

Coenogonium moniliforme (Coenogoniaceae, Lichenized Ascomycota) New to Japan, with Taxonomic Notes of the Photobiont in Culture

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Coenogonium moniliforme Tuck. is new to Japan. Although this species has been recorded as corticolous and foliicolous, it was found on rock for the first time. A key to Japanese taxa of *Coenogonium* is also provided.

Key words: Distribution, lichens, saxicolous, *Trentepohlia monile*.

The genus *Coenogonium* Ehrenb. (*Coenogoniaceae*, *Ascomycota*), consisting of ca. 85 species, is mainly distributed in tropical and subtropical regions (Rivas Plata et al. 2006, Lücking 2008, Ferraro and Michlig 2013). This genus is characterized by biatorine apothecia with a yellow to orange or brown disc, a paraplectenchymatous excipulum, unitunicate asci with entirely thin walls, uniseptate (rarely simple), colorless ascospores, and a trentepohlioid photobiont (Rivas Plata et al. 2006, Lücking 2008).

In Japan, nine species of *Coenogonium* have been recorded before the present study (Kurokawa and Kashiwadani 2006, Lücking 2008). As part of our biotic studies of Japanese lichens, an interesting *Coenogonium* species, *C. moniliforme* Tuck., was collected from Kyushu in southern Japan.

The purpose of this study is to show the

features of *C. moniliforme* and its photobiont based on the Japanese material. A key to Japanese species of *Coenogonium* is also provided.

Material and Methods

Field investigations were carried out in 2015. Voucher lichen specimens are housed in the National Museum of Nature and Science (TNS), Tsukuba, Japan, and the cultures of the photobiont isolated from the lichen samples are maintained at Hiroshima Environment and Health Association, Hiroshima, Japan.

Morphological observations of lichen specimens were made using a dissecting microscope (Olympus SZX16) and a differential interference contrast microscope (Olympus BX51). Anatomical examination was undertaken using hand-cut sections mounted in GAW (glycerin : ethanol : water, 1:1:1). Statistical

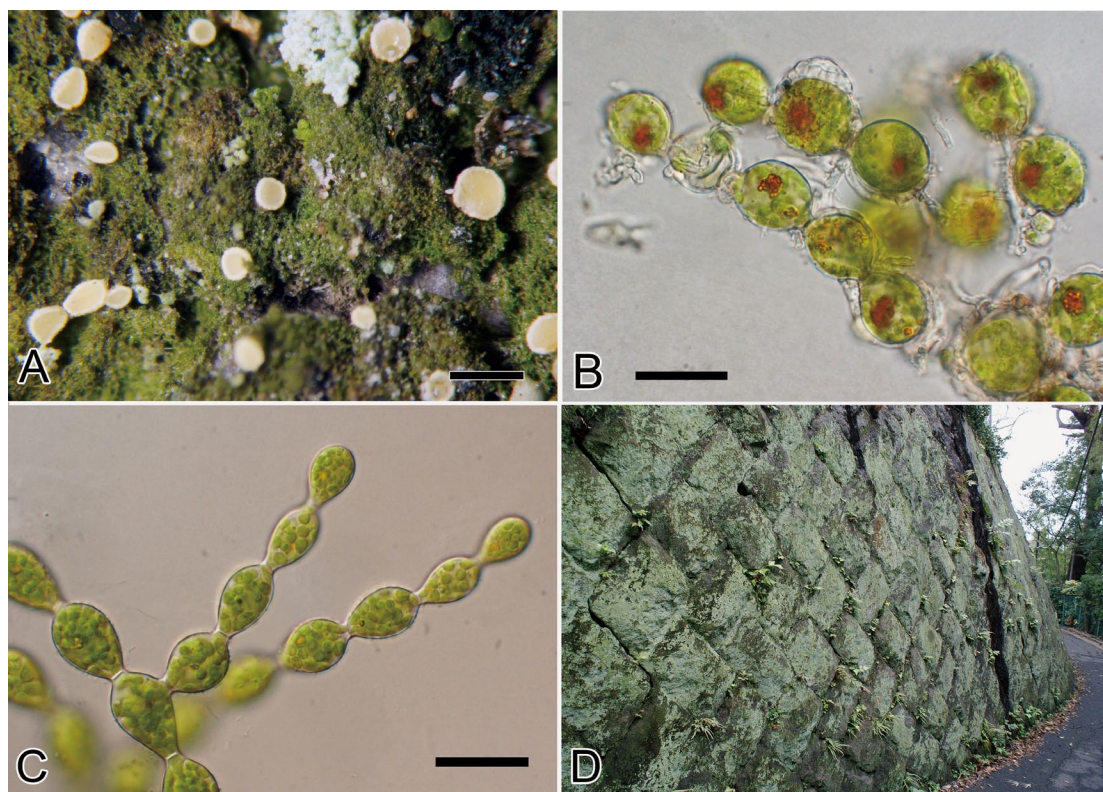


Fig. 1. *Coenogonium moniliforme* and the photobiont, *Trentepohlia monile*. A. Lichen thallus with apothecia (Y. Ohmura 10563 & A. Mizobuchi, TNS). B. *T. monile* in a lichenized state (S. Handa & al. 3084, TNS). C. *T. monile* in a culture state isolated from the photobiont of *C. moniliforme* (voucher culture: Handa-3084). D. Habitat on a stone wall. Scales: 0.5 mm (A), 25 μ m (B, C).

