

RESEARCH PAPER

New records and a key to the species of *Malmidea* (lichenized Ascomycota) from India

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Six species of the genus *Malmidea*, *M. atlantica* (M. Cáceres & Lücking) M. Cáceres & Kalb, *M. duplomarginata* (Papong & Kalb) Kalb & Papong, *M. hypomelaena* (Nyl.) Kalb & Lücking, *M. papillosa* Weerak. & Aptroot, *M. subaurigera* (Vain.) Kalb *et al.*, and *M. variabilis* Kalb, are reported as new records to India. A key to all known Indian species of *Malmidea* is provided.

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1 Introduction

The genus *Malmidea* was established together with the family Malmideaceae by Kalb *et al.* (2011) to accommodate the *Lecidea piperis*- and *Lecanora granifera* groups into their corresponding phylogenetic position. At present, the family Malmideaceae includes five genera, and the genus *Malmidea* comprises actually 55 species (Kalb, 2011; Spribille *et al.*, 2011; Kalb *et al.*, 2012; Schumm and Aptroot, 2012; Cáceres *et al.*, 2012, 2013; Weerakoon and Aptroot, 2013, 2014; Singh and Pinokiyo, 2014; Breuss and Lücking, 2015; Weerakoon *et al.*, 2016; Cáceres *et al.*, 2017). Breuss and Lücking (2015) keyed out all known species of *Malmidea* in the world.

The genus *Malmidea* is characterized by a crustose thallus composed of goniocysts, biatorine excipulum often encrusted with hydrophobic granules, asci without tubular structure and simple ascospores (Kalb *et al.*, 2011). The species are mostly found in tropical rainforests and mainly corticolous while two species *viz.*, *M. nagalandica* (G.P. Sinha & Kr.P. Singh) G.P. Sinha *et al.* and *M. trailiana* (Müll. Arg.) Kalb *et al.* are foliicolous lichens. Six species of *Malmidea* are so far known from India *viz.*, *M. bakeri* (Vain.) Kalb *et al.*, *M. fuscella* (Müll. Arg.) Kalb & Lücking, *M. granifera* (Ach.) Kalb *et al.*, *M.*

indica (Awasthi & Agarwal) Hafellner & T. Sprib., *M. nagalandica* (G.P. Sinha & Kr. P. Singh) G.P. Sinha *et al.*, and *M. psychotrioides* (Kalb & Lücking) Kalb *et al.* (Spribille *et al.*, 2011; Singh and Pinokiyo, 2014; Sinha *et al.*, 2015; Gupta and Sinha, 2016; Sinha and Gupta, 2017). During the examinations of the specimens earlier identified as *Lecidea granifera* deposited in the herbarium LWG and fresh collections from Goa, the authors came across with some interesting specimens which resulted in six new records for India. A brief account of the new records and a key to all known species of *Malmidea* in India are provided.

2 Materials and Methods

The specimens examined are housed at LWG herbarium. Morphological details were examined using a Leica S8APO stereomicroscope. Anatomical details were studied using a Leica DM2500 light microscope equipped with camera and image analysis software. Hand-cut sections of thalli and ascomata mounted in distilled water, KOH solution (K), and lactophenol cotton blue (LPCB) were studied. The amyloid reactions were tested in Lugol's iodine solution without (I) or with pre-treatment with KOH (KI). All the measurements were made on material mounted in distilled water. The length, breadth, and length/breadth ratio (*l/b*) of ascospores are given as: (min–){ \bar{X} – SD} – { \bar{X} + SD}(–max), where 'min' and

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'max' are the extreme values, \bar{X} the arithmetic mean, and SD the corresponding standard deviation followed by the number of measurements (n). The chemistry was studied by spot tests and thin layer chromatography following Orange *et al.* (2001).

3 Results and Discussion

Malmidea atlantica (M. Cáceres & Lücking) M. Cáceres & Kalb, Biblioth. Lichenol. 106: 164. 2011. *Malcolmiella atlantica* M. Cáceres & Lücking in Cáceres, Libri Botanici 22: 101. 2007.

