热带亚热带植物学报 2018, 26(4): 421 ~ 428
Journal of Tropical and Subtropical Botany

中国绒衣属地衣的初步研究

吴晓晗, 刘飞月, 赵欣, 贾泽峰*
(聊城大学生命科学学院, 山东 聊城 252059)

摘要：绒衣属(*Coenogonium*)地衣属于真菌界(Fungi)子囊菌门(Ascomycota)茶渍纲(Lecanoromycetes)厚顶盘亚纲(Ostropomycetidae)厚顶盘目(Ostropales)绒衣科(Coenogoniaceae)，主要分布于热带和亚热带地区。综述了绒衣属地衣研究简史和中国研究概况；报道了中国该属 10 种地衣，其中 1 种为中国新记录种: 疏羽绒衣(*Coenogonium disjunctum*)。对各种进行了描述和讨论，并给出了中国绒衣属的检索表和新记录种的图片。这是首次对中国绒衣属地衣的系统研究，为地衣型真菌分类学研究提供了基础资料。

关键词：孢子植物；地衣型真菌；分类学；新记录
doi: 10.11926/jtsb.3880

A Preliminary Study on the Lichen Genus *Coenogonium* from China

WU Xiao-han, LIU Fei-yue, ZHAO Xin, JIA Ze-feng*
(*College of Life Sciences, Liaocheng University*, Liaocheng 252059, Shandong, China)

Abstract: The lichen genus *Coenogonium* belongs to Coenogoniaceae, Ostropales, Ostropomycetidae, Lecanoromycetes, Ascomycota, Fungi, mainly distributed in tropics and subtropics. Ten species of *Coenogonium* were reported, including a species, *C. disjunctum*, as new record to China. Each species is described and discussed in detail, and the key to the genus and the photos of the new record species are presented. It is the first systematic study on Chinese *Coenogonium*, which can provide the basic information for the taxonomy of lichenized fungi.
Key words: Cryptogamae; Lichenized fungi; Taxonomy; New record

The genus *Coenogonium* Ehrenb. including more than 130 species which are mainly found in tropical and subtropical habitats, belonging to the lichenized fungi family Coenogoniaceae (Ascomycota, Lecanoromycetes, Ostropomycetidae, Ostropales), is characterized by crustose or filamentous thallus, biatorine (rarely zeorine), yellow to orange or brown apothecia with paraplectenchymatous excipulum, partially amyloid hymenium (I+ blue then quickly sordid green then red-brown), 8-spored, thin-walled unitunicate asci, 1-septate or rarely non-septate hyaline ascospores and trentepohlioid photobiont. The *Coenogonium* usually grow on organic substrata, including bark, bryophytes and leaves, and many species are typically or at least facultatively foliicolous[1–6]. It was established by Ehrenberg in 1820 based on type species *C. linkii* Ehrenb., originally only including species with filamentous thallus, has recently been emended to include *Dimerella* Trev. which shares all apothecial characters with *Coenogonium* and differs only by the crustose thallus[3]. Based on DNA sequences of the nuclear small and large subunit ribosomal RNA genes, molecular studies supported the synonymy of *Coenogonium* and *Dimerella*[7].

Received: 2018-01-16 **Accepted**: 2018-02-27
This work was supported by the National Natural Science Foundation of China (Grant No. 31750001, 31700018, 31270066), and the Project for Adolescent Education Scientific Planning of Shandong Province (Grant No. 18BSH054 & 18BSH055).
WU X H, borned in 1992, Female, MD, interesting in taxonomic study of lichenized fungi. E-mail: 353933093@qq.com
* Corresponding author. E-mail: zfjia2008@163.com

Recent evidence based on ontogenetic, anatomical and morphological studies also showed that the combination of the two different morphotypes into same family Coenogoniaceae is natural and accurate[7–10].

In China, nine species of *Coenogonium* s.l. (including *Dimerella*) were sporadically reported[11–27]. A new record species *Coenogonium disjunctum* is found in our study, and all the ten species are described in the present paper.

The specimens are deposited in the Herbarium Mycologicum Academiae Sinicae-Lichenes (HMAS-L), the Lichen Herbarium of the College of Life Sciences, Liaocheng University (LCU) and the Herbarium, Kunming Institute of Botany (KUN-L). Stereomicroscope (OLYMPUS SZX12) and a light microscope (OLYMPUS BX53) were used for the morphological and anatomical studies. Sections of thallus and ascomata were mounted in water, 10% KOH (K) and Lugol's solution (I), respectively. The lichen substances were examined by thin-layer chromatography[28–30].

