.

Thalli microscopic, monostromatic, fan–shaped, 200–600 μ in width, showing marginal and radial growth by division of terminal cells; cells of the marginal portion 5–9 μ broad and 8–20 μ long; cell wall not thin; cell contains a single chromatophore, pyrenoid obscure; the plants grow epiphytic on other algae; colour yellowish pink.

The present specimens were found growing on the fronds of *Padina* collected from Si Racha, on March 2, 1983. The thallus attached closely to the lower portion of the frond of *Padina* and formed a fan–shaped monostromatic structure. Cell centained a single chromatophore. Pyrenoid was not clearly found in the central part of chromatophore. In general structure, this species is close to *Erythrocladia subintegra*, but it is different from the latter by lacking of forked cells at the margin. At present, we still could not find any description fitted to our specimens. Further observation is recommended for the identification of this species.

Place of collection : Chon Buri.

Erythrotrichia carnea (Dillwyn) J. Agardh Pl. II, Figs. 9–12.

Boergesen (1935) p.41; Tanaka (1952) p.14–16, Fig.7, B–E; Dawson (1956) p.45; Taylor (1960) p.292; Durairatnam (1961) p.47, Pl. XI. Figs. 3, 4; Noda (1968) p.75, Fig. 4, 1–4; Pham–Hoang Ho (1969) p.71, Fig.2.3; Trono (1969) p.42; Edwards (1970) p.30, Figs.96, 97; Abbott and Hollenberg (1976) p. 286, Fig. 288; Islam (1976) p.49–50, Pl.50, Figs. 288–290.

Filaments simple, minute, erect, solitary, uniseriate, 4–15 mm tall and 12–24μ in diameter, epiphytic, attaching to other algae by a basal cell which extends a short rhizoid; cells usually longer than broad, 11–20μ broad and 11–25μ long, containing a chromatophore with a central pyrenoid; gelatinous sheath about 2–4μ thick; monosporangia usually cut off by an oblique wall at the upper end of the cells; monospores spherical 16–22μ in diameter; colour light red or purplish red.

The plants were found as epiphytes on the fronds of *Padina*. This species is commonly distributed along the coasts of Gulf of Thailand.
Placeof collection : Chon Buri and Prachuab Khiri Khan.

This is a new record for Thailand.

Erythrotrichia parietalis Tanaka Pl. II, Figs. 13–16.

Tanaka (1952) p.18–19, Fig. 10; Dawson (1954a) p.412, Fig. 23, d, e ; Pham–Hoang Ho (1969) p.72, Fig. 2.4; Cordero (1977) p.34, Fig. 3.

Filaments microscopic, caespitose, uniseriate, epiphytic on other algae, 4–5 mm tall, 14–24μ in diameter; cells with rounded angles, often longer than broad, 12–22μ in diameter and 15–25μ long, having a parietal chromatophore; pyrenoid obscure; monosporangia spherical or ovate 10–15μ in diameter, forming in the middle to the upper part of filament; cystocarp producing a protuberance, forming two carpospores; colour of fronds purplish red.

The present specimens were found growing on the fronds of *Padina* collected from Si Racha, Chon Buri. It is closely related to *Erythrotrichia carnea*. but the shape of chromatophore and the presence of branching are distinctively different from those of *Erythrotrichia carnea*. This material corresponds with Tanaka's descriptions and figures of *Erythrotrichia parietalis*. The species is always found growing on the fronds of *Padina* and is widely distributed along the coasts of the Gulf of Thailand.

Place of collection : Chon Buri and Prachuab Khiri Khan.

This is a new record for Thailand.

Bangia fusco-purpurea (Dillwyn) Lyngbye Pl. II. Figs. 17–20.

Tseng (1936) p.33; Tanaka (1952) p.23–24, Pl. II, 2; Lee (1965) p.68, Pl. 1, Figs A, C, G, L, Pl. 7, Fig. A; Noda (1968) p.72–73, Fig. 2; Pham-Hoang Ho (1969) p.74–75, Fig. 2.7; Edwards (1970) p.30–31, Figs, 98–101; Abbott and Hollenberg (1976) p.294, Fig. 237.

