




Standard Paper

New species and additional records in the lichen genus *Malmidea* from India

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Abstract

A detailed examination of *Malmidea* specimens deposited in the herbarium LWG and freshly collected samples resulted in the description of 10 new species. *Malmidea glabromarginata* has a finely verrucose thallus and *granifera*-type whitish apothecial margins. *Malmidea globosa* is characterized by having a strongly verrucose thallus with almost spherical warts and *piperis*-type apothecial margins. *Malmidea incrassatispora* has a thalline excipulum and ascospores with end wall thickenings. *Malmidea kalbii* has a thalline excipulum, dark brown to black apothecial discs and ascospores mostly < 15 µm in length. In *Malmidea lutea* the medulla of the thallus and verrucae is white to cream-coloured, with beige-coloured apothecial discs. *Malmidea palghatensis* has a thalline excipulum and with medulla of verrucae pink-coloured. *Malmidea rubra* has an irregularly verrucose thallus, with the medulla of verrucae orange-red and whitish apothecial margins. *Malmidea subindica* has light to dark orange-brown apothecial discs, 2–4-spored asci, and broadly ellipsoid ascospores mostly exceeding 30 µm in length. *Malmidea upretii* has prominent and confluent verrucae with an orange-red medulla, and ascospores exceeding 25 µm in length. *Malmidea verrucosa* has a characteristic whitish grey, densely verrucose thallus, dark reddish brown apothecial discs and contains atranorin. Additionally, seven species, viz. *Malmidea fenicis* (Vain.) Kalb *et al.*, *M. leptoloma* (Müll. Arg.) Kalb & Lücking, *M. piae* (Kalb) Kalb, *M. piperina* (Zahlbr.) Aptroot & Breuss, *M. reunionis* Kalb, *M. sulphureosorediata* Cáceres *et al.* and *M. vinosa* (Eschw.) Kalb *et al.*, are reported as new distributional records for the Indian lichen biota. The world key of *Malmidea* by Breuss & Lücking (2015) has been updated with all the species discovered after 2015 by mentioning specific couplets.

Keywords: biodiversity; Himalaya; *Lecidea*; *Malmideaceae*; *piperis*-type; Sunderdhunga

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Introduction

The genus *Malmidea* Kalb *et al.* and the family *Malmideaceae* were together established by Kalb *et al.* (2011) to resolve the phylogenetic position of the *Lecidea piperis* and *Lecanora granifera* groups. At present the family *Malmideaceae* contains a total of nine genera: *Australidea* Kantvilas *et al.*; *Cheiomycina* B. Sutton; *Crustospathula* Aptroot; *Kalbionora* Sodamuk *et al.*; *Malmidea* Kalb *et al.*; *Multisporidea* Kalb & Aptroot; *Savoronala* Ertz *et al.*; *Sprucidea* M. Cáceres *et al.*; *Zhurbenkoa* Flakus *et al.* Of these, *Zhurbenkoa* is lichenicolous while the others are lichenized fungi (Sutton & Muhr 1986; Aptroot 1998; Kalb *et al.* 2011; Ertz *et al.* 2013; Breuss & Lücking 2015; Cáceres *et al.* 2017; Muggia *et al.* 2017; Sodamuk *et al.* 2017; Flakus *et al.* 2019; Kalb & Aptroot 2021; Kantvilas *et al.* 2021). The genus *Malmidea* is characterized by having a mostly corticolous habitat, a crustose, smooth to verrucose thallus, often formed by goniocysts, pigmentation often present in the medulla, an excipulum usually with medullary hyphae in layers or in chambers

incrusted with opaque to pigmented hydrophobic granules, asci without a distinct tubular structure in the tholus, simple, hyaline ascospores (1–2)4–8 per ascus, the wall halonate and evenly thickened or thickened at the ends, and atranorin often present (Kalb *et al.* 2011). A world key to the known species of *Malmidea* was provided by Breuss & Lücking (2015) which included 50 species. Prior to the present study, 72 species of *Malmidea* were known worldwide, of which 17 have been reported from India (Singh & Pinokiyo 2014; Sinha *et al.* 2015; Joseph *et al.* 2018; Gogoi *et al.* 2020; Islary *et al.* 2023). Our recent lichen collections from Western Himalaya and a detailed study of specimens preserved in the herbarium LWG resulted in several novel or interesting species that are described herein.

Materials and Methods

The specimens reported in the present study were recently collected from the Western Himalayas, en route to Sunderdhunga glacier spanning an altitude of 2000–4000 m. In addition, identified and unidentified specimens of *Malmidea* preserved in the herbarium LWG of the CSIR-National Botanical Research Institute, Lucknow were re-examined. Morphological analysis and image capture were carried out using a Leica S9i stereo

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zoom microscope with an integrated digital camera. Anatomical characters were analyzed using Leica S8 APO and Leica DM2500 microscopes. For the spot tests, the reagents 10% KOH (K) and p-Phenylenediamine (P) were used. The presence of secondary metabolites was detected by performing thin-layer chromatography (TLC) in solvent system A following Orange et al. (2001).

Results and Discussion

This study resulted in the description of 10 species of *Malmidea* new to science and seven new records for the Indian lichen biota. As a result, the global count of *Malmidea* has increased to 82 species, with 34 for India. The re-examination of specimens that were previously identified as *Lecidea granifera* (Ach.) Vain. yielded several intriguing species. Notable among them are species with a thalline excipulum. Previously only *M. duplomarginata* (Papong & Kalb) Kalb & Papong was known to have a thalline excipulum, but here we add three more species, viz. *M. incrassatispora*, *M. kalbii* and *M. palghatensis*. Furthermore, thickened ascospore cell wall ends were observed in *M. incrassatispora*, a species-specific characteristic previously known in only two other species, *M. incrassata* Kalb and *M. reunionis* Kalb. Detailed descriptions of the new species are provided and the world key by Breuss & Lücking (2015) has also been updated by providing the key couplets of all the *Malmidea* species.

The New Species

Malmidea glabromarginata R. Adhikari, S. Joseph & Nayaka sp. nov.

Mycobank No.: MB 852244

Similar to *Malmidea badimioides* (M. Cáceres & Lücking) M. Cáceres & Kalb but differs in having smaller ascospores, 10–15 × 6–9 μm (vs 15–20 × 6–10 μm).

Type: India, Odisha, Kandhamal District, Raikia, near Mandasaru valley, 19°58'27"N, 84°14'27"E, 726 m, 27 December 2019, R. R. Paul 19-047442 (LWG—holotype).

(Fig. 1)

Thallus crustose, corticolous, greenish grey, continuous, finely verrucose; verrucae small and sparse, up to 0.1 mm diam. and



Figure 1. Habit of *Malmidea glabromarginata* (holotype LWG-19-047442). Scale = 1 mm. In colour online.

0.1 mm high; isidia and soredia absent. *Prothallus* indistinct. *Medulla* of thallus and verrucae white.

Apothecia round, sessile, 0.4–0.7 mm diam.; disc plane to slightly concave, orange-brown, margin *granifera*-type, distinctly white, 80–100 μm thick, smooth, continuous. *Thalline exciple* absent. *Proper exciple* 70–120 μm wide, externally hyaline filled with a continuous layer of medullary hyphae incrustated with opaque to whitish granules which dissolve in K with a lemon yellow reaction, internally pale to brownish, ectal excipulum poorly developed. *Epihymenium* indistinct. *Hymenium* hyaline, 60–70 μm high. *Subhymenium* hyaline, 20–25 μm high. *Hypothecium* 60–70 μm high, dark brownish, K–. *Apothecial base* below hypothecium 70–80 μm high with a continuous layer of medullary hyphae and greyish granules. *Asci* 45–65 × 10–17 μm, 4–8-spored. *Ascospores* simple, hyaline, ellipsoid, 10–14 (–15) × 6–8 (–9) μm, wall evenly thickened, halonate (1 μm wide).

Pycnidia not observed.

Chemistry. Medulla of thallus and verrucae K+ bright yellow, P–. TLC: no secondary metabolites detected.

Etymology. The epithet ‘*glabromarginata*’ refers to the smooth apothecial margin of the species.

Remarks. This species is characterized by having a finely verrucose thallus, small-sized apothecia (up to 0.7 mm diam.) with orange-brown coloured discs and distinctly white margins. It is close to *Malmidea badimioides* and *M. psychotrioides* (Kalb & Lücking) Kalb et al. *Malmidea badimioides* has larger ascospores (15–20 × 6–10 μm), reddish brown apothecial discs with margins becoming granular with age and an orange-coloured hypothecium (Breuss & Lücking 2015; Kalb 2021). *Malmidea psychotrioides* has mostly 4-spored asci, a well-developed ectal excipulum, smooth to crenulate apothecial margins and a foliicolous habit (Lücking & Kalb 2000).

Additional specimens examined. **India:** Odisha: Kandhamal District, Raikia, near Mandasaru valley, 19°58'27"N, 84°14'27"E, 726 m, 2019, R. R. Paul 19-047443 & 19-047444 (LWG).

Malmidea globosa R. Adhikari & Nayaka sp. nov.

Mycobank No.: MB 852245

Similar to *Malmidea papillosa* Weerakoon & Aptroot and *M. allo-papillosa* Kalb but differs in having smaller ascospores, 9–15 × 6–9 μm.

