

**THE TAXONOMIC STATUS OF *COENOGONIUM*
SUBVIRESCENS AND *C. INTERPLEXUM*
NEWLY FOUND IN TAIWAN**

JEN-RONG WANG YANG⁽¹⁾

ABSTRACT

(1) Two species of *Coenogonium* are treated. *C. interplexum* Nyl. is recorded for the first time from Taiwan.

(2) *C. linkii* Ehrenb. is redetermined for *C. subvirescens* (Nyl.) Nyl.; *C. boninense* Sato is suggested to be conspecific with *C. linkii* Ehrenb.; *C. subvirescens* (Nyl.) Nyl. must be rejected as a *nomen dubium*.

(3) It is emphasized that *C. linkii* Ehrenb., type species of this genus, is a simple-spore species; *C. linkii* Ehrenb. *sens. lat.* is suggested to include *C. subvirescens* (Nyl.) Nyl., *C. lepricarii* (Mont.) Nyl. and also *C. boninense* Sato.

(4) *C. implexum* Nyl., *C. curculum* Zahlbr. and *C. disjunctum* Ny. are suggested to be very near to *C. interplexum* Nyl.

INTRODUCTION

Coenogonium subvirescens (Nyl.) Nyl. was first recorded by Zahlbruckner (1933: 26, from Nantou Co., Rengchi (蓮華池), leg. *Asahina 374.*). This name had been used by Zahlbruckner for a species with simple spores in his Section *Holocoenis*. Another name *C. boninense* Sato was reported by Asahina (1939: 630, pl. 303, f. 1-4) with a question mark indicating uncertainty, as to whether it had been collected from Taiwan (no voucher specimens were mentioned). *C. boninense* is also characterized by having simple spores, this name was also adopted by Syo Kurokawa in 1964 for a fertile specimen collected from Taitung Co., Hsinkang (新港), leg. *Suzuki, s. n.* Dec. 5, 1939 (TAI). It is believed that these two names must refer to the same lichen. Recently, another fertile specimen of this genus (Hualien Co., Hopping (和平), leg. *Lai 2040*) with 1-septate spores was collected, which evidently is a new record for Taiwan. The nomenclature of these two taxa is discussed in the present study. The author is deeply indebted to Mr. Ming-Jou Lai, a graduate student of Institute of Dendrology, Forestry Dept., N. T. U., for his assistance in various ways in the preparation of this paper. Sincere thanks are due to Dr. Charles E. DeVol, Botany Dept., N. T. U., in reviewing the manuscript.

COENOGONIUM EHRENBERG

Coenogonium Ehrenb. apud Nees von Esenb., *Horae Phys. Berol.* 120. 1820.—Type species: *C. linkii* Ehrenb.

Thallus spongy byssoid. Fungal hypae forming a network over the algal threads. Apothecia scattered on surface of thallus, round, short stalked or sessile; asci 8-spored; paraphyses unbranched, often clavate at the tips; spores hyaline, fusiform or ellipsoidal, simple or 1-septate.

(1) Lecturer of Botany, National Taiwan University (王貞蓉).

Symbiotic algae: species of *Trentepohlia* and *Physolinum* (phycobiont of *C. moniliforme* Tuck.).

Tropical.

Key to species of *Coenogonium* in Taiwan

- Spores simple; apothecia dark orange or red, 0.8 mm. in diameter, stalked.....*C. linkii* Ehrenb.
 Spores 1-septate; apothecia yellow, 0.5 mm. in diameter, nearly sessile
*C. interplexum* Nyl.

COENOGONIUM LINKII EHRENB.

Coenogonium linkii Ehrenb. in Nees von Esenb., Horae Phys. Berol. 120, pl. 27, 1820. *sens. lat.* (Type from Brasil, Santa Catharina, leg. Chamisso. *s.n.*)

C. controversum Pers. apud Gaudich. in Freycinet, Vey. Uranie, Bot. 214, 1826. *nom. illeg.*

C. linkii Ehrenb. var. *leprieurii* Mont. in Ann. Sci. Nat. Bot., 3 ser., 16: 47, 1851. (Type from French Guiana, leg. *Leprieuri*, *s.n.*)

C. leprieurii (Mont.) Nyl. in Ann. Sci. Nat. Bot., 4 ser., 16: 89, f. 15-19, 1862.

C. leprieurii (Mont.) Nyl. var. *subvirescens* Nyl. in Ann. Sci. Nat. Bot., 4 ser., 16: 89, 1862. (This variety was described from French Guiana without collector)

C. subvirescens (Nyl.) Nyl. in Flora 57: 72, 1874. *nom. dub.* (Type from Brazil, Amazonas, Rio Negro, leg. *Spruce* 28)

C. boninense Sato in Journ. Jap. Bot. 8: 390, 1933; *ibid.* 10: 17, f. 1. 1934. *syn. nov.* (Type from Bonin, Isl. Hahazima, Mt. Sekimon, leg. *Sato* 106)

Holocoenis leprieurii (Mont.) Clements, Genera of fungi, 174, 1909.