(Figure 1A)

It is characterized by a densely verrucose, greyish thallus having yellow medulla, yellow to sulphur yellow, irregular and farinose soredia, both medulla and soralia turning K⁺ orange-red, apothecia solitary, excipular

medullary hyphae encrusted with lemon yellowish granules that dissolving in K with golden yellow reaction, hypothecium K⁺ reddish brown, asci (6–) 8-spored, and ascospores of (12.8–) 14.4–16.8 (–18.1) × (8.2–) 9.0–10.7 (–11.3) μm, l/b = (1.2–) 1.4–1.8 (–2.2) μm. *Malmidea atlantica* so far known only from Atlantic rain-forest of Brazil (Cáceres, 2007). It is the first known species of *Malmidea* from India with a sorediate thallus.

Specimen examined: Andaman Islands, South Andaman Group, Nilambur Oral Kachha, Baratang Island, alt. 30 m, 21 April 1961, A. Singh 79716 (LWG).

Malmidea duplomarginata (Papong & Kalb) Kalb & Papong, Biblioth. Lichenol. 106: 165. 2011. *Malcolmiella duplomarginata* Papong & Kalb, Mycotaxon 110: 116. 2009.

(Figure 1B)

It is characterized by apothecia with thalline excipulum surrounding the proper excipulum (this character is

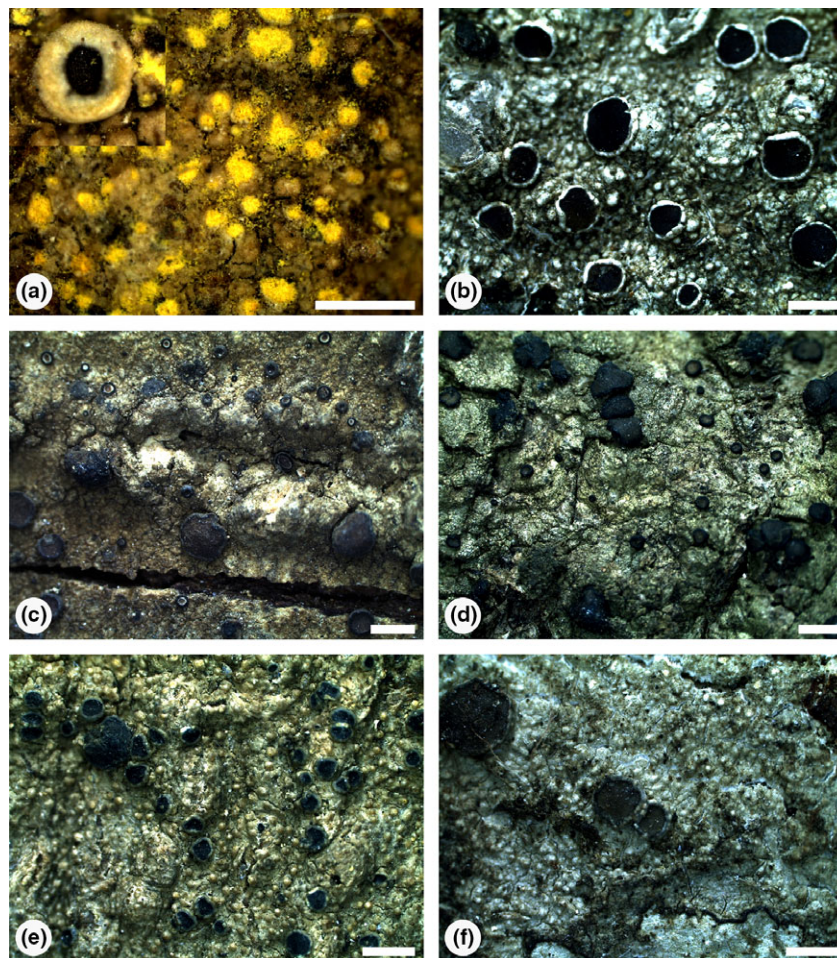


Figure 1. (A–F) Habits of *Malmidea* species. (A) *M. atlantica* (inset: an enlarged view of apothecia); (B) *M. duplomarginata* (P.P. Randive GU-183); (C) *M. hypomelaena*; (D) *M. papillosa*; (E) *M. subaurigera* (A. Singh & Party 79863); (F) *M. variabilis*. Scale bars: A–F = 1 mm.

