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Three new species of *Chapsa* (lichenized Ascomycota: *Ostropales*: *Graphidaceae*) from tropical Asia

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Abstract: Three new species of *Chapsa* in the family *Graphidaceae* are described from tropical Asia. *Chapsa mastersonii* Rivas Plata, Lumbsch & Lücking from the Philippines is characterized by large apothecia with thickly white-pruinose discs, large, muriform, non-amyloid ascospores, and the stictic acid chemosyndrome. *Chapsa wijeyaratniana* Weerakon, Lumbsch & Lücking from Sri Lanka has apothecia similar to the preceding species but forms an ecorticate thallus with maculiform to capitate soralia, has small, submuriform ascospores, and lacks secondary substances. *Chapsa wolseleyana* Weerakon, Lumbsch & Lücking forms apothecia with red to pinkish or purplish red discs and large, muriform ascospores becoming pale brown.

Key words: Lecanoromycetes, lichens, paleotropics, taxonomy, *Thelotremataceae*

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Introduction

Tropical forests harbour high biodiversity, play a crucial role in the provision of key ecosystem services and are an important source of income at both national and local levels. Paleotropical areas within South and Southeast Asia are characterized not only by their high organismal diversity, but also by their high degree of endemism (Groombridge 1992; Heaney 1993; Oliver & Heaney 1996; Alcala & Custodio 1997; Heaney & Mittermeier 1997). Lichen diversity in the tropics is generally high, and some of the major groups of microlichens are chiefly tropical (Sipman & Harris 1989; Aptroot 2001; Lücking *et al.* 2009). Recent surveys concentrating on Central and South America have unveiled a large number of new species and genera of microlichens. In contrast, the eastern paleotropics represent an extensive area with a major gap in lichenological knowledge, mainly regarding crustose microlichens. The largest family of tropical microlichens is *Graphidaceae* (which now includes *Thelotremataceae*), with approximately 50 genera and *c.* 1500 currently accepted species, a number which is expected to increase to 2000 (Mangold *et al.* 2008, 2009; Lücking *et al.* 2009; Rivas Plata *et al.* 2010).

Chapsa is one of the largest genera in the emended *Graphidaceae*, with over 70 species (Rivas Plata *et al.* 2010). Previously referred to as *Asteristion* Leight. or included in *Thelotrema* Ach. (Hale 1981; Matsumoto 2000), the genus was resurrected by Frisch *et al.* (2006). *Chapsa* is characterized by being corticolous and having chroodiscoid ascomata; the proper exciple forms lateral paraphyses; the paraphyses are distinct and rigid with either moniliform or branched tips (occasionally simple); and the walls of the ascospores are often thickened (Salisbury 1972; Hale 1980, 1981; Matsumoto 2000; Frisch *et al.* 2006). The other two genera that show the same type of chroodiscoid ascoma morphology, *Acanthotrema* and *Chroodiscus*, differ from *Chapsa* by thin-walled ascospores and by having warty paraphysis tips (*Acanthotrema*), or being foliicolous and lacking

