

Chapsa leprieurii, *Ocellularia cavata* and *O. pyrenuloides* (Graphidaceae, Lichenized Ascomycota) New to Japan

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Abstract *Chapsa leprieurii* (Mont.) Frisch, *Ocellularia cavata* (Ach.) Müll. Arg. and *O. pyrenuloides* Zahlbr. are reported from Iriomote and Kita-Iwo Islands and are additions to the lichen biota of Japan. The species are described and illustrated, and information on their ecology and distribution is provided. The new combination *Rhabdodiscus crassus* (Müll. Arg.) Frisch is also made.

Key words: chemistry, description, floristics, Japan, morphology, Thelotremaaceae, tropical islands.

Introduction

The thelotremoid Graphidaceae (=Thelotremaaceae (Nyl.) Stiz.; Stizenberger, 1862) of Japan are rather well known, particularly the species of *Thelotrema* s.l., which have been monographed by Matsumoto (2000). Forty-two species are listed in the checklist of Japanese lichens (Kurokawa and Kashiwadani, 2006) which, according to the present classification of the family (e.g., Frisch, 2006; Frisch and Kalb, 2006; Rivas Plata *et al.*, 2012), belong to the genera *Chapsa*, *Chroodiscus*, *Diploschistes*, *Ingvariella*, *Leucodecton*, *Myriotrema*, *Ocellularia*, *Rhabdodiscus*, and *Thelotrema*. *Chroodiscus defectus* Papong & Lücking (Papong *et al.*, 2009) and *Rhabdodiscus crassus* (Müll. Arg.) Frisch [as *Stegobolus crassus* (Müll. Arg.) Frisch in Frisch and Kalb (2006); see below for the new combination] have recently been added to the Japanese lichen biota, while *Thelotrema cinereum* Müll. Arg. [= *Myriotrema cinereum* (Müll. Arg.) Hale] and *Thelotrema sendaiense* Vain. were placed in the synonymy of *Ocellularia microstoma* (Müll. Arg.) Frisch (Mangold *et al.*, 2009; Ohmura, 2012), and *T. inallescens* Nyl. in the synonymy

of *Rhabdodiscus fissus* Vain. (Mangold *et al.*, 2009). Additional species can be expected mainly in the subtropical islands in the south of the country. In this contribution we report three species from Iriomote and Kita-Iwo Islands as new to Japan, by which the total number of species in this country become six in *Chapsa* and five in *Ocellularia*.

Material and Methods

This study is based on the herbarium specimens housed in the National Museum of Nature and Science (TNS) in Tsukuba, in which recent materials collected by the authors are also included.

The morphological descriptions of the species were made using Olympus BX40 and Leica MZ8 microscopes on hand cuttings mounted in water, 1% aqueous iodine solution or 10% aqueous KOH solution. Measurements were always made on water preparations. At least 10 mature spores were measured for each specimen with 1 µm precision. Paraphyses and periphysoids were measured with 0.5 µm precision. Chemical compounds were identified by means of thin layer

chromatography (TLC) using solvent C (Orange *et al.*, 2010).

Results and Discussion

Chapsa lepreurii (Mont.) Frisch, Biblioth. Lichenol. **92**: 105 (2006).

[Fig. 1A]

THALLUS cartilaginous, brown-olive, matt to weakly shining, continuous to slightly fissured, uneven to shallowly warty, up to 0.2 mm thick; phenocortex 20–50 μm , moderately dense to dense, strongly conglutinated, mainly of periclinial hyphae, often with inclusions of calcium oxalate crystals and decomposed bark cells; photobiont layer 10–100 μm , with calcium oxalate crystals, largely endophloeodal; medulla not differentiated. PYCNIDIA unknown.

