



Carbonea vitellinaria* new to Japan, with a key to lichenicolous fungi growing on species of *Candelariella

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Abstract

Carbonea vitellinaria is reported new to Japan growing on *Candelariella vitellina*. A key to lichenicolous fungi known on the species of *Candelariella* is provided.

Key words – biogeography – *Candelariella vitellina* – parasite

Introduction

Reports of lichenicolous fungi from Japan are still very fragmentary (e.g. Tibell & Thor 2003, Kurokawa & Kashiwadani 2006, Frisch & Ohmura 2013), not including many presumably common species. This contribution deals with one such species newly reported for Japan from *Candelariella vitellina*, also providing a key to lichenicolous fungi known to grow on species of this host lichen genus.

Materials & Methods

A total of 83 Japanese specimens of Candelariaceae housed in the National Museum of Nature and Science (TNS), Tsukuba, were checked.

Morphological observations were made using a dissecting microscope or a differential interference contrast microscope. Anatomical examinations were made using hand-cut sections mounted in GAW (glycerin: ethanol: water = 1:1:1). Ascus apex structure was observed in 0.5% Lugol's iodine solution with pretreatment of 10% KOH (K/I) (Smith et al. 2009). Spore measurements are given as (minimum–)average(–maximum) (SD = standard deviation; *n* = number of measurements).

Results & Discussion

Carbonea vitellinaria (Nyl.) Hertel, Mitt. bot. StSamml., Münch. 19: 442 (1983). Fig. 1A
Specimen examined. JAPAN, Honshu, Prov. Kozuke (Pref. Gunma), between Oyamasawatashiro and Mt. Koshibutsu, Katashina-mura, Tone-gun, 36°53'N, 139°10'E, elev. ca. 2100 m, on *Candelariella vitellina* on rock, 9 October 2001, H. Kashiwadani 44328 (TNS).