measurements are given as (minimum)–average \pm standard deviation(–maximum); n = number of measurements.

For isolation of the lichen photobiont, a sample of lichen thallus was cut into segments using sterilized tweezers, and the segments were spread onto 1.0% agar plate. The cleaned segments were then transferred onto 1.5% agar plates of modified Bold's basal medium (Bischoff and Bold 1963). This process was repeated to counter fungal or bacterial contamination. The algal strains were cultivated for one month under the following conditions: 22 ± 1 °C, 50 μ mol/m²/s, and 12:12 hr of light/dark cycle. Light microscopy was carried out using a Nomarski differential interference

microscope (Nikon Eclipse E600).

Results and Discussion

Coenogonium moniliforme Tuck. in Proc. Amer. Acad. Arts & Sci. 5: 416 (1862). [Fig. 1]

Type: CUBA. On bark, C. Wright 172 (FH–holotype, not seen; BM!, H!, M!, S!–isotypes).

Biatorinopsis torulosa Müll. Arg. in Revue Mycol. 10: 114 (1888). Type: PARAGUAY. Balansa 4165 (G–holotype!).

Coenogonium (Gyalecta) haitiensis G. Merr., nom. inval. (unpublished herbarium name). Original material: HAITI. Leonard 9965 (BM!, S-L2159!).

Morphological features of the Japanese material (Fig. 1A) agree with the protologue and

the descriptions provided by Uyenco (1963), Thor and Vězda (1984) and Lücking (1992, 1999, 2008), but no pycnidia were found. The statistical values of morphological features for the Japanese material agreed with the range of the known sizes as follows: apothecia up to 0.45 mm diameter; ascospores $(8.0\text{--}11.5 \pm 2.0\text{--}14.0) \times (3.0\text{--}3.8 \pm 0.5\text{--}5.0) \mu\text{m}$ ($n = 50$).

The photobiont was identified as *Trentepohlia monile* De Wild. (De Wildeman 1888, 1891), after the observations of both lichenized and culture states. The features of Japanese material agree with the protologue and the description of *Trentepohlia monile* provided by Chowdary (1963): i.e., the cottony algal mass is formed by entangled green to orange filaments which are erect, richly branched and deeply constricted at the segments, to form a distinctive moniliform shape; cells nearly spherical, 16–22 μm in diam. in lichenized state (Fig. 1B), and elliptical to barrel-shaped, 20–30 \times 12–16 μm in culture state (Fig. 1C); cell walls smooth on the surface, <1.0 μm thick, uniformly thickened for the whole cell; sporangia borne intercalary between vegetative cells or laterally on a vegetative cell, sessile, green to yellowish-brown, spherical, 27–30 μm in diam.; biflagellate swimmers ellipsoidal, slightly flattened, 6–7 \times 8–10 μm .

Trentepohlia monile is currently being treated as synonym of *T. rigidula* (J. Müller) Hariot (Hariot 1889, Cribb 1958, Guiry and Guiry 2015). However, the latter was originally described as a lichen fungus under the name *Coenogonium rigidulum* Müll. Arg. (Müller 1882) and hence, since the original material is lichenized and has been identified with the name *C. implexum* Nyl. (Nylander 1862), the name *C. rigidulum* refers to a lichen fungus and not to the photobiont and hence cannot be used in the genus *Trentepohlia*. *Trentepohlia monile* is usually treated as *T. monilia* in the literature but was originally described with the epithet *monile* (De Wildemann 1888: 140). Since the original epithet is grammatically correct, representing a noun in apposition meaning “neckless”, it cannot

be changed and has to be used in its original form.

Coenogonium moniliforme has been recorded as corticolous and foliicolous (e.g., Santesson 1952, Uyenco 1963, Thor and Vězda 1984, Lücking 2008), but Japanese material was found on a stone wall at 40 m elevation in Kyushu with a warm-temperate climate (Fig. 1D). Because of the tiny apothecia and the inconspicuous algal-based thallus, it is easily overlooked in the field. This species has been rarely collected from North and South America, Africa, Australia and Asia (Nepal) (see Thor and Vězda 1984, Lücking 2008), but further careful investigation would no doubt expand its distribution.