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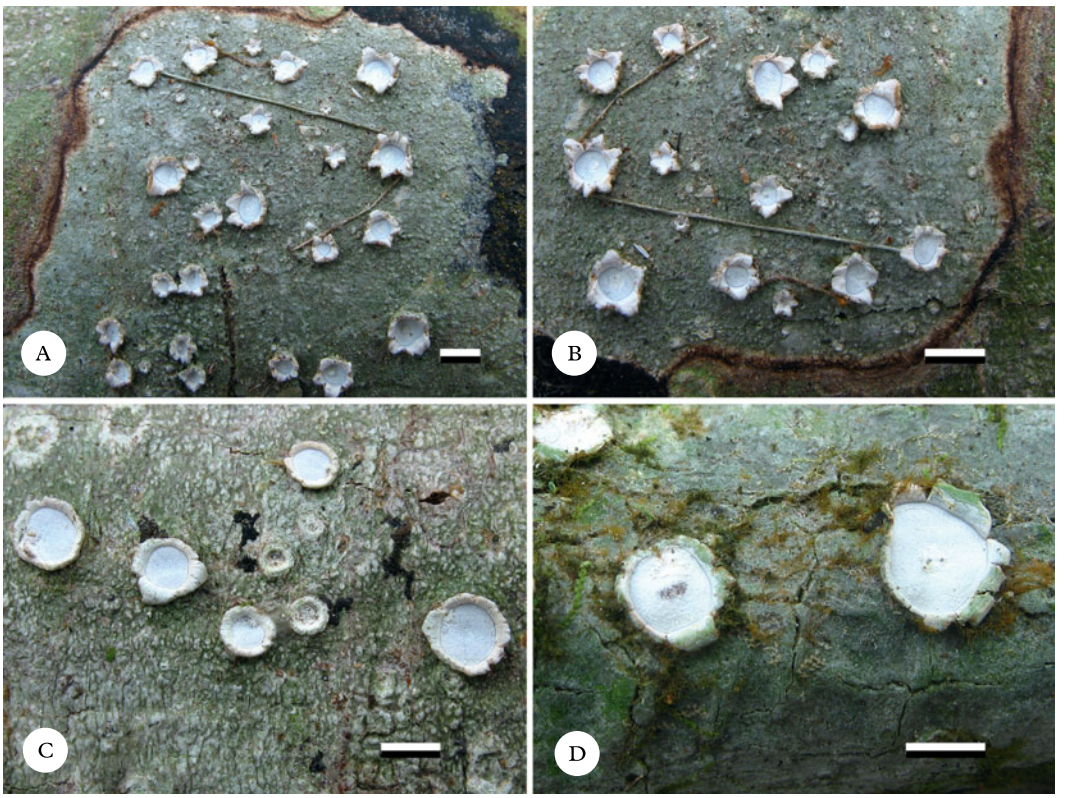

FIG. 1. *Chapsa mastersonii*. A–D, thallus with apothecia. [A & B *Rivas Plata* 1111G (F); C, *Rivas Plata* 1077A (F); D, *Rivas Plata* 1076 (F)]. In colour online.

lateral paraphyses (*Chroodiscus*). The genus *Reimnitzia,* which also has chroodiscoid ascomata, differs mainly in the absence of lateral paraphyses, a different ascus type and ascospore development, and the presence of columnar calcium oxalate crystals (Rivas Plata *et al.* 2010).

In the present paper, we describe three new species of *Chapsa*, all collected in tropical Asia.

Materials and Methods

Specimens were examined using Leica MS5, Motic K400, and Olympus SZX12 dissecting microscopes and Zeiss Axioscop 2, Olympus BH-2, and Vista Vision VWR V036 compound microscopes, in part connected to Jenoptic ProgRes C3 and C5 digital microscope cameras. Images were also made with Nikon Coolpix 5400 and Nikon Coolpix 8400 digital cameras. Specimens are deposited at F and PDA, with duplicates at BM. Anatomical measurements refer to specimens mounted in water; for iodine reactions, we used Fluka 62650 Lugol solution. We employed thin-layer chromatography (TLC) using solvent C (Lumbsch 2002).

Results

Chapsa mastersonii Rivas Plata, Lumbsch & Lücking sp. nov.

MycoBank No.: MB564107

Sicut *Chapsa recurva* sed ascosporis longioribus differt.

Typus: Philippines, Nueva Vizcaya (Luzon), Mt. Palali, near Solano, 16°26′N, 121°13′E, 1400 m, montane rain forest, on lower stem in semi-exposed situation, March 2007, *Rivas Plata & Lücking* 1111G (F—holotypus).

(Fig. 1)

Thallus corticolous, up to 5 cm diam., 60–120 µm thick, continuous, endoperidermal;

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surface uneven to shallowly verrucose, grey; in section with dense, paraplectenchymatous cortex and irregular algal layer with clusters of calcium oxalate crystals.