Thalli erect to suberect, simple, filamentous, caespitose, 3–7 cm tall, 40–100μ broad, attached to substratum by rhizoids which come out downwards from the lower cells of filament; lower part of filament uniseriate, upper part becoming multiseriate by longitudinal and transverse divisions of cells; cells with rounded angles, 8–10μ in thickness for uniseriate part, usually 1/2–1/3 times shorter than broad, with a stellate chromatophore and a conspicuous pyrenoid; cell walls getting thicker at the lower part of filament, 7–9μ in thickness; species dioecious; male frond cylindrical about 80–90μ in diameter, yellowish red; female frond cylindrical up to 100μ in diameter, red or dark red, sometimes yellowish red; 8–16 carpospores formed in a carposporangium; carpospores 12–20μ in diameter.

The present specimens were collected from cement poles at the pier in front of the National Institute of Coastal Aquaculture, Gao Seng, Songkhla. They formed tufts on rocks together with *Porphyra vietnamensis* at the high tide mark. This specimen is very similar to *Bangia yamadai*, which was described by Tanaka (1952), but the latter is only 1.5–2.0 cm in length. The specimens which were collected from Koh Nu, Songkhal, on January 25, 1976, reached the length of 16–18 cm.

Place of collection : Songkhla.

This is a new record for Thailand.

Porphyra crispata Kjellman Pl. III., Figs. 21–23.

Tanaka (1952) p. 34–36, Fig. 17; Dawson (1954a) p. 412, Fig. 24; Domantay (1961) p. 293; Pham-Hoang Ho (1969) p. 77, Fig. 2.9; Cordero (1974) p. 138, Fig. 2, A–E; (1977) p. 36, Figs. 6–8; Lewmanomont and Ogawa (1978) p. 8–9, Pl. 3, Fig. b.

Thalli rounded to reniform, 2–4 cm tall, 1.5–3.0 cm broad, monostromatic 10–30μ thick, with microscopic denticulation at the margin and a small discoid holdfast; chromatophore stellate, single; species monoecious, spermatangial and carposporangial zones formed on the marginal parts of frond,

each zone located in definite area; antheridium with 128 spermatia (a x b/16, c/8), carposporangium with 32 spores (a x b/8, c/4); thallus purple red, sometimes yellowish red in colour.

This species has been reported formerly from Hua Hin, Prachuab Khiri Khan and Phangnga. The present specimens were collected from Hua Hin, locating about 80 km north from Prachuab Khiri Khan. This is to confirm the previous collection of this species.

Place of collection: Prachuab Khiri Khan.

Porphyra vietnamensis Tanaka et Pham-Hoang Ho Pl. III, Figs. 24-30.

Tanaka and Pham-Hoang Ho (1962) p. 34-36, Figs. 10, 11; Pham-Hoang Ho (1969) p. 78-79, Fig. 2.10; Lewmanomont and Ogawa (1978) p. 7-8, pl. 3, Fig. a; Ogawa and Lewmanomont (1978) p. 31-34, Figs. 2-5; (1979) p. 95-98.

Thalli linear, lanceolate to elliptical, 3-27 cm long, 0.3-3.6 cm broad, often branching near the basal portion, with cordate or cuneate base; monostromatic, 15-29μ thick, with microscopic denticulation at the margin; chromatophore stellate, single; species monoecious, spermatangial zone formed in the marginal portion of frond, carposporangial zone appeared in the inner portion of spermatangial zone; antheridium with 64 spermatia (a x b/16, c/4), carposporangium with 8 spores (a x b/4, c/2), 10-18μ in diameter; colour of the plant light purple to purplish red, sometimes yellowish red.