Type: India, Mizoram, Champhai District, Murlen National Park, 2122 m, 24 September 2014, A. R. Logesh & Chinlampang 14-021051/A (LWG—holotype).

(Fig. 2)

Thallus crustose, corticolous, continuous, greenish grey, densely verrucose; verrucae confluent, almost spherical, constricted at base, 0.1–0.15 mm diam. and c. 0.1 mm high; isidia and soredia absent. *Prothallus* indistinct. *Medulla* of the thallus white, medulla of verrucae cream to yellowish.

Apothecia sessile, round to irregular, 0.4–0.5 mm diam.; disc plane to slightly convex, brown to dark brown; margin of *piperis-*

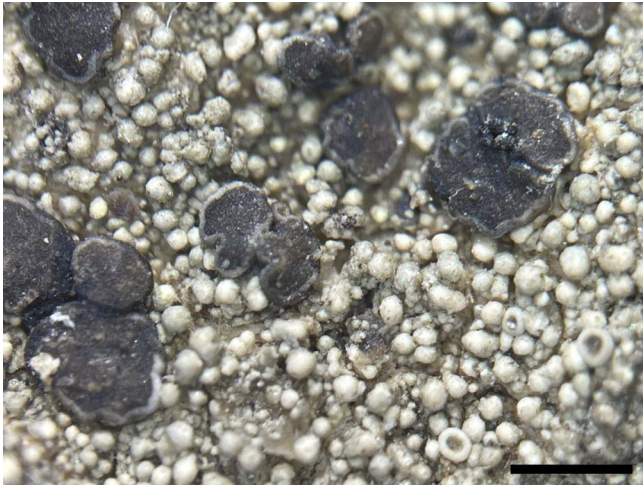


Figure 2. Habit of *Malmidea globosa* (holotype LWG-14-021051/A). Scale = 0.5 mm. In colour online.

type, thin, 30–40 μm , level with disc, concolorous with the thallus or paler. *Thalline exciple* absent. *Proper exciple* 40–95 μm wide, hyaline externally, light to dark brown inside, lacking hydrophobic granules. *Epihymenium* indistinct. *Hymenium* 35–50 μm high, hyaline. *Subhymenium* 16–20 μm high, hyaline, *piperis*-type. *Hypothecium* 50–65 μm high, pale brown to dark brown, K–. *Apothecial base* below hypothecium 70–80 μm high, hyaline to pale. *Asci* 35–45 \times 11–18 μm , mostly 8-spored. *Ascospores* simple, hyaline, ellipsoid, 9–13(–15) \times 6–8(–9) μm , wall equally thickened, halonate (1 μm wide).

Pycnidia not observed.

Chemistry. Medulla of thallus K+ yellow, P–; medulla of verrucae cream to yellowish, K+ orange-yellow, P–. TLC: atranorin (major) and unknown purple spots at R_f class 5 and just below 7 in solvent A.

Etymology. The species epithet ‘*globosa*’ refers to its globose verrucae.

Remarks. This species is characterized by having a strongly verrucose thallus with almost spherical warts, a *piperis*-type exciple and medulla of verrucae cream to yellowish. A combination of the verrucose thallus, pigments in the medulla and *piperis*-type apothecial margins, suggests this species resembles *M. papillosa* and *M. allopapillosa*. However, in both, the verrucae are not constricted at the base, and ascospores are larger (15–18 \times 9–11 μm in *M. papillosa* and 14–17 \times 8–10 in *M. allopapillosa*). The medulla of verrucae in *M. allopapillosa* is peach-coloured and also contains atranorin, and in *M. papillosa* the apothecial margin is darker than the disc (Weerakoon & Aptroot 2014; Kalb 2021). *Malmidea amazonica* (Redinger) Kalb *et al.* also has some resemblance, but the thallus medulla is orange-red turning purple in K (Breuss & Lücking 2015).

Additional specimen examined. **India:** Mizoram: Champhai District, Murlen National Park, 2122 m, 2014, A. R. Logesh & Chinlampianga 14-021051/B (LWG).

***Malmidea incrassatispora* R. Adhikari, S. Joseph & Nayaka sp. nov.**

Mycobank No.: MB 852246

Similar to *Malmidea duplomarginata* but differs in having ascospores with end wall thickenings and yellowish to faintly orange-yellow pigmented medulla of verrucae.

Type: India, Karnataka, Uttara Kannada, Castle Rock, Singargao cross, 25 February 2018, S. Nayaka, S. Joseph & S. Dudani 18-047441 (LWG—holotype).

(Fig. 3)

Thallus crustose, corticolous, greenish grey, verrucose; verrucae 0.1–0.14 mm diam. and 0.1 mm high, confluent; isidia and soredia absent. **Prothallus** indistinct. **Medulla** of thallus white to cream-coloured, medulla of verrucae faintly yellow to light orange-yellow.

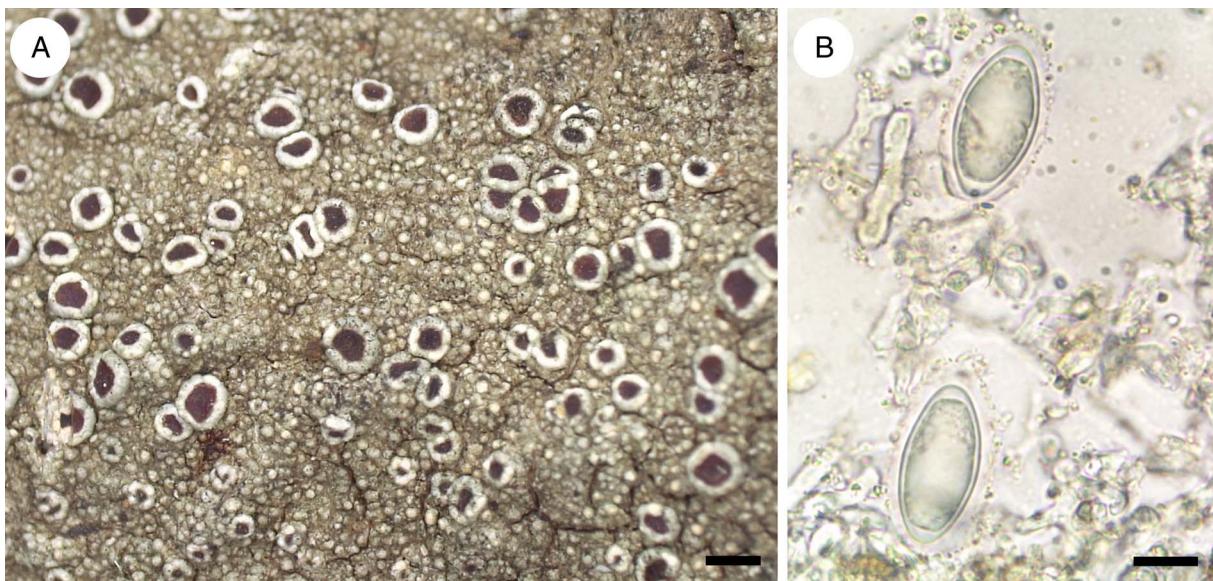


Figure 3. Habit of *Malmidea incrassatispora* (holotype LWG- 18-047441). A, thallus. B, ascospores with end wall thickenings. Scales: A = 1 mm; B = 10 μm . In colour online.

Apothecia round, sessile, 0.4–0.8 mm diam.; disc orange-brown to dark reddish brown, plane to slightly concave; margin *granifera*-type, 130–170 µm thick, prominent, continuous to slightly granular. *Thalline exciple* hyaline, 30–40 µm thick, densely filled with algal cells. *Proper exciple* 110–140 µm wide, internally brownish, externally hyaline, filled with a continuous layer of medullary hyphae and creamish to pale hydrophobic granules, dissolving in K with a lemon yellow to greenish yellow reaction. *Ephymenium* pale to orange-brown, 10–15 µm high. *Hymenium* hyaline, 75–90 µm high. *Subhymenium* hyaline, 20–25 µm high. *Hypothecium* 70–85 µm high, dark brown, K–. *Apothecial base* below hypothecium 110–130 µm high, hyaline with a continuous layer of medullary hyphae with greyish to cream-coloured granules. *Asci* 80–90 × 15–22 µm, 3–6-spored (rarely 8). *Ascospores* simple, hyaline, ellipsoid, 20–24 (–27) × 10–13 (–14) µm, wall not uniformly thickened, slightly to prominently thickened at ends, halonate (2–3 µm wide).

Pycnidia not observed.

Chemistry. Medulla of thallus K+ yellow, P–; medulla of verrucae K+ orange, P–. TLC: atranorin, unknown grey-brown spots at R_f classes 5 and 6.

Etymology. The species epithet '*incrassatispora*' refers to the ascospores having prominently thickened ends.

Remarks. This species is characterized by having a thalline excipulum and ascospores with distinct end wall thickenings. The presence of such ascospores is not common in this genus and is considered to be a prominent character in distinguishing species (Kalb et al. 2011, 2012; Breuss & Lücking 2015). Currently *Malmidea duplomarginata* is the only known *Malmidea* species with a thalline excipulum but it has ascospores with evenly thickened walls and differs in the medulla of verrucae being cream to white-coloured, larger apothecia up to 1.5 mm diam., and up to 8-spored asci (Kalb et al. 2009).

