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Two Lichenicolous Fungi, *Illosporium carneum* and *Ovicuculispora parmeliae* (Bionectriaceae, Ascomycota), New to Japan

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Absract Two lichenicolous fungi, *Illosporium carneum* and *Ovicuculispora parmeliae*, are reported as new to Japan. *Illosporium carneum* was found on *Peltigera didactyla* growing on rock in Nagano Prefecture, central Honshu, at an elevation of 2,300 m. *Ovicuculispora parmeliae* was found on *Heterodermia japonica* growing on rock in Saitama Prefecture, central Honshu, at an elevation of 1330 m.

Key words: anamorph, Asia, distribution, *Heterodermia japonica*, lichen, mycota, parasite, *Peltigera didactyla*, *Pronectria robergei*, taxonomy.

Introduction

Lichenicolous fungi are parasitic or parasymbiotic fungi growing on lichens and over 1,800 species have been described in the world (Lawrey and Diederich, 2018). In Japan, ca. 150 species have been reported (Zhurbenko *et al.*, 2015, 2017; Tadome *et al.*, 2018; Zhurbenko and Ohmura, 2019). However, only about 30% of Japanese lichenicous fungi is estimated to be found (Zhurbenko *et al.*, 2015).

During the course of our research on the diversity of lichenicolous fungi in Japan, *Illosporium carneum* Fr. and *Ovicuculispora parmeliae* (Berk. & M.A.Curtis) Etayo were newly found in Japan based on morphological and chemical examinations.

The genus *Illosporium* is an anamorph of the genus *Pronectria* (Bionectriaceae, Ascomycota), and characterized by the pink irregular-shaped sporodochial conidiomata and globose to subglobose conidia (Hawksworth, 1979). Most species of *Illosporium* are non-lichenicolous parasitic fungi found usually on vascular plants, but *I. carneum* is only known as lichenicolous species within the genus (Diederich *et al.*, 2018). *Illosporium carneum* is an anamorph of *Pronectria robergei*. It was proved that *P. robergei* was developed from *I. carneum* on infected *Peltigera* by long-term observation in the field (Killian and Erner, 1925).

The genus *Ovicuculispora* is characterized by the ascus producing two types of ascospores, i.e., macrospores and microspores, and currently two accepted taxa have been known in the world (Etayo, 2010).

This paper aims to describe the morphological and anatomical features of these two species based on the Japanese materials.

Materials and Methods

This study is based on the examinations of herbarium specimens housed in the herbarium of the National Museum of Nature and Science (TNS), Tsukuba, Japan.

Morphological observations were made using a dissecting microscope (Olympus SZX12, Tokyo, Japan) and a differential interference contrast microscope (Olympus BX51, Tokyo, Japan). Anatomical examinations were made on hand-cut sections mounted in water. Measurements of ascospores and conidia are given as (minimum–) range including mean ± standard deviation (–maximum) (*n* = number of measurements).

Chemical reactions of the epihymenium were observed by the use of 10% KOH (K). The amyloidity of the hymenial gels was observed in 1.5% Lugol's iodine solution directly (I) or after a 10% KOH pretreatment (K/I).

Results and Discussion

Illosporium carneum Fr., Syst. Mycol. (Lundae) 3(1): 259. 1829.

[Fig. 1A–B]

Colonies formed by sporodochial conidiomata, usually discrete, sometimes confluent each other to form irregular mass in shape, erumpent through the upper cortex of the host thallus, 200–300 µm wide, 80–100 µm tall, pink to orange, K–, K/I–. **Conidiophores** micronematous, subglobose to ellipsoid or irregular in shape, densely compacted with adjacent cells. **Conidiogenous cells** ellipsoid to irregular in shape, hyaline. **Conidia** subglobose but often rather angular due to compression by adjacent conidia, connected, (4.7–)5.3–6.7(–7.7) × (4.7–)4.3–6.1(–7.0) µm (n = 40), hyaline to pale pink.

This species is characterized by the pink irregular-shaped sporodochial conidiomata and subglobose conidia. Morphological and anatomical features of the Japanese material mentioned above agree well with the protologue and the description provided by Hawksworth (1979) as well as those of exsiccatae of *Illosporium carneum* [Santesson: Fungi Lichenicoli Exs. 13, 265, 354 (TNS!); conidia size (4.5–)5.2–6.6(–7.3) × (4.0–)4.8–6.2(–6.9) µm (*n* = 45)].