1 *Coenogonium dilucidum* (Kremp.) Kalb & Lücking 亮绒衣

In Lücking & Kalb, Bot. Jb. **122** (1): 32 (2000).

≡ *Lecidea dilucida* Kremp., J. Mus. Godeffroy **1** (4): 103 (1873). —— *Dimerella dilucida* (Kremp.) R. Sant., Symb. Bot. Upsal. **12** (1): 394 (1952).

Thallus foliicolous, rarely corticolous, glabrous. Apothecia small, rounded, 0.1–0.4 mm in diam., disc pale wax-colored. Ascospores broadly ellipsoid, 1-septate, 10–12.5 μm ×2.5 μm, about 4–5 times as long as wide, usually uniseriate. Pycnidia not found.

Chemistry: No lichen compounds detected.

Substrate: On leaves.

Distribution and ecology: Pantropical[4]. The species is a foliicolous (on living leaves) crustose species previously reported from Hong Kong[22] (Aptroot et al. 2001, as *Dimerella dilucida*)[23]. Worldwide, it was also reported from Thaliand[31], Vietnam[32] and South America[6].

Specimens examined: China. Hainan: Changjiang County, Mt. Bawangling, Yajia, 820 m, 26/XI/2010, J. C. Wei 54 (HMAS-L 119014), 55 (HMAS-L 119012), 51 (HMAS-L 119017); Ledong County, Mt. Jianfengling, elevation unrecorded, 27/XI/2010, J. C. Wei & W. Guo 71 (HMAS-L 119032); Lingshui County, Mt. Diaoluoshan, elevation unrecorded, 01/XII/2010, J. C. Wei & W. Guo 282 (HMAS-L 119045). **Guangxi:** Shangsi County, Mt. Shiwandashan, 463 m, J. Li, GX15221 (LCU).

Notes: *Coenogonium dilucidum* is similar to *C. subluteum* in morphology, but differs in having more brightly orange apothecia and rare or no pycnidia. However, pycnidia are usually abundant in *C. subluteum*, contributing to a verrucose appearance in thallus.

2 *Coenogonium disjunctum* Nyl. 疏羽绒衣 Fig. 1: A–C

Bot. Zeitschr. **20**: 178 (1862).

Thallus filamentous, sometimes forming closely appressed mat, loosely or closely attached to substrate, prostrate or pannose, yellow-green. Apothecia rounded, substipitate, 0.3–0.6 mm in diam., 150–200 μm high. Disc flat and slightly concave, yellow-orange, margin thick, cream-colored, smooth. Exciple colorless, 60–70 μm high. Hypothecium 30–50 μm high, pale-brown. Hymenium 50–70 μm high, colorless, I+ blue. Asci 8-spored, clavate, 57.5–72.5 μm ×5–7 μm. Ascospores irregularly biseriate, ellipsoid, 1-septate, 10–14 μm ×2.5 μm. Pycnidia not found.

Chemistry: No lichen compounds detected.

Substrate: On bark.

Specimens examined: China. Taiwan: Taizhong, Guguan, Mt. Baxian, 1 053 m, 19/IX/2015, L. S. Wang & X. Y. Wang 15-49036 (KUN-L 52034).

Distribution and ecology: Tropical[4]. Worldwide, it was reported from the United States[33]. It is the first report from China.

Notes: *Coenogonium disjunctum* is characterized by filamentous, prostrate or pannose thallus, rounded and substipitate apothecia, and irregularly biseriate ascospores, 10–14 μm ×2.5 μm in size. It is similar to *C. interplexum*, in filamentous thallus, and in some extent, they are difficult to be distinguished from the outer morphology. But *C. disjunctum* has much larger

ascospores (10−14 μm ×2.5 μm) than *C. interplexum* (6−9 μm ×2.5−3.75 μm). It is also similar to *C. implexum*, but the apothecia of *C. implexum* are sessile.

Fig. 1 *Coenogonium disjunctum* (L. S. Wang & X. Y. Wang 15-49036). A Thalli; B: Section of ascomata; C: An ascus with 8 ascospores.

3 *Coenogonium interplexum* Nyl.　　**网绒衣**

Annls Sci. Nat., Bot., sér. 4 **16**: 92 (1862).

Thallus filamentous, prostrate and effuse, irregularly woven, with large interspaces between individual filaments, yellow-green. Apothecia rounded, 0.3−1.0 mm in diam., substipitate, 130−150 μm high; disc flat, yellow-orange; margin thin, not prominent, smooth, cream-colored. Asci 60−70 μm ×4−6 μm. Ascospores uniseriate, ellipsoid, 1-septate, 6−9 μm × 2.5−3.75 μm, 2−3 times as long as wide. Pycnidia not found.

