

Three new lichen species from Nicaragua, with keys to the known species of *Eugeniella* and *Malmidea*

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Abstract: *Eugeniella palleola*, *Graphis paraschiffneri*, and *Malmidea cineracea* are described from Nicaragua. *Eugeniella palleola* is characterized by having pale apothecial discs and prominent, white margins, and producing a complex chemistry including atranorin, stictic and norstictic acids, and an unknown substance. *Graphis paraschiffneri* has lirellae with a lateral thalline margin, striate labia, a completely carbonized excipulum, transversely septate ascospores, and contains norstictic acid in the thallus. *Malmidea cineracea* is characterized by a granulose-isidiate thallus with a yellowish medulla and a compact, crystal-encrusted excipulum. *Malmidea nigromarginata* and *M. piperina* are proposed as new combinations. Keys are presented to all known species of *Eugeniella* (9) and *Malmidea* (50).

Key words: lichenized Ascomycotina, Neotropics, taxonomy

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Introduction

The geographical area of Central America between Mexico and Costa Rica, including the five countries Guatemala, Belize, Honduras, El Salvador, and Nicaragua, is still largely a blank map with regard to lichenological studies. Apart from a number of broader monographic treatments and some miscellaneous works that cite occasional records from these countries, only nine studies have been explicitly dedicated to this area (Resnick & Weberling 1963; Nowak & Winkler 1972; Barclay-Estrup 1992; Barillas & Lücking 1992; Barillas *et al.* 1993; Sipman 2001; Breuss 2002, 2011; van den Boom *et al.* 2007). This is a far cry from the literally hundreds of works available for Mexico, Costa Rica, and Panama, making the central part of the Central American land bridge the least studied area in all of the Neotropics, in terms of lichens.

In this paper, we continue studies initiated by the first author in Nicaragua (Breuss

2002, 2011) and describe three species from that country as new to science, in the genera *Eugeniella*, *Graphis*, and *Malmidea*. We also take the opportunity to provide updated world keys for *Eugeniella* and *Malmidea*.

Material and Methods

The specimens treated were collected in Nicaragua in 2001 and examined at the first author's laboratory and at The Field Museum with WILD-M7A, LEICA MS5, and OLYMPUS SZX12 dissecting microscopes and ZEISS AxioLab, 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, using standard techniques of light microscopy. Apothecial sections were mounted in tap water. Chemical tests with K, C, and P were applied to the thallus and apothecial sections. MERCK and FLUKA 62650 Lugol's solution were used to test for hymenium amyloidity. Thin-layer chromatography (TLC) was performed following standard methods for lichens, using solvent C (Arup *et al.* 1993; Orange *et al.* 2010). The specimens are preserved in LI.

The Species

Eugeniella palleola Breuss & Lücking **sp. nov.**

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Similar to *Eugeniella leucocheila*, from which it differs in having pale discs and larger apothecia, in addition to

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producing norstictic acid in the excipulum and stictic acid and an unknown substance in the thallus.

Type: Nicaragua, Granada, Volcán Mombacho, montane rainforest, c. 1100 m, 8 July 2001, *O. Breuss* 18.920 (LI—holotype).

(Figs 1A–C, 2A, 3C)

Thallus corticolous, 70–100 µm thick, continuous, slightly rimose, dull, uneven to minutely rough, greyish green, K+ yellow (atranorin, stictic acid), C–, P–, with a thin, indistinct, whitish prothallus, ecorticate; *photobiont* chlorococcoid, algal cells 4–8 µm diam., in irregular clusters 30–50 µm diam.

Apothecia 0.6–1.5 mm diam., sessile, rounded to irregular in outline when older; *disc* plane, grey to pale brownish, slightly pruinose; *margin* distinct, prominent, 0.1–0.2 mm thick, whitish, biatorine. *Excipulum* white under the dissecting microscope, semi-opaque in microscopical section, except for a thin outer, clear zone strongly incrustated with minute, hyaline crystals, with K+ yellow efflux forming red crystals (norstictic acid). *Hypothecium* 100–150 µm deep, brown-black, K–, fusing with the dark apothecial base. *Epihymenium* indistinct, with small, hyaline crystals. *Hymenium* colourless, c. 80 µm tall, I+ blue. *Paraphyses* unbranched or slightly branched in upper part, not or slightly thickened at apices. *Asci* narrowly clavate, 60–75 × 11–15 µm, 8-spored, of *Byssoloma*-type *sensu* Hafellner (1984). *Ascospores* 3-septate, oblong-ellipsoidal, colourless, 13–17(–20) × 4.5–5.5 µm.