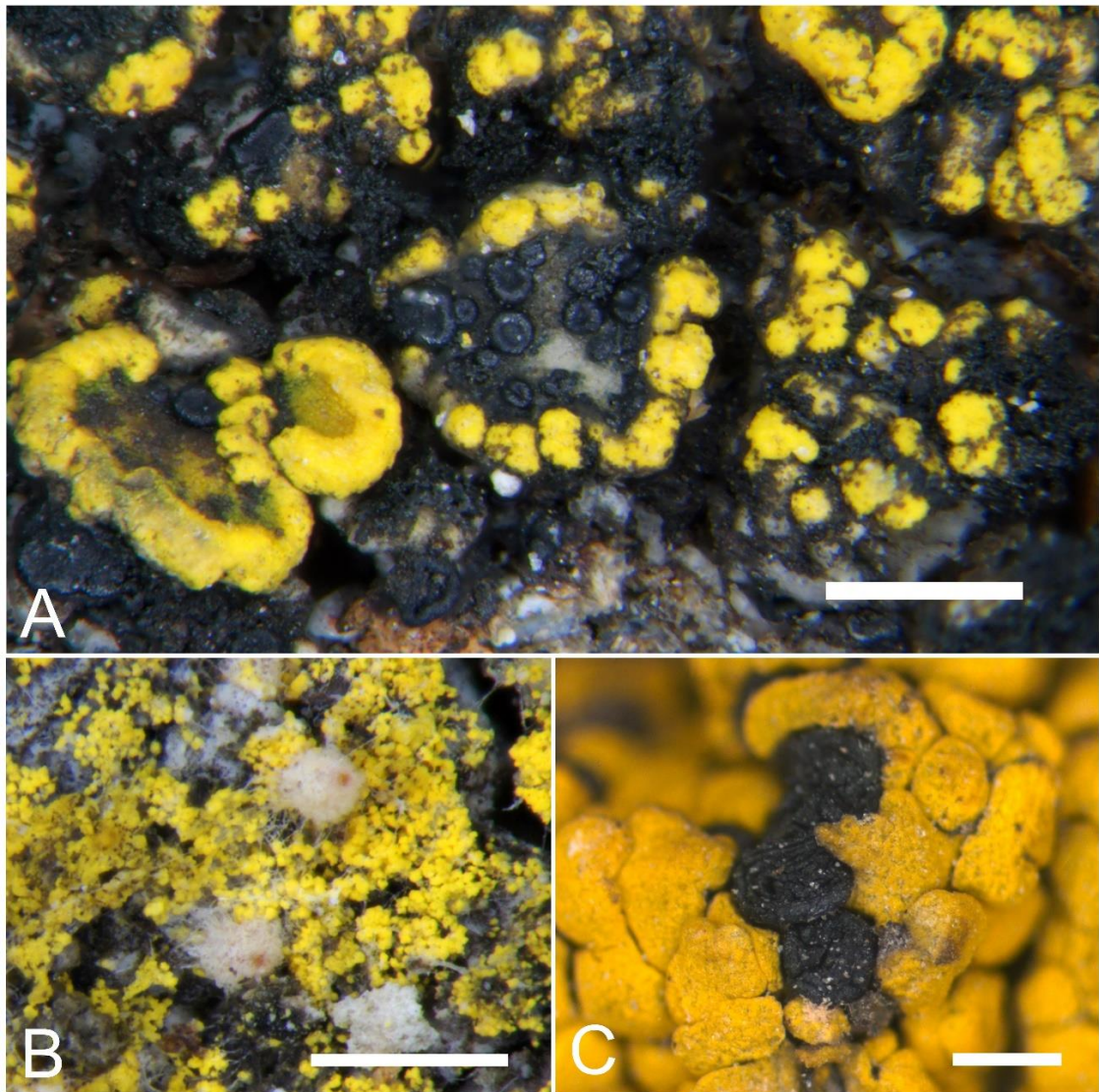


Fig. 1 – Some representative lichenicolous fungi on Candelariaceae. A. *Carbonea vitellinaria* (H. Kashiwadani 44328, TNS). B. *Paranectria oropensis* (R. Santesson: Fungi Lichenicoli Exsiccati 214, TNS). C. *Sarcogyne sphaerospora* (M. Zhurbenko 1323, LE 260996). Bars = 0.5 mm.

Morphological and chemical features of the Japanese material fit with the descriptions provided by Knoph et al. (2004) and Chambers et al. (2009). The statistical values of morphological features for the Japanese material are as follows. Apothecia up to 0.27 mm diam.; margin up to 40 μm thick; ascospores (8.0–)9.0(–11.0) \times (4.0–)4.9(–5.5) μm (SD=1.0, 0.5; $n=12$).

Generally *Carbonea vitellinaria* is a very common parasymbiotic dweller of *Candelariella* species with cosmopolitan distribution, known from Europe, North and South America, Oceania, and Asia (e.g. Hertel & Zhao 1982, Obermayer 2004, Galloway 2007, Etayo & Sancho 2008, Chambers et al. 2009, Zhurbenko 2009). However, this species seems to be rare in Japan since just one of 83 examined specimens of Candelariaceae collected from Hokkaido to Kyushu (elevations 5–2700 m) was infected by the parasite. In addition, no other lichenicolous fungi were found on those specimens. *Carbonea vitellinaria* has also been reported from lichen species of *Lecanora*, *Lecidea* s. l., *Rhizocarpon*, *Tephromela* and *Toninia*, mainly growing on non-calciferous rocks (Clauzade et al. 1989, Knoph et al. 2004, Zhurbenko 2009). This is the first non-lichenized lichenicolous species of *Carbonea* found in Japan, all previously known ones, viz. *C. atronivea* (Arnold) Hertel, *C. latypizodes* (Nyl.) Knoph & Rambold, and *C. vorticosa* (Flörke) Hertel (Inoue & Moon 1995, Kurokawa & Kashiwadani 2006, Inoue & Kanda 2009), are autonomous lichens.