not yet found in the other species of *Malmidea*), 8-spored asci and ascospores of (13.1–) 16.4–21.2 (–22.2) × (9.6–) 9.8–12.8 (–15.2) μm, (n = 20), l/b = (1.1–) 1.4–2.0 (–2.3) μm. The species is reported from Sri Lanka (Weerakoon and Aptroot, 2014) and Thailand (Kalb *et al.*, 2009). In the present study, this species is reported from Cotigao Wildlife Sanctuary in Goa, a part of the Western Ghats Biodiversity Hotspot.

Specimens examined: Goa, Cotigao Wildlife Sanctuary, Nadkem Village, N15°00'0.36", E074°05'85.9 with, 22 Dec. 2016, P.P. Randive GU-183 (LWG); Kuske Waterfall, N15°01'08.28", E074°12'32.40", 05 Nov. 2016, P.P. Randive GU-221 (LWG).

Malmidea hypomelaena (Nyl.) Kalb & Lücking, [as 'hypomela'], Biblioth. Lichenol. 106: 165. 2011. *Lecidea hypomelaena* Nyl., Ann. Sci. Nat., Bot., sér. 4(11): 223. 1859.

(Figure 1C)

The species is characterized by a thallus and verrucae with white medulla which is K-, apothecia solitary, excipulum lacking medullary layer, hypothecium brownish to dark brown, asci 8-spored, ascospores of (18.1–) 20.4–23.2 (24.4) × (10.9–) 11.6–13.0 (–13.6) μm, (n = 21), l/b = (1.4–) 1.6–2.0 (–2.2) μm. It is a pantropical species (Aptroot, 2001), earlier known in the name of *Lecidea hypomela* Nyl. Kalb *et al.* (2011) transferred the species under the genus *Malmidea* with a new combination, *M. hypomelaena* (Nyl.) Kalb & Lücking.

Specimen examined: Tamil Nadu, Nilgiri hills, Doddabetta, alt. 1830 m, on bark, 30.11.1973, K.P. Singh 73.449 (LWU-LWG).

Malmidea papillosa Weerak. & Aptroot, Cryptog. Mycol. 35: 60. 2014.

(Figure 1D)

It is characterized by a thallus with white medulla, thalline verrucae with pale yellowish medulla turning K+ yellow to orange, apothecia solitary, rarely grouped, excipulum lacking a medullary layer, hypothecium brown to dark brown, asci (6–) 8-spored, and ascospores of (12.7–) 13.0–16.2 (–18.5) × (6.0–) 6.4–7.2 (–7.6) μm, (n = 21), l/b = (1.8–) 1.9–2.3 (–2.9) μm. The species has earlier been known only from Sri Lanka by its type collection (Weerakoon and Aptroot, 2014).

Specimen examined: Goa, Mahavir Wildlife Sanctuary, around Mahavir Temple, 20.07.2003, on bark, Upreti, Nayaka, Samuel & Phathak 03-001700/B (LWG).

Malmidea subaurigera (Vain.) Kalb *et al.*, Biblioth. Lichenol. 106: 161. 2011. *Lecidea subaurigera* Vain., Ann. Acad. Sci. Fenn., Ser. A 15(6): 120. 1921.

(Figure 1E)

It is characterized by a yellow-orange medulla of thallus as well as verrucae that turns K+ orange to red, apothecia solitary to grouped, medullary layer of excipulum encrusted with greyish to ochraceous-yellow granules that dissolve in K with orange-yellowish to

lemon yellow reaction, asci (6–) 8-spored, and ascospores of (14.6–) 15.8–19.6 (–22.5) × (9.1–) 10.0–11.0 (–11.2) μm, (n = 21), l/b = (1.4–) 1.5–1.9 (–2.1) μm. Earlier this species was known from the Philippines (Vainio, 1921), Sri Lanka (Weerakoon *et al.*, 2016) and Thailand (Kalb *et al.*, 2011). The species is in the earlier collections of Ajay Singh from the Andaman Islands during 1961 where it annotated as *Lecidea granifera*.

Specimens examined: Andaman Islands, South Andaman, Port Blair, 20 March 1961, A. Singh & party 68979 (LWG); Middle Andaman, Parloli Tig, 30 March 1961, A. Singh & Party 79863 (LWG).

Malmidea variabilis Kalb, Biblioth. Lichenol. 106: 162. 2011.

(Figure 1F)

The species is characterized by a white medulla of thallus as well as verrucae which turns K+ orange, apothecia solitary, rarely grouped, medullary layer of excipulum encrusted with yellow granules dissolving in K with yellowish orange reaction, asci 8-spored, and ascospores of (8.4–) 9.7–13.7 (–15.8) × (4.8–) 5.7–7.6 (–8.1) μm, (n = 20), l/b = (1.3–) 1.5–2.1 (–2.5) μm. Previously, the species was known from both Paleotropics (Thailand; Kalb *et al.*, 2011) and Neotropics (Florida, North America; Lücking *et al.*, 2011).

Specimen examined: Goa, Cotigao Wildlife Sanctuary, Zamblim Enderem, N14°58'22.8", E074°09'35.7", 22 Dec. 2016, P.P. Randive GU-275 (LWG).

Key to the species of *Malmidea* in India

- 1a. Thallus foliicolous *M. nagalandica* (G.P. Sinha & Kr. P. Singh) G.P. Sinha *et al.*
- 1b. Thallus corticolous 2
- 2a. Thallus sorediate *M. atlantica* (M. Cáceres & Lücking) M. Cáceres & Kalb
- 2b. Thallus without soredia 3
- 3a. Apothecia with thalline excipulum surrounding the proper excipulum *M. diplomarginata* (Papong & Kalb) Kalb & Papong
- 3b. Apothecia without thalline excipulum 4
- 4a. Apothecial margin with medullary layer throughout or in papillae or internal chambers 5
- 4b. Apothecial margin without a medullary layer, with compact radiating hyphae 10
- 5a. Asci 2–4-spored, ascospores 30–37 × 13–20 μm *M. indica* (Awasthi & Agarwal) Hafellner & T. Sprib.
- 5b. Asci (6–) 8-spored, ascospores less than 30 μm 6
- 6a. Medulla of thalline verrucae white 7
- 6b. Medulla of thalline verrucae yellowish to orange or red 9
- 7a. Apothecial margin entire, excipulum with greyish granules, ascospores 13–18 × 6–8 μm *M. psychotrioides* (Kalb & Lücking) Kalb *et al.*

- 7b. Apothecial margin papillate, excipulum with yellowish or ochraceous granules 8
- 8a. Medulla of verrucae K+ yellow, ascospores 12–18 × 8–10 µm *M. bakeri* (Vain.) Kalb *et al.*
- 8b. Medulla of verrucae K+ orange, ascospores 8.4–15.8 × 4.8–8.1 µm *M. variabilis* Kalb
- 9a. Medulla of thalline verrucae yellow to peach coloured, K+ yellow-orange, ascospores 13.2–17.8 × 7.4–10.1 µm *M. granifera* (Ach.) Kalb *et al.*
- 9b. Medulla of thalline verrucae yellow to orange coloured, K+ orange-red, ascospores 14.6–22.5 × 9.1–11.2 µm *M. subaurigera* (Vain.) Kalb *et al.*
- 10a. Hypothecium pale, ascospores 12–20 × 6–10 µm *M. fuscella* (Müll. Arg.) Kalb & Lücking
- 10b. Hypothecium dark brown to brown-black 11
- 11a. Medulla of thalline verrucae and thallus white, K- *M. hypomelaena* (Nyl.) Kalb & Lücking
- 11b. Medulla of thalline verrucae pale yellow, K+ yellow-orange, medulla of thallus white *M. papillosa* Weerak. & Aptroot

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