

NOTES ON MARINE ALGAE OF TAIWAN

II. THE GENUS OF *PORPHYRA**

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Abstract: This paper describes five species of *Porphyra* (Rhodophyceae, Bangiales) from the coasts of Taiwan. They are *Porphyra angusta* Ueda, *Porphyra dentata* Kjellman, *Porphyra crispata* Kjellman, *Porphyra subobiculata* Kjellman, and *Porphyra* sp.. Of these, only *P. crispata* has previously been reported (Okamura, 1936; Shen and Fan, 1950; Chiang, 1962) while the other four are newly recorded.

The genus *Porphyra* was created by C. Agardh in 1824, and since then a number of species have been added to the genus by many authors throughout the world. The study of Kurogi (1972) on Japanese *Porphyra* marked an important advance in our knowledge of the genus. He indicated that the species of *Porphyra* can be grouped into three subgenera, *Euporphyra*, *Diplastidis*, and *Diploderma* based on the presence or absence of microscopic dentations on the margin of the blades (Plate 1, Figs. 1, 2) and on the sexuality of the species. Under these groupings, each species is distinguished morphologically by the shape and thickness of the blade, division pattern or number of sexual reproductive cells and by additional ecological factors.

The first record of *Porphyra* from Taiwan is found in Okamura's book (1936) under the name of *Porphyra crispata* Kjellman. Since then no other species of *Porphyra* have been added to the marine flora of this area. Recently we have made extensive collections to seek for species of *Porphyra* along the coasts of Taiwan, and have found that there are several species. This paper is the continuation of "Notes on Marine Algae of Taiwan" (Chiang, 1973) and deals with these species of *Porphyra*.

All plants of *Porphyra* were collected by the authors from various localities along the coasts of Taiwan (Fig. 1). Part of the collected materials were fixed and preserved in 5 percent formalin seawater solution, and others were prepared as herbarium specimens for the study of their external structure. The microscope preparations were made from hand sections, and stained with aniline blue for the study of their reproductive structures.

Taxonomic and morphological examinations of these specimens reveal that there are five distinct species of this genus in this region. As the plants of these species all have a monostromatic thallus and their cells each has a single plastid, we refer all these species to the same subgenus, *Euporphyra*.

KEY TO THE SPECIES OF *PORPHYRA* OCCURRING ON THE COASTS OF TAIWAN

- | | |
|--|---------------------------|
| 1. Margin with microscopic dentation | 2. |
| 1. Margin without microscopic dentation | <i>Porphyra angusta</i> . |
| 2. Monoecious | 3. |
| 2. Dioecious | <i>Porphyra dentata</i> . |
| 3. Thallus round to reniform, unbranched | 4. |

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Fig. 1. Map showing the collection localities

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|------------|-------------|---------------|
| 1. Laomei | 4. Patoutzu | 7. Fengping |
| 2. Shihmen | 5. Makang | 8. Chialoshui |
| 3. Yehliu | 6. Tali | 9. Paisha |

3. Thallus branched and with linear-lanceolate branchlets.....*Porphyra* sp.
 4. Pattern for the division of antheridia, 128 (a/4, b/4, c/8).....*Porphyra crispata*.
 4. Pattern for the division of antheridia, 64 (a/4, b/4, c/4).....*Porphyra subobovata*.

1. *Porphyra angusta* Ueda

Plate I, Figs. 3-8

Ueda 1932, p. 28, pl. 1, 4, 10, pl. 6, 8-16, pl. 18, 2-3. Okamura (1936); Kurogi (1961, 1972).

Frond lanceolate to linear-lanceolate, generally narrowed downwards or at both ends, with cuneate or oblique base, slightly undulate margins, 9-25 cm long, 1-3 cm broad; monostromatic, 40-60 μ thick in the middle, without microscopic spines on the margin, in surface view, the cells are irregularly rectangular or polygonal, irregularly arranged, provided with one stellate chromatophore in each cell; dioecious; antheridia and carposporangia formed in the upper marginal part, antheridia pale yellow, carposporangia purplish-red. The antheridial mother cell divides according to the pattern of a/4, b/4, c/8 and that of carposporangia a/2, b/2, c/2.

HABITAT: The specimens were collected at Patoutzu, near Keelung (No. 75032, Nov. 18, 1975; No. 75033, Dec. 12, 1975) and at Yehliu, near Keelung (No. 76005, Feb. 27, 1976).

GEOGRAPHICAL DISTRIBUTION: Japan.

In every character our plants agree with the descriptions of this species. However, the margins of our plants are not so undulated as those illustrated by Kurogi (1961) on pl. 35, A-F, pl. 36, A-H. The plants are very abundant on the rocks near the upper littoral zone from the end of October to the following February.