APOTHECIA dispersed or aggregated in loose groups, level with the thallus, rounded to usually angular or shortly elongated, occasionally with short branches, 0.6–2.5 mm broad and long; margin raised, rim-like, $\pm$ jagged to lobed, upright to strongly recurved, with a prominent, white-felty to crystalline inner surface; proper exciple fused to partly free in the apical parts, low and rather thick, white-felty; disc pale brown, covered by thick white pruina. THALLINE MARGIN with phenocortex 15–40 μm thick; photobiont layer including the indistinct periderm layer 25–80 μm thick, with numerous calcium oxalate crystals and decomposed periderm cells, only weakly conglutinated. PROPER EXCIPIE cupular, 10–15 μm tall and wide, hyaline to pale brown, of slightly conglutinated prosoplectenchymatic hyphae; periphysoids up to 40 μm long, 2–3 μm wide, the tips moniliform, finely adspersed with greyish to brownish granules. HYMENIUM 70–90 μm tall, clear; ascospores 8/ascus, 1 seriate, brown, transversely septate, (2–)4 loculate, 10–12 $\times$ 5–6 μm , thick-walled, with subacute ends, I+ purplish-blue; asci narrowly clavate, 70–85 $\times$ 8–9 μm ; paraphyses 1.5–2 μm wide, tips moniliform, finely adspersed with greyish to brownish granules; epihymenium greyish to pale brownish, 8–12 μm tall.

CHEMISTRY. No lichen compounds detected by TLC.

ECOLOGY AND DISTRIBUTION. *Chapsa lepreurii* is mainly collected in the canopy and more open places in rainforests in coastal areas, coastal forest and open coastal scrub up to 1250 m altitude. On Iriomote Island, *C. lepreurii* was found on the bark of a broad-leaf tree in a slightly shaded rainforest besides the brackish river.

Chapsa lepreurii is a pantropical species, being reported from tropical America, Africa, India, Sri Lanka, The Philippines, Sumatra and Australia (Awasthi, 1991; Frisch, 2006; Hale, 1981; Mangold *et al.*, 2009). New to Japan.

NOTES. *Chapsa lepreurii* is easily recognized by the cartilaginous, olive-brown thallus; the small and typically aggregated chroodiscoid apothecia with prominently white-felty to crystalline margin; the brown, (2–)4 loculate ascospores 10–16 $\times$ 5–6 μm in size; and the absence of lichen compounds. The specimens from Iriomote Island show a noticeable proportion of 2–3 loculate spores which are slightly smaller than given in Frisch (2006: 12–16 $\times$ 5–6 μm) and at the lower end of the range reported by Mangold *et al.* (2009) from Australia: 4–7(–8) $\times$ 1(–2) loculate, 9–25(–28) $\times$ 6–8(–11) μm .

Chapsa lepreurii has been included in *Chapsa* based on the chroodiscoid apothecia with periphysoids, the thick-walled ascospores and *Chapsa*-type paraphysoids (Frisch, 2006). Molecular data, however, indicate *C. lepreurii* to be more closely related to *Ocellularia* s.l. than to *Chapsa* (K. Kalb, pers. comm.). Further investigations are needed for a correct placement of this species. For synonymy see Frisch (2006).

Specimens examined: JAPAN. Yaeyama Islands (Pref. Okinawa). Iriomote Island, along the stream at SE foot of Mt. Goza, Taketomi-cho, Yaeyama-gun, on bark of broad-leaf tree, 24°17'N, 123°49'E, 10 m a.s.l. 11. iii. 2011, Y. Ohmura 8045, 8048 (TNS).