Conidiomata not observed.

Chemistry. Atranorin (major), unknown substance forming red-brown spot with $R_f = c. 45$ in solvent C (major), stictic acid (major), and norstictic acid (minor, in excip-

ulum) detected with TLC. Spot tests: thallus K+ yellow, C–, P–; excipulum K+ yellow then red, forming red crystals in microscopic sections.

Etymology. The epithet ('rather pale') refers to the colour of the discs, which are paler than in the other species of *Eugeniella*.

Ecology and distribution. The species was found growing on smooth bark of thin stems in a montane rainforest. Known only from Nicaragua.

Notes. *Eugeniella* Lücking, Sérus. & Kalb is a recently established genus (Lücking 2008) that is recognized by its characteristic excipulum anatomy (composed of moniliform hyphae and strongly incrustated with crystals), in combination with mostly unbranched paraphyses, 'Byssoloma' ascus type (tholus with amyloid tubular structure), and septate to muriform ascospores. Nine species are currently known (Lücking 2008; Cáceres *et al.* 2013a; this paper), six of which are predominantly foliicolous. All species with the exception of *E. micrommata* are neotropical. Further species are likely to be found in the large artificial genus *Bacidia*. The Nicaraguan material could not be keyed using Santesson's (1952), Malme's (1935) or Vainio's (1890) treatments of neotropical *Bacidia* s. lat.

Eugeniella palleola is characterized by large apothecia with pale discs and very prominent white margins, whereas the other species known have darker discs, and it is the only species known thus far to produce norstictic acid (in the excipulum). The diverse thallus chemistry is also unusual.

Key to the presently known species of *Eugeniella*

- | | | |
|------|---|---|
| 1 | Ascospores submuriform, 7–10 µm broad | |
| | | <i>E. newtoniana</i> (Henriques) Lücking <i>et al.</i> |
| | Ascospores transversely septate, 2.5–5.5 µm broad | 2 |
| 2(1) | Thallus verrucose | 3 |
| | Thallus smooth to minutely farinose | 4 |