Key to non-lichenized lichenicolous fungi growing on species of *Candelariella*

1. Spores produced in asci2
2. Ascomata apothecioid; ascospores hyaline, aseptate3
3. Asci with more than 8 spores.....4
4. Ascospores globose to broadly ellipsoid, (3–)4–5(–6) × (3–)3.5–4(–4.5) µm. See Lendemer et al. (2009) and Zhurbenko (2013)*Sarcogyne sphaerospora* J. Steiner
- 4*. Ascospores narrowly to broadly ellipsoid, (3–)4–4.5(–5) × (1–)1.5–2(–3) µm. See Knudsen & Kocourkova (2008).....*Polysporina subfuscescens* (Nyl.) K. Knudsen & Kocourk.
- 3*. Asci 8-spored; ascospores ellipsoid or obovoid, 6–12(–13) × 4–7 µm. See Knoph et al. (2004) *Carbonea vitellinaria* (Nyl.) Hertel
- 2*. Ascomata perithecioid; ascospores brown, septate5
5. Asci with 64–100 spores; ascospores (4.5–)5–6(–7) × (2–)2.5–3(–3.5) µm, (0–)1-septate. See Triebel (1989) and Vondrák & Etayo (2007).....*Muellerella lichenicola* (Sommerf.) D. Hawksw.
- 5*. Asci 2–8-spored6
6. Ascospores brown, 1-septate; interascal filaments absent.....7
7. Ascomata (100–)150–200(–400) µm in diam.; asci (4–)8-spored; ascospores (7.5–)8.5–12.5(–13) × 5–7(–7.5) µm. See Triebel (1989) and Coppins (2000)*Endococcus propinquus* (Körb.) D. Hawksw.
- 7*. Ascomata 160–190 µm in diam.; asci 4-spored; ascospores 12.5–17 × 5–7 µm. See Vondrák et al. (2008).....*Endococcus* sp.
- 6*. Ascospores hyaline8
8. Asci with dimorphic, 1(–2)-septate spores, macroascospores 34–50(–60) × 12–18(–20) µm, microascospores 8–17 × 3.5–7 µm; ascomata superficial, pink to orangish, clothed with white hair-like hyphae. See Hawksworth & Booth (1976) and Flakus et al. (2006)*Ovicuculispora parmeliae* (Berk. & Curt.) Etayo
- 8*. Ascospores monomorphic9
9. Ascospores muriform, ellipsoid, bicaudate, body (22–)25–32(–36) × (9–)11–14(–15) µm, 2–8 per ascus; ascomata superficial, hairy. See Hawksworth (1982), Santesson (1994) and van den Boom & van den Boom (2006)*Paranectria oropensis* (Ces.) D. Hawksw. & Piroz.
- 9*. Ascospores 0(–1)-septate, oblong to obovoid, non-caudate, (11–)12.6–19.4(–20.5) × (5.5–)6–8.6(–10) µm, (6–)8 per ascus; ascomata semi-immersed, hairless. See Hoffmann & Hafellner (2000) and Halici & Aksoy (2009)... *Zwackhiomyces lecanorae* (Stein) Nik. Hoffm. & Hafellner [Note also a slightly lichenized lichenicolous pyrenomycete *Sarcopyrenia cylindrospora* (P. Crouan & H. Crouan) M. B. Aguirre, occurring on *Candelariella* species. The fungus is characterized by large, finally sessile perithecia, evanescent paraphyses, 8-spored, unitunicate asci, hyaline, bacilliform with rounded ends, 1-septate ascospores, measuring 24–35 × 2.5–3 µm, and distinct pathogenicity (Calatayud & Barreno 1994, Kocourková 2000).]
- 1*. Spores not produced in asci10
10. Hyphomycetes11
11. Colonies superficial, arising in dark brown to almost black caespitose tufts of straight conidiophores, 15–30(–50) × 3.5–6 µm; conidia acrogenous, brown, doliiform, 1(–2)-septate, 7–11 × 3.5–5(–6) µm, mostly adhering in chains. See Hawksworth (1979).....*Taeniolella delicata* M.S. Christ. & D. Hawksw.
- 11*. Colonies immersed in the hymenium of the host apothecia, which usually become darkened in the presence of the fungus; conidia developing at the surface of the host hymenium. See Hawksworth (1979), Diederich (1990) and Hawksworth & Cole (2002)12
12. Conidia 0(–1)-septate, brownish, subspherical to ellipsoid, 3–4.5 × 2.5–4 µm, adhering in chains.....*Intralichen lichenum* (Diederich) D. Hawksw. & M.S. Cole
- 12*. Conidia always septate13
13. Conidia 1-septate, pale brown, ellipsoid to doliiform, 5–8(–9) × 4–6 µm, adhering in chains.....*Intralichen christiansenii* (D. Hawksw.) D. Hawksw. & M.S. Cole

- 13***. Conidia 2 to multi-septate to muriform, dark brown, subcylindrical to irregularly ellipsoid, mainly 18–25 × 6–12 µm, solitary or adhering in chains.....
 *Intralichen lichenicola* (M.S. Christ. & D. Hawksw.) D. Hawksw. & M.S. Cole
- 10***. Basidiomycetes **14**
- 14**. Fructifications of subspherical or irregular pinkish or reddish bulbils up to 250 µm in diam., initially developing inside the lichen thallus, later erumpent and superficial, composed of subspherical to elongate, catenate cells. See Diederich & Lawrey (2007) and Kocourková (2000)
 *Marchandiomyces corallinus* (Roberge) Diederich & D. Hawksw.
- 14***. Fructifications of basidiomata developing on swollen, bright yellow, pruinose galls on the host thallus; hymenium of numerous paraphyses-like hyphae intermixed with the basidia, covered by a 20–50 µm thick orange to brownish layer of crystals. See Diederich (1996).....
 *Tremella candelariellae* Diederich & Etayo

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