This species was formerly reported from Narathiwat, Pattani and Songkhla, along the west coast of the Gulf of Thailand. The present specimens were collected from cement poles at the pier in front of the National Institute of Coastal Aquaculture, Gao Seng, Songkhla. This species was collected from Hua Hin, Prachuab Khiri Khan, on March 18, 1983, which is the first collection from this place. Growing season of this species in Thailand is from the end of November to the middle of February.

Place of collection: Songkhla, and Prachuab Khiri Khan.

Compsopogon aeruginosus (J. Agardh) Kützing Pl. IV. Figs. 31-38.

Krishnamurthy (1962) p. 216-217, Pl. 1, Fig. 3.

Thalli erect, dichotomously branched, light blue in colour, 10–15 cm long; main axis 0.8–1.0 mm in diameter; thallus except the upper portion of branches composed of an axial row of large cells surrounded by one or two layers of corticated cells; the inner corticated cells, 40–110μ in diameter larger than the outer ones, 5–20μ in diameter; branches usually erect and uniseriate; cells of the uniseriate branches two to three times broader than long, axial cells 700–800μ in diameter at the lower portion of axis; short spinous branches and cushion–like masses occurred on the main axis and the older portions of branches.

This specimens were collected from a fresh–water pond in Khao Tao, Prachuab Khiri Khan. Although monosporangia have not been confirmed in our specimens. However, our specimens produced many short spinous branches and cushion–like masses on the axis and the older portions of branches, and showed the dichotomously branching system. These characteristics are agreed with the description of *Compsopogon aeruginosus* pointed out by Krishnamurthy (1962).

Place of collection : Prachuab Khiri Khan.

This is a new record for Thailand.

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PLATES AND EXPLANATION OF PLATES

PLATE I

Goniotrichum alsidii (Zanardini) Howe

Fig. 1. Habit of a filament (x 200)
2. Young filament (x 200)
3. Middle part of filament (x 410)
4. Apex of filament with monosporangia (x 410)
5. Matured part with monosporangia (x 410)

Erythrocladia subintegra Rosenvinge

Fig. 6. Surface view of young fronds (x 410)
7. Surface view of matured fronds (x 410)

Erythrocladia sp.

Fig. 8. Surface view of frond (x 410)