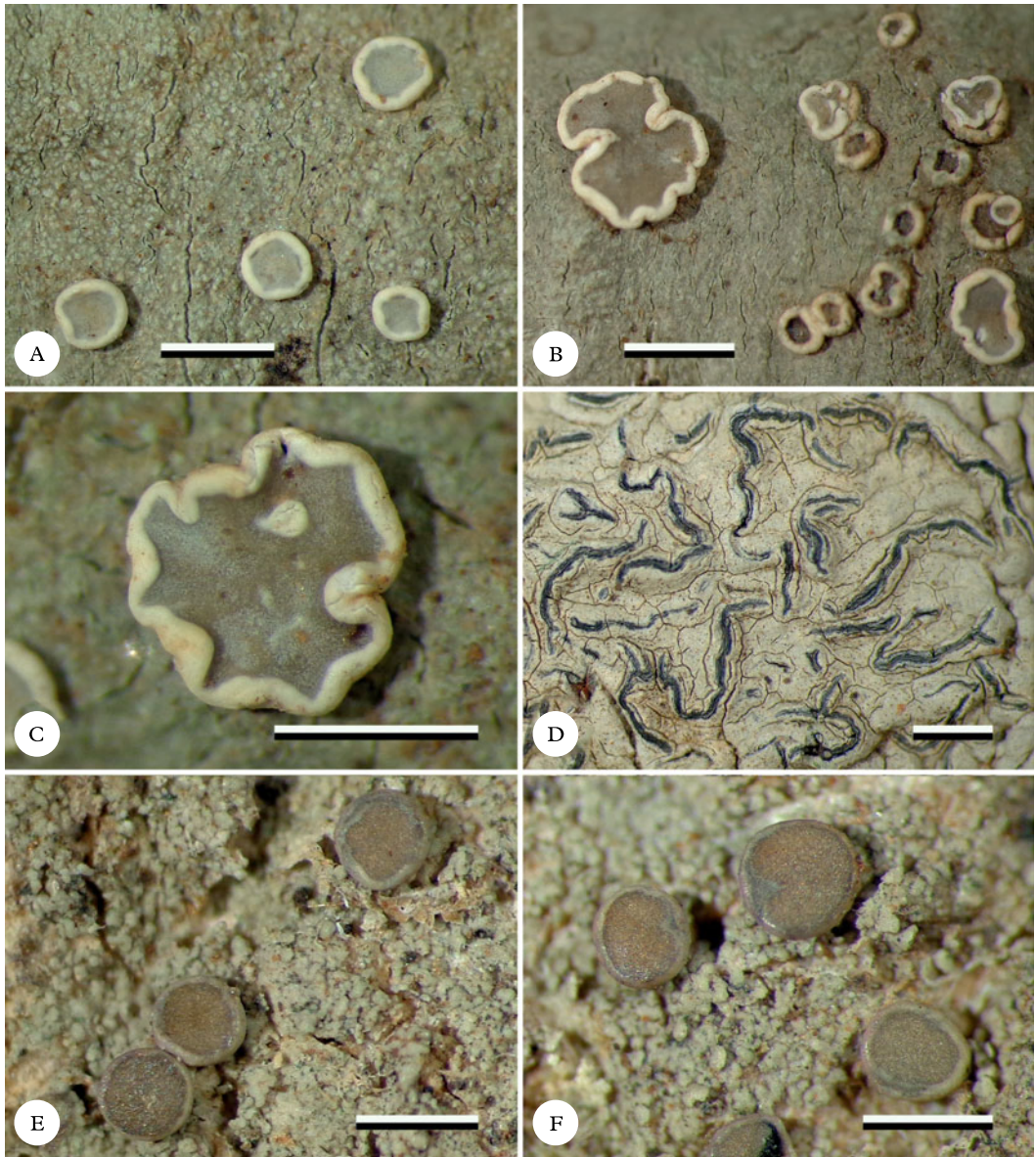


FIG. 1. Habitus of new species (holotypes). A & B, *Eugeniella palleola*, different parts of the thallus with apothecia; C, *Eugeniella palleola*, enlarged apothecium; D, *Graphis paraschiffneri*, thallus with lirellae; E & F, *Malmidea cineracea*, thallus and apothecia. Scale = 1 mm. In colour online.

- 3(2) Paraphyses unbranched; thallus greenish, verrucae white. **E. psychotriae** (Müll.Arg.) Lücking *et al.*
 Paraphyses branched and anastomosing; thallus with a bluish tinge, verrucae of same
 colour as thallus or paler. **E. micrommata** (Kremp.) Lücking *et al.*