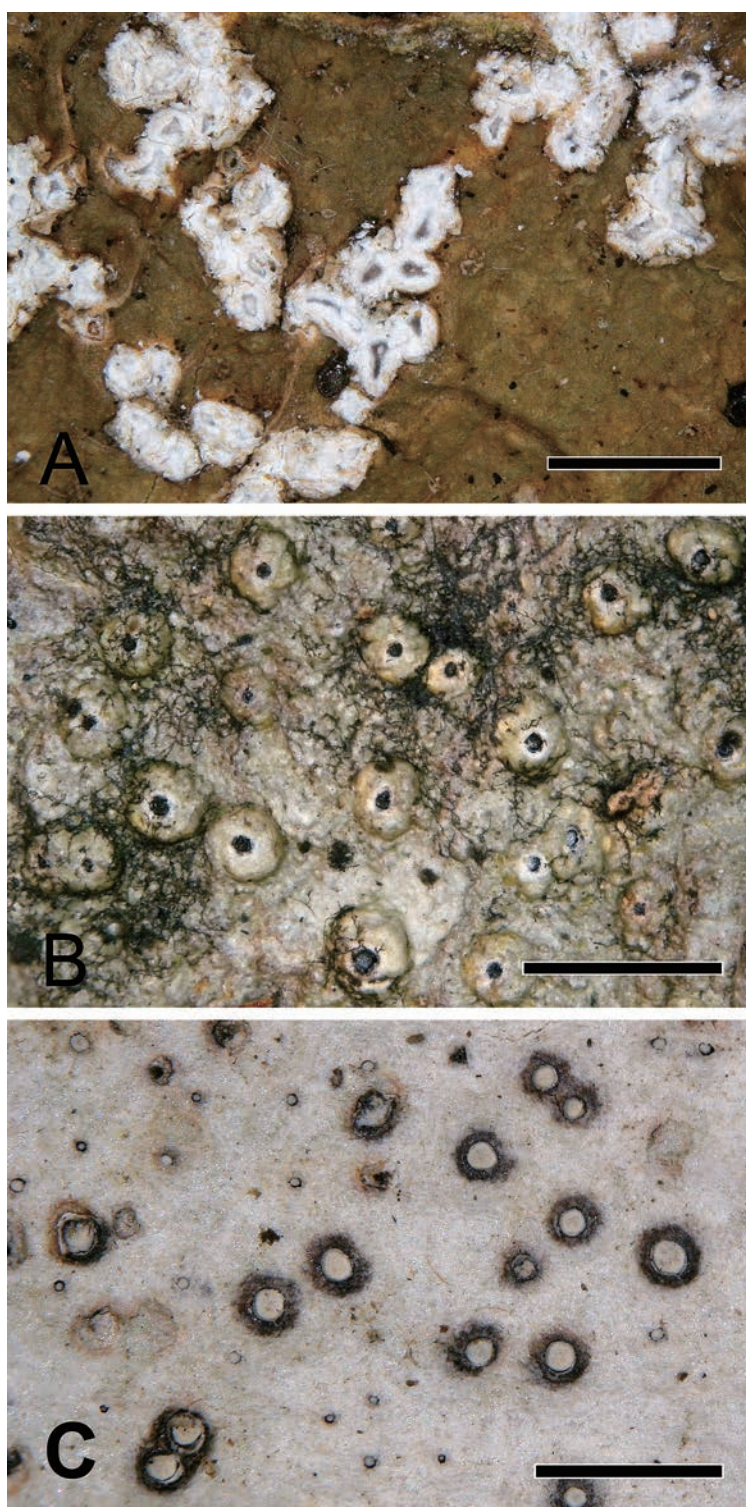


Fig. 1. Three Graphidaceae new to Japan. A. *Chapsa leprieurii* (Y. Ohmura 8045, TNS). B. *Ocellularia cavata* (Y. Ohmura 8056, TNS). C. *O. pyrenuloides* (Y. Ohmura 6367, TNS). Scales = 2 mm.

Ocellularia cavata (Ach.) Müll. Arg., Flora, Jena 65: 499 (1882).

[Fig. 1B]

THALLUS corticolous, olive-grey, matt to weakly shining, continuous, uneven to shallowly warty, up to 0.2 mm thick; medulla of thallus warts with pale fawn to deep yellow-orange pigment; phenocortex 5–12 μm , continuous, moderately dense, conglutinated, mainly of irregular hyphae, not always clearly separated from the photobiont layer; photobiont layer 30–70 μm thick, with numerous photobiont cells and some clusters of calcium oxalate crystals towards the base; thallus warts filled with orange granules and calcium oxalate crystals; medulla thin or endophloeodal. PYCNIDIA not seen in the Japanese collection.