2. *Porphyra dentata* Kjellman

Plate I, Figs. 9, 10; Plate II, Figs. 1-5

Kjellm. *Porphyra*, 1897, p. 13, pl. 1, f. 7-8, pl. 3, f. 1-4, pl. 5, f. 8-13. Okamura (1936); Kurogi (1961, 1972).

FronD broad lanceolate to linear-lanceolate, narrowed toward one or both ends, base cordate, undulate along the margin on the lower part of the thallus, 14-36 cm long, 0.5-1.8 cm broad; monostromatic, the thickness at the middle varies from 39 μ to 62 μ , cells irregularly rectangular and irregularly arranged, stellate chromatophore one per cell, and with microscopic dentations on the margins of the frond; dioecious; antheridia nearly colorless, extending almost to the margin of the whole thallus, the antheridial mother cell divides according to the pattern of a/4, b/4, c/8; carposporangia deeply red, situated in the upper portion of the frond or appearing on both margins of the upper frond, carpospores are formed according to the pattern of a/2, b/4, c/2.

HABITAT: The specimens were collected at Laomei, Taipei County (No. 75037, Dec. 24, 1975) and at Paisha, Penghu Islands (No. 76003, Feb. 21, 1976).

GEOGRAPHICAL DISTRIBUTION: Japan and Korea.

Although the shape of this species resembles that of *P. angusta* it is characterized by having microscopic marginal dentations and the division pattern of its antheridia and carpogonia. Generally, the male plants are more slender than the female. Examination of our materials show that they are in good agreement both with Okamura's descriptions and with Kurogi's illustrations.

3. *Porphyra crispata* Kjellman

Plate II, Figs. 6-9

Kjellm. *Porphyra*, p. 15, pl. 1, f. 4-5, pl. 3, f. 5-7, pl. 5, f. 15. Okamura (1936); Dawson (1954); Ho (1969); Kurogi (1972); Cordero (1974).

FronD round, reniform to elliptical, rarely lobed at the base, provided with a cordate base, margin slightly undulated or entire, 1.5-6.5 cm in length, 2.0-6.5 cm in breadth, with microscopic spines on the margin; monostromatic, 31-37 μ in thickness. In surface view, cells are irregularly rectangular or polygonal and irregularly arranged, with one stellate chromatophore in the center of each cell; monoecious; male areas situated on both sides along the lower margins as well as intercalarily in the upper carpogonial part of the thallus; the upper intercalarily antheridial patches yellowish, carpogonial areas purplish, antheridial mother cell divides according to the pattern of a/4, b/4, c/8 and the carpospores arranged according to the pattern of a/2, b/4, c/4 in the carposporangium.

HABITAT: The specimens were collected at Tali from Ilan County (No. 70503, Dec. 5, 1975; No. 76007, Mar. 9, 1976), Makang, Ilan County (No. 76001, Jan. 7, 1976) and Yehliu near Keelung (No. 76004, Feb. 27, 1976).

GEOGRAPHICAL DISTRIBUTION: China, Japan, the Philippines and Vietnam.

Our plants are in full agreement with this species as known from Japan, the Philippines and Vietnam except for the length of the thallus. Our collections are generally taller than those from other regions.

On the coasts of northeastern Taiwan at Tali and Makang, we found the plants of this red algae growing very abundantly on the rocks during the winter months but they became dwarf ones and turned to yellowish-brown after late spring and continue in this condition until summer or late autumn.

4. *Porphyra subobicularata* Kjellman

Plate III, Figs. 1-7

Kjellm. *Porphyra*, p. 10, pl. 1, f. 1-3, pl. 7, f. 4-7. Okamura (1936); *P. leucosticta* (non Thuret) Yendo, Notes on Alg. IV, p. 52 (Yendo, 1916); *P. areolata* Kjellman, p. 8, pl. 2, f. 1-4, pl. 5, f. 1-3. Okamura (1936); Kurogi (1972); Cordero (1974).