Additional specimens examined. **India:** Karnataka: Shimoga District, Sagar, Marur Village, 14°12'47.2"N, 75°05'45.7"E, 630 m, 2018, S. Nayaka, S. Joseph & S. Dudani 18-034389 (LWG); Uttara Kannada, towards Castle Rock Town, 2018, S. Nayaka, S. Joseph & S. Dudani 18-036458 (LWG). **Madhya Pradesh:** Hoshangabad District, Panchmarhi, Patharchatta, 762 m, 1973, S. R. Singh 73.54 (LWG). **Mizoram:** Champhai District, Murlen National Park, 2092 m, 2014, A. R. Logesh & Chinlamianga 14-031409 (LWG).

Malmidea kalbii R. Adhikari & Nayaka sp. nov.

MycoBank No.: MB 852247

Similar to *Malmidea duplomarginata* but differs in having smaller ascospores, 9–15 × 6–9 µm (vs 20–24 × 11–15 µm).

Type: India, Odisha, Kandhamal District, Raikia, near Mandasaru valley, 19°58'27"N, 84°14'27"E, 726 m, 27 December 2019, R. R. Paul 19-039538/B (LWG—holotype).

(Fig. 4)

Thallus crustose, corticolous, greenish grey, continuous to cracked, verrucose; verrucae not prominent; isidia and soredia

absent. *Prothallus* whitish with grey margin. *Medulla* of thallus and verrucae white.

Apothecia round, sessile, 0.5–1.2 mm diam.; disc dark reddish brown to black, plane to slightly convex; margin *granifera*-type, concolorous with the thallus, 75–90 µm thick, not prominently raised, continuous. *Thalline exciple* 50–60 µm wide, densely filled with algal cells. *Proper exciple* 70–130 µm wide, filled with a continuous layer of medullary hyphae and greyish hydrophobic granules, dissolving in K with a pale to lemon yellow reaction. *Ephymenium* indistinct. *Hymenium* hyaline, 65–75 µm high. *Subhymenium* 20–25 µm high, hyaline to slightly pale. *Hypothecium* 65–90 µm high, orange-brown to dark brown, K–. *Apothecial base* below hypothecium 100–130 µm high, hyaline, filled with a continuous layer of medullary hyphae and greyish granules. *Asci* 60–70 × 10–15 µm, (4–)6–8-spored. *Ascospores* simple, hyaline, ellipsoid, 9–14 (–15) × 6–8 (–9) µm, wall uniformly thickened, halonate (1 µm wide).

Pycnidia not observed.

Chemistry. Medulla of thallus and verrucae K+ bright yellow to light orange-yellow, P–. TLC: atranorin.

Etymology. This species is named in honour of Prof. Dr Klaus Kalb, a renowned German lichenologist.

Remarks. This species is characterized by having a thalline excipulum, dark brown to black apothecial discs and ascospores mostly < 15 µm in length. It is similar to *M. duplomarginata*, the only known *Malmidea* species with a thalline excipulum, and two other species (*M. incrassatispora* and *M. palghatensis*) described in the present study. *Malmidea duplomarginata* has larger ascospores, 20–24 × 11–15 µm, and plane to concave comparatively less dark apothecial discs (Kalb et al. 2009). *Malmidea incrassatispora* and *M. palghatensis* also have larger ascospores (mostly > 15 µm), pigmented medulla of verrucae, less dark apothecial discs and lack a prothallus.

Additional specimen examined. **India:** Odisha: Mayurbhanj District, Lanjioghosara, 2019, D. K. Upreti & S. Pradhan CUTM-073 (LWG).

Malmidea lutea R. Adhikari, Ingle & Nayaka sp. nov.

MycoBank No.: MB 852248

Similar to *Malmidea badimioides* but differs in having beige-coloured apothecia (red-brown in *M. badimioides*), a hyaline hypothecium (orange in *M. badimioides*) and larger ascospores, 20–25 × 10–15 µm (vs 14–20 × 7–10 µm).

Type: India, Uttarakhand, Bageshwar District, en route to Jatoli from Khati Village, 30°08'30.33"N, 79°55'21.57"E, 2440 m, 19 June 2023, Komal K. Ingle & R. S. Adhikari 23-047445 (LWG—holotype).

(Fig. 5)

Thallus crustose, corticolous, greenish grey, thick, continuous, verrucose; verrucae 0.20–0.24 mm diam. and 0.1–0.15 mm high, confluent, hemispherical to irregular. *Prothallus* indistinct. *Medulla* of thallus and verrucae white to creamish.

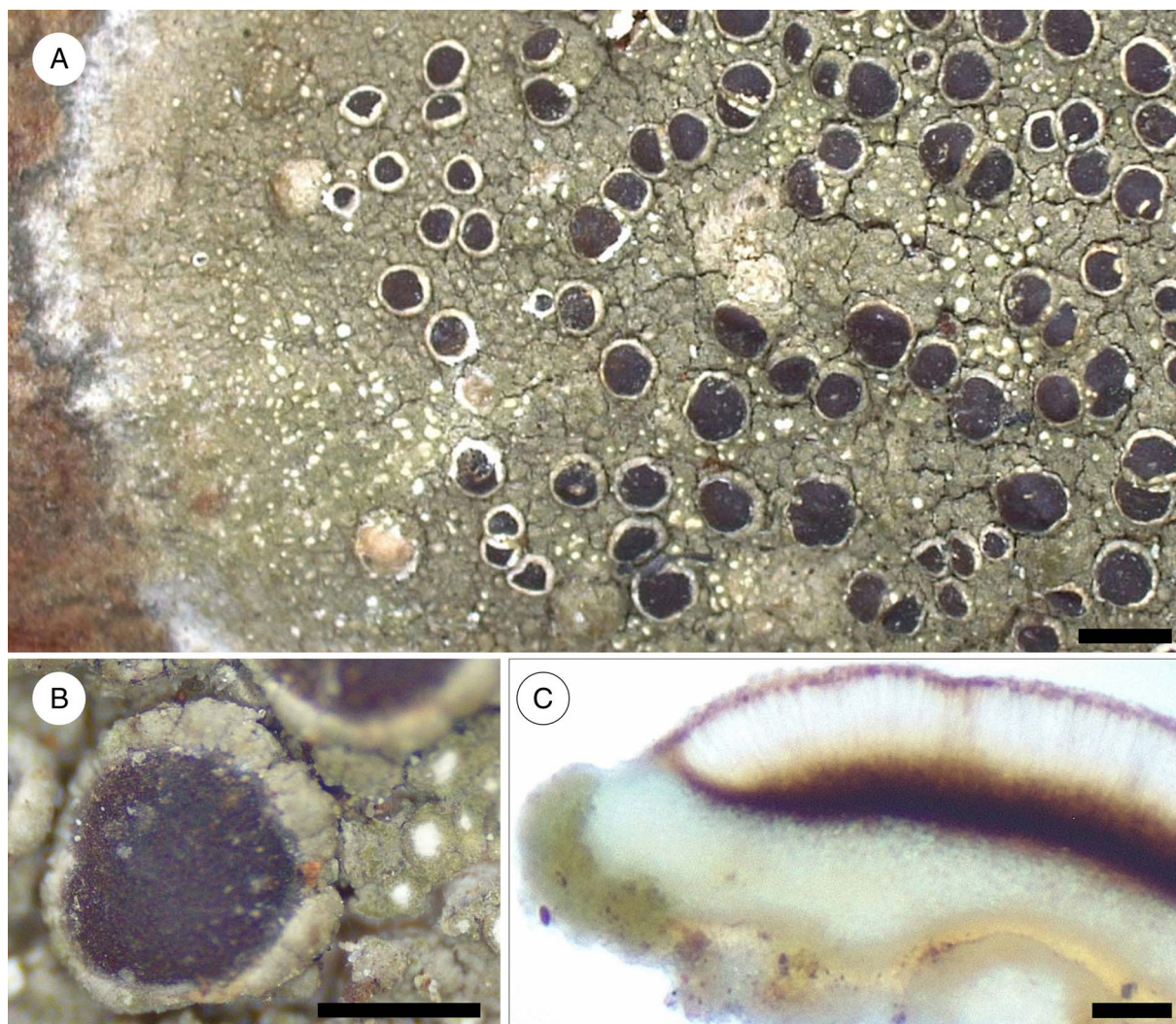


Figure 4. Habit of *Malmidea kalbii* (holotype LWG- 19-039538/B). A, thallus. B, apothecium. C, apothecial section. Scales: A = 1 mm; B = 0.5 mm; C = 50 μ m. In colour online.

Apothecia round, sessile, 0.4–0.9 mm diam., constricted at base; disc beige, plane to concave; margin *granifera*-type, pale, lighter than disc colour, 0.11–0.14 mm thick, slightly prominent, smooth, continuous to slightly papillate towards maturity. *Thalline exciple* absent. *Proper exciple* 80–115 μ m wide, hyaline,



Figure 5. Habit of *Malmidea lutea* (holotype LWG- 23-047445). Scale = 2 mm. In colour online.

internally with medullary hyphae in layers or chambers, incrustated with yellowish hydrophobic granules which dissolve in K with an orange-yellow reaction. *Epithymenium* indistinct. *Hymenium* hyaline, 90–110 μ m high. *Subhymenium* indistinct. *Hypothecium* hyaline, 25–50 μ m high, K–. *Apothecial base* below hypothecium 100–125 μ m high, hyaline, filled with medullary hyphae and yellowish granules in a continuous layer or chambers. *Asci* 80–90 \times 15–22 μ m, 4–6(–8)-spored. *Ascospores* simple, hyaline, 20–24(–25) \times 10–13(–15) μ m, wall uniformly thickened, halonate (1 μ m wide).