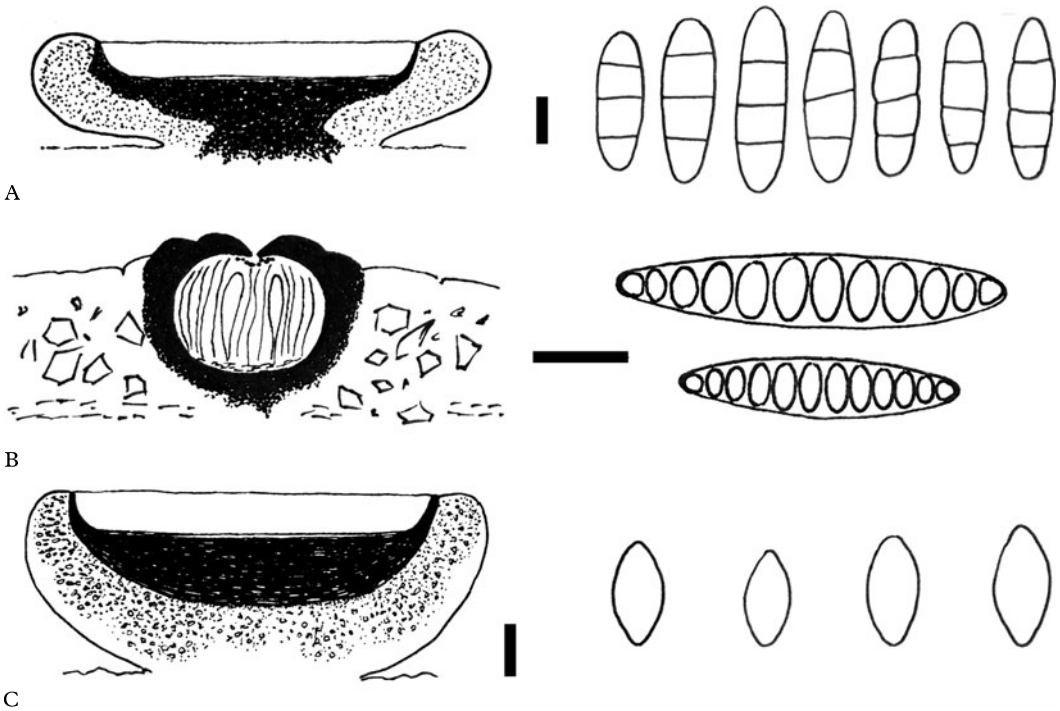


FIG. 2. Anatomies of the new species (holotypes). Schematic views of vertical sections through apothecia and ascospore structures for A, *Eugeniella paleola*; B, *Graphis paraschiffneri*, and C, *Malmidea cineracea*. Scales (sections): A–C = 100 μ m. Scales (ascospores): A & C = 5 μ m; B = 10 μ m.

4(2) Ascospores (3–)5–7-septate, 17–42 μ m long. 5
 Ascospores 3-septate, 10–18 μ m long. 6

5(4) Ascospores predominantly 5-septate, 17–27 μ m long.
 **E. ortizii** (Lücking) Lücking *et al.*
 Ascospores consistently 7-septate, 25–42 μ m long
 **E. nigrodiscus** M. Cáceres *et al.*

6(4) Apothecial discs pale grey; excipulum with norstictic acid
 **E. paleola** Breuss & Lücking
 Apothecial discs dark brownish grey to brown-black; excipulum lacking substances. . . 7

7(6) Apothecial margins evanescent; tubular pycnidia usually present.
 **E. corallifera** (Lücking) Lücking *et al.*
 Apothecial margins persistent and distinct; pycnidia absent 8

8(7) Apothecial discs dark greyish brown, margins thin, pale grey to brownish grey
 **E. atrichoides** (Malme) Lücking *et al.*
 Apothecial discs dark brown to black, margins very distinct, chamois-coloured to
 white, sharply delimited from disc.
 **E. leucocheila** (Tuck.) Lücking *et al.*

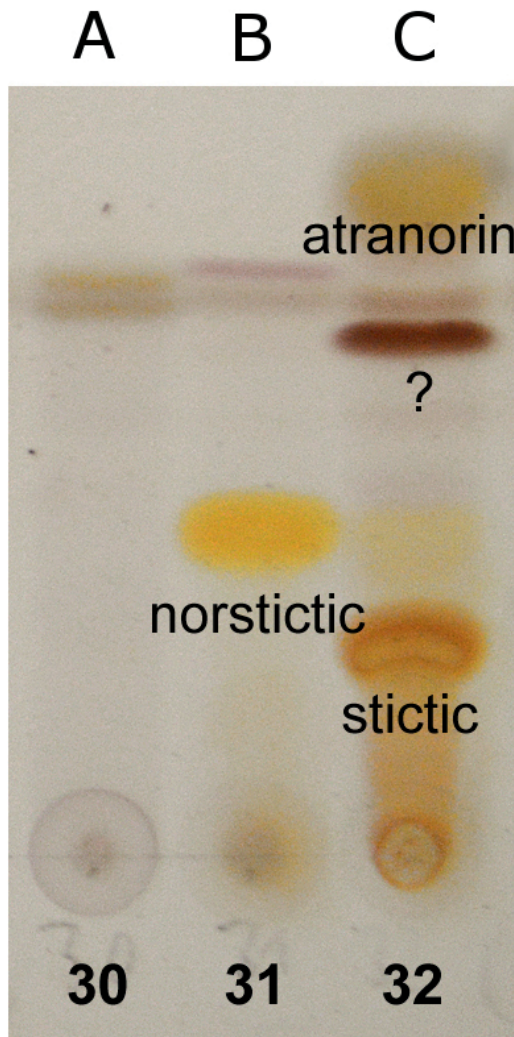


FIG. 3. TLC chromatograms of the holotype specimens. A (30), *Malmidea cineracea*; B (31), *Graphis paraschiffneri*; C (32), *Eugeniella palleola*. In colour online.

***Graphis paraschiffneri* Lücking & Breuss sp. nov.**

Mycobank No.: MB 807099

Similar to *Graphis schiffneri*, from which it differs in having longer ascospores with more numerous septa and much longer lirellae.

Type: Nicaragua, Rivas, Pacific coast, Playa El Coco c. 18 km S of San Juan del Sur, 19 July 2001, O. Breuss 19.338 (LI—holotype).