Thallus shelf-like, pannose, orbicular or reniform in outline, dull yellowish-green. Phycobiont *Trentepohlia*, partially covered with colorless anatomosing fungal hyphae. Apothecia 0.8 mm. in diameter, round, dark orange or red, stalked, margin pale; disk flat or convex; paraphyses septate, 1.2 μ in width, apices clavate; asci fusiform-cylindric, 5.0 \times 50 μ , 8-spored; spores simple, fusiform-elliptic, 3 \times 7.5 μ . (Pl. 2)

Specimens examined:

Taipei Co., Kankou (乾溝), *DeVol* 9055 (TAI), on bark.

Taitung Co., Hsinkang (新港), *Suzuki* 19972, *Suzuki s.n.* Dec. 5, 1939 (TAI), on bark of *Persea japonica* Sieb. & Zucc.

Four other collections were made from the same locality at Kankou, *Lai* 2192, 2206, 2207, 2215 are all sterile; these may be considered as only slightly lichenized *Trentepohlia*.

When establishing *C. linkii* as the type species of this genus, Ehrenberg (1820) illustrated the spores of this species as simple, however Santesson (1952: 407) assumed that this might be incorrect on account of Ehrenberg's primitive optical equipment and this opinion is shared by Uyenco (1963: 222), the septation of the type specimen needs to be re-examined.

Montagne (1851) established the variety *leprieurii* because of the supposed difference in color of the apothecia. He did not mention the septation of the spores, but an isotype specimen studied by Santesson (1952: 407) revealed that this was mistreated. The color of the apothecia is supposed to be the character which differentiates *C. leprieurii* (Mont.) Nyl. from all other species of *Coenogonium* and

C. leprieurii has been regarded as a species with simple spores (Nylander 1862a; Vainio 1896; Zahlbruckner 1907: 128 & 1926: 149; Dodge 1933: 397). The septation of the spores of type specimen of this species should also be re-examined.

While *C. linkii* has long been considered to be a species with 1-septate spores (Nylander 1862a; Zahlbruckner 1907: 128 & 1926: 149; Karling 1934; Fink 1935: 141; Uyenco 1963; Hale 1969: 184) it has rarely been thought of as being a simple-spored species (Redinger 1933, p. 203). Nylander (1862a) redescribed *C. linkii* Ehrenb. as being very near to his *C. leprieurii* (Mont.) Nyl. except for the septate spores and the wider filaments and paraphyses, but apparently Nylander did not re-examine the type specimen of *C. linkii* to check on the septation of the spores, however, he mentioned it had simple spores with only poorly developed septa. Fink's (1935: 141) statement "spores becoming 1-septate" is ambiguous. Uyenco (1963b: 222) noted material with very thin septa which could be very easily overlooked unless carefully stained, but lichens with similar thalli having apothecia with simple spores he would tentatively call *C. leprieurii*. Fink may be right (1935: 141) in citing *C. linkii* var. *leprieurii* Mont. as a synonym of *C. linkii* Ehrenb. but he clearly described *C. linkii* as a species with 1-septate spores.

Nylander (1862a 89) established the var. *subvirescens* of *C. leprieurii* (which was later changed by him to *C. subvirescens* in 1874) based on a sterile specimen and distinguished only by its thinner algal threads. It was proposed first by Santesson (1852; 407) that *C. subvirescens* should be rejected as it is a *nomen dubium* and cannot be proved to be related to *C. leprieurii*. The name has been used for species both with simple spores (Malme 1947: 17) and 1-septate spores (Dodge 1933: 398). Ascospores examined by Dodge were not mature but seemed to be slender and 2-celled. Dodge (1933: 402) also mentioned a sterile specimen which evidently had very young algae as *C. subvirescens* under his name *C. pannosum* Müll.

M. M. Sato (1933: 390 and 1934: 17) established *C. boninense* from the Bonin Islands, which was said to be allied to *C. leprieurii* but easily distinguished from it by its smaller algal cells. This character can not be used in differentiating *C. boninense* from *C. leprieurii* or *C. linkii* as Uyenco (1963 a and 1965) has pointed out because the algal filaments vary greatly in width and can not be used to characterize the species of *Coenogonium*.

Uyenco (1963b) reported on *C. interplexum* Nyl., *C. interpositum* Nyl., and *C. linkii* Ehrenb., based on his specimens Nos. 65, 67, 66 respectively, which he collected from the same locality in U. S. A. (Low hammock near Sanford). However, a preliminary comparison with their descriptions does not reveal any marked differences which would suggest that they should be accepted as specifically different. This also holds true in a similar way for the descriptions of *C. interplexum* Nyl. and *C. disjunctum* in his above mentioned paper. These taxa seem difficult to separate and may be regarded as a species complex. The numerous species of *Coenogonium* established by Nylander (1862a) and other later lichenologists and the species enumerated by Dodge (1933), Uyenco (1963b) which were also cited by Hale & Culberson (1970: 512) all need further study. Dodge (1933: 396) commented that few characters are available for separating the species of *Coenogonium* except that of spore size and septation and so he said that for lack of time he was following the traditional arrangement and using the diameter of algal filaments to distinguish species. It is clear that a monographic study of *Coenogonium* is badly needed and will certainly involve considerable revision of the presently accepted names.

COENOGONIUM INTERPLEXUM NYL.

Coenogonium interplexum Nyl. in Ann. Sci. Nat. Bot., 4 ser., 16: 62, pl. 12, f. 20, 21, 1862. (Type from Columbia, *Linding 2561*)

Thallus adnate, pannose, greyish green. Phycobiont *Trentepohlia*, hyphae uncolored. Apothecia yellow, 0.5 mm. in diameter, round, margin pale, nearly sessile; disk flat or concave or convex; paraphyses about 1.2μ in width, septate, apices clavate; asci fusiform-cylindric, $6.3 \times 50 \mu$, 8-spored; spores 1-septate colorless, ellipsoidal, $2.5 \times 9 \mu$. (Pl. 1. Top fig)

Specimens examined:

Hualien Co., Hoping (和平) Forest Station, 4th Compartment, *Lai 2040* (TAI).

This species was collected in a deciduous broad-leaved forest about 1500 m. above sea level. This lichen was associated with the moss *Leucoloma molle* (C. Muller) Mitten or adnate on it and growing on twigs of *Piper kadsura* (Chois.) Ohwi which were twining on the basal portion of a slender trunk of *Lithocarpus uraiana* Hayata. Fruiting bodies were abundant.

Coenogonium interplexum seems to be a relatively good autonomous species characterized by somewhat yellowish apothecia and apparently 1-septate spores, which was selected by Vainio's (1921) as the type species for his Section *Coenobiatorina*. The oblique nature of the spores of this species needs further study. Asahina (1928: 271 & 1939: 631) recorded this taxon from Japan which was identified by Zahlbruckner for a species with curved 1-septate spores. While Uyenco (1963b: 220-221) used the name *C. implexum* Nyl. for a species with oblique 1-septate spores and *C. interplexum* Nyl. for a species with linear 1-septate spores. Fink (1935: 141) reported that *C. interplexum*, *C. linkii* and *C. disjunctum* all have oblique (1-septate, uniseriate) spores. Santesson (1952: 408) mentioned *C. curvulum* Zahlbr. being the only species characterized by having curved spores that he knew of.

When establishing *C. implexum*, Nylander (1862a) stated that it was similar to *C. interplexum* but its algal cells were a little smaller, spores a little larger, and paraphyses thicker. It is evident that *C. implexum* Nyl⁽¹⁾; type from Australia, Victoria, Jarvin, leg. *Ferd. Muller s.n.* and *C. curvulum* Zahl⁽²⁾; type from Java, leg. *Schiffer 3056* and even *C. disjunctum* Nyl⁽³⁾, type from Martinique and Cuba, leg. *Wright 170* are very near to *C. interplexum* and so should be placed in the *C. interplexum* group.

THE LICHENIZED ALGAE.**Culture methods:**

Individual filaments from the thallus were picked up by means of fine forceps and washed in sterilized distilled water, and then inoculated into flasks containing Bristol's inorganic medium (Bold modified form 1942), and soil water medium (Starr 1950) which contained a small amount of CaCO_3 (Uyenco 1965). The cultures were placed under continuous fluorescent light and kept at approximately 20°C.

Observations:

Two days after introducing the algae, the cultures were examined for vegetative growth. The fungal partners began to separate from the algal threads. Fungal

(1) Ann. Sci. Nat. Bot., 4 ser. 16: 92, 1892.

(2) Ann. Crypt. Exot. 1: 164, 1928.

(3) Bot. Zeit. 20: 178, 1862.

hyphae disintegrated after four days, allowing the algae to grow independently. The cell walls of the algae thus appeared clear and branches were formed.

Trentepohlia of *C. interplexum* (Pl. 1, Bottom fig.) Algal filaments thin, vegetative cells of the erect filaments cylindrical, about 7.5μ in width, 32.5μ in length. With numerous oval, elongated, somewhat irregular and disc-shaped plastids, together with yellow and orange oil droplets in the cytoplasm. Branchings were formed in all directions in the absence of the fungal hyphae. Prostrate branches were small and somewhat moniliform in shape. Terminal cells were thinner, rounded, but sometimes pointed, shorter than the other cells. The terminal cells became swollen after a period of one week. The vegetative filaments of this symbiont very closely resemble those of *T. abietina* which was also isolated from *C. interplexum* by Uyenco (Uyenco 1965).

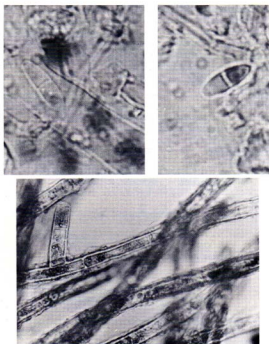
Slightly lichenized Trentepohlia of sterile thalli (Lai 2207) (Pl. 3. Top fig.) Vegetative cells are ellipsoidal or cylindrical, 25μ in width, 51.5μ in length, filaments branching at right angles, 3-5 buds are formed on 2-day old cultures. Terminal cells are swollen and appear larger than the other vegetative cells of the filament. Branching occurs on both sides.

Slightly lichenized Trentepohlia of sterile thalli (Lai 2215) (Pl. 3. Bottom fig.) Vegetative cells are cylindrical, 23.7μ in width, 56.9μ in length. Branchings occur on both sides, dichotomous, at almost right angles to the main axis. Buds appeared after 2-days of culture, 3-5 buds were formed on one of the main filaments. Buds are round, some occur at the nodes (these look like zoosporangia).

LITERATURE CITED

- ASAHINA, Y., 1928. Raiken's soliloguy on botanical science (Notes on lichens) 31. J. Jap. Bot. 6: 269-271.
- _____. 1939. Nippon Inkwasyokubutu Duken (Illustrated flora of Japanese Cryptogams). Sansendo, Tokyo.
- BOLD, H. C., 1942. The cultivation of algae. Bot. Rev. 8: 69-138.
- CLEMENTS, F. E., 1909. The genera of fungi. New York.
- DODGE, C. W., 1933. The foliose and fruticose lichens of Costa Rica I. Ann. Miss. Bot. Gard. 20: 373-467.
- FINK, B., 1935. The lichen flora of the United States. Ann Arbor.
- GAUDICHAUD-BRAUPRÉ, C., 1825. Botanique du voyage autour du monde par order du Roi sur les corvettes l'Uranie et la physicienne pendant années 1817-1828 par M. Louis de Freycinet. Paris.
- HALE, M. E., 1969. How to know the lichens. Iowa.
- _____. & W. Culberson, 1970. A fourth checklist of the lichens of the Continental United States & Canada. The Bryologist 73 (3): 499-543.
- HUE, A. M., 1892. Lichenes exotici a Professor W. Nylander descriptive recognite, Paris.
- KARLING, J. S., 1934. A preliminary contribution to the structure and development of *Coenogonium Linkii*. Ann. Bot. 48: 823-855.
- LAMB, I. M., 1963. Index Nominum Lichenum inter annos 1932-1960 Divulgatorum. Ronald Press, New York.
- MALME, G., 1937. Lichenes nonnulli in expeditione regnelliana prima collecti. Ark. för Bot. 29 (6): 16-19.
- MONTAGNE, C., 1851. Cryptogamia Guyanensis. Ann. Sci. Nat. Bot., ser. 3, 16.
- MULLER, A. J., 1892. Lichenes epiphylli Spruceani. J. Linn. Soc. Bot. 29: 322-333.
- NEES VON ESENBECK, C. G., 1820. Horae physicae berolinenses. Bonn.
- NYLANDER, W., 1852a. Quelques observations sur le genre *Coenogonium*. Ann. Sci. Nat. Bot., 4 ser., 16: 83-96.

- _____. 1862b. Exposito synoptica generis *Coenogonii*. Bot. Zeit. **20**: 177-178.
- _____. 1874. Animadversiones circa Spruce, Lichenes Amazonicos et Andinos. Flora 57.
- REDINGER, K. M., 1933. Eine bemerkungswerte Wachstumsweise von *Coenogonium Linkii* Ehrenb. Rev. Bryol. Lichénol. **6**.
- SANTESSON, R., 1952. Follicolous lichens I. A revision of the taxonomy of the obligate follicolous lichenized fungi. Symb. Bot. Upsal. **12** (1): 1-590. pl. 1. f. 1-12.
- SATO, M. M., 1933. Materials for a lichen flora of Bonin Islands. I. J. Jap. Bot. **8**: 388-391. 1. fig.
- _____. 1934. Studies on the lichens of Japan (1). J. Jap. Bot. **10** (1): 17. fig. 1.
- SATO, T., 1939. Notes on the lichen flora of Hiroshima-ken. J. Jap. Bot. **15** (4): 224-242.
- SCHWENDENER, S., 1862. Über die Entwicklung der Apothecium von *Coenogonium Linkii*, mit Berücksichtigung der Darstellungen karstens. Flora **45**: 225-234. Taf. I.
- SMITH, A. L., 1906. British *Coenogoniaceae*. J. Bot. **44**: 266-268.
- STARR, R. C., 1960. The culture collection of algae. Amer. J. Bot., **47**: 67-86.
- UYENCO, F. R., 1963a. Studies on the genus *Coenogonium* Ehrenberg. Thesis, Michigan State University (unpublished).
- _____. 1963b. The species of *Coenogonium* in the United States. The Bryologist **66**: 217-224.
- _____. 1965. Studies on some lichenized *Trentepohlia* associated in lichen thalli with *Coenogonium*. Trans. Amer. Microscop. Soc. **84**: 1-14. 2 pl. 3 tab.
- VAINIO, E. A., 1890. Etude sur la classification naturelle et la morphologie des lichens du Brésil. Helsingfors.
- ZAHLEBRUCKNER, A., 1907 & 1926. *Coenogoniaceae* in Engler & Prantl, Die natür. Pflanz.-fam. **1** (1): 127-128, 1907; ed. 2. **8**: 147-149.
- _____. 1908. Beiträge zur Flechten flora Brasiliens. Bull. Herb. Boiss. ser. 2, **8** (7): 459-468.
- _____. 1924. Catalogus Lichenum Universalis, **2**: 735-741.
- _____. 1928. Neue und ungenügend beschriebene javanische Flechten. Ann. Crypt. Exot. **1**: 164.
- _____. 1933. Flechten der Insel Formosa. Fedd. Repert. **31**: 194-224; **33**: 22-68.



Explanation of figure

Plate 1. *Coenogonium interplexum* Nyl.

Top: 1-septate ascospores ($\times 1000$). (left and right)

Bottom: Thallus filaments ($\times 400$).

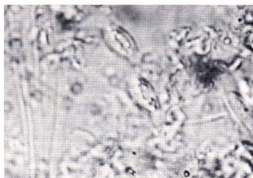


Plate 2. *Coenogonium Linkii* Ehrenb.
Simple ascospores ($\times 1000$).

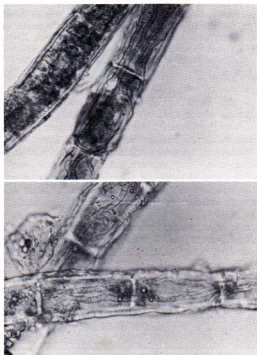


Plate 3. Slightly lichenized *Trentepohlia* from sterile specimens.

Top: Slightly lichenized *Trentepohlia* of sterile thalli (Lai 2207) showing filaments partially covered with anastomosing fungal hyphae ($\times 400$).

Bottom: Slightly lichenized *Trentepohlia* of sterile thalli (Lai 2215) showing filaments partially covered with anastomosing fungal hyphae ($\times 400$).