Plate I

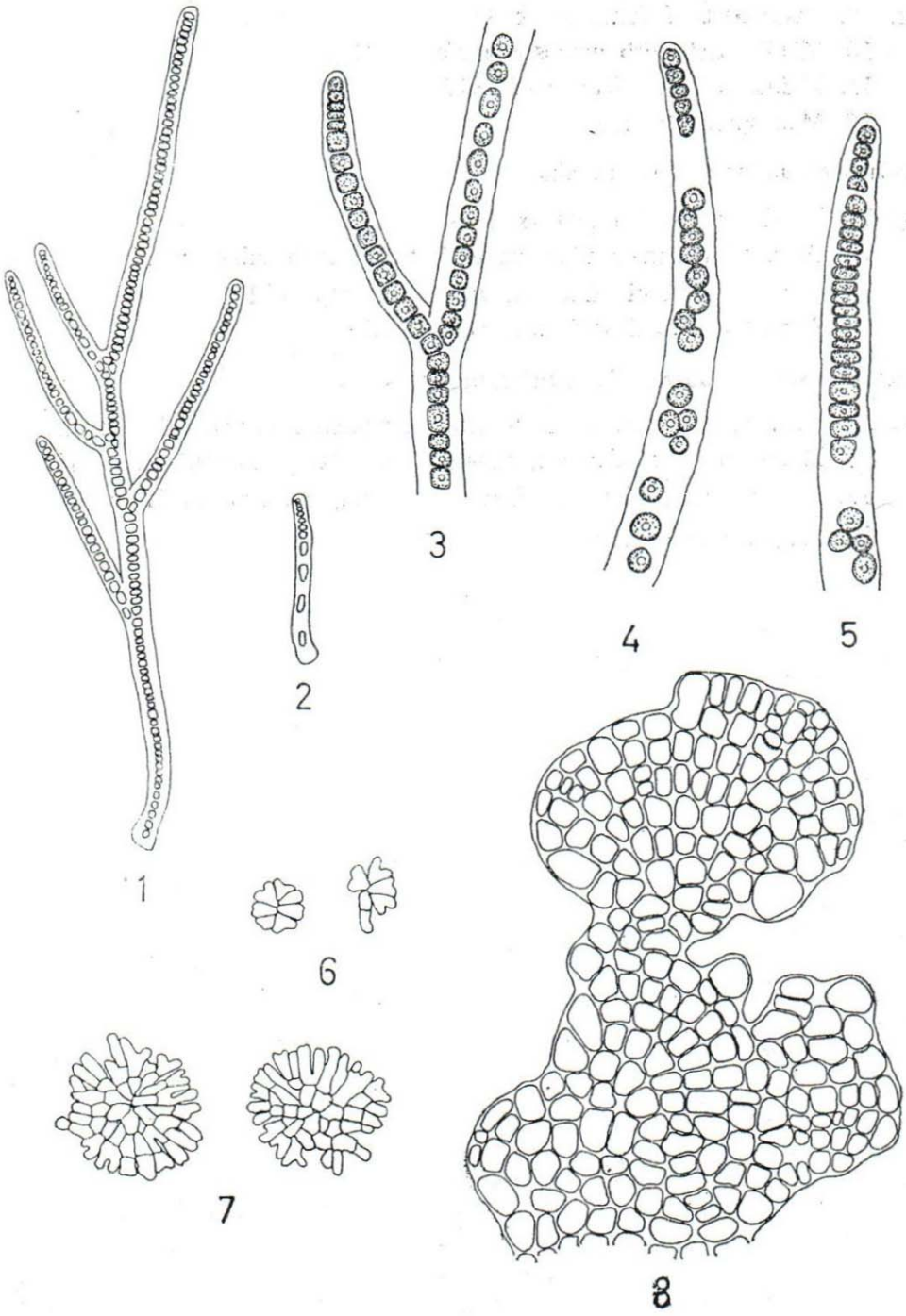

PLATE II

Erythrotrichia carnea (Dillwyn) J. Agardh

Fig. 9. Basal part of filament (x 410)
10. Middle part with monosporangia (x 410)
11. Middle part of filament (x 410)
12. Monospores (x 410)

Erythrotrichia parietalis Tanaka

Fig. 13. Basal part of filament (x 410)
14. A part of female filament with fertilization tubes (x 410)
15. A part of female filament with cystocarp (x 410)
16. A part of frond with branchlet (x 410)

Bangia fusco-purpurea (Dillwyn) Lyngbye

Fig. 17. Basal part of filament, showing elongated rhizoidal cells (x 410)
18. Middle part of filament, showing uniseriate arrangement (x 410)
19. Matured part of male filament, showing carposporangia (x 410)
20. Carpospores (x 410)