APOTHECIA dispersed, rounded, moderately emergent, with $\pm$ steep flanks and a broadly rounded apex, 0.5–1.2 mm in diam.; margin shallowly warty, concolorous with the thallus; pore 0.2–0.3 (–0.6) mm wide, rounded to angular, surrounded by an incomplete black ring formed by the proper exciple; columella black, simple, with bulging tip, filling the pore; disc pale brown to wax-coloured, covered by thin white pruina. THALLINE MARGIN with phenocortex 3–8 μm thick; photobiont layer 20–45 μm thick, an additional large cavity filled with orange granules and calcium oxalate crystals often present below the photobiont layer; periderm layer 50–60 μm thick, comprising a dense, brown conglutinated prosoplectenchyme with periderm inclusions. PROPER EXCIPLE cupular, 10–15 μm tall and hyaline to pale brown at the base, 50–100 μm wide laterally, strongly carbonised at least in the upper half; columella conical, with a bulging tip, carbonised throughout. HYMENIUM 100–120 μm tall, clear; subhymenium 10–15 μm tall; ascospores 8/ascus, 1–2 seriate, hyaline, transversely septate, 6–9 loculate, 21–27 $\times$ 6–7 μm , with subacute to rounded ends, I+ purplish-blue; asci narrowly clavate, 90–100 $\times$ 10–14 μm ; paraphyses 1.5–2 μm wide; tips with a single slightly thickened cell, adspersed with fine greyish to brownish granules; epihymenium unpi-

mented, 5–8 μm tall.

CHEMISTRY. *Cinchonarum* unknown (see Frisch 2006; major), unknown 1 (Rf value 5, pale yellow, minor), unknown 2 (Rf value 10, orange-brown, trace), unknown 3 (Rf value 26, grey to brown, trace), and orange pigment (Rf value 17) were detected by TLC. The orange pigment is K+ purple.

ECOLOGY AND DISTRIBUTION. *Ocellularia cavata* is a common pantropical species, being collected in a wide range of tropical rain and cloud forests from sea-level to 2400 m altitude. On Iriomote Island, it was found on the bark of a broad-leaf tree in a slightly shaded rain-forest besides the brackish river.

Ocellularia cavata has been reported from tropical America, Africa, Sri Lanka, Australia and Hawaii (Frisch, 2006; Hale, 1974, 1978; Magnusson and Zahlbruckner, 1943; Mangold *et al.*, 2009; Redinger, 1936; Sipman, 1992). New to Japan.

NOTES. *Ocellularia cavata* is characterized by moderately to strongly emergent carbonized apothecia with a conical columella; pale straw to orange pigment concentrated in warts on the thallus and thalline margin of the apothecia; hyaline, transversely septate, I+ purplish-blue ascospores of moderate size (6–16 loculate, 20–60 $\times$ 6–11 μm); and the *cinchonarum* unknown and an unknown orange pigment as lichen compounds. On the world level, *O. cavata* is a polymorphic species regarding ascospore size, pigmentation and apothecia morphology, and obviously represents a complex of closely related taxa. With respect to the small ascospores and the deep orange, K+ purple pigment of the medulla, the specimen from Iriomote Island shows affinities to the type of *O. punctulata* (Leight.) Zahlbr. from Sri Lanka. However, the relationship of this species and the similar and older *O. obturata* (Ach.) Spreng. from Sierra Leone is not clear and needs further study. Until a thorough revision of *O. cavata* s.l. on the world level has been done, we prefer to use the broad circumscription of this species as adopted by Frisch (2006).

Specimen examined: JAPAN. Yaeyama Islands (Pref. Okinawa). Iriomote Island, along the stream at SE foot of Mt. Goza, Taketomi-cho, Yaeyama-gun, on bark of broad-leaf tree, 24°17'N, 123°49'E, 10 m a.s.l. 11. iii. 2011, Y. Ohmura 8056 (TNS).

Ocellularia pyrenuloides Zahlbr., in Magnusson and Zahlbruckner, *Ark. Bot.* **31A(1)**: 46 (1944).

[Fig. 1C]

THALLUS pale greenish-grey, weakly glossy, smooth to indistinctly verruculose, continuous, up to 0.07 mm thick, the bark substrate shining through the thallus surface; phenocortex 3–7 μ m thick or indistinct, loosely organized to moderately dense, mostly not clearly separated from the photobiont layer, formed from irregular hyphae; photobiont layer 40–60 μ m thick, with large complexes of calcium oxalate crystals, largely endophloeodal; medulla endophloeodal. PYCNIDIA unknown.