Chemistry: No lichen compounds detected.

Substrate: On bark and on rock.

Specimens examined: China. Yunnan: Simao County, Laiyang River, 1 570 m, 07/II/2009, L. S. Wang 09-30131 (KUN-L); Puer, Lahu Autonomous County of Lancang, Macheng Village, 1 450 m, 14/XI/2014, L. S. Wang & M. X. Yang 15-49918 (KUN-L 53197). **Taiwan:** Taizhong, Guguan, Mt. Baxian, 1 053 m, 19/IX/2015, L. S. Wang & X. Y. Wang 15-49032 (KUN-L 52030).

Distribution and ecology: Pantropical[4]. The species was previously reported from Taiwan[14–15]. Worldwide, it was also reported from North, Central and South American, Thaliand and Australia[31,34].

Notes: *Coenogonium interplexum* is distinguished by the prostrate thallus formed from irregularly woven filaments which is not easily detached from the substrate (mostly bark). Compared to *C. implexum*, it has shorter and narrower paraphyses. Besides, the main differences between the two species are the pannose thallus with very densely arranged filaments[35] and the larger ascospores in *C. implexum*.

4 *Coenogonium isidiatum* (G. Thor & Vězda) Lücking, Aptroot & Sipman　　**裂芽绒衣**

In Rivas Plata, Lücking, Aptroot, Sipman, Chaves, Umaña & Lizano, Fungal Diversity **23**: 297 (2006).

≡ *Dimerella isidiata* G. Thor & Vězda, Folia Geobot. Phytotax. **19**(1): 72 (1984).

Thallus crustose, corticolous, continuous, thin, smooth, partly shiny, yellowish green to greenish grey, 5−30 mm in diam.; prothallus absent, isidia crowded, 0.2−0.4 mm high, 0.05 mm in diam., simple or rarely branched, covered by colorless, warty papillae. Apothecia sessile, rounded in outline, 1.2−1.5 mm in diam., 380−410 μm high; disc plane, later slightly convex, orange-red; margin thick, prominent. Asci 80−95 μm ×6−10 μm. Ascospores oblique-uniseriate, narrowly ellipsoid, 1-septate, 9−14 μm ×3−4 μm, 3−4 times as long as wide. Pycnidia not found.

Chemistry: No lichen compounds detected.

Substrate: On bark and on rock.

Specimens examined: No specimens are listed here and the original materials have not been studied.

The descriptions and notes are cited from literatures [26,36].

Distribution and ecology: Pantropical[4]. The species was previously reported from Xizang and Sichuan[26]. Worldwide, it was known from the Neotropics and eastern Paleotropics[4], and North America[36].

Notes: *Coenogonium isidiatum* is characterized by large (up to 2.5 mm), flat, orange apothecia with a slightly pale margin, and dispersed, rarely branched, up to 0.3 mm long isidia. It is similar to *C. isidiosum*, but its ascospores (2.5−3 μm wide) are little narrower than *C. isidiatum* (3−4 μm wide).

5 *Coenogonium leprieurii* (Mont.) Nyl. 勒氏绒衣

Ann. Sci. Nat. Bot. sér. 4 **16**: 89, pl. 12, fig. 15−19 (1862).

≡ *Coenogonium linkii* var. *leprieurii* Mont., Annls Sci. Nat., Bot., sér. 3, **16**: 47 (1851).

Thallus filamentous, mostly corticolous, occasionally foliicolous, on old perennial leaves, usually forming hemispherical and shelf-like structures projecting horizontally from the substrate, yellow-green to bright green, up to 40 mm across, ecorticate. Apothecia rounded, 0.25−0.6 mm in diam., substipitate or conical, 100−150 μm high; disc flat, pale orange to yellow-orange; margin thin, not prominent, smooth, cream-colored. Ascospores irregularly biseriate, ellipsoid, non-septate, 5−8 μm ×2−3 μm, 2.5−3 times as long as wide.

Chemistry: No lichen compounds detected.

Substrate: On bark and on rock.