Plate II

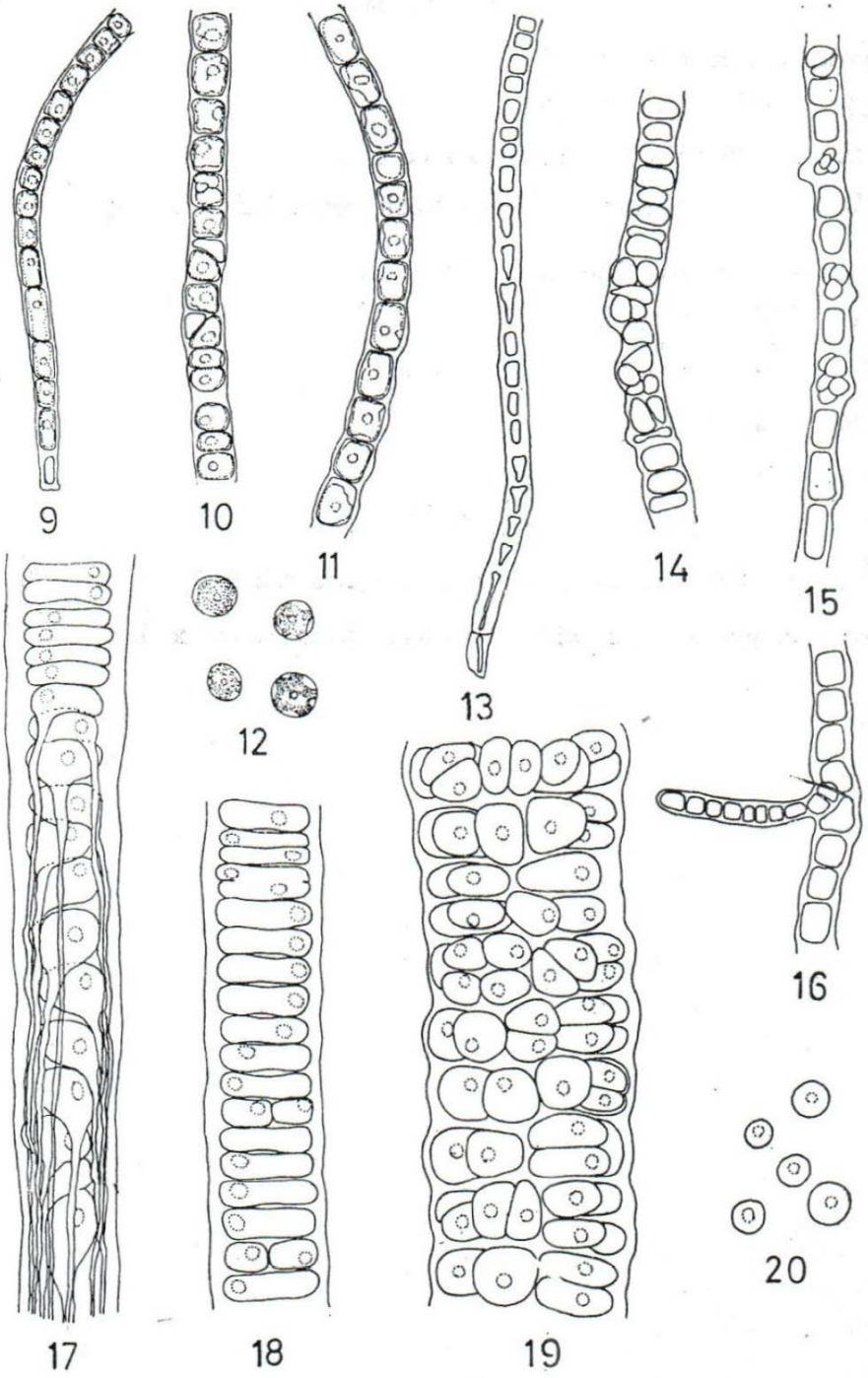

PLATE III

Porphyra crispata Kjellman

Fig. 21. Surface view of male part (x 410)

22. Surface view of female part (x 410)

23. Marginal portion with microscopic denticulation (x 410)

Porphyra vietnamensis Tanaka et Pham-Hoang Ho

Fig. 24. Habit of a frond (x 1)