In Japan, the teleomorph of *I. carneum*, i.e., *Pronectria robergei*, has not been found so far. However, it will be expected to be found in further investigation as it is common lichenicolous fungus parasitized on various *Peltigera* genera around the world (Vondrák and Liška, 2013; Moisejevs, 2017; Maloles *et al.*, 2018; Suija and Jüriado, 2020).

This species was reported in Asia (Turkey) (Volker *et al.*, 2020), Europe (Austria, England, Finland, Greenland, Latvia, Norway, Poland, Russia, Romania, and Spain) (Elvebakk and Prestrud, 1996; Urbanavichus *et al.*, 2007; Hansen, 2008; Kukwa and Flakus, 2009; Hawksworth *et al.*, 2010; Vondrák and Liška, 2013; van den Boom and Etayo, 2014; Hafellner, 2015; Moisejevs, 2017; Suija and Jüriado, 2020), North America (Canada) (Maloles *et al.*, 2018), and Oceania (New Zealand) (Galloway, 2007). The distribution is now extended to Japan.

Specimen examined. JAPAN. Nagano Pref.: Mt. Akadake, 2300 m elev., on *Peltigera didactyla* on rock, 13 September 2017, K. Tadome 496 (TNS).

Exsiccate examined. SWEDEN. Uppland: Estuna par., 0.5 km of Kullsta, on a sandy road side, on *Peltigera spuria* (=*P. didactyla*) (thallus), 7 July 1940 (Santesson: Fungi Lichenicoli Exs. 13, TNS); Torne Lappmark Prov., the Torne-trask area, Abisko, near the Tourist Station, 68°20′N 18°51′E, alt. 385 m, on the railway bank, on *Peltigera didactyla* (thallus), 16 August 1947 (Santesson: Fungi Lichenicoli Exs. 265, TNS). AUSTRIA. Salzburg Prov., Pinzgau, Hohe Tauern, Glockner-group, Stubachtal, Enzingerboden, on the W lowermost slope of Rotenkogel, 47°10′20″N 12°37′40″E, alt. 1500 m, slope with boulders and open *Pinus mugo* grove, on *Peltigera polydactylon* (thallus), 31 August 1996 (Santesson: Fungi Lichenicoli Exs. 354, TNS).

Ovicuculispora parmeliae (Berk. & M.A.Curtis) Etayo, Bull. Soc. Linn. Provence 61: 112. 2010.

[Fig. 1C–G]

Ascomata occur on upper surface of thallus of the host lichen, scattered or grouped, globose to subglobose, with brighter colored small papilla, surface covered with long hair, pink to red, 200–