Specimens examined: China. Yunnan: Puer, National Forest Park, 1 596 m, 18/XII/2013, X. Y. Wang & D. Liu 13-41444 (KUN-L 22326), **Fujian:** Wuyishan, Mt. Wuyi, Taoyuanyu, 640 m, 28/V/2015, L. S. Wang & X. Y. Wang 15-47138 (KUN-L 50025), 15-47157 (KUN-L 50044), 15-47142 (KUN-L 50029); L. S. Wang & X. Y. Wang 15-47121 (KUN-L 50008), 15-47133 (KUN-L 50020); Wuyishan, Mt. Wuyi, Pikeng, 430 m, 25/V/2015, L. S. Wang & X. Y. Wang 15-46799 (KUN-L 49686), 15-46759 (KUN-L 49646), 15-46746 (KUN-L 49633).

Distribution and ecology: Pantropical[4]. The species was previously reported from Fujian[11]. Worldwide, it was reported from South and Central America, Thailand[31].

Notes: *Coenogonium leprieurii* is characterized by its filamentous and shelf-shaped thallus which projects from the substrate, apothecia on the underside of the thallus and non-septate ascospores[5]. It is very similar to *C. linkii*, but distinguished in non-septate ascospores.

6 *Coenogonium linkii* Ehrenb. 林氏绒衣

In Nees von Esenbeck (ed.), Horae Phys. Berol.: 120, pl. 27 (1820).

= *Coenogonium boninense* Sato, J. Japan. Bot. **8**: 390 (1933).

Thallus filamentous, very regularly shelf-like, rather thin and compact, with few and narrow interspaces between individual filaments, usually bright green, ecorticate. Apothecia rounded, 0.2−1.0 mm in diam., substipitate, 150−200 μm high; disc flat to convex, yellow-orange; margin thin, not prominent, smooth, cream-colored. Ascospores irregularly biseriate, ellipsoid, 1-septate, 6.5−9 μm ×2−2.5 μm, 2.5−3.5 times as long as wide. Pycnidia not found.

Chemistry: No lichen compounds detected.

Substrate: On bark.

Specimens examined: China. Guangxi: Jingxi County, Tongling Cayon, 511 m, 06/VI/2011, L. S. Wang 11-32199, 11-32209 (KUN-L). **Hainan:** Ledong County, Mt. Jianfengling, 920 m, 11/XII/2014, R. D. Liu & J. H. Wang HN2014187 (HMAS-L 0132558).

Distribution and ecology: The species was previously reported from Taiwan[12–15]; (Yoshimura 1994, as *C. boninense*)[19] and Hong Kong[22] (Seaward & Aptroot 2005, as *C.* cf. *linkii*)[27]; (Pfister 1978, as *C. disjunctum*)[16]; (Aptroot et al. 2001, as *C. linkii*)[23]. Worldwide, it distributes in Neotropical lowland rain forests[4] and the United States[33].

Notes: *Coenogonium linkii* is characterized by filamentous and shelf-like thallus, rounded, yellow-orange disc and smooth margin, substipitate apothecia and the ascospores irregularly biseriate, 1-septate, 5−7 μm ×1.5−2.5 μm. It is very similar to *C. leprieurii*,

but *C. leprieurii* has non-septate ascospores.

7 *Coenogonium luteum* (Dicks.) Kalb & Lücking 金黄绒衣

In Lücking & Kalb, Bot. Jb. **122** (1): 32 (2000).

≡ *Lichen luteus* Dicks., Fasc. Pl. Crypt. Brit. (London) **1**: 11 (1785). —— *Dimerella lutea* (Dicks.) Trevis., Rend. Reale Ist. Lomb., Milano, sér. **2**: 129 (1836).

Thallus crustose, corticolous, continuous, thin, smooth, pale greenish. Apothecia sessile, rounded to slightly irregular, 0.5−2 mm in diam; disc concave, orange; margin thin, slightly prominent, smooth, cream-colored. Ascospores irregularly uniseriate, broadly ellipsoid, 1-septate, 7.5−8.75 μm ×2.5 μm, 3−3.5 times as long as wide.

Chemistry: No lichen compounds detected.

Substrate: On bark.

Specimens examined: China. Hainan: Changjiang County, Mt. Bawangling, Yajia, 800 m, 26/XI/2010, S. N. Cao CSN067 (HMAS-L 118099). **Fujian:** Wuyishan, Mt. Longjing, 200 m, 22/VII/2016, Q. D. Wang FJ16004, FJ16005, FJ16006 (LCU); Mt. Wuyi, Zhongzheng Park, 400 m, 23/VII/2016, Z. F. Jia FJ16122, FJ16123, FJ16134, FJ16135, FJ16136 (LCU). **Anhui:** Huangshan, Mt. Huangshan, Banshan Temple, 1 440 m, X. H. Wu AH17146 (LCU). **Hainan:** Lingshui County, Mt. Diaoluo, 970 m, 01/XII/2010, Z. F. Jia 10-644 (HMAS-L 117951).