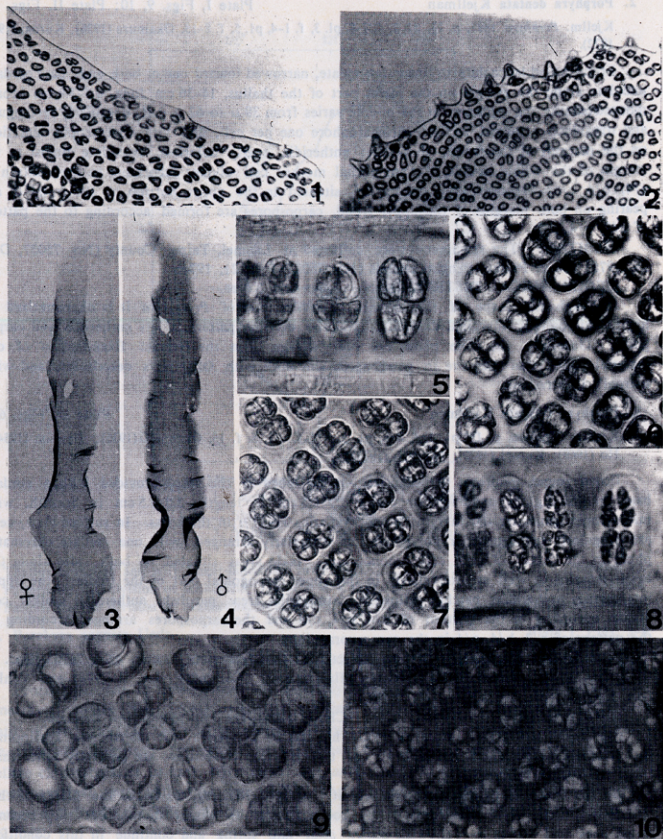


Plate I. 1, 2. Marginal parts of the *Porphyra* thallus; 1. Without microscopic spine, 2. With microscopic spines. 3-8. *Porphyra angusta*; 3. A female plant collected at Yehliu, $\times 1/2$, 4. A male plant collected at Patoutzu, $\times 1/2$, 5. Cross section of carposporangia, $\times 700$, 6. Surface view of carposporangia, $\times 625$, 7. Surface view of antheridia, $\times 500$, 8. Cross section of antheridia, $\times 800$. 9, 10. *Porphyra dentata*; 9. Surface view of carposporangia, $\times 600$, 10. Surface view of antheridia, $\times 600$.

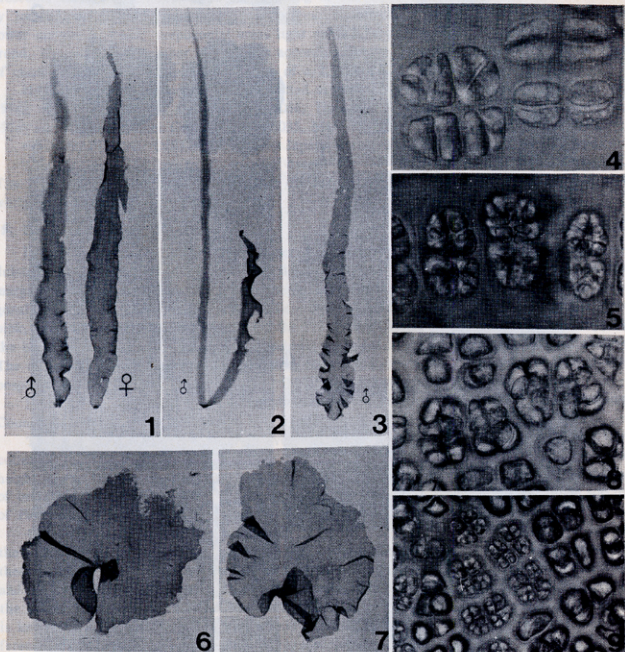


Plate II. 1-5. *Porphyra dentata*; 1, 2. Plants collected at Laomei, 1, $\times 1/2$, 2, $\times 1/3$, 3. A male plant collected at Paisha, $\times 1/3$, 4. Cross section of carposporangia, $\times 800$, 5. Cross section of antheridia, $\times 800$. 6-9. *Porphyra crispata*; 6. A plant collected at Makang, $\times 4/5$, 7. A plant collected at Tali, $\times 4/5$, 8. Surface view of carposporangia, $\times 625$, 9. Surface view of antheridia, $\times 625$.