(Figs 1D, 2B, 3B)

Thallus epiperidermal, 100–150 µm thick, greyish white, smooth, slightly rimose, thinly corticate, with irregular algal layer and calcium oxalate crystals; prothallus absent. *Lirellae* immersed to erumpent, (1.0–)1.5–3.0 mm long, c. 0.25 mm wide, simple or sparsely branched, with lateral thalline margin. *Labia* entire to slightly furrowed apically, apices free and black, non-pruinose; *disc* concealed. *Excipulum* completely carbonized, 230–280 µm wide and 170–200 µm high. *Hypothecium* c. 20 µm tall, colourless. *Hymenium* clear, 90–120 µm tall, I–; *paraphyses* hyaline, unbranched. *Epihymenium* granulose, grey-brown. *Ascospores* 8 per ascus, colourless, I+ violet-blue, elongate, 30–42(–50) × 7.5–8.5 µm, transversely septate, 10–14-locular.

Chemistry. Norstictic acid detected by TLC. Spot tests: thallus K+ yellow then slowly orange-red, C–, P–, in section with K+ yellow efflux slowly forming red crystals.

Ecology and distribution. The species was found growing on tree bark at the Pacific coast. Known only from Nicaragua.

Notes. Lücking (2009) revised the species concept of *Graphis* and Lücking *et al.* (2009) accepted 330 species out of the c. 550–600 published taxa in a world key to the genus. More than 40 additional species have been described since then (Barcenos Peña *et al.* 2014).

Graphis paraschiffneri is characterized by the following combination of characters: thallus with norstictic acid, slightly striate labia, completely carbonized excipulum, and transversely septate ascospores. It is apparently close to *G. schiffneri* Zahlbr., which agrees in most features but has much shorter lirellae and smaller ascospores (Lücking *et al.* 2009). *Graphis caesiocarpa* Redinger is similar, but differs in its richly branched lirellae and entire (non-furrowed), white-pruinose labia with a complete thalline cover; its spores are of the same size as those in *G. paraschiffneri* but have fewer (7–10) septa (Lücking *et al.* 2008).

**Malmidea cineracea Breuss & Lücking
sp. nov.**

Mycobank No.: MB 807100

Similar to *Malmidea furfurosa*, from which it differs in having pale, rather than black apothecial margins, an excipulum with crystals but no medullary tissue, and a yellowish medulla.

Type: Nicaragua, Río San Juan, Indio-Maíz nature reserve, Caribbean lowland rainforest, 13 July 2001, O. Breuss 19.049 (LI—holotypus).

(Figs 1E & F, 2C, 3A)

Thallus corticolous, granulose-isidiate, greenish grey, dull, on a whitish fibrous hypothallus, 150–200 µm thick; granules when discrete 70–150 µm diam., cortex 10–15 µm thick, colourless; *photobiont* chlorococcoid, cells 6–8 µm diam., in globular or flattened packages 30–60 µm diam., medulla yellowish, K–.

Apothecia sessile, rounded to slightly irregular, 0.5–1.1 mm diam. and 0.20–0.35 mm high; *disc* plane, grey-brown to brown; *margin* entire, smooth, pale brownish grey, paler than disc, distinct but hardly prominent, *c.* 0.1 mm broad. *Excipulum* compact, hyaline at periphery (10–30 µm), inner part densely encrusted with yellowish brown granules, K+ pale greenish yellow. *Subhymenium* 10–20 µm high, brownish. *Hypothecium* dark brown to brownish black, 100–150 µm deep, K–. *Hymenium c.* 80 µm high, hyaline, I+ blue; *paraphyses* simple, not thickened at the tips. *Epihymenium* inapparent. *Asci* narrowly clavate, 60–70 × 12–16 µm, apical wall thickening without visible internal structure. *Ascospores* (6–)8 per ascus, 12–15 × 6–8 µm, ellipsoidal with somewhat pointed ends, halonate, halo 0.5–1.0 µm thick.

Conidiomata not observed.

Chemistry. No substances detected by TLC except thin bands of terpenoids that possibly originate from the bark. Spot tests: thallus K–, C–, P–; excipulum K+ greenish yellow.

Etymology. The epithet ('ash-greyish') refers to the colour of the apothecial margins.

Ecology and distribution. The species was found growing on tree bark in a lowland rainforest. It is known only from Nicaragua.