Distribution and ecology: The species was previously reported from Hubei[17], Zhejiang[37], Fujian[11] and Hong Kong[22], (Seaward & Aptroot 2005, as *Dimerella lutea*)[27]; (Pfister 1978, as *Gya- lecta lutea*)[16]; (Aptroot et al. 2001, as *D. lutea*)[23]. Corticolous and muscicolous in upper montane rain forest and subparamo, widespread in temperate regions[4].

Notes: *Coenogonium luteum* is characterized by large apothecia with more or less concave and orange disc, excipulum with rather small, thick-walled cells, and broadly ellipsoid ascospores. The most similar species are *C. eximium* (with ascospores 2−2.5 μm wide) and *C. fallaciosum* (with apothecia plane, pale yellow to pale orange).

8 *Coenogonium pineti* (Ach.) Lücking & Lumbsch 皮氏绒衣

In Lücking, Stuart & Lumbsch, Mycologia **96** (2): 290 (2004).

≡ *Lecidea pineti* Ach., Lich. Univ.: 195 (1810). —— *Dimerella pineti* (Ach.) Vězda, Lichenes Selecti Exsiccati: no. 1279 (1975).

Thallus crustose, mostly corticolous, also on mosses, continuous, sometimes barely visible, smooth, greyish green to greenish black, 5−20 mm in diam., without a distinct corticiform layer; prothallus absent. Apothecia sessile, rounded, 0.2−0.5 mm diam.; disc plane to concave, white to pinkish white, very rarely with an orange tinge; margin prominent, relatively thick, whitish to cream-colored. Asci 65−75 μm ×9−11 μm. Ascospores (irregularly) uniseriate, ellipsoid, 1-septate, 9−14 μm ×2.3−4.5 μm, 2.5−3.5 times as long as wide. Pycnidia wart-shaped, 0.1−0.2 mm in diam., whitish. Conidia oblong, non-septate, 6−8 μm × 1.8−2.6 μm.

Chemistry: No lichen compounds detected.

Substrate: On bark.

Specimens examined: No specimens are listed here and the original materials have not been studied. The descriptions and notes are cited from literatures.

Distribution and ecology: The species was previously reported from Taiwan (Aptroot and Sparrius, 2003, as *D. pineti*)[25] and Hong Kong (Aptroot et al. 2001, as *D. pineti*)[23]. Cosmopolitan with a preference for temperate regions, rare in the tropics[4,31]. Worldwide, it was reported from South Korea[34] and northeastern United States[38].

Notes: *Coenogonium pineti* is distinguished by small, pale apothecia with a wide margin and relative large, and broadly ellipsoid ascospores. It is similar to *C. stramineum*, but differs in having apothecia with a smooth margin (denticulate in *C. stramineum*) and asci with uniseriate ascospores (biseriately arranged in *C. stramineum*)[31].

9 *Coenogonium subluteum* (Rehm) Kalb & Lücking 亚深黄绒衣

In Lücking & Kalb, Bot. Jb. **122**(1): 34 (2000).

≡ *Biatorina sublutea* Rehm, Philipp. J. Sci., C, Bot. **8** (5): 404 (1913).

= *Biatorinopsis epiphylla* Müll. Arg., Flora, Regensburg **64**(7): 103 (1881). —— *Dimerella epiphylla* (Müll. Arg.) Malme, Ark. Bot. **26**A (13): 9 (1935) [1934]. —— *Microphiale epiphylla* (Müll. Arg.) Zahlbr., Cat. Lich. Univers. **2**: 696 (1924).

= *Microphiale brachyspora* (Müll. Arg.) Zahlbr., in Rechinger, Denkschr. Kaiserl. Akad. Wiss. Wien, Math.-Naturwiss. Kl. **88**: 22 (1911). —— *Biatorinopsis brachyspora* Müll. Arg., Lichenes Epiphylli Novi: 16 (1890).

= *Microphiale lutea* f. *foliicola* Zahlbr., in Rechinger, Denkschr. Kaiserl. Akad. Wiss. Wien, Math.-Naturwiss. Kl. **81**: 247 (1907).

Thallus crustose, foliicolous, rarely muscicolous, continuous, thin, smooth, green, greenish grey or brownish grey, dull. Apothecia sessile, rounded, 0.2–0.5 mm in diam.; disc plane or concave, pale wax-colored to pale orange; margin comparatively thick, prominent, smooth, concolorous to disc. Ascospores uniseriate or irregularly biseriate, ellipsoid, 1-septate, 6–12 μm ×3–3.5 μm, 2–3 times as long as wide.