Specimens examined: **JAPAN**. Kyushu: Prov. Chikuzen (Pref. Fukuoka): Tani, Chuo-ku, Fukuoka-city (33°34'26"N, 130°23'06"E), on stone wall, ca. 40 m elev., 20 March 2015, S. Handa & al. 3084 (TNS); ditto, 11 June 2015, Y. Ohmura 10563 & A. Mizobuchi (TNS).

A key to Japanese taxa of *Coenogonium*

1. Thallus dominated by the photobiont, filamentous, felt-like or pilose with short, upright algal threads 2
 1. Thallus appressed and glabrous, crustose 4
 2. Photobiont cells distinctly moniliform-barrel-shaped [Fig. 1] *C. moniliforme* Tuck.
 2. Photobiont cells rectangular-cylindrical 3
 3. Apothecia distinctly stipitate; ascospores simple, 5–8 \times 2–3 μm *C. leprieurii* (Mont.) Nyl.
 3. Apothecia sessile; ascospores 1-septate, 8–11 \times 3–4 μm *C. nigromaculatum* Kurok.
 4. Apothecial margin denticulate *C. kawanai* (H. Harada & Vězda) H. Harada & Lumbsch
 4. Apothecial margin smooth 5
 5. Apothecia small to medium-sized (<0.5 mm in diam.) 6
 5. Apothecia medium-sized to large (>0.5 mm in diam.) 8
 6. Ascospores large (18–25 \times 3–4 μm)
 - *C. wrightii* (Vězda) H. Harada & Lumbsch
 6. Ascospores small (6–12 \times 2.5–4.5 μm) 7
 7. Foliicolous (rarely corticolous); apothecia up to 0.3 mm in diam.; disc pale wax-colored; ascospores 6–10 \times 2.5–3.5 μm ; conidia

- 1-septate, 12–18 × 2–2.5 μm
 *C. dilucidum* (Kremp.) Kalb & Lücking
7. Corticolous; apothecia up to 0.5 mm in diam.;
 disc pale yellow to orange; ascospores 9–15 ×
 2–4.5 μm; conidia non-septate, 6–8 × 1.8–2.6
 μm
 *C. pineti* (Ach.) Lücking & Lumbsch
8. Apothecia medium-sized, 0.3–0.8 mm diam;
 conidia 1-septate, 12–18 × 2–3 μm
 *C. subluteum* (Rehm) Lücking & Lumbsch
8. Apothecia large, (0.5–)0.8–2 mm diam.;
 conidia non-septate, 2.5–5 × 1.5–2 μm 9
9. Apothecia 0.5–2 mm diam., 200–300 μm
 high; disc orange-yellow to orange; ascospores
 7–11 × 2.5–3.5 μm; conidia 3–5 × 1.5–2 μm
 *C. luteum* (Dicks.) Kalb & Lücking
9. Apothecia 0.4–1 mm diam., 130–180 μm
 high; disc bright yellow; ascospores 6–9 ×
 1.8–2.5 μm; conidia 2.5–3.5 × 1.7–2 μm
 *C. geralense* (Henn.) Lücking

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大村嘉人^a, 溝渕 綾^b, 半田信司^b, R. Lücking^c: 日本
 新産のジュズスミレモドキ (ダイダイサラゴケ科, 地
 衣化子嚢菌) およびその共生藻の分類学的特徴

ダイダイサラゴケ科ダイダイサラゴケ属地衣類の
Coenogonium moniliforme ジュズスミレモドキ (新称)
 が日本で初めて福岡県福岡市の住宅地の石垣上で発見

された。本種は北米, 南米, アフリカ, オーストラリア,
 アジア (ネパール) から報告されているが, 地衣体が自
 由生活の糸状体緑藻類のスミレモ類と見間違えやすく,

子器も小さく淡黄色で目立たないため、世界での採集事例も多くない。これまでに生葉上および樹皮からのみ採集されてきたが、今回世界で初めて岩上に生育していることを確認した。ジュズスミレモドキの地衣体はフェルト状、子器直径は最大 0.45 mm、子嚢胞子は大きさ $8-14 \times 3-5 \mu\text{m}$ 、共生藻はスミレモ科の *Trentepohlia monile* ジュズスミレモ（新称）であった。藻体は細胞が数珠状に連なり、地衣化状態では細胞はほぼ球形で

径 $16-22 \mu\text{m}$ 、培養状態では長円形から樽型で $20-30 \times 12-16 \mu\text{m}$ であった。ジュズスミレモを共生藻に持つダイダイサラゴケ属地衣類は本種のみであり、近縁種から容易に区別できる。

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