Pycnidia not observed.

Chemistry. Medulla of thallus K+ yellow, P–; medulla of verrucae K+ orange-yellow, P–. TLC: unknown grey-brown spot at R_f class 5 (UV+ orange).

Etymology. The epithet '*lutea*' refers to the pale yellow colour of the apothecial disc in this species.

Remarks. This species is characterized by having a densely verrucose thallus, medulla of thallus and verrucae white to cream-coloured, and beige-coloured apothecial discs. It is similar to *M.*

badimioides and *M. glabromarginata* (present paper) in having medulla of thallus and verrucae white to cream-coloured, *granifera*-type apothecial margins and an absence of atranorin (Kalb 2021). Both these species differ in having comparatively less verrucose thalli, smaller ascospores ($14\text{--}20 \times 7\text{--}10 \mu\text{m}$ in *M. badimioides* and $10\text{--}15 \times 6\text{--}9 \mu\text{m}$ in *M. glabromarginata* vs $20\text{--}25 \times 10\text{--}15 \mu\text{m}$ in this species), an orange-brown to dark brown hypothecium (hyaline in this species), and an apothecial disc that is orange-brown in *M. glabromarginata* and red-brown in *M. badimioides* (Kalb 2021).

Additional specimen examined. **India:** Uttarakhand: Bageshwar District, en route to Jatoli from Khati Village, $30^{\circ}08'30.33''\text{N}$, $79^{\circ}55'21.57''\text{E}$, 2440 m, 2023, Komal K. Ingle & R. S. Adhikari 23-047446 (LWG).

***Malmidea palghatensis* R. Adhikari & Nayaka sp. nov.**

Mycobank No.: MB 852249

Similar to *Malmidea duplomarginata* but differs in having pink-coloured medulla of verrucae.

Type: Kerala, Palghat, Parambikulam Wildlife Sanctuary, 600 m, 14 November 2006, Biju Haridas 06-009856 (LWG—holotype).

(Fig. 6)

Thallus corticolous, crustose, pale greyish, thick, continuous to cracked, verrucose; verrucae 0.2–0.28 mm diam. and 0.1 mm high, confluent to sparse, not prominent; isidia and soredia absent. *Prothallus* indistinct. *Medulla* of thallus white to creamish, medulla of verrucae pink-coloured.

Apothecia round to irregular, sessile, 1–3.5 mm diam.; disc plane to slightly convex, orange-brown to reddish-brown; margin *granifera*-type, concolorous with the thallus, thick, 90–110 μm thick, smooth, continuous, strongly flexuous. *Thalline exciple* 100–120 μm wide, densely filled with algal cells and pink-coloured granules, granules dissolving in K with a yellowish reaction. *Proper exciple* 25–30 μm , brown. *Epithymenium* pale to orange-brown, 12–15 μm high. *Hymenium* hyaline, 100–110 μm high. *Subhymenium* hyaline to pale, 10–15 μm high. *Hypothecium* 120–160 μm high, dark brown to black, K–. *Apothecial base* below hypothecium 150–160 μm high, hyaline. *Asci* 80–90 \times 18–22 μm , (4–)6–8-spored. *Ascospores* simple, hyaline, ellipsoid, 17–22(–24) \times 10–12(–13) μm , wall uniformly thickened, halonate (2–3 μm wide).

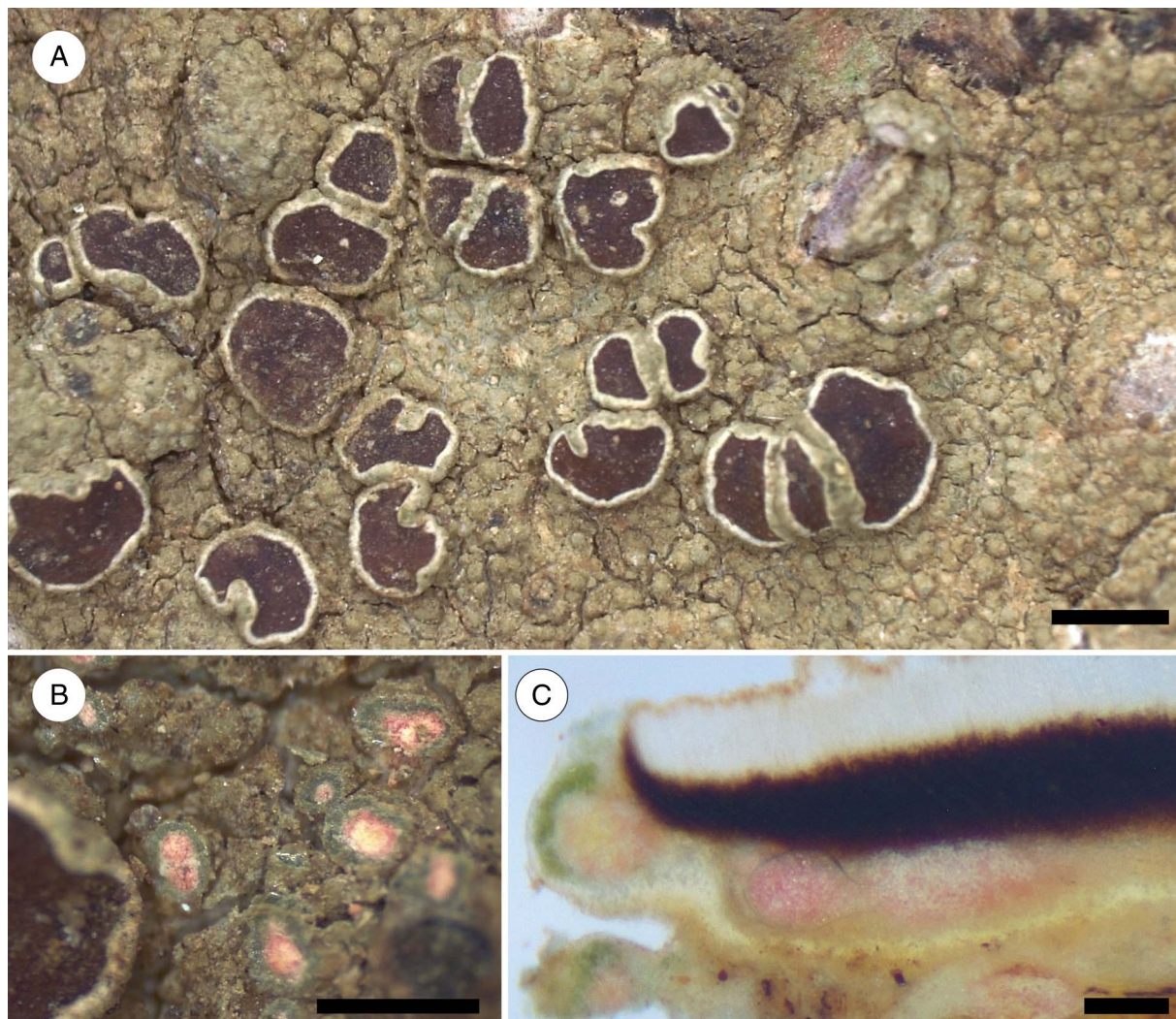


Figure 6. Habit of *Malmidea palghatensis* (holotype LWG- 06-009856). A, thallus. B, enlarged portion of thallus showing pink-coloured medulla of verrucae. C, apothecial section. Scales: A & B = 1 mm; C = 50 μm . In colour online.

Pycnidia not observed.

Chemistry. Medulla of thallus K+ yellow, P–; medulla of verrucae K+ orange-yellow, P–. TLC: atranorin together with an unknown purple-violet spot.

Etymology. The species epithet ‘palghatensis’ is based on the name of the locality from where the holotype is collected.

Remarks. This species is characterized by having a thalline excipulum and pink-coloured medulla of verrucae. *Malmidea duplo-marginata* also has a thalline excipulum but differs in having a white to cream-coloured medulla of verrucae and smaller apothecia up to 1.5 mm diam. (Kalb *et al.* 2009). *Malmidea kalbii* and *M. incrassatispora* described above also have a thalline excipulum. *Malmidea kalbii* differs in having smaller ascospores, 9–15 × 6–9 μm, and a whitish medulla of verrucae. *Malmidea incrassatispora* differs in having ascospores with distinct end wall thickenings and a yellowish medulla of verrucae.

Additional specimen examined. India: Odisha: Kandhamal District, Raikia, near Mandasaru valley, 19°58'27"N, 84°14'27"E, 726 m, 2019, R. R. Paul 19-039538/C (LWG).

Malmidea rubra R. Adhikari & Nayaka sp. nov.

Mycobank No.: MB 852250

Similar to *Malmidea granifera* (Ach.) Kalb *et al.*, from which it differs in having an orange-red pigmented (vs yellowish to peach-coloured) medulla of verrucae and light-brown (vs dark brown to black) apothecial discs.

Type: India, Arunachal Pradesh, West Siang District, Bahadur Hill Reserve Forest, 11 April 2006, *Urvashi Dubey* 06-006408 (LWG—holotype).