Chemistry: No lichen compounds detected.

Substrate: On living leaves.

Specimens examined: China. Yunan: Mengla County, Wangtianshu, 700 m, 19/XII/2013, X. Y. Wang & D. Liu 13-41532 (KUN-L 22414), 13-41528 (KUN-L 22410); 691 m, 05/VI/2013, L. S. Wang & X. Y. Wang 13-38032 (KUN-L).

Distribution and ecology: Pantropical[4]. The species was previously reported from Yunnan (Zahlbrückner 1930, as *Microphiale brachyspora*, *M. epiphylla*, and *M. lutea* f. *foliicola*)[11,18,20,24], Taiwan[24] and Hong Kong (as *D. epiphylla*)[22–23]. Worldwide, it was reported from Thaliand[31].

Notes: *Coenogonium subluteum* is characterized by crustose and foliicolous thallus, sessile and rounded apothecia, 0.2–0.5 mm in diam., and uniseriate or irregularly biseriate, ellipsoid, ascospores 1-septate, 6–12 μm ×3–3.5 μm. It is similar to *C. zonatum*, but differs in having a thallus with white prothallus and very rare pycnidia[4,31].

10 *Coenogonium zonatum* (Müll. Arg.) Kalb & Lücking 带绒衣

In Lücking & Kalb, Bot. Jb. **122**(1): 34 (2000).

≡ *Biatorinopsis zonata* Müll. Arg., Lich. Epiphylli Novi: 16 (1890).

Thallus glabrous, foliicolous or corticolous, smooth, with white prothallus. Apothecia biatorine, lacking thalline margin, epiphyllous; Apothecia medium-sized to large, 0.3–0.8 mm diam. Disc wax-colored to pale yellow or pale orange, margin smooth; ascospores broadly ellipsoid, usually uniseriat, 1-septate, 6–12 μm ×1.5–4 μm. Conidia unknown.

Chemistry: No lichen compounds detected.

Substrate: On living leaves.

Specimens examined: No specimens are listed here and the original materials have not been studied. The descriptions and notes are cited from literature [6].

Distribution and ecology: Pantropical[4]. The species was previously reported from Yunnan[24]. Worldwide, it was reported from southern South America[6].

Notes: *Coenogonium zonatum* is characterized by foliicolous or corticolous thallus, wax-colored to pale yellow or pale orange apothecia, smooth margin, and broadly ellipsoid, usually uniseriate ascospores, 6–12 μm ×1.5–4 μm. It is similar to *C. subluteum*, but the latter species lacks prothallus and has abundant pycnidia[4,31].

Key to species of the genus *Coenogonium* from China

1a. Isidia present; ascospores 1-septate, 9–14 μm ×3–4 μm ····· *C. isidiatum*

1b. Isidia absent ····· 2

2a. Thallus filamentous; ascospores 1-septate or non-septate ····· 3

2b. Thallus crustose or glabrous; ascospores 1-septate ····· 6

3a. Thallus prostrate and effuse ····· 4

3b. Thallus shelf-like ……5
4a. Ascospores 1-septate, 6–9 μm ×2.5–3.75 μm ……*C. interplexum*
4b. Ascospores 1-septate, 10–14 μm ×2.5 μm ……*C. disjunctum*
5a. Ascospores uniseriate, non-septate, 5–8 μm ×2–3 μm ……*C. leprieurii*
5b. Ascospores biseriate, 1-septate, 6.5–9 μm ×2–2.5 μm ……*C. linkii*
6a. Foliicolous ……7
6b. Corticolous ……9
7a. Apothecia shorter, 0.1–0.4 mm in diam; ascospores 10–12.5 μm ×2.5 μm ……*C. dilucidum*
7b. Apothecia longer, 0.3–2 mm in diam; ascospores 6–12 μm ×1.5–4 μm ……8
8a. Thallus with white prothallus; pycnidia rare; ascopores 6–12 μm ×3–3.5 μm ……*C. subluteum*
8b. Thallus without prothallus; pycnidia frequent; ascopores 6–12 μm ×1.5–4 μm ……*C. zonatum*
9a. Apothecia orange, 0.5–2 mm in diam.; ascopores 7.5–8.75 μm ×2.5 μm ……*C. luteum*
9b. Apothecia pale yellow to pale orange-yellow, 0.2–0.5 mm in diam.; ascopores 9–14 μm ×2.3–4.5 μm ……*C. pineti*

Acknowledgments The authors are grateful to the curators of Herbariums for offering materials.