Apothecia erumpent, angular-rounded, 1·0–3·5 mm diam.; *disc* exposed, covered by thick, white pruina; proper margin indistinct, fused or sometimes free in upper part; thalline margin lobulate, with 4–7 conspicuous, erect to recurved lobules covered with white pruina along inner margin. *Columella* absent. *Excipulum* indistinctly paraplectenchymatous, 100–150 µm thick, orange-brown; lateral paraphyses present. *Hymenium* 120–160 µm high, clear; *paraphyses* unbranched. *Ascospores* 1–2(–4) per ascus, richly muriform, 90–130 × 17–25 µm, oblong and often slightly curved, with rather thin septa and rectangular lumina, colourless, I−.

Chemistry. Stictic acid (major) and satellite substances.

Etymology. This new species is dedicated to Patrick Masterson (Chicago) for his interest in the Botany Department of The Field Museum (Chicago).

Ecology and distribution. *Chapsa mastersonii* has been found in the (lower) montane rain forest of Mt. Palali between 1000 and 1400 m. It typically grows on small stems and on branches and twigs in shaded to semi-exposed situations, the large and conspicuous apothecia then contrasting with the comparatively small thallus.

Notes. The new species is characterized by rather large apothecia with the disc covered by a thick, white pruina, large, muriform ascospores, and a stictic acid chemistry. It is most closely related to *C. recurva* (G. Salisb.) Frisch, which was also described from the Philippines and agrees in most features except that the ascospores are much shorter (30–60 µm) (Frisch *et al.* 2006). *Chapsa lordhowensis* Mangold and *C. zahlbruckneri* (Redinger) Frisch agree in the muriform ascospores and stictic acid chemistry but have more irregular, fissurinoid-chroodiscoid apothecia with more or less erect lobules (Frisch *et al.* 2006; Mangold *et al.* 2009); *C. lordhowensis* also differs in the broader, amyloid ascospores, whereas in *C. zahlbruckneri* the ascospores are both shorter and broader. *Chapsa eitenii* (Hale) Frisch and *C. patens* (Nyl.) Frisch are also superficially similar but both lack a thallus cortex, and *C. eitenii* produces protocetraric acid whereas *C. patens* lacks lichen substances (Frisch *et al.* 2006; Rivas Plata *et al.* 2010); in both species the ascospores are also broader.

Additional specimens examined. **Philippines:** *Nueva Vizcaya (Luzon)*: Mt. Palali, near Solano, 16°26′N, 121°13′E, 1400 m, montane rain forest, on liana in shaded situation, 2007, *Rivas Plata & Lücking* 1076 (F); *ibid*., 1000 m, (lower) montane rain forest, on lower stem in shaded situation, 2007, *Rivas Plata & Lücking* 1077A (F); *ibid*., 1400 m, montane rain forest, on branch in shaded situation, 2007, *Rivas Plata & Lücking* 1139 (F); *ibid*., 1400 m, montane rain forest, on branch in shaded situation, 2007, *Rivas Plata & Lücking* 1200 (F).

Chapsa wijeyaratniana Weerakoon, Lumbsch & Lücking sp. nov.

MycoBank No.: MB564108

Sicut *Chapsa alstrupii* sed thallo sorediato et ascosporis septis et parietibus tenuibus differt.

Typus: Sri Lanka, Central Province, Knuckles Conservation area, Dotalugala mountain, 3·5 km SWS of Hunnasgiriya, 7°20′N, 80°51′E, 1310 m, submontane forest, on bark of *Symplocos cochinchinensis*, September 2008, *Weerakoon & Wijeyaratne* 742 (PDA—holotypus; BM, F—isotypi).

(Fig. 2)

Thallus corticolous, up to 10 cm diam., 50–100 µm thick, continuous, endoperidermal; surface smooth to uneven, appearing finely grainy (periderm cells), olive-grey to olive-brown, abundantly sorediate; in section ecorticate, with irregular algal layer largely immersed in periderm, with a few scattered clusters of calcium oxalate crystals. *Soralia* maculiform to capitate, 0·3–1·0 mm diam., white, farinose.