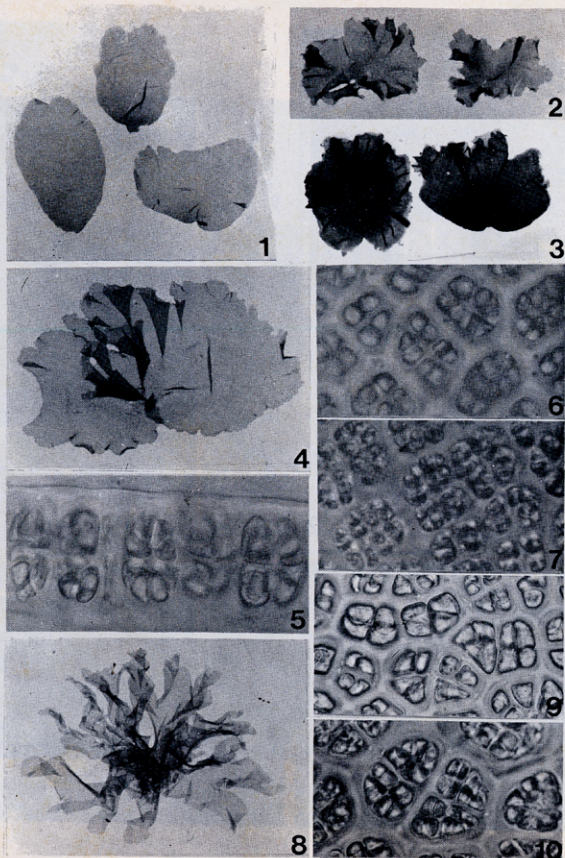


Plate III. 1-7. *Porphyra subobiculata*; 1, 3. Plants collected at Patoutzu, 1, $\times 4/5$, 3, $\times 2/3$, 2, 4. Plants collected at Shimen, 2, $\times 2/3$, 4, $\times 1$, 5. Cross section of antheridia, $\times 750$, 6. Surface view of carposporangia, $\times 700$, 7. Surface view of antheridia, $\times 700$. 8-10. *Porphyra* sp.; 8. A sexual plant collected at Chialoshui, $\times 2/3$, 9. Surface view of carposporangia, $\times 500$, 10. Surface view of antheridia, $\times 750$.

FronD round, reniform to elliptical, base cordate, with entire or undulate margin, the size of plants varies from 1.5 cm to 4.5 cm in length and from 2.5 cm to 6.5 cm in breadth; microscopic dentation processes intense, consisting of one layer of cell, each cell with a centrally located stellate chromatophore; monoecious; antheridial areas yellowish, located on the lower margin of frond, carpogonial areas light reddish, appearing on the upper margin of the frond, the antheridial mother cell divides according to the pattern of a/4, b/4, c/4 and that of carposporangia according to the pattern of a/2, b/4, c/4 or a/2, b/2, c/4.

HABITAT: The specimens were collected at Patoutzu near Keelung (No. 76006, Feb. 12, 1976), Fengping, Hualien County (No. 75056, Dec. 30, 1975), Laomei (No. 76008, April 12, 1976) and Shimen, Taipei Country (No. 75035, Mar. 12, 1975; No. 76009, April. 12, 1976).

GEOGRAPHICAL DISTRIBUTION: Japan, Korea, the Philippines, and the Ryukyus.

This species is similar to *P. crispata* except for the division pattern of the antheridia. The antheridial mother cell of this alga divides according to the pattern of a/4, b/4, c/4 while that of *P. crispata* is a/4, b/4, c/8.

5. *Porphyra* sp.

Plate III, Figs. 8-10

FronD branched, branchlets linear-lanceolate, provided with a cordate base, margins undulate, light purplish-red, 3-4 cm long, 0.8-1.0 cm broad; with microscopic spines on the margin, monostromatic, 31-39 μ in thickness, vegetative cells irregularly rectangular or polygonal, irregularly arranged, with one stellate chromatophore; monoecious; carpogonial areas pink, situated on the apical margins of the frond, antheridial patches yellowish, occupying the basal portions of the thallus or intercalarily among the upper carpogonial part of thallus. The antheridial mother cell divides according to the pattern of a/4, b/4, c/4 and that of carpospores a/2, b/2, c/2.

HABITAT: The specimens were collected on the rocky shore of Chialoshui, Pingtung County (No. 76002, Feb. 2, 1976).

The present alga is very similar in every character to *Porphyra* sp. of Cordero (1974) who collected it from the coasts of northern Philippines except for the size of the plant. The height of the Philippines plant is 10-14 cm, while ours is only 3-4 cm. The branched thallus of both our plant and Cordero's is very characteristic and, to our knowledge, no other species of *Porphyra* has this kind of a thallus.

On the other hand, our plants resemble *Porphyra tenera* of the same subgenus in having the same manner of division of antheridia and carposporangia but the external morphology of these plants is very different. The frond of *P. tenera* is simple, oblong to linear-oblancoleolate, and without microscopic dentations on the margin, while our plants have a branched frond, the branchlets being linear-lanceolate, and with microscopic spines on the margins. *P. tenera* is known from temperate regions while our plant is from tropical waters. Whether the differences in morphological features are due to ecological conditions or not needs to be further studied.

ACKNOWLEDGEMENT

The authors are greatly obliged to Dr. Charles E. DeVol, Professor of Botany, National Taiwan University, for his critical reading of the manuscript.

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ACKNOWLEDGEMENT

The author is greatly obliged to Dr. Charles E. Boyer, Professor of Botany, National Taiwan University, for his critical reading of the manuscript.

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