References

[1] VĚZDA A, FARKAS E. Neue foliicole arten der flechtengattung *Dimerella* trevisan (*Gyalectaceae*) aus Tansania [J]. Folia Geobot Phytotaxon, 1988, 23(2): 187–197. doi: 10.1007/BF02853348.

[2] LÜCKING R. Additions and corrections to the foliicolous lichen flora of Costa Rica. The family *Gyalectaceae* [J]. Lichenologist, 1999, 31(4): 359–374. doi: 10.1006/lich.1999.0205.

[3] LÜCKING R, KALB K. Foliikole flechten aus Brasilien (vornehmlich Amazonien), inklusive einer checkliste und bemerkungen zu *Coenogonium* und *Dimerella* (Gyalectaceae) [J]. Bot Jahrb Syst, 2000, 122: 1–61.

[4] RIVAS PLATA E, LÜCKING R, APTROOT A, et al. A first assessment of the Ticolichen biodiversity inventory in Costa Rica: The genus *Coenogonium* (Ostropales: Coenogoniaceae), with a world-wide key and checklist and a phenotype-based cladistic analysis [J]. Fungal Divers, 2006, 23(2): 255–321.

[5] LÜCKING R. Foliicolous lichenized fungi [J]. Flora Neotr, 2008, 103: 560–585.

[6] FERRARO L I, ANDREA M. New species and additional records of *Coenogonium* (Ostropales: Coenogoniaceae) from southern South America [J]. Lichenologist, 2013, 45(4): 497–504. doi: 10.1017/S0024282913000169.

[7] KAUFF F, LUTZONI F. Phylogeny of the Gyalectales and Ostropales (Ascomycota, Fungi): Among and within order relationships based on nuclear ribosomal RNA small and large subunits [J]. Mol Phylogenet Evol, 2002, 25(1): 138–156. doi: 10.1016/S1055-7903(02)00214-2.

[8] KAUFF F, BÜDEL B. Ascoma ontogeny and apothecial anatomy in the Gyalectaceae (Ostropales, Ascomycota) support the re-establishment of the Coenogoniaceae [J]. Bryologist, 2005, 108(2): 272–281. doi: 10.1639/0007-2745(2005)108[0272:AOAAAI]2.0.CO;2.

[9] BALOCH E, LÜCKING R, LUMBSCH H T, et al. Major clades and phylogenetic relationships between lichenized and non-lichenized lineages in ostropales (Ascomycota: Lecanoromycetes) [J]. Taxon, 2010, 59(5): 1483–1494.

[10] NEUWIRTH G, STOCKER-WÖRGÖTTER E, BOONPRAGOB K, et al. *Coenogonium coronatum* (Ostropales: Coenogoniaceae), a new foliicolous species from Thailand, ecological aspects and a key to the species occurring in the country [J]. Bryologist, 2014, 117(2): 161–164. doi: 10.1639/0007-2745-117.2.161.

[11] ZAHLBRÜCKNER A. Lichenes (Übersicht über sämtliche aus China bekannten Flechten) [M] // Symbolae sinicae botanisch ergebinsse der expedition der akademie der wissenschaften in wien nach Südwest-China 1914–1918, Teil 3. Julius A. Berlin: Springer, 1930: 1–254.

[12] ZAHLBRÜCKNER A. Flechten der insel Formosa [J]. Feddes Repert, 1933, 33(1/2/3/4/5/6/7): 22–68. doi: 10.1002/fedr.19330330103.

[13] ASAHINA Y. Nippon Inkwasyokubutu Dukan [M]. Tokyo: Sanseido, 1939: 713.

[14] WANG-YANG J R. The taxonomic status of *Coenogonium subvirescens* and *C. interplexum* newly found in Taiwan [J]. Taiwania, 1972, 17(1): 40–47. doi: 10.6165/tai.1972.17.40.

[15] WANG-YANG J R, LAI M J. A checklist of the lichens of Taiwan [J]. Taiwania, 1973, 18(1): 83–104. doi: 10.6165/tai.1973.18.83.

[16] ROGERSON C T. Cryptogams of the United States North Pacific Exploring Expedition, 1853–1856 by D. H. Pfister, Geneva Sayre [J]. Mycologia, 1978, 70(6): 1312–1313. doi: 10.2307/3759350.