Apothecia erumpent, angular-rounded to rarely lobate or aggregate, 1·0–2·0 mm diam.; *disc* exposed, flesh-coloured where visible but usually covered by thick, white pruina; proper margin indistinct, fused; thalline margin lobulate to recurved with 5–10 small, erect to recurved lobules covered with

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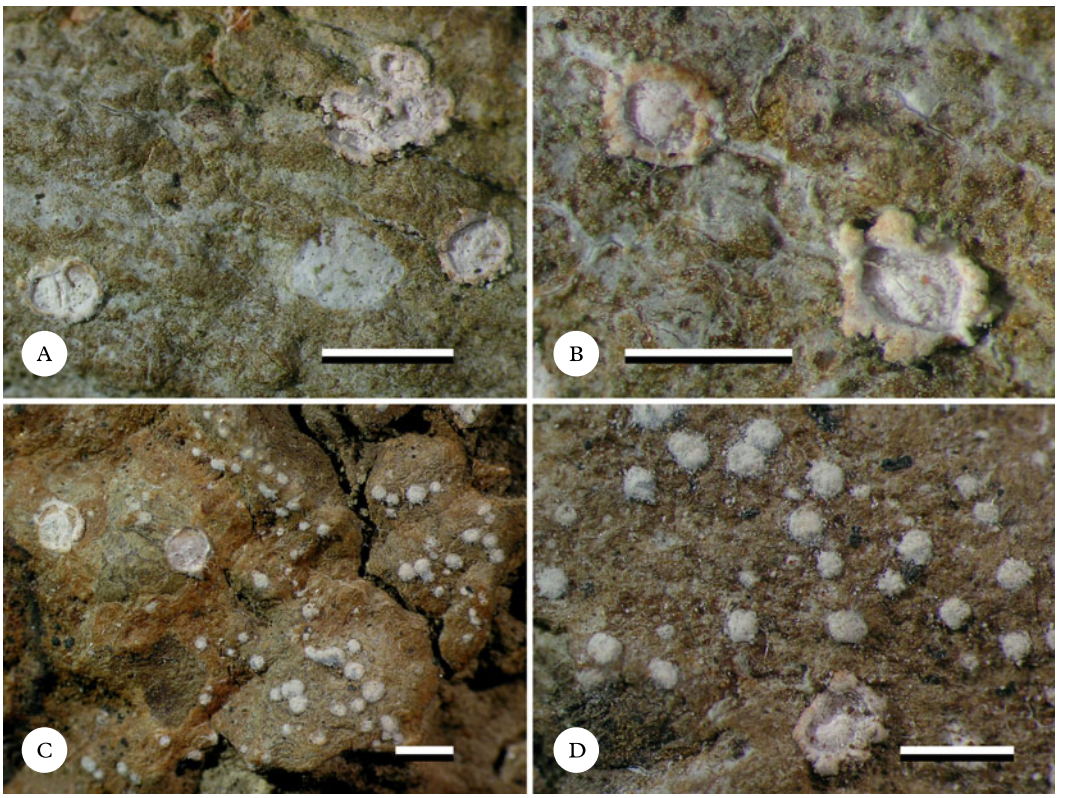

FIG. 2. *Chapsa wijeyaratniana*. A–D, thallus with apothecia. [A & B, *Weerakoon* 1025 (PDA); C & D, *Weerakoon* 742 (F)]. In colour online.

white pruina along inner margin. *Columella* absent. *Excipulum* paraplectenchymatous, 50–70 µm thick, colourless; lateral paraphyses present. *Hymenium* 80–120 µm high, clear; *paraphyses* unbranched. *Ascospores* 8 per ascus, submuriform with 3–5 transverse septa and 0–2 longitudinal septa per segment, 15–25 × 6–8 µm, oblong, with rather thin septa and rectangular lumina, colourless, I−.

Chemistry. No substances detected by TLC.

Etymology. This new species is named in honour of Professor Chandrani Wijeyaratna, Chair of Botany of the University of Sri Jayawardenepura, Sri Lanka, and pioneer lichenologist in the country, who initiated lichen studies in the early nineties. She has collected lichens from various parts of Sri Lanka, and the collection includes several new species and many new records.

Ecology and distribution. The new species was collected in submontane forest on the bark of *Symplocos cochinchinensis* in the Knuckles mountain range. Another collection was made in March 2010 on a *Calophyllum* sp. from Hulankanda Trail of the Kalupahana Mountains. The species appears to prefer shady moist conditions and smooth bark.