25. Surface view of male part (x 800)

26. Cross section of the same part (x 800)

27. Surface view of female part (x 800)

28. Cross section of the same part (x 800)

29. Basal part of frond, showing elongated rhizoidal cells (x 800)

30. Marginal portion with microscopic denticulation (x 600)

Plate III

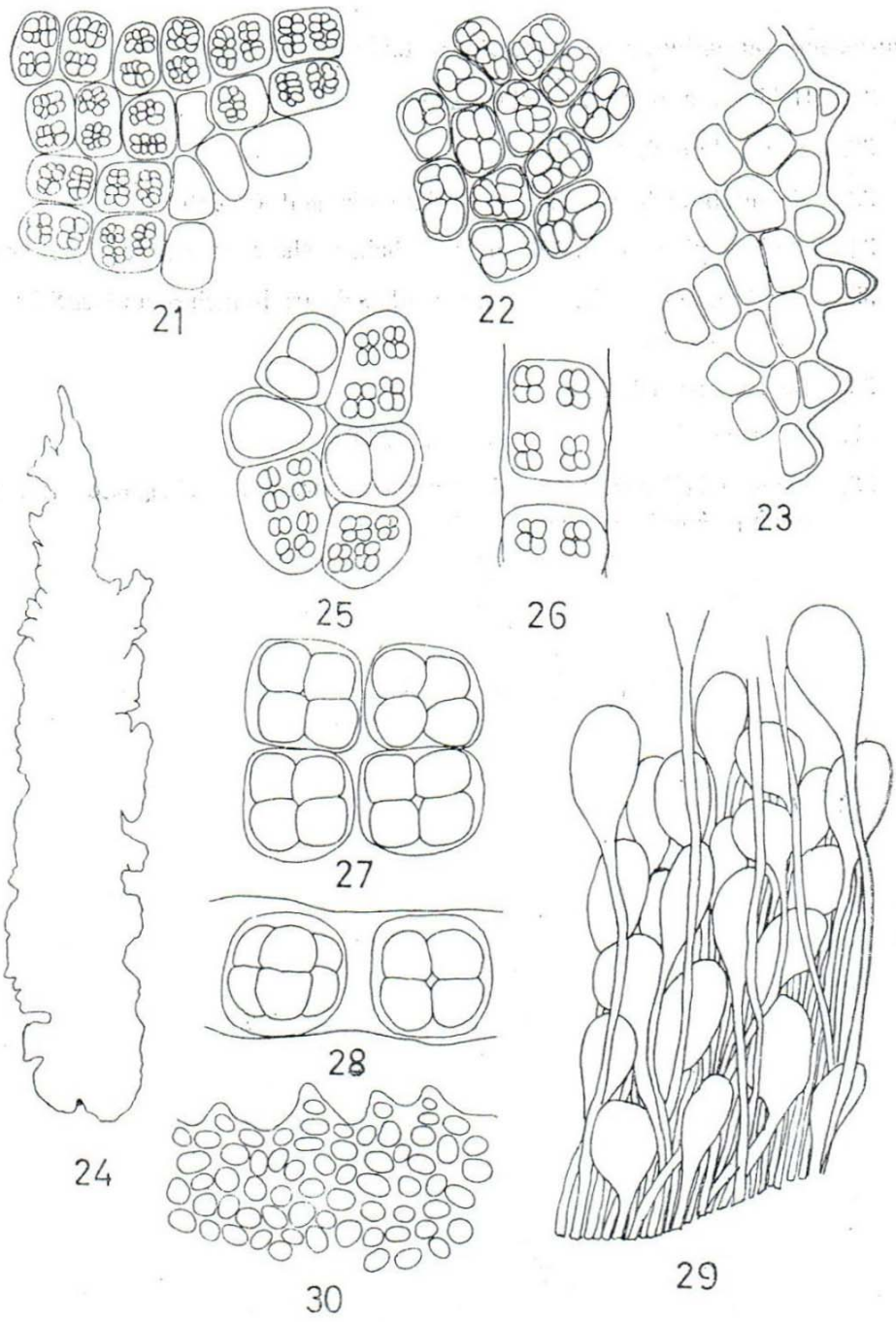

PLATE IV

Compsopogon aeruginosus (J. Agardh) Kützing

Fig. 31. Habit of a part of thallus (x 1)

32. Young branch (x 100)

33. Young branch, showing uniseriate filament (x 410)

34. Surface view of middle part of thallus, showing cortical cells (x 410)

35. Basal part of axis, showing small spinous branches and cushion–like masses (x 40)

36. Spinous branch (x 100)

37. Cross section of old filament (x 100)

38. Longitudinal section of old filament, showing the elongated axial cells and the small corticated cells (x 100)

Plate IV