(Fig. 7)

Thallus crustose, corticolous, greenish grey, continuous, smooth to irregularly verrucose; verrucae sparse, not prominent; isidia and soredia absent. **Prothallus** greyish brown to black. **Medulla** of thallus creamish to faintly yellow, medulla of verrucae orange-red to dark red.

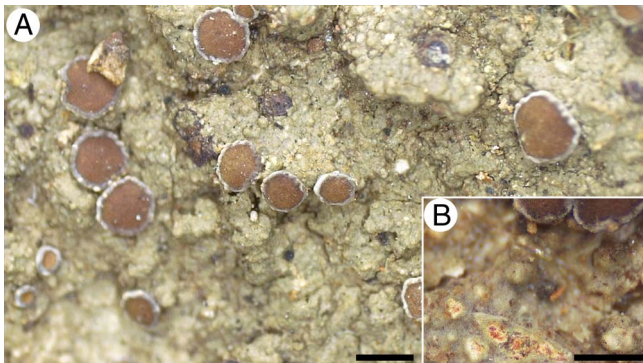


Figure 7. Habit of *Malmidea rubra* (holotype LWG-06-006408). A, thallus. B, enlarged portion of thallus showing orange-red coloured medulla of verrucae. Scales: A & B = 1 mm. In colour online.

Apothecia round, sessile, 0.5–1 mm diam.; disc light to dark orange-brown, plane to slightly convex; margin *granifera*-type, moderately thick, 55–70 μm thick, continuous, smooth to papillate, apically whitish. **Thalline exciple** absent. **Proper exciple** 70–120 μm wide, externally pale brown, internally dark brown to black, with medullary hyphae in chambers, incrustated with yellowish hydrophobic granules, K+ intense yellow. **Epihymenium** indistinct or slightly pale. **Hymenium** hyaline, 55–70 μm high. **Subhymenium** hyaline to pale, 12–17 μm high. **Hypothecium** 120–160 μm high, dark brown to black, K–. **Apothecial base** indistinct from hypothecium. **Asci** 50–75 × 15–20 μm, 4–8-spored. **Ascospores** simple, hyaline, ellipsoid, 14–18(–20) × 6–9(–10) μm, wall evenly thickened, halonate (1–1.5 μm wide).

Pycnidia not observed.

Chemistry. Medulla of thallus K+ yellow, P–; medulla of verrucae K+ red, P–. TLC: atranorin (minor).

Etymology. The epithet ‘*rubra*’ is based on its orange-red coloured medulla of verrucae.

Remarks. This species is characterized by having irregularly distributed, fine verrucae, medulla of thallus creamish to faintly yellow, medulla of verrucae orange-red to dark red and whitish apothecial margins. The other species of *Malmidea* with a pigmented medulla, *granifera*-type exciple and similar ascospore size are *M. eeuuae* Kalb, *M. granifera* and *M. subaurigera* (Vain.) Kalb *et al.* (Breuss & Lücking 2015). *Malmidea granifera* differs in having yellowish to peach-coloured medulla of verrucae, dark brown to black apothecial discs, 8-spored asci and a different chemistry (Kalb *et al.* 2011; Breuss & Lücking 2015). *Malmidea subaurigera* and *M. eeuuae* both differ in having a thallus with well-developed regular warts and an apothecial margin that becomes granular and excluded towards maturity (Kalb *et al.* 2011). Furthermore, the medulla of verrucae is creamish to sulphur yellowish in *M. eeuuae* and in *M. subaurigera* the medulla of both the thallus and verrucae is orange-red pigmented (Kalb *et al.* 2011). In having whitish apothecial margins, it is also similar to *M. albomarginata* Kalb & Hernández but in this species the medulla of verrucae is white to faintly yellow-pigmented, the warts become coralloid granular with age, and it has smaller ascospores (10–14 × 6–9 μm) (Kalb 2021).

Additional specimens examined. India: Arunachal Pradesh: West Siang District, Bahadur Hill Reserve Forest, 2006, *Urvashi Dubey* 06-006408, 06-006412, 06-006417, 06-006463 & 06-006488 (LWG).

Malmidea subindica R. Adhikari & Nayaka sp. nov.

Mycobank No.: MB 852251

Similar to *Malmidea indica* (D. D. Awasthi & M. R. Agarwal) Hafellner & T. Sprib. and *Malmidea sorsogona* (Vain.) Kalb *et al.* but differing in its slightly (vs distinctly) verrucose thallus and light to dark orange-brown (vs dark brown to black) apothecial discs.

Type: India, Sikkim, East Sikkim, Rumtek, 1500 m, 4 September 2000, *Chatterjee & Divakar* 20-77064/A (LWG—holotype).

(Fig. 8)

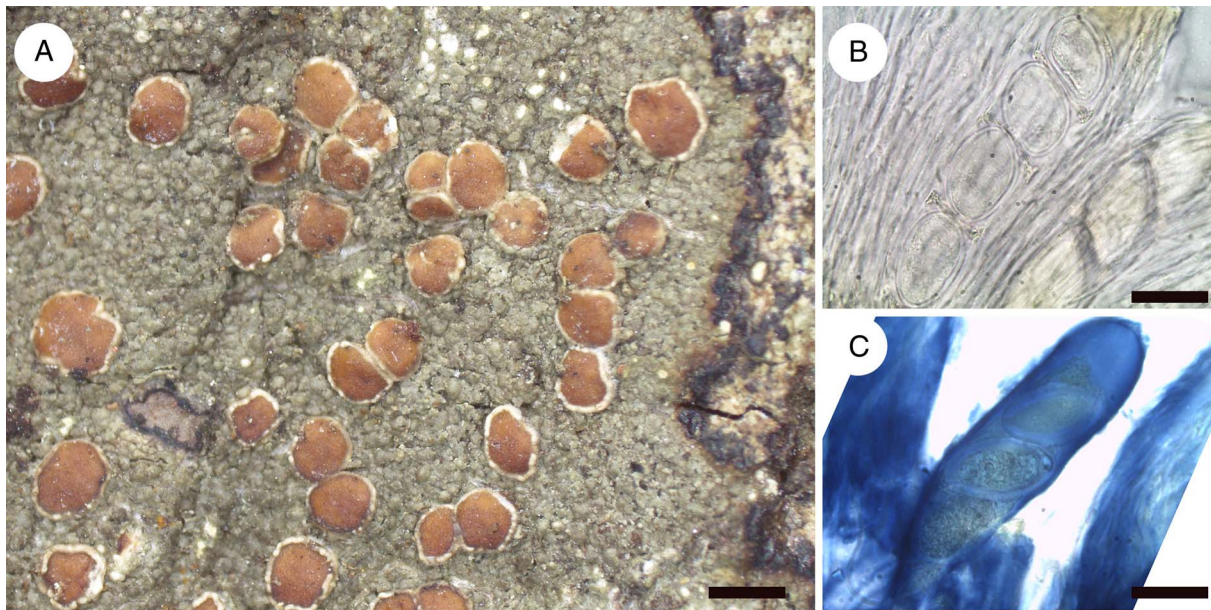


Figure 8. *Malmidea subindica* (holotype LWG-20-77064/A). A, thallus. B, 4-spored ascus. C, ascus lacking a tubular structure in the tholus (in Lugol's iodine solution). Scales: A = 1 mm; B & C = 20 μ m. In colour online.

Thallus crustose, corticolous, continuous, dark greenish grey, verrucose; verrucae confluent, 0.15–0.2 mm diam., height < 0.1 mm; isidia and soredia absent. *Prothallus* brownish black. *Medulla* of thallus white, medulla of verrucae creamish to faintly yellow.

Apothecia sessile, round, 0.4–1 mm diam.; disc plane to slightly convex, light to dark orange-brown; margin *granifera*-type, continuous, smooth to slightly granular, 50–60 μ m thick, whitish to cream-coloured. *Thalline exciple* absent. *Proper exciple* 50–95 μ m wide, externally hyaline, internally brownish with medullary hyphae and hydrophobic granules in chambers, granules dissolving in K with a lemon yellow reaction. *Epihymenium* indistinct. *Hymenium* hyaline, 100–110 μ m high. *Subhymenium* 30–40 μ m thick, hyaline. *Hypothecium* 65–80 μ m high, orange-brown to dark brown, K–. *Apothecial base* below hypothecium 100–120 μ m high, hyaline with medullary hyphae and granules in chambers. *Asci* 75–100 \times 18–25 μ m, 2–4-spored. *Ascospores* simple, hyaline, ellipsoid, 28–35(–40) \times 17–21(–24) μ m, wall evenly thickened, 1.5–2 μ m thick, halonate (1–2.5 μ m wide).

Pycnidia not observed.

Chemistry. Medulla of thallus K+ yellow, P–; medulla of verrucae K+ deep yellow, P–. TLC: two unknown grey-brown spots at R_f class 5 and 6 in solvent system A.

Etymology. The epithet '*subindica*' refers to the close resemblance of the species to *Malmidea indica*.

Remarks. This species is characterized by having light to dark orange-brown apothecial discs, 2–4-spored asci, and broadly ellipsoid ascospores mostly exceeding 30 μ m in length. It is similar to *M. indica* and *M. sorsogona* in having ascospores with evenly thick walls and lengths exceeding 25 μ m but both these species have dark brown to black apothecial discs and a sparsely verrucose thallus (Vainio 1921; Awasthi & Agarwal 1968; Kalb et al. 2011). *Malmidea indica* has 2–3-spored asci and longer and narrower ascospores, 31–39 \times 12–18 μ m (Awasthi & Agarwal 1968). Furthermore, the chemistry of the holotype of *M. indica* showed

the presence of atranorin. *Malmidea sorsogona* has smaller and narrower ascospores, 22–34 \times 9–16 μ m, with the medulla of verrucae yellowish turning orange-red in K (Vainio 1921). It is also close to *M. upretii* (described below) but that species has dark brown to blackish apothecial discs, a whitish grey thallus with prominent and confluent verrucae and an orange-red medulla.

Additional specimen examined. India: Sikkim: East Sikkim, Rumtek, 1500 m, 2000, Chatterjee & Divakar 20-77064/B (LWG).

***Malmidea upretii* R. Adhikari, Ingle & Nayaka sp. nov.**

Mycobank No.: MB 852252

Similar to *Malmidea indica* and *M. sorsogona* but differs in having prominent and confluent verrucae with medulla orange-red coloured.

Type: India, Goa, Mollem, Bhagwan Mahavir Wildlife Sanctuary, May 1983, A. Singh & D. K. Upreti L-11490/A (LWG—holotype).

(Fig. 9)

Thallus crustose, corticolous, whitish grey, thick, continuous, verrucose; verrucae prominent and confluent, 0.12–0.2 mm diam. and 0.1 mm high; isidia and soredia absent. *Prothallus* indistinct. *Medulla* of thallus whitish to cream-coloured, medulla of verrucae orange-red.

Apothecia round, sessile, up to 1.3 mm diam.; disc orange-brown to black, plane to slightly convex; margin *granifera*-type, thick, 90–110 μ m thick, not prominently raised, grey-brown turning black, continuous, smooth to slightly papillate, persistent. *Thalline exciple* absent. *Proper exciple* 100–140 μ m wide, externally hyaline to pale, internally brownish, filled with medullary hyphae and creamish to pale granules which dissolve in K with a lemon yellow to orange-yellow reaction. *Epihymenium* indistinct. *Hymenium* hyaline, 110–120 μ m high. *Subhymenium* 15–20 μ m high, hyaline to pale. *Hypothecium* dark brown, 75–95 μ m high, K–. *Apothecial base*

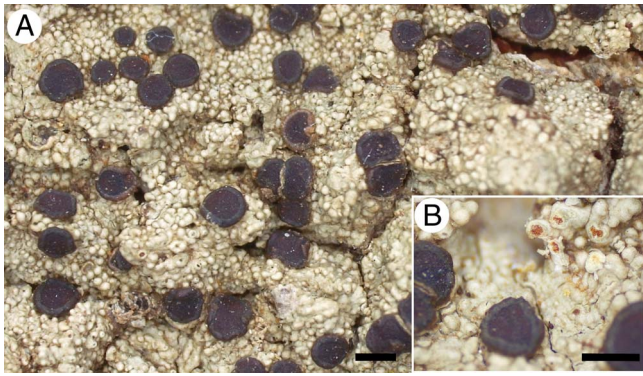


Figure 9. Habit of *Malmidea upreti* (holotype LWG- L-11490/A). A, thallus. B, enlarged portion of thallus showing orange-red pigmented medulla of verrucae. Scales: A & B = 1 mm. In colour online.

below hypothecium hyaline, 100–130 μm high, filled with medullary hyphae and pale granules. *Asci* 65–90 \times 18–22 μm , 2–3-spored. *Ascospores* simple, hyaline, broadly ellipsoid, 24–30(–34) \times 13–17(–19) μm , wall uniformly thick, halonate (1.5–2 μm wide).

Pycnidia not observed.

Chemistry. Medulla of thallus K+ yellow, P–; medulla of verrucae K+ deep red, P–. TLC: atranorin only.

Etymology. This species is named in honour of Dr D. K. Upreti, an eminent Indian lichenologist.

Remarks. This species is characterized by a whitish grey thallus with prominent and confluent verrucae, with medulla of verrucae orange-red and ascospores exceeding 25 μm in length. This species is similar to *M. indica*, *M. sorsogona* and *M. subindica*, described in the present paper, by having ascospores with uniformly thick walls and lengths exceeding 25 μm . *Malmidea indica* differs in having a granulose to granular verrucose thallus with sparse verrucae, with medulla of verrucae faintly yellowish and larger ascospores, 31–39 \times 12–18 μm (Awasthi & Agarwal 1968). *Malmidea sorsogona* has a sparsely verrucose thallus, 4-spored asci and medulla of verrucae yellowish (Vainio 1921; Breuss & Lücking 2015). *Malmidea subindica* differs in having orange-brown coloured apothecial discs with thin margins and medulla of verrucae creamish to faintly yellow; it also lacks atranorin.

Additional specimens examined. **India:** Goa: Mollem, Bhagwan Mahavir Wildlife Sanctuary, 1983, A. Singh & D. K. Upreti L-11490/B (LWG). West Bengal: Darjeeling District, Kalimpong division, on way to Munsog from Kalimpong, 1500 m, D. D. Awasthi & M. R. Agarwal 67.328/G (LWG).

***Malmidea verrucosa* R. Adhikari, R. Ngangom & Nayaka sp. nov.**

MycoBank No.: MB 852253

Similar to *Malmidea eeuuae* and *M. subaurigera* but differs in having confluent and prominent verrucae, darker and entire apothecial margins and by containing atranorin.

Type: India, Uttarakhand, Bageshwar District, en route to Jatoli from Khati Village, 30°08'30.33"N, 79°55'21.57"E, 2440 m, 3 December 2021, S. Nayaka, R. S. Adhikari & R. Ngangom 21-045440 (LWG—holotype).

(Fig. 10)

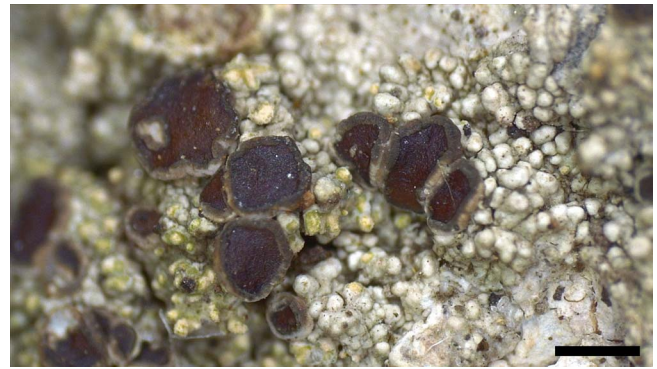


Figure 10. Habit of *Malmidea verrucosa* (holotype LWG- 21-045440). Scale = 1 mm. In colour online.

Thallus crustose, corticolous, whitish to whitish grey, verrucose; verrucae prominent and confluent, round to coralloid, 0.2–0.3 mm diam., 0.1–0.2 mm high; isidia and soredia absent. *Prothallus* indistinct. *Medulla* of thallus whitish to cream-coloured, medulla of verrucae pale to yellowish.

Apothecia round, sessile, 0.5–1.4 mm diam.; disc orange-brown to chocolate brown, plane to slightly concave; margin *granifera*-type, greyish black, 80–100 μm thick, continuous, smooth, becoming flexuous. *Exciple* lacking algal cells, externally hyaline with medullary hyphae and creamish to yellowish hydrophobic granules partly dissolving in K with a lemon yellow to greenish yellow reaction. *Epihymenium* slightly pale, 10–15 μm high. *Hymenium* 80–95 μm high, hyaline. *Hypothecium* 80–135 μm high, dark brown to black, K–. *Apothecial base* below hypothecium 100–130 μm high, hyaline, with medullary hyphae and yellowish granules in chambers. *Asci* 70–95 \times 15–22 μm , (2–)4–6-spored. *Ascospores* simple, hyaline, 17–22(–25) \times 10–12(–13) μm , wall evenly thickened, halonate (1–2 μm wide).

Pycnidia not observed.

Chemistry. Medulla of thallus K+ yellow, P–; medulla of verrucae K+ orange-yellow, P–. TLC: atranorin.

Etymology. The species epithet '*verrucosa*' refers to the presence of prominent and confluent verrucae.

Remarks. This species is characterized by having a whitish grey, densely verrucose thallus and orange-brown to chocolate brown apothecial discs. The medulla of verrucae is pigmented, with *granifera*-type apothecial margins, a dark brown hypothecium, and in ascospore size, this species is close to *M. eeuuae*, *M. fenicis* and *M. subaurigera*. *Malmidea eeuuae* and *M. subaurigera* differ in having comparatively sparse verrucae, a greenish grey thallus (whitish grey in this species), whitish to cream-coloured apothecial margins and the medulla of verrucae differing in colour (cream to bright sulphur yellow in *M. eeuuae* and orange-yellow in *M. subaurigera*), both also lack atranorin (Kalb *et al.* 2011). Furthermore, in *M. eeuuae* and *M. subaurigera* the apothecial margins become warty with age and finally disappear (Kalb *et al.* 2011), while remaining entire in the new species. *Malmidea fenicis* differs in having distinctly black apothecial discs with thin margins (Vainio 1921; Breuss & Lücking 2015). In having confluent and coralloid verrucae, the new species is also similar to *M. coralliformis* Kalb, but this differs in the whitish medulla in the thallus and verrucae, and absence of atranorin (Kalb *et al.* 2011).

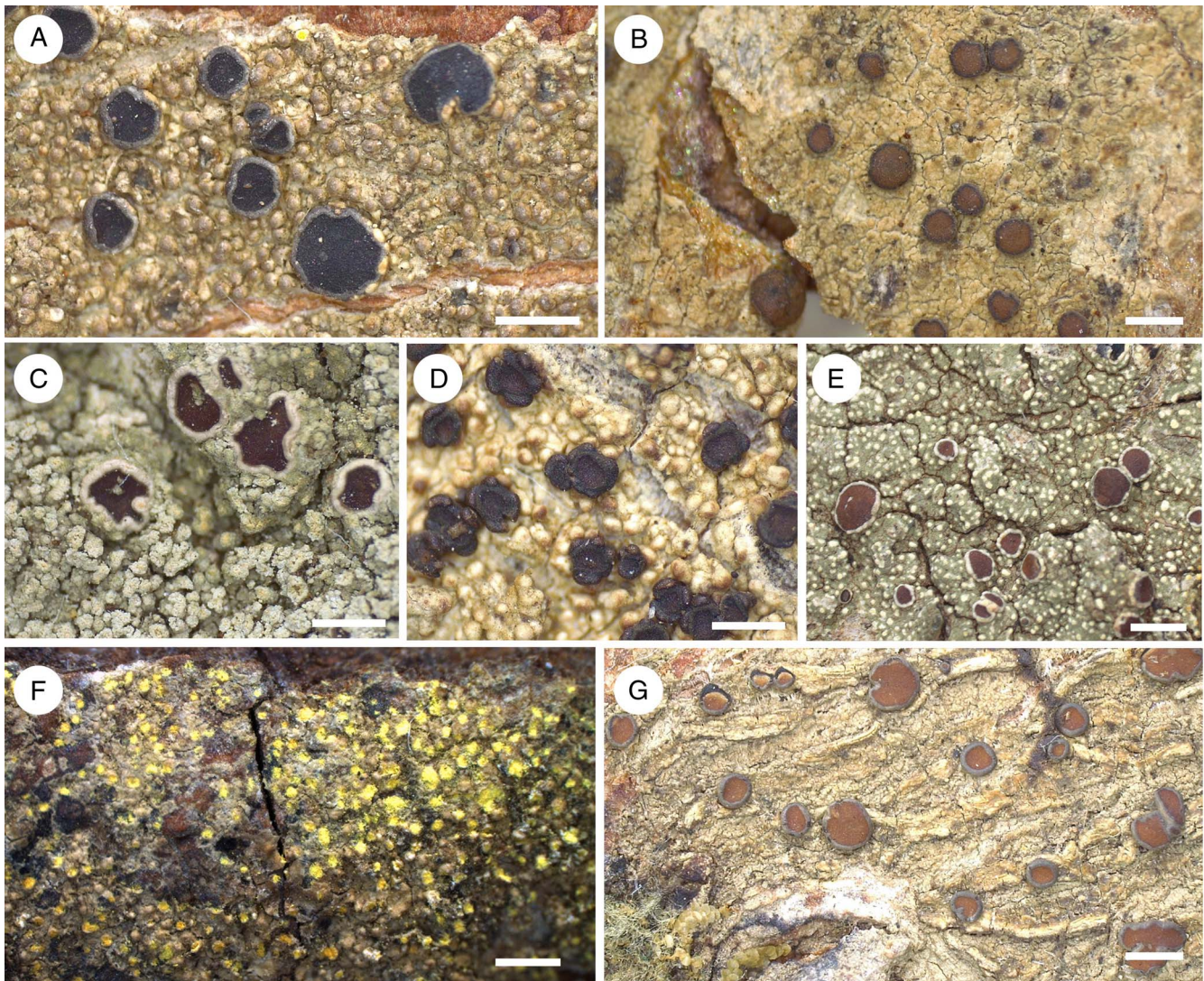


Figure 11. New records. A, *Malmidea fenicis* (LWG-89436). B, *M. leptoloma* (LWG-67685). C, *M. piae* (LWG-18-036012). D, *M. piperina* (LWG-13-021839). E, *M. reunionis* (LWG-18-029254). F, *M. sulphureosorediata* (LWG-79716). G, *M. vinosa* (LWG-99-75945). Scales: A–G = 1 mm. In colour online.

Additional specimens examined. India: Uttarakhand: Bageshwar District, en route to Jatoli from Khati Village, 30°08'30.33"N, 79°55'21.57"E, 2440 m, 2021, S. Nayaka, R. S. Adhikari & R. Ngangom 21-045520 (LWG); Uttarkashi District, Govind Wildlife Sanctuary, way to Kedarkantha, 31°03.833"N, 78°11.26"E, 2324 m, D. K. Upreti, S. Nayaka & R. Bajpai 11-016086(LWG).

New Records

Malmidea fenicis (Vain.) Kalb, Rivas Plata & Lumbsch

Characterized by a crustose, corticolous, verrucose thallus, with a white, K+ yellow medulla and the medulla of verrucae yellow, K+ orange-red. The apothecial disc is black, and the margin *granifera*-type, greyish brown to black (Fig. 11). Asci are 6–8-spored, ascospores simple, hyaline, 18–25 × 9–13 μm, and the wall evenly thickened. No chemical detected by TLC. This species is previously known from its type locality in the Philippines only (Paguirigan *et al.* 2020).

Specimen examined. India: Andaman Islands: Middle Andaman, Long Island, 1961, A. Singh 89436 (LWG). Karnataka: Uttara

Kannada, Siddapur, Mattigar, 2019, D. K. Upreti, G. K. Mishra & S. Dudani 19-036438 (LWG).

Malmidea leptoloma (Müll. Arg.) Kalb & Lücking

Characterized by a thallus that is crustose, corticolous, rugulose, ±smooth with a white, K– medulla. The apothecial disc is beige to ochre-brown with a *piperis*-type margin that is concolorous to disc, apically turning black (Fig. 11). Asci are 8-spored, and ascospores 9–15 × 5–7 μm. No chemical detected by TLC. Previously known from Australia, Bolivia, Brazil and the Solomon Islands (Bailey 1896; Lücking *et al.* 2011; Flakus *et al.* 2013; Kalb 2021; Kantvilas *et al.* 2021).

Specimen examined. India: Andaman Islands: Middle Andaman, Long Island, 1961, A. Singh 67685 (LWG).

Malmidea piae (Kalb) Kalb

Thallus is crustose, corticolous, verrucose, with verrucae developing into polysidiangia-like clumps, bursting apically and exposing the

medulla; medulla of thallus and verrucae lemon yellow, K+ orange. Apothecia are sessile, the disc light to dark brown, and the *granifera*-type margin white to cream-coloured (Fig. 11). Asci are 4–8-spored, ascospores simple, hyaline, 15–22 × 9–12 µm, and the wall evenly thickened. Atranorin detected by TLC. Previously reported from Australia and Thailand (Kalb *et al.* 2009).

Specimens examined. India: Nagaland: Tuensang District, Konya Village, 26°15'53.00"N, 94°53'11.00"E, 1754 m, 2018, R. Ngangom 18-036012 (LWG). Uttarakhand: Dehradun District, Chandrabani Wildlife Institute of India campus, 2013, Adhikari 13-025347 (LWG).

Malmidea piperina (Zahlbr.) Aptroot & Breuss

Thallus is crustose, corticolous, verrucose, and medulla of verrucae yellow, K+ orange. Apothecia are sessile, 0.6 mm diam., the disc black, and *granifera*-type margin papillate and concolorous with the disc (Fig. 11). Asci are 8-spored, ascospores simple, hyaline, 10–15 × 5–7 µm, and wall evenly thickened. No chemical detected by TLC. Previously known from Brazil, Sri Lanka and Taiwan (Wang-Yang & Lai 1973; Weerakoon *et al.* 2016; Oliveira Junior *et al.* 2021).

Specimens examined. India: Andaman Islands: Middle Andaman, Bajalungta, 1961, A. Singh 52945 (LWG); South Andaman, T.L.D. range, 90 m, 1961, A. Singh & party 88221 (LWG). Assam: Nagaon District, Chapanala Village, 60 m, 2013, Amit Kumar Dey 13-021839 (LWG). Mizoram: MZU campus, 2018, Nurpen Meitei Thangjam 33 (LWG).

Malmidea reunionis Kalb

Thallus is crustose, corticolous, verrucose, and medulla of verrucae cream to yellowish, K+ orange. The apothecial disc is brown and the margin *granifera*-type and cream-coloured (Fig. 11). Asci

are 6–8-spored, ascospores simple, hyaline, 22–30 × 12–15 µm, and walls thickened at ends. Unknown substances detected by TLC. Previously known from its type locality of Reunion Island only (Kalb *et al.* 2012).

Specimen examined. India: Karnataka: Uttara Kannada, Dandeli, Singargao cross, 15°19'55.6"N, 74°32'38.9"E, 640 m, 2018, S. Nayaka, S. Joseph & S. Dudani 18-029254 (LWG).

Malmidea sulphureosorediata M. Cáceres, D. A. Mota & Aptroot

Characterized by a crustose, corticolous, thin, densely sorediate thallus, lacking verrucae. Medulla and soredia bright yellow, K+ orange-red (Fig. 11). Apothecia are absent. Unknown substances detected by TLC. Previously known from Brazil only (Cáceres *et al.* 2013).

Specimen examined. India: Andaman Islands: South Andaman group, Nilambur, Baratang Island, 30 m, 1961, A. Singh 79716 (LWG).

Malmidea vinosa (Eschw.) Kalb, Rivas Plata & Lumbsch

Thallus is crustose, corticolous, slightly rough, wrinkled. Medulla white, K–. Apothecial disc is brownish, the margin *piperis*-type, thick and dark greyish (Fig. 11). Asci are 6–8-spored, ascospores simple, hyaline, 10–20 × 6–8 µm, and wall evenly thickened. No chemical detected by TLC. Previously reported from Bermuda, Bolivia, Brazil, Guyana and Florida (Flakus *et al.* 2013; Berger & LaGreca 2014; Aptroot & Souza 2021).

Specimen examined. India: Tamil Nadu: Kambam District, Meghamalai Wildlife Sanctuary, Vannatiiparai, 400 m, 1999, S. Nayaka 99-75945 (LWG).

Corresponding positions of *Malmidea* species (discovered between 2015–2023) in the world key by Breuss & Lücking (2015)

Couplet 6 Isidia verruciform to shortly cylindrical; apothecial margin *granifera*-type; ascospores 11–12.5 × 4.5–5.5 µm; atranorin present **M. densisidiata** Aptroot & Oliveira-Junior (Aptroot *et al.* 2022)

Couplet 6 Isidia verruciform to shortly cylindrical; apothecial margin *granifera*-type; 12–15 × 7–8 µm; atranorin absent **M. isidiopiperina** Lücking *et al.* (Lücking *et al.* 2023)

Couplet 7 Isidia granular to coralloid; medulla orange-red; atranorin and norsolorinic acid present; ascospores 17–23 × 7–10 µm **M. isidiifera** Kalb (Kalb 2021)

Couplet 7 Isidia granular to coralloid; medulla white; ascospores 14–22 × 8–10 µm; lichen substances absent **M. hernandeziana** Kalb (Kalb 2021)

Couplet 7 Isidia distinctly granular; medulla orange-red; ascospores 15–20 × 9–12 µm; norsolorinic acid present **M. rhodopisoides** Kalb (Kalb 2021)


Couplet 8 Medulla pale yellow; apothecial disc brown, margin cream-coloured to brown, *granifera*-type; ascospores 12–16 × 7.5–9 µm **M. attenboroughii** Kukwa *et al.* (Guzow-Krzemińska *et al.* 2019)

Couplet 10 Medulla orange-yellow, K+ purple; apothecial disc beige to chocolate brown, margin cream-coloured to greyish, thin; ascospores 11–17 × 7–10 µm **M. volcaniana** Kalb & Hernández (Kalb 2021)

Couplet 13 Ascospores 28–40 × 17–24 µm, 2–4 per ascus; thallus verrucae confluent, not prominent; atranorin absent **M. subindica** R. Adhikari & Nayaka (this paper)

- Couplet 16** Ascospores $24\text{--}34 \times 13\text{--}19 \mu\text{m}$, 2–3 per ascus; medulla of verrucae orange-red, K+ deep red
 **M. upretii** R. Adhikari *et al.* (this paper)
- Couplet 17** Apothecia with a continuous or granular thalline excipulum surrounding the proper excipulum; disc dark brown to black; ascospores $9\text{--}15 \times 6\text{--}9 \mu\text{m}$ **M. kalbii** R. Adhikari & Nayaka (this paper)
- Couplet 17** Apothecia with a continuous or granular thalline excipulum surrounding the proper excipulum; disc reddish brown; ascospores $20\text{--}27 \times 10\text{--}14 \mu\text{m}$ with end wall thickenings **M. incrassatispora** R. Adhikari *et al.* (this paper)
- Couplet 17** Apothecia with a continuous thalline excipulum surrounding the proper excipulum; disc light to dark orange-brown; medulla of verrucae pink-coloured; ascospores $17\text{--}24 \times 10\text{--}13 \mu\text{m}$ **M. palghatensis** R. Adhikari & Nayaka (this paper)
- Couplet 20** Apothecial disc beige, margin thick, pale; hypothecium hyaline; ascospores $20\text{--}25 \times 10\text{--}15 \mu\text{m}$
 **M. lutea** R. Adhikari *et al.* (this paper)
- Couplet 23** Thallus verrucae conspicuous (0.1–0.25 mm diam.), medulla of thallus and verrucae K+ lemon yellow, P+ orange; ascospores $13\text{--}17 \times 7\text{--}9 \mu\text{m}$ **M. hechicerae** Kalb (Kalb 2021)
- Couplet 24** Ascospores mainly 4–8 per ascus, $10\text{--}15 \times 6\text{--}9 \mu\text{m}$; medulla of thallus and verrucae K+ bright yellow; apothecial margin distinctly white, entire; lichen substances absent **M. glabromarginata** R. Adhikari *et al.* (this paper)
- Couplet 25** Medulla of thallus and verrucae white to faintly yellow, K+ orange-red; ascospores $10\text{--}14 \times 7\text{--}8 \mu\text{m}$; atranorin absent
 **M. allobakeri** Kalb & M. Cáceres (Kalb 2021)
- Couplet 30** Excipulum with a continuous medullary layer; verrucae rare becoming coralloid granular with age; medulla of thallus and verrucae white to faintly yellow **M. albomarginata** Kalb & Hernández (Kalb 2021)
- Couplet 32** Apothecial disc beige to light brownish, margin thick, bulging, white to cream-coloured medulla of excipulum K+ lemon yellow; hypothecium dark brown; medulla of thallus and verrucae orange-yellow, K+ orange-red
 **M. atlanticoides** Kalb & M. Cáceres (Kalb 2021)
- Couplet 32** Apothecial disc light to dark brown; margin thin, whitish grey to dark brownish grey; medulla of excipulum K+ greenish yellow; hypothecium dark brown; medulla of thallus verrucae peach-coloured to pink, K+ orange-red
 **M. allopapillosa** Kalb (Kalb 2021)
- Couplet 35** Apothecial disc orange-brown to chocolate brown; ascospores 2–6 per ascus, $17\text{--}25 \times 10\text{--}13 \mu\text{m}$, hypothecium $80\text{--}135 \mu\text{m}$ high; medulla of verrucae pale to yellowish **M. verrucosa** R. Adhikari *et al.* (this paper)
- Couplet 35** Apothecial disc light to dark orange-brown; ascospores 4–8 per ascus, $14\text{--}20 \times 6\text{--}10 \mu\text{m}$, hypothecium $120\text{--}160 \mu\text{m}$ high; medulla of verrucae orange-red to dark red **M. rubra** R. Adhikari & Nayaka (this paper)
- Couplet 38** Apothecia 0.3–0.6 mm diam., disc light beige, brown-grey to brown, margins whitish grey to dark brown-black; thallus smooth, cortex abraded; ascospores $9\text{--}12 \times 4\text{--}6 \mu\text{m}$ **M. leucopiperis** Kalb (Kalb 2021)
- Couplet 38** Apothecia 0.5–1 mm diam., disc dark brown, margins whitish; thallus granulose-verrucose; ascospores $8\text{--}15 \times 5\text{--}7.5 \mu\text{m}$
 **M. nagalandica** (G. P. Sinha & Kr. P. Singh) G. P. Sinha *et al.* (Singh & Pinokiyo 2014)
- Couplet 41** Apothecial margin brownish grey, disc grey-brown to brown; thallus \pm smooth
 **M. fulva** (Malme) Kalb & van den Boom (van den Boom *et al.* 2014)
- Couplet 44** Medulla of verrucae pale yellow, K+ orange; medulla of thallus white; apothecial disc brown, margin pale; ascospores $9\text{--}15 \times 6\text{--}9 \mu\text{m}$ **M. globosa** R. Adhikari & Nayaka (this paper)
- Couplet 46** Apothecial margins black; ascospores $7\text{--}9 \times 3.5 \mu\text{m}$ **M. demutans** (Nyl.) Lücking (Lücking *et al.* 2021)
- Couplet 49** Thallus grey to grey-brown; apothecial disc dark brown, margin slightly prominent, pale bluish black; ascospores $9\text{--}16 \times 5.5\text{--}6.5 \mu\text{m}$ **M. floridensis** (Nyl.) M. Cáceres *et al.* (Cáceres *et al.* 2017)
- Couplet 49** Thallus dull, grey, plicate folded; apothecial disc brown-grey, margin prominent, pale ochraceous; ascospores $7.5\text{--}8.5 \times 3.0\text{--}3.5 \mu\text{m}$ **M. plicata** Weerakoon & Aptroot (Weerakoon *et al.* 2016)
- Couplet 49** Thallus pale greenish at the margin, almost black in most parts; apothecial disc pale brown, margin prominent, grey; ascospores $10\text{--}11.5 \times 2.5\text{--}3.5 \mu\text{m}$ **M. nigra** Aptroot & Oliveira Junior (Aptroot *et al.* 2022)
- Couplet 49** Thallus grey, greenish grey to olive; apothecial disc beige to greyish brown, margin whitish grey to brownish grey, moderately thick; ascospores $9\text{--}12 \times 5\text{--}7 \mu\text{m}$ **M. subcinerea** Kalb (Kalb 2021)

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