Discussion. *Chapsa wijeyaratniana* is only the fourth species in the genus to produce genuine soralia. Two other recently described species, *C. defectosorediata* Lücking (Sipman *et al.* 2012) and *C. thallotrema* Lücking & N. Salazar (Lumbsch *et al.* 2011), differ in having

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olive-green, epiperidermal thalli with a dense cortex and large, transversely septate, amyloid ascospores. *Chapsa sorediata* Kalb can also be distinguished by transversely septate, amyloid ascospores which are, however, smaller than in the two preceding species (Kalb 2009); in addition, its thallus lacks a distinct cortex but is epiperidermal. Apart from the soralia, *Chapsa wijeyaratniana* is similar to *C. alstrupii* Frisch and *C. sipmanii* Frisch & Kalb in having large apothecia and small, muriform ascospores, but those taxa have epiperidermal, corticate thalli and ascospores with a distinct endospore and rounded lumina (Frisch *et al.* 2006). *Chapsa hiata* (Hale) Sipman (Sipman *et al.* 2012) and *C. kalbii* Frisch are two other species with small, muriform ascospores which, like the new species, have ecorticate thalli (Frisch *et al.* 2006); both lack soralia. *Chapsa kalbii* differs also in the weakly amyloid ascospores having a well-developed endospore and rounded lumina, whereas the ascospores in *C. hiata* are very small (12–15 µm long).

Additional specimen examined. **Sri Lanka:** *Central Province*: Kalupahana, Ranamure, 7°27′N, 80°48′E, 1240 m, mossy montane cloud forest, 2010, *Weerakoon & Wijeyaratne* 1025 (PDA).

Chapsa wolseleyana Weerakoon, Lumbsch & Lücking sp. nov.

MycoBank No.: MB564109

Sicut *Chapsa rubropulveracea* sed thallo corticato differt.

Typus: Sri Lanka, Central Province, Knuckles Conservation area, Kalupahana Mountain along the Lebannan watta, Rathnagiriya-Kalupahana, 16 km WNW of Hettipola, 7°25′N, 80°46′E, 1280 m, mossy mountain forest, growing on twigs of *Calophyllum trapezifolium*, April 2009, *Weerakoon & Wijeyaratne* 1043 (PDA—holotypus; BM, F—isotypi).

(Fig. 3)

Thallus corticolous, up to 8 cm diam., 50–100 µm thick, continuous; surface uneven, white-grey to grey-green; in section with loose, irregular upper cortex, irregular algal layer and indistinct medulla with clusters of calcium oxalate crystals.

Apothecia erumpent, rounded to lobate, 0·5–1·0 mm diam.; *disc* exposed, flesh-coloured where visible but usually covered by thick, red to purplish red or mottled white-red pruina; proper margin indistinct; thalline margin lobulate to recurved with 4–6 erect to recurved lobules covered with white pruina along inner margin. *Columella* absent. *Excipulum* paraplectenchymatous, 30–60 µm thick, colourless or infused with red pigment; lateral paraphyses present. *Hymenium* 200–225 µm high, clear, epihymenium with layer of red granules, K+ dissolving into a yellow-green cloud; *paraphyses* unbranched. *Ascospores* 1 per ascus, richly muriform, oblong-ellipsoid, 120–150 × 30–35 µm, with rather thin septa and rectangular to slightly rounded lumina, colourless to pale olive-brown, I−.

Chemistry. No substances detected by TLC but apothecial disc with pigment dissolving and producing K+ yellow-green efflux, suggesting presence of isohypocrelline (Mathey *et al.* 1994).

Etymology. This new species is dedicated to Pat Wolseley, lichenologist at the Natural History Museum in London, in honour of her invaluable contributions to lichenological studies in Sri Lanka for more than a decade by conducting workshops, supervising post-graduate students and assisting in several lichen projects carried out in the country.

Ecology and distribution. The new species was collected in the Knuckles Mountains, in mossy montane forests located in the central region of Sri Lanka, growing on twigs of *Calophyllum trapezifolium*. The new species is rare and known only from the type locality. It was found on twigs of trees that were exposed to high light intensity and winds.

Notes. This new species is distinguished by its pigmented disc and muriform ascospores that become olive-brown. Only a few species of *Chapsa* have pigmented discs: *C. magnifica* (Berk. & Broome) Rivas Plata & Mangold with orange, *C. waasii* (Hale) Sipman & Lücking with pink-purple, *C. rubropulveracea* Hale ex Mangold *et al.* with red-purple, *C. rubropruinosa* Messuti & Codesal with red-brown, and *C. neei* (Hale) Mangold &

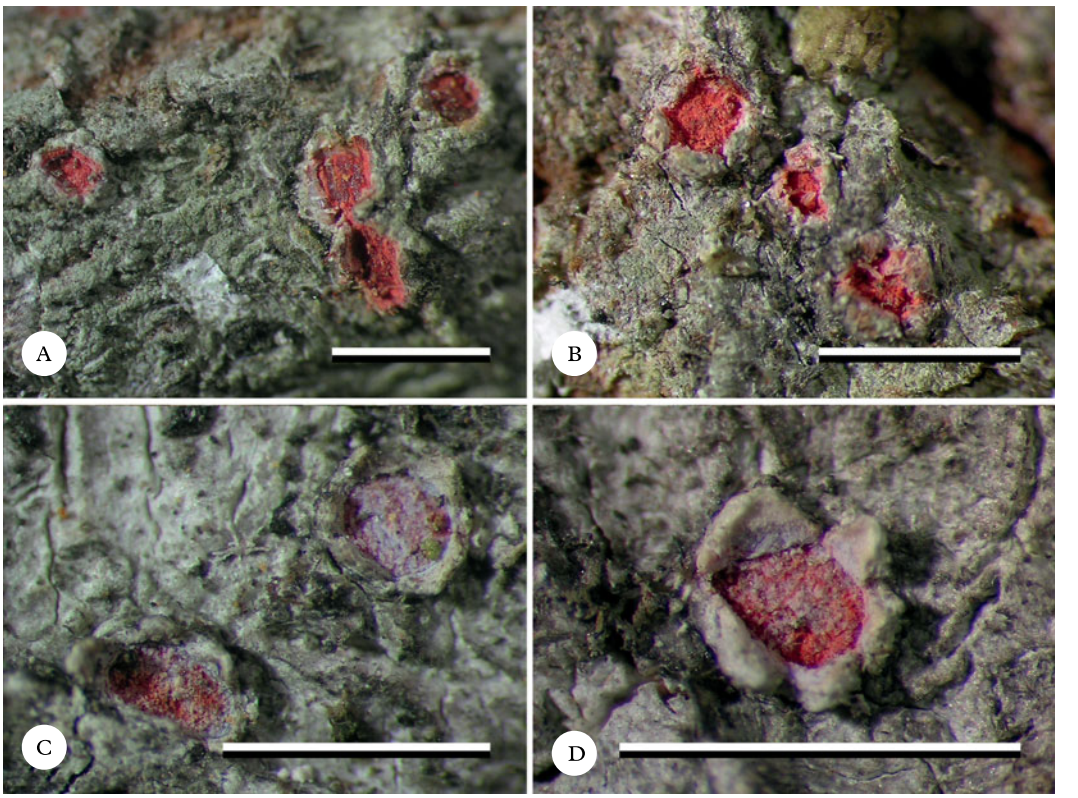

FIG. 3. *Chapsa wolseleyana*. A–D, thallus with apothecia. [A–D *Weerakoon* 1043 (F)]. In colour online.

Lücking with purple-brown pigment (Messuti *et al.* 2010; Rivas Plata *et al.* 2010; Lumbsch *et al.* 2011). All have small, transversely septate ascospores (brown in *C. neei*). *Chapsa rubropulveracea* is otherwise morphologically most similar to the new species, but lacks a cortex and its thallus is farinose. The only other known species of *Chapsa* with large, muriform, grey-brown ascospores is *C. stellata* (Hale) Sipman, which has an olive-green to yellowish thallus with dense cortex and grey-pruinose apothecial discs.

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