[17] CHEN J B, WU J N, WEI J C, et al. Fungi and Lichens of Shennongjia [M]. Beijing: World Book Inc, 1989: 386–493. (in Chinese)

[18] SANTESSON R. Foliicolous lichens: 1, A revision of the taxonomy of the obligately foliicolous, lichenized fungi [D]. Uppsala: Uppsala University, 1952: 1–590.

[19] YOSHIMURA I, ARVIDSSON L. Taxonomy and chemistry of the *Lobaria crenulata* group in Ecuador [J]. Acta Bot Fenn, 1994, 150: 223–233.

[20] WEI J C, JIANG Y M. Some foliicolous lichens in Xishuangbanna, China [M]// GALLOWAY D J. Tropical Lichens: Their Systematics, Conservation and Ecology. Oxford: Oxford Sciience Publications, 1991: 201–216.

[21] WEI J C. An Enumeration of Lichens in China [M]. Beijing: International Academic Publishers, 1991: 1–278.

[22] APTROOT A, SEAWARD M R D. Annotated checklist of Hongkong lichens [J]. Trop Bryol, 1999, 17: 57–101.

[23] APTROOT A, SIPMAN H J M. New Hong Kong lichens, ascomycetes and lichenicolous fungi [J]. J Hattori Bot Lab, 2001, 91: 317–343.

[24] APTROOT A, FERRARO L I, LAI M J, et al. Foliicolous lichens and their lichenicolous ascomycetes from Yunnan and Taiwan [J]. Mycotaxon, 2003, 88: 41–47.

[25] APTROOT A, SPARRIUS L B. New microlichens from Taiwan [J]. Fungal Divers, 2003, 14: 1–50.

[26] OBERMAYER W. Additions to the lichen flora of the Tibetan region [J]. Bibl Lichenol, 2004, 88: 479–526.

[27] SEAWARD M R D, APTROOT A. Hong Kong lichens collected on the United States North Pacific exploring expedition, 1853–1856 [J]. Bryologist, 2005, 108(2): 282–286. doi: 10.1639/0007-2745(2005)108[0282:HKLCOT]2.0.CO;2.

[28] CULBERSON C F, KRISTENSSON H. A standardized method for the identification of lichen products [J]. J Chromatogr A, 1970, 46: 85–93. doi: 10.1016/S0021-9673(00)83967-9.

[29] CULBERSON C F. Improved conditions and new data for identification of lichen products by standardized thin-layer chromatographic method [J]. J Chromatogr A, 1972, 72(1): 113–125. doi: 10.1016/0021-9673(72)80013-X.

[30] WHITE F J, JAMES P W. A new guide to microchemical techniques for the identification of lichen substances [J]. Brit Lich Soc Bull, 1985, 57(S1): 1–41.

[31] KALB J, BOONPRAGOB K, KALB K. New *Coenogonium* species (Ostropales: Coenogoniaceae) from Thailand, new reports and a revised key to the species occurring in the country [J]. Phytotaxa, 2016, 283(2): 101–122. doi: 10.11646/phytotaxa.283.2.1.

[32] THUY N T, YOGESH J, ANH D N, et al. First report of a fertile specimen of *Coenogonium disciforme*: a species new to the Vietnamese lichen flora [J]. Lichenologist, 2011, 43(2): 184–186. doi: 10.1017/S0024282910000691.

[33] UYENCO F R. The species of *Coenogonium* in the United States [J]. Bryologist, 1963, 66(4): 217–224. doi: 10.2307/3240632.

[34] JOSHI Y, GAGARINA L, HALDA J P, et al. A new species and a new record of the lichen genus *Coenogonium* (Ostropales: Coenogoniaceae) from South Korea, with a world-wide key to crustose *Coenogonium* having prothalli [J]. Mycosphere, 2015, 6(6): 667–672. doi: 10.5943/mycosphere/6/6/3.

[35] KANTVILAS G. Alpine lichens of Tasmania's South West wilderness [J]. Lichenologist, 1995, 27(6): 433–449. doi: 10.1016/S0024-2829(95)80004-2.

[36] SEAVEY F, SEAVEY J. Four new species and sixteen new lichen records for North America from Everglades National Park [J]. Bryologist, 2014, 117(4): 395–404. doi: 10.1639/0007-2745-117.4.395.

[37] WU J N, WU J F. Lichens from Nantong City, Jiangsu Province of China [J]. J Nanjing Norm Univ (Nat Sci), 1991, 14(3): 85–91. (in Chinese)

[38] HARRIS R C. A Preliminary list of the lichens of New York [J]. Opusc Philolich, 2004, 1: 55–74.