APOTHECIA dispersed, rounded, moderately emergent, 0.5–0.9 mm in diam.; margin concolorous with the thallus, thin, entire to somewhat fissured, forming a 0.3–0.4 mm wide, rounded to angular pore lined by a brown to black ring of the exposed proper exciple and periderm layer; columella broad, flat to slightly bulging, $\pm$ filling the pore, black, tipped with white. THALLINE MARGIN with phenocortex 3–5 μ m thick to absent; photobiont layer 20–35 μ m thick; periderm layer 15–50 μ m thick, moderately dense, comprising a brown conglutinated prosoplectenchyme with periderm inclusions and large complexes of calcium oxalate crystals. PROPER EXCIPLE cupular, 7–10 μ m tall and hyaline to pale brown at the base, 25–60 μ m wide laterally, carbonised, with a thin apical layer of hyaline hyphae; columella broad trunk-shaped, carbonised, simple, flat, with a thin apical layer of hyaline hyphae. HYMENIUM 90–110 μ m tall, clear, subhymenium 8–10 μ m tall; ascospores 8/ascus, 2 seriate, hyaline to pale olivish, transversely 6–8 loculate, 21–25 $\times$ 6–7 μ m, with subacute to rounded ends, I+ purplish-blue. Asci narrowly clavate, 80–105 $\times$ 10–14 μ m; paraphy-

ses 1.5–2 μ m wide, tips with a single slightly thickened cell, adspersed with fine greyish to brownish granules; epihymenium unpigmented, 8–10 μ m tall.

CHEMISTRY. Stictic acid (major), cryptostictic acid (trace) and constictic acid (trace) were detected by TLC.

ECOLOGY AND DISTRIBUTION. *Ocellularia pyrenuloides* has been collected in *Pandanus* forest in the Hawaii Islands and is further reported from lowland to submontane rainforests in tropical America, Africa, Australia and Hawaii (Frisch, 2006; Hale, 1974, 1981; Magnusson and Zahlbruckner, 1943; Mangold *et al.*, 2009). The specimen from Kita-Iwo Island was collected from *Pandanus boninensis* in a lowland rainforest. New to Japan.

NOTES. *Ocellularia pyrenuloides* is an inconspicuous and somewhat nondescript species that can be characterized by the thin to endophloeodal, pale greenish-grey to fawn thallus without clearly defined phenocortex; small immersed to moderately emergent apothecia of 0.3–0.9 mm diam., with strong carbonization and a broad, flat, and typically white-tipped columella; hyaline to pale olive, I+ purplish blue ascospores, 6–8 loculate, 18–25 $\times$ 6–8 μ m in size; and the stictic acid chemosyndrome. Species of the habitually similar the genus *Clandestinotrema* (Rivas Plata *et al.*, 2012) can be distinguished by the I-negative ascospores of the *clandestina*-type (Frisch, 2006). The specimen from Kita-Iwo Island is morphologically close to the type collections from Hawaii.

Specimen examined: JAPAN. Sulphur Islands. Kita-Iwo Island, on bark of *Pandanus boninensis*, 25°26'13.2"N, 141°17'14.6"E, 186 m a.s.l. 17. vi. 2009, Y. Ohmura 6367 (TNS).

Rhabdodiscus crassus (Müll. Arg.) Frisch, comb. nov.

Basionym: *Leptotrema crassum* Müll. Arg., *Flora* **65**: 332 (1882). — *Stegobolus crassus* (Müll. Arg.) Frisch, in Frisch and Kalb, *Biblioth. Lichenol.* **92**: 448 (2006).

This species had been included in the

Stegobolus auberianus group by Frisch and Kalb (2006), which is now accepted as the separate the genus *Rhabdodiscus* Vain. (Vainio, 1921) following recent molecular research in the family Graphidaceae (e.g. Rivas Plata and Lumbsch, 2011; Rivas Plata *et al.*, 2012). Therefore, the new combination *Rhabdodiscus crassus* is made. *R. crassus* has been reported from Japan based on the type specimen of *Leptotrema oleosum* Zahlbr., collected on Yakushima Island by Abbé Faurie in 1906 (Frisch and Kalb, 2006).

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References

- Awasthi, D. D. 1991. A key to the microlichens of India, Nepal and Sri Lanka. *Bibliotheca Lichenologica* 40: 1–332.
- Frisch, A. 2006. Contributions towards a new systematics of the lichen family Thelotremaaceae I. The lichen family Thelotremaaceae in Africa. *Bibliotheca Lichenologica* 92: 3–370.
- Frisch, A. and Kalb, K. 2006. Contributions towards a new systematics of the lichen family Thelotremaaceae II. A monograph of Thelotremaaceae with a complex structure of the columella. *Bibliotheca Lichenologica* 92: 371–516.
- Hale, M. E. 1974. Morden-Smithsonian Expedition to Dominica: The lichens (Thelotremaaceae). *Smithsonian Contribution to Botany* 16: 1–46.
- Hale, M. E. 1978. A revision of the lichen family Thelotremaaceae in Panama. *Smithsonian Contributions to Botany* 38: 1–60.
- Hale, M. E. 1981. A revision of the lichen family Thelotremaaceae in Sri Lanka. *Bulletin of the British Museum (Natural History), Botany Series* 8: 227–332.
- Kurokawa, S. and Kashiwadani, H. 2006. Checklist of Japanese lichens and allied fungi. *National Science Museum Monographs* 33: 1–157.
- Magnusson, A. H. and Zahlbruckner, A. 1943. Hawaiian lichens I. The families Verrucariaceae to Peltigeraceae. *Arkiv för Botanik* 31 A(1): 1–96.
- Mangold, A., Elix, J. and Lumbsch, H. T. 2009. Thelotremaaceae. In: McCarthy, P. M. (ed.), *Flora of Australia Volume 57. Lichens* 5: 195–420. ABRIS and CSIRO Publishing, Canberra and Melbourne.
- Matsumoto, T. 2000. Taxonomic studies of the Thelotremaaceae (Graphidales, lichenized Ascomycota) in Japan (1) Genus *Thelotrema*. *Journal of the Hattori Botanical Laboratory* 88: 1–50.
- Ohmura, Y. 2012. *Lichenes minus cogniti exsiccati*, fasc. XVIII (Nos. 426–450). National Museum of Nature and Science, Tokyo.
- Orange, A., James, P. W. and White, F. J. 2010. *Microchemical Methods for the Identification of Lichens*, 2nd edition. British Lichen Society, 101 pp.
- Papong, K., Lücking, R., Thammathaworn, A. and Boonpragob, K. 2009. Four new taxa of *Chroodiscus* (thelotremoid Graphidaceae) from Southeast Asia. *The Bryologist* 112: 152–163.
- Redinger, K. 1936. Thelotremaaceae brasilienses imprimis ex herbario Regnelliano cognitae praetereaue in herbariis Krempelhuberi, Mülleri Arg., Nylanderi, Wainionis et Zahlbruckneri asservatae. *Arkiv för Botanik* 28 A: 1–122.
- Rivas Plata, E. and Lumbsch, H. T. 2011. Parallel evolution and phenotypic divergence in lichenized fungi: A case study in the lichen-forming fungal family Graphidaceae (Ascomycota: Lecanoromycetes: Ostropales). *Molecular Phylogenetics and Evolution*: 45–63.
- Rivas Plata, E., Lücking, R. and Lumbsch, H. T. 2012. A new classification for the family Graphidaceae (Ascomycota: Lecanoromycetes: Ostropales). *Fungal Diversity* 52: 107–121.
- Sipman, H. J. M. 1992. Results of a lichenological and bryological exploration of Cerro Guaiquinima (Guayana Highland, Venezuela). *Tropical Bryology* 6: 1–31.
- Stizenberger, E. 1862. Beitrag zur Flechtensystematik. Bericht über die Tätigkeit der Sankt Gallischen naturwissenschaftlichen Gesellschaft 1861–1862: 124–182.
- Vainio, E. 1921. Lichenes insularum Philippinarum III. *Annales Academiae Scientiarum Fennicae* 15(6): 1–368.