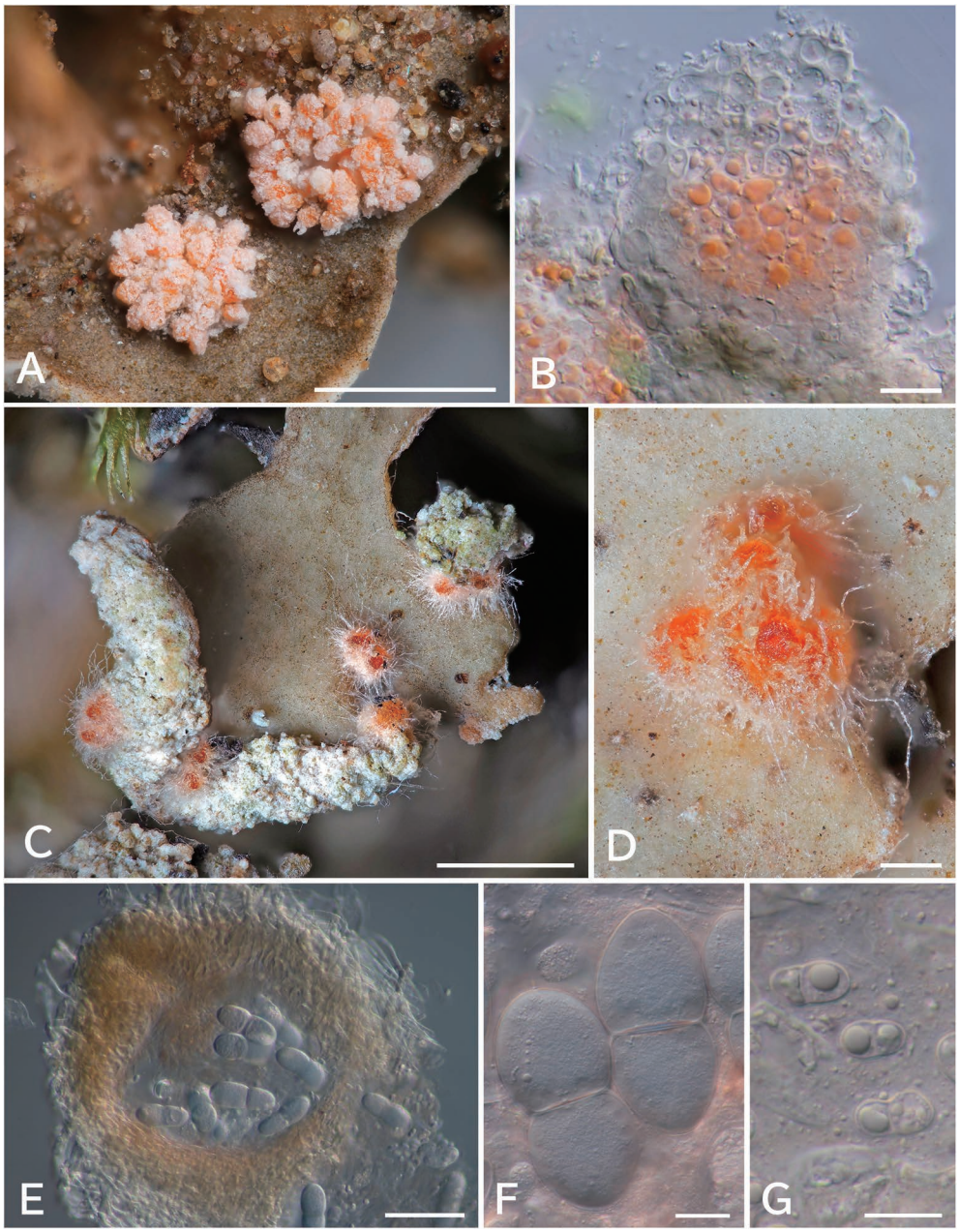

Fig. 1. *Illosporium carneum* and *Ovicuculispora parmeliae* collected in Japan. A–B. *Illosporium carneum* (K. Tadome 496, TNS). C–G. *Ovicuculispora parmeliae* (K. Tadome 613, TNS). A. Growth habit on *Peltigera didactyla*. B. Conidiomata. C. Growth habit on *Heterodermia japonica.* D. Ascomata. E. Cross section of an ascoma. F. Macrospores. G. Microspores. Scale bars: A=0.5 mm, B = 20 µm, C = 1 mm, D = 100 µm, E = 50 µm, F = 10 µm, G = 5 µm.

250 µm diam, K–, K/I–; ascomatal wall hyaline to slightly orange, 30–45 µm thick; hymenium hyaline, 100–130 µm tall. **Asci** clavate, 100 × 30 µm, with 1 macrospore and 3–4 microspores/ascus. **Ascospores** ellipsoid to narrowly ellipsoid, rounded at the apices, con-

Table. 1. Comparisons of morphological features of *Ovicuculispora parmeliae* depending on country

Country	macrospore	microspore	Shape of macrospora	Host	Reference
Bolivia	34–60 × 12–23 µm	8–17 × 3–7 µm	1–septate	*Candelariella* sp.	Flakus *et al.* (2006)
Canada	34–50(–60) × 12–18(–20) µm	8–17 × 3.5–7 µm	1(–3)-septate	Hypogymnia physodes, *Parmelia sulcata*	Samuel (2020)
Dominica	40–45 × 20 µm	8–10 × 5 µm	Not observing	*Pyxine* sp.	Etayo and van den Boom (2013)
England	34–50(–60) × 12–18(–20) µm	8–17 × 3.5–7 µm	1–2-septate	*Lecanora chlarotera*, *Xanthoria parietina*	Hawksworth *et al.* (2010)
Japan	(30.4–)29.7–47.7(–54.4) × (11.1–)12.0–22.1(–25.5) µm	(4.9–)6.6–11.2(–12.1) × (2.3–)3.1–5.9(–6.6) µm	1-septate	*Heterodermia japonica*	This study
Russia	(18.4–)42.4–73.0(–86.0) × (6.8–)18.3–33.3(–40.0) µm	(6.8–)8.7–11.7(–16.5) × (3.3–)4.5–5.5(–7.0) µm	1-septate (very rarely 2-septate)	*Anaptychia* sp., *Cladonia* sp., *Heterodermia* cf. *microphylla*, *Heterodermia* cf. *obscurata*, *Myelochroa entotheiochroa*, *Parmelia* sp., *Pyxine sorediata*, *Rinodina xanthophaea*	Zhurbenko (2014)
U.S.A. (North Carolina)	N/A	N/A	1–septate	*Physcia millegrana*, *Punctelia rudecta*	Flakus *et al.* (2006)
U.S.A. (South Carolina) (Type locality)	51 × 23 µm	9–11 × 4–6 µm	1-septate	*Punctelia rudecta*	Hawksworth (1981)

stricted at the septum, hyaline; macrospore 1-septate, (30.4–)29.7–47.7(–54.4) × (11.1–)12.0–22.1(–25.5) µm (*n*=22); microspore 0–1-septate, (4.9–)6.6–11.2(–12.1) × (2.3–)3.1–5.9(–6.6) µm (*n* = 44). **Anamorph** not observed.

This species is characterized by the hairy pink to reddish ascomata and extremely different sized ascospores (macrospore and microspore) within an ascus. Morphological and anatomical features of the Japanese material mentioned above agree well with the protologue and the description provided by Berkely (1874).

In the genus *Ovicuculispora*, only two species, *O. parmeliae* and *O. macrospora* Etayo, are known. *Ovicuculispora parmeliae* is reported from worldwide, while *O. macrospora* is known only from Peru. These species were originally distinguished by the macrospore size: 31–45 × 13–18 µm for *O. parmeliae* vs. 67–105 × 32–40 µm for *O. macrospora* (Etayo, 2010). However, various range of ascospore size both for macrospores and microspores were reported in *O. parmeliae* (Table 1) and the ranges of ascospores are largely overlapped with those of *O. macropora*. Further taxonomic studies are needed for the independency of *O. macrospora* or the possibility of multiple species within *O. parmeliae*.

Ovicuculispora parmeliae was reported in Asia (South Korea) (Zhurbenko *et al.*, 2015), Europe (England and Russia) (Etayo, 2010; Hawksworth *et al.*, 2010), North America (Hawksworth, 1981; Maloles *et al.*, 2018), and South America (Bolivia and Dominica) (Flakus *et al.*, 2006; Etayo and van den Boom, 2013). The distribution is now extended to Japan.

Specimen examined. JAPAN. Saitama Pref.: Mt. Myouhou, 1330 m elev., on *Heterodermia japonica* on rock, 29 July 2018, K. Tadome 613 (TNS).

References

Berkely, M. J. 1874. Notices of North American fungi. Grevillea 3(25): 1–48.

Diederich, P., Lawrey, J. D. and Ertz, D. 2018. The 2018 classification and checklist of lichenicolous fungi, with 2000 non-lichenized, obligately lichenicolous taxa. The Bryologist 121: 340–425.

Elvebakk, A. and Prestrud, P. (eds.). 1996. A catalogue of Svalbard plants, fungi, algae and cyanobacteria. Norsk Polarinstitutt, Skrifter 198: 1–395.

Etayo, J. 2010. Hongos liquenícolas de Perú: Homenaje a Rolf Santesson. Bulletin de la Société linnéenne de Provence 61: 83–128.

Etayo, J. and van den Boom, P. 2013. A first checklist of lichenicolous fungi from the Dominican Republic, including the description of a new species of *Xenonectriella*. Opuscula Philolichenum 12: 142–150.

Flakus, A., Kukwa, M. and Czarnota, P. 2006. Some interesting records of lichenized and lichenicolous ascomycota from south america. Polish Botanical Journal 51: 209–215.

Galloway, D. J. 2007. Flora of New Zealand Lichens. Revised Second Edition Including Lichen-Forming and Lichenicolous Fungi. Volumes 1 and 2. Manaaki Whenua Press, Lincoln, New Zealand.

Hafellner, J. 2015. Lichenicolous Biota (Nos 201–230). Fritschiana (Graz) 80: 21–41.

Hansen, E. S. 2008. A contribution to the lichen flora of the Scoresby Sund area, Central East Greenland. Cryptogamie Mycologie 29(3): 293–302.

Hawksworth, D. L. 1979. The lichenicolous Hyphomycetes. Bulletin of the British Museum (Natural History), Botany 6: 183–300.

Hawksworth, D. L. 1981. The lichenicolous Coelomycetes. Bulletin of the British Museum (Natural History), Botany 9: 1–98.

Hawksworth, D. L., Atienza, V. and Coppins, B. J. 2010. Artificial Keys to the Lichenicolous Fungi of Great Britain, Ireland, the Channel Islands, Iberian Peninsula, and Canary Islands. Fourth draft edition for testing only. Published by the authors. http://www.ascofrance.fr/uploads/forum_file/LichenKeys2010-0001.pdf [Accessed 16 December 2020].

Killian, C. and Werner, R. G. 1925. Observations sur l' *Illosporium carneum* Fries. Bulletin trimestriel de la Société mycologique de France. 41: 382–384.

Kukwa, M. and Flakus, A. 2009. New or interesting records of lichenicolous fungi from Poland VII. Species mainly from Tatra Mountains. Herzogia 22: 191–211.

Lawrey, J. D. and Diederich, P. 2018. Lichenicolous fungi worldwide checklist, including isolated cultures and sequences available. http://www.lichenicolous.net (Accessed 1 December 2020).

Maloles, J. R., McMullin, R. T., Consiglio, J. A., Chapman, C. J., Riederer, L, L. and Renfrew, D. E. 2018. The lichens and allied fungi of the Credit River Watershed, Ontario, Canada. Rhodora 120(983): 229–253.

Moisejevs, R. 2017. Lichens and allied fungi new for Latvia. Folia Cryptogamica Estonica 54: 9–12.

Samuel, R. B. 2020. Contributions to the Ontario flora of lichens and allied fungi, with emphasis on the Great Lakes Basin. Opuscula Philolichenum 19: 58–157.

Suija, A. and Jüriado, I. 2020. Records of new and interesting lichenicolous fungi from Finland and Norway. Graphis Scripta 32(5): 86–100.

Tadome, K., Ohmura, Y. and Frisch, A. 2018. *Arthonia molendoi* (Arthoniaceae, Ascomycota), a lichenicolous fungus, new to Japan. Journal of Japanese Botany 93: 407–409.

Urbanavichus, G., Motiejūnaitė, J., Kukwa, M. and Urbanavichene, I. 2007. Contribution to the biota of lichens and lichenicolous fungi of Murmansk region (NW Russia). Botanica Lithuanica 13(3): 197–202.

Van den Boom, P. and Etayo, J. 2014. lichens from the Iberian Peninsula, with the description of four new species and one new genus. Opuscula Philolichenum 13: 44–79.

Volker, J., Şaban, G. and Ayşen, T. 2020. Additions to the checklist and bibliography of the lichens and lichenicolous fungi of Turkey. Archive for Lichenology 19: 1–32.

Vondrák, J. and Liška, J. 2013. Lichens and lichenicolous fungi from the Retezat Mts and overlooked records for the checklist of Romanian lichens. Herzogia 26: 293–305.

Zhurbenko, M. P. 2014. Lichenicolous fungi from Far East of Russia. Folia Cryptogamica Estonica 51: 113–119.

Zhurbenko, M. P. and Ohmura. 2019. New and Interesting Records of Lichenicolous Fungi from the TNS Herbarium Part I. Opuscula Philolichenum 18: 74–89.

Zhurbenko, M. P., Ezhkin, A. K., Skirina, I. F. and Ohmura, Y. 2017. *Dactylospora anziae*, a new lichenicolous ascomycete on *Anzia* from East Asia. Folia Cryptogamica Estonica 54: 13–716.

Zhurbenko, M. P., Frisch, A., Ohmura, Y. and Thor, G. 2015. Lichenicolous fungi from Japan and Korea: new species, new records and a first synopsis for Japan. Herzogia 28: 762–789.