Notes. The genus *Malmidea* Kalb *et al.* in the separate family *Malmideaceae* was only recently established for tropical, lecideoid lichens characterized by biatorine excipula often incrustated with hydrophobic granules, asci supposedly without a tubular structure in the tholus, and simple ascospores (Kalb *et al.* 2011). Prior to that study, representatives of this genus were treated under the name *Malcolmiella* Vězda (Lücking & Kalb 2000; Kalb 2004; Aptroot *et al.* 2007; Cáceres 2007; Lücking 2008; Kalb *et al.* 2009). Since the introduction of the genus, many additional species have been newly described or transferred to *Malmidea* (Kalb *et al.* 2011, 2012; Spribille *et al.* 2011; Cáceres *et al.* 2012, 2013b; Kalb *et al.* 2012; Schumm & Aptroot 2012; Weerakoon & Aptroot 2013, 2014).

Malmidea species occur chiefly in tropical rainforests. They are mainly corticolous, but several species are found also on leaves (Lücking 2008 sub *Malcolmiella*). *Malmidea trailiana* is so far known only from foliicolous occurrences (Santesson 1952; Lücking 2008). Currently, 50 species are assigned to *Malmidea*, but no comprehensive study of the genus has yet been published. The key presented below is preliminary and aims to provide an overview of the presently known species. Additional species are expected to be described or found among tropical reports of *Lecidea* s. lat. None of the possible candidates in the large artificial genus that have been checked (e.g. in Malme 1936) have the combination of characters that is shown by the species described in the present paper. *Malmidea cineracea* is characterized by a granulose-isidiate thallus with a yellowish medulla and apothecia with a compact but crystal-incrusted excipulum, grey-brown to brown discs and grey margins. It was collected from smooth bark in a lowland rainforest.

Eugeniella (see above) is similar to *Malmidea*, but differs in having septate ascospores and tholi with a tubular structure. These

genera are placed in separate families: *Pilocarpaceae* and *Malmideaceae*, respectively (Kalb *et al.* 2011). However, illustrations in Schumm & Aptroot (2012) demonstrate a tubular structure in two *Malmidea* species (very weak in *M. chryso stigma*, clearly visible in *M. bakeri*) and Spribille *et al.* (2011) report a dark apical amyloid cylinder in *Malmidea indica*. This character therefore has to be studied further.

Key to the currently known species of *Malmidea*

- 1 Thallus with isidia or soredia 2
 Thallus without isidia or soredia, but sometimes farinose to granulose due to formation of goniocysts, often verrucose 13
- 2(1) Thallus with coralloid, polysidiangia-like clumps that eventually burst open producing soredia-like corticate granules and exposing the medulla; medulla lemon yellow, K+ orange; ascospores 16–22 × 9–12 µm. **M. piae** (Kalb) Kalb
 Thallus not with polysidiangia-like clumps; medulla white or yellowish, K– 3
- 3(2) Thallus isidiate 4
 Thallus sorediate. 9
- 4(3) Ascospores 2 per ascus, 50–65 × 20–30 µm; isidia verruciform to cylindrical, internally yellow and K+ orange-red. **M. polisensis** (Vain.) Kalb *et al.*
 Ascospores 4–8 per ascus, up to 30 × 15 µm 5
- 5(4) Ascospores *c.* 30 × 15 µm; isidia cylindrical or coralloid, thin, dense; apothecial margin with medullary chambers; disc brown, margin whitish or cream.
 **M. corallophora** Aptroot & Schumm
 Ascospores smaller (up to 25 µm); apothecial margin compact. 6
- 6(5) Isidia verruciform to shortly cylindrical, simple, internally white and K+ yellow; apothecial margin verrucose to isidiate; ascospores 14–25 × 10–15 µm.
 **M. taytayensis** (Vain.) Kalb *et al.*
 Isidia granular to coralloid or thallus irregularly granulose-isidiate 7
- 7(6) Isidia granular to coralloid; ascospores 14–22 × 9–13 µm
 **M. perisidiata** (Malme) Kalb & Lücking
 Thallus irregularly granulose-isidiate; ascospores 11–15 × 5–8 µm 8
- 8(7) Medulla white; apothecial disc beige, margin black; excipulum without crystals
 **M. furfurosa** (Tuck. ex Nyl.) Kalb & Lücking
 Medulla yellowish; apothecial disc brown, margin grey; excipulum with crystals
 **M. cineracea** Breuss & Lücking
- 9(3) Thallus verrucