

Occurrence of Four Freshwater Rhodophytes in Taiwan

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Abstract: Four species of freshwater rhodophytes are reported for the first time in Taiwan. They are *Batrachospermum ectocarpum* Sirod, *B. moniliforme* Roth, *Thorea ramosissima* Bory, and *Hildenbrandia rivularis* (Liebm.) Bréb. The morphology, habitat, and geographical distribution of these species are described. All of these species are found in clear, cool, and well-aerated subalpine streams in the central ridge of Taiwan. However, they inhabit in the streams with quite different water quality. A comparison between their inhabitations is done.

Key words: Distribution, Ecology, Freshwater Rhodophyta, Morphology, Taiwan.

INTRODUCTION

The Rhodophyta is one of algal groups pigmented with phycobilines in addition to chlorophylls and carotenoids. Phycobilines are often present in sufficient quantity to obscure other pigments that various shades of green, olive, brown and red are common. Morphologically, the primary distinguishing characteristics of this group of algae are the sex organs, the methods of sexual reproduction, and the types of life cycle entailed (van den Hoek *et al.*, 1995).

The majority of the rhodophytes are marine, but a few genera are freshwater. The marine rhodophytes in Taiwan have been reported by Chiang (1992, 1973), Chen *et al.* (1981), and Chen and Chiang (1982). However, there is no record about the freshwater member in Taiwan till now. Freshwater rhodophytes are usually found in the streams in alpine or subalpine habitats, usually inhabiting in cool, well-aerated, clear water (Cole and Sheath, 1990). As a result, this has given rise to a restriction in their distribution, especially in Taiwan, because there are increasing water pollution and environmental disturbance due to human activities. As a matter of fact, freshwater rhodophytes have become rare and endangered species in the nature.

This article reports four species of freshwater rhodophytes for the first time in Taiwan island. They are identified according to Prescott (1951), Triffany and Britton (1952), Hu *et al.* (1979), Sheath and Vis (1994), Shi *et al.* (1994), and Yamagishi and Akiyama (1996).

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TAXONOMY

Classification of freshwater Rhodophyta

Four species of rhodophytes are recorded in the present article. Adopting from the classification of Gabrielson and Garbary (1986), they are classified as following:

Class Florideohyceae

Order Batrachospermales

Family Batrachospermaceae

Genus *Batrachospermum*

Batrachospermum moniliforme Roth

Batrachospermum ectocarpum Sirod

Family Thoreaceae

Genus *Thorea*

Thorea ramosissima Bory

Order Hildenbrandiales

Family Hildenbrandiaceae

Genus *Hildenbrandia*

Hildenbrandia rivularis (Liebm.) Bréb.

Key to the genera of Formosan freshwater rhodophytes

- | | |
|---|---------------------------|
| 1. Thallus palmelloid | 2. <i>Hildenbrandia</i> |
| 1. Thallus branched filamentous | 2 |
| 2. Thallus monoaxial; branches in whorls | 1. <i>Batrachospermum</i> |
| 2. Thallus multiaxial; branches not in whorls | 3. <i>Thorea</i> |

Description of species

1. *Batrachospermum* Roth

Thallus macroscopic, up to 10 cm in length, pigmentation olive, brown or violet, gelatinous, filiform, abundantly and irregularly branched, the branches in dense globose whorls; main axis a single row of large, broad cells bearing lateral branches, and cortical thread which grow downward completely surrounding the central axis and often giving rise to secondary whorls of branches; lateral branches forked, about equal in length, of limited growth, often terminating in hairs; cells of branches small, ellipsoid or moniliform, with several parietal, discoid or elongate chromatophores with a single pyrenoid; monoecious or dioecious.

Two species are recorded in Taiwan.

Key to species of *Batrachospermum*

- | | |
|---|-----------------------|
| (1) Thallus dioecious, lateral branches with terminal hairs | <i>B. moniliforme</i> |
| (1) Thallus monoecious, lateral branches without terminal hairs | <i>B. ectocarpum</i> |

Batrachospermum moniliforme Roth (Prescott, 1951; Hu *et al.*, 1980) Fig. 1

Thallus dioecious, reddish brown or violet-brown, up to 10 cm in length; primary branchlets 8-11 cell-stories, with terminal hairs; hairs with bulbous bases; monospore ellipsoid or ovoid, ca. 5.0-8.0 μm wide, 8.0-10.0 μm long.

Locality: Yuenyang Lake (鴛鴦湖) (Hsintsu county).

Habitat: epilithic or epiphytic, in acidic, cool, running, oligosaprobic water; appeared in every season.

Batrachospermum ectocarpum Sirod (Prescott, 1951; Hu *et al.*, 1980) Fig. 2

Thallus monoecious, brown, up to 6 cm in length; primary branchlets 9-13 cell-stories, without terminal hairs; monospore ellipsoid or ovoid, ca. 7.0-9.0 μm wide, 8.0-12.0 μm long; carposprangium 9-10 μm wide, 13-15 μm long.

Locality: Tien-fa-hu (天花湖) (Miaoli county).

Habitat: epilithic or epiphytic in slightly alkaline, running, β -mesosaprobic water; appeared only in winter.

2. Hildenbrandia Nardo

Thallus palmelloid, bright red to reddish brown; cells aggregated to form thin layer on stones; cells with a red, parietal chromatophore.

One species is recorded in Taiwan.

Hildenbrandia rivularis (Liebm.) Bréb. (Hu *et al.*, 1980) Figs. 3-1~3

Thallus palmelloid, bright red or reddish brown, not gelatinous; cells irregular in shape, 4.5-8.0 μm wide, 5.0-11.0 μm long, aggregated to form an irregularly expanded, thin layer on stones.

Locality: Tachia River (大甲溪)(Taichung county); Gu-guan (谷關)(Taichung county); Su-ou (蘇澳)(Ilan county); Nan-ou (南澳) (Ilan county).

Habitat: epilithic on siliceous or calcareous rocks in well-aerated, xeno- to oligosaprobic streams; appeared only in winter.

3. Thorea Bory

Thallus macroscopic, gelatinous, multiaxial, consisting of an axial core of irregularly interlaced hyaline filaments surrounded by a zone of branched lateral branches disposed along the entire axis; mature plants consisting of several shoots attached to a disc of interlaced, lime-encrusted filaments; chromatophore numerous, discoid or irregular.

One species is recorded in Taiwan:

Thorea ramosissima Bory (Triffany and Britton, 1952; Hu *et al.*, 1980) Figs. 3-4~6

Thallus 2-3 cm wide and up to 10-50 cm long, olive or dark brown; cells 2.5-5.5 μm in diameter.

Locality: San-may (山美)(Chiayi county); Tien-fa-hu (天花湖) (Miaoli county).

Habitat: epilithic, in subalpine streams of oligo- to β -mesosaprobic water; appeared in winter or early spring.

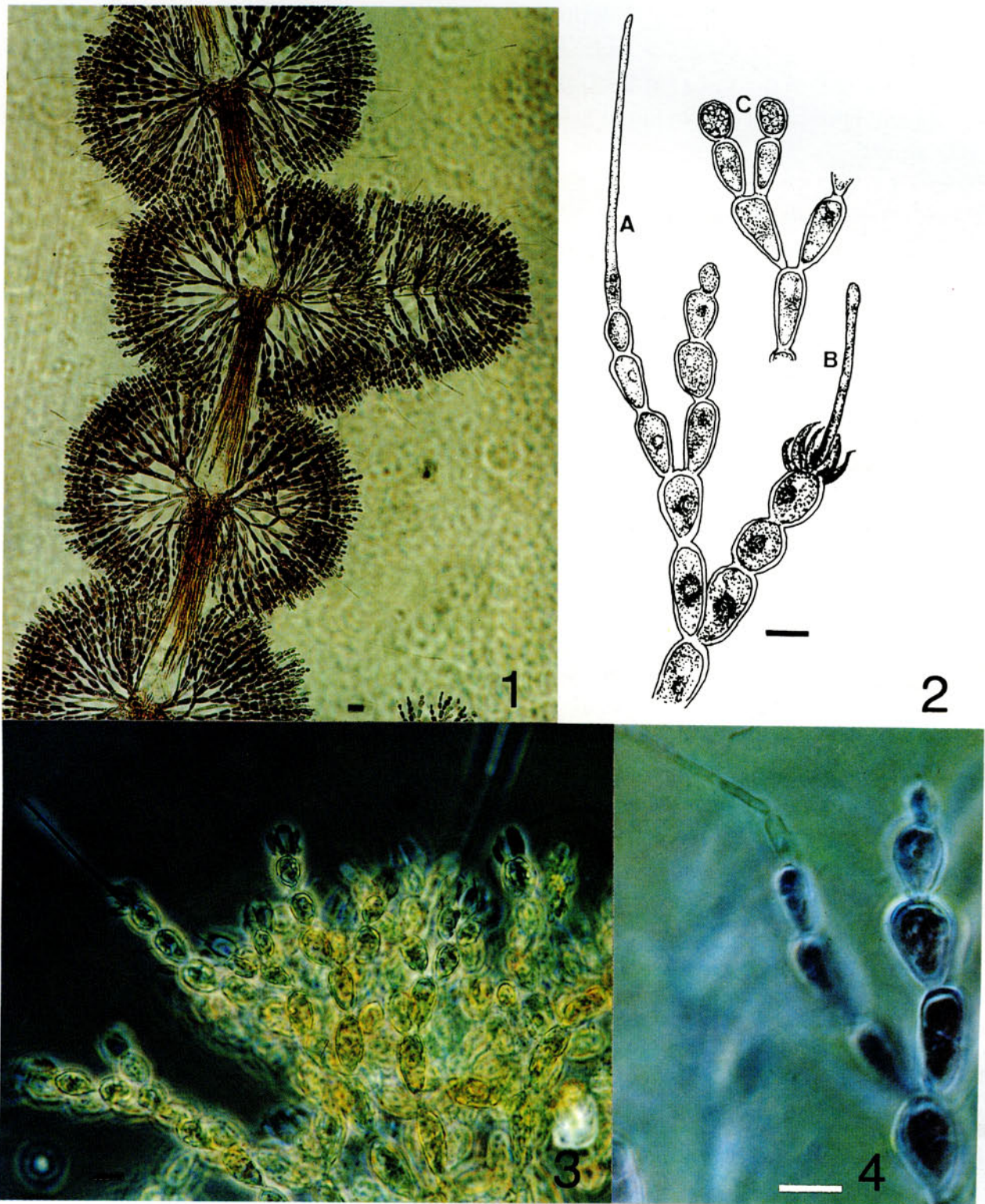


Fig. 1. *Batraachospermum moniliforme* Roth. (1) portion of plant with whorl branches and a lateral branch; (2) portion of branch tips showing (A) & (B) terminal hair, (C) monospores; (3) & (4) branches under different magnification. Bar = 10 μ m.

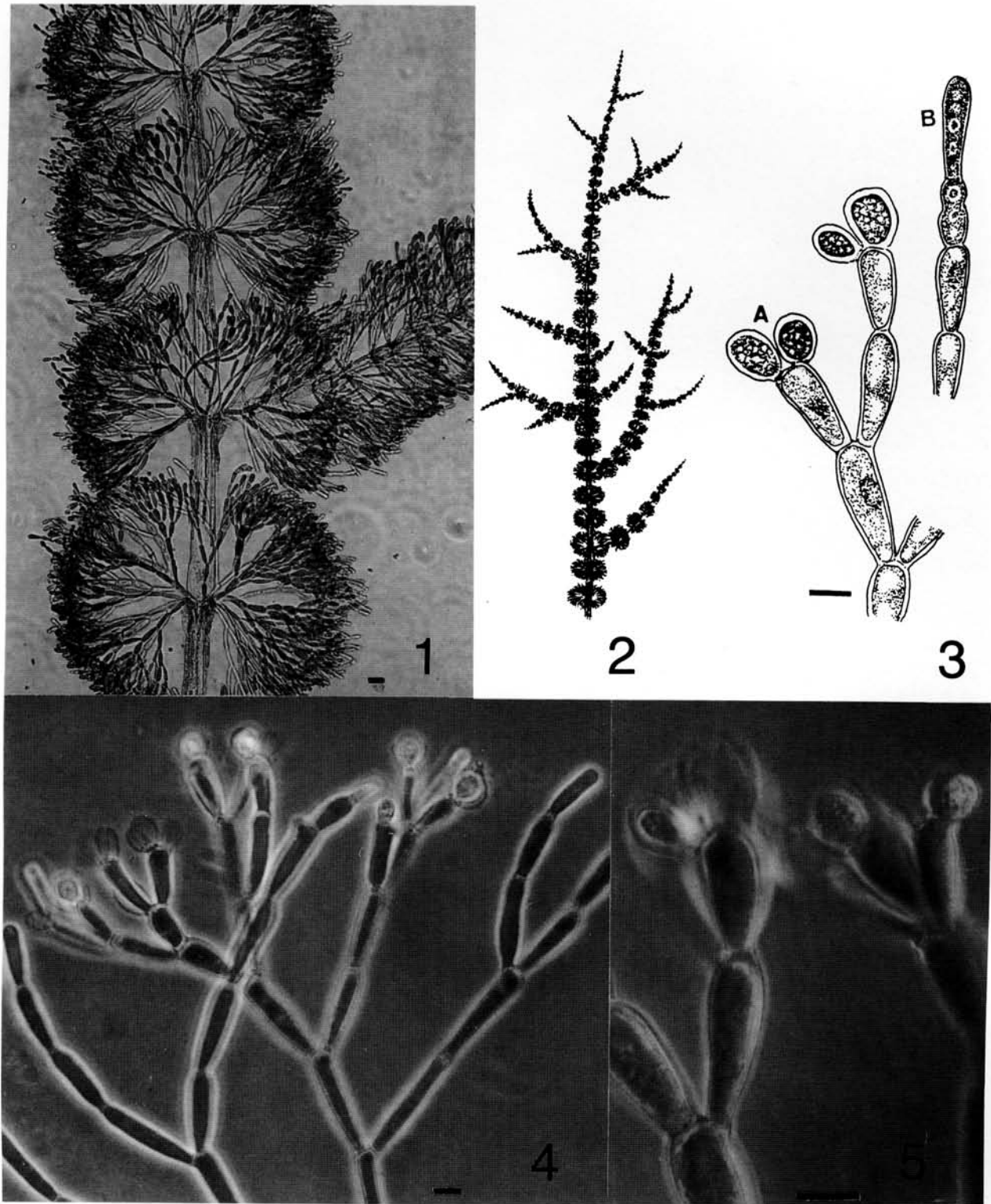


Fig. 2. *Batrachospermum ectocarpum* Sirod. (1) portion of plant showing whirl branches and a lateral branch; (2) portion of plant with abundant branching; (3) branch tips showing (A) monospores, (B) developing carposporangium; (4) & (5) portions of branches under different magnification. Bar = 10 μ m.

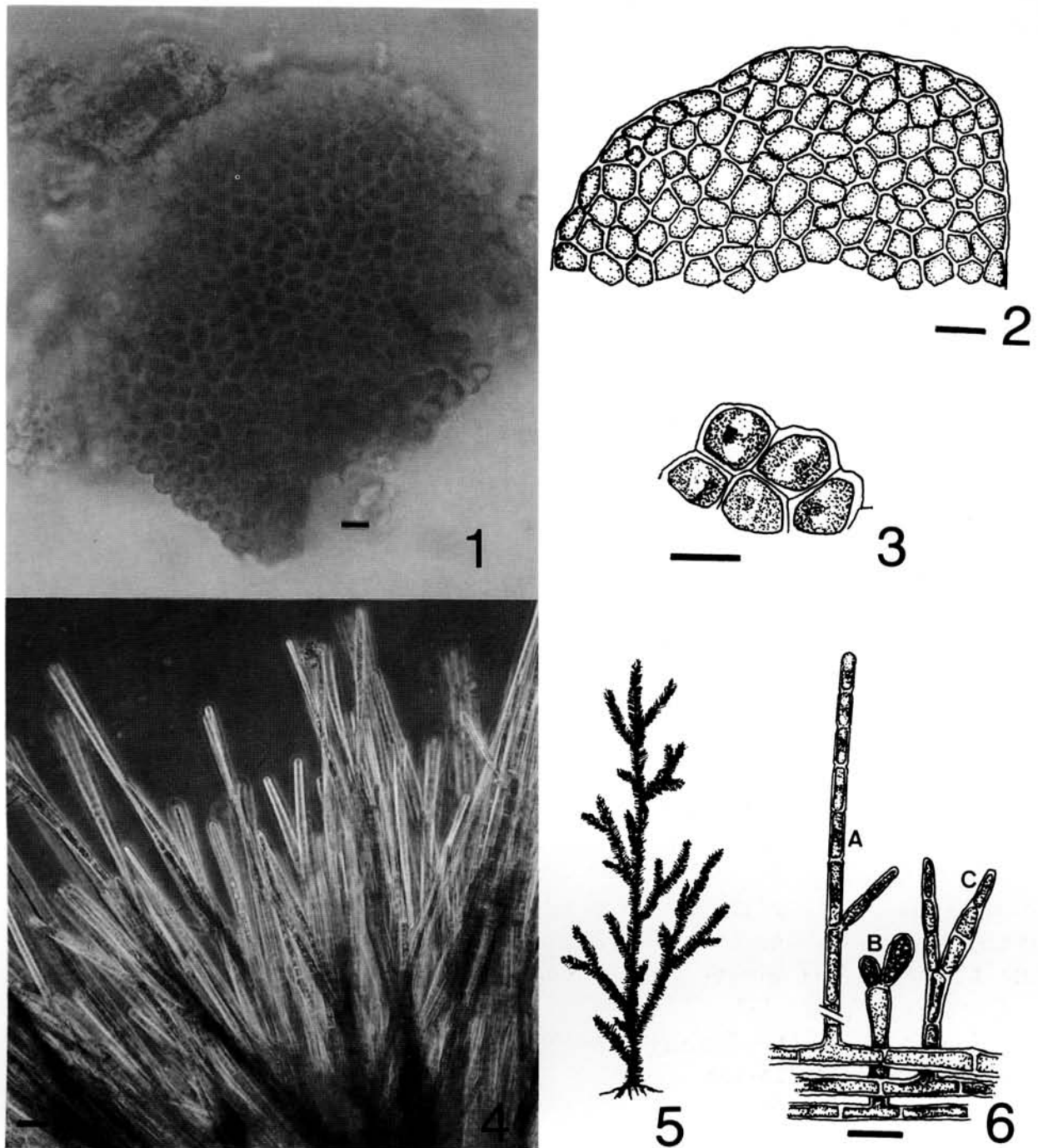


Fig. 3. *Hildenbrandia rivularis* (Liebm.) Bréb. (1-3) and *Thorea ramosissima* Bory (4-6). (1) & (2) aggregated cells on stone; (3) portion of a colony, showing cells with parietal chromatophore; (4) portion of thallus; (5) habit sketch; (6) part of thallus, showing (A) filament with branching, (B) monosporangia, and (C) a developing carposporangium. Bar = 10 μ m.

ECOLOGICAL DISTRIBUTION

Although all four species are growing in cool and well-aerated streams, their habitats have different water quality, especially in acidity. Table 1 shows that either species of

Batrachospermum inhabits in quite different environment: *i.e.*, *B. moniliforme* Roth is found in acidic water, whereas *B. ectocarpum* in alkaline one. *T. ramosissima* Bory grows in slightly alkaline environment. *Hildenbrandia rivularis* (Liebm.) Bréb. is found in neutral streams.

All of four freshwater rhodophytes are distributed in subalpine streams within the area of the central ridge of Taiwan. According to this nature of geographical distribution and abundance, it is assumed that there should exist more taxa of freshwater rhodophytes in Taiwan. To ascertain this question, further investigation should be done.

Table 1. Comparisons of some variables of water quality and saprobity at the localities where the Formosan freshwater rhodophytes were found.

	<i>B. moniliforme</i>	<i>B. ectocarpum</i>	<i>H. rivularis</i>	<i>T. ramosissima</i>
pH	5.5-6.8	7.6-8.0	6.8-7.3	7.6-8.1
Conductivity ($\mu\text{S}/\text{cm}$)	25-40	220-400	30-60	220-350
Water temperature ($^{\circ}\text{C}$)	7-15	16-19	15-22	14-23
Dissolved oxygen (%)	65-85	60-83	80-98	50-82
Saprobity	oligo	oligo to β -meso	xeno to oligo	oligo to β -meso

LITERATURE CITED

- Chen, C., Y.-M. Chiang and S.-H. Tsai Chiang. 1981. Morphological studies on the family Helminthocladiaceae (Nemaliales, Rhodophycophyta) of Taiwan. I. *Helminthocladia*. Biol. Bull. Nat. Taiwan Normal Univ. **16**: 27-32.
- Chen, C. and Y.-M. Chiang. 1982. Morphological studies on the family Helminthocladiaceae (Nemaliales, Rhodophycophyta) of Taiwan. II. *Dermonema*. Biol. Bull. Nat. Taiwan Normal Univ. **17**: 95-101.
- Chiang, Y.-M. 1962. Marine algae of northern Taiwan (Rhodophyta). *Taiwania* **8**: 143-165.
- Chiang, Y.-M. 1973. Notes on marine algae of Taiwan. *Taiwania* **18**: 13-17.
- Cole, K. M. and R.G. Sheath. 1990. *Biology of the Red Algae*. Cambridge Univ. Press, Cambridge, Pp.423-453.
- Gabrielson, P. W. and D. J. Garbary. 1986. Systematics of red algae (Rhodophyta). *CRC Crit. Rev. Plant Sci.* **3**: 325-366.
- Hu, H.-G, Y.-X. Wei, Y.-Y. Li, H.-Z. Zhu, J.-Y. Chen and Z.-X. Shi. 1980. *Freshwater Algae of China*. Sci. & Tech. Press, Shanghai. Pp. 70-88.
- Prescott, G.W. 1951. *Algae of the Western Great Lake Area*. Cranbrook Inst. Science, Michigan. Pp. 562-570.
- Sheath, R. G. and M. L. Vis. 1994. Distribution and systematics of *Batrachospermum* (Batrachospermales, Rhodophyta) in North America. 6. Section *Turfosa*. *J. Phycol.* **30**: 872-884.
- Shi, Z.-X., Y.-X. Wei, J.-Y. Chen, Y.-Y. Li, H.-H. Zhu, R.-H. Li and Y. Yao. 1994. *Compilation of Reports on the Survey of Algal Resources in South-western China*. Science Press, Beijing. Pp. 210-221.
- Triffany, L. H. and M. E. Britton. 1952. *The Algae of Illinois*. The Univ. of Chicago Press, Chicago. Pp. 379-382.

- van den Hoek, C., D.G. Mann and H.M. Jahns. 1995. *Algae, An Introduction to Phycology*. Cambridge Univ. Press, Cambridge. Pp. 48-101.
- Yamagishi, T. and M. Akiyama (eds). 1996. *Photomicrographs of Freshwater Algae*. Uchida Rokakuho. **17**: 5-24.

四種台灣的淡水紅藻

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摘 要

本文報導台灣島內首次發現的四種淡水紅藻，它們分屬於串珠藻 (*Batrachospermum ectocarpum* Sirod 和 *B. moniliforme* Roth)，紅索藻 (*Thorea ramosissima* Bory) 和胭脂藻 (*Hildenbrandia rivularis* (Liebm.) Bréb)。此四種均分佈於中央山脈中、低海拔的山區溪流，棲地之水溫低，溶氧量高，屬於貧腐水或 β -中腐水級的水域。不過，四藻種所棲習之水域水質略有不同，有的在酸性，有的在鹼性環境。本文除對此四藻種之形態、棲地、分佈等作敘述外，並將其棲地之水質環境作比較。

關鍵詞：分佈、生態、淡水紅藻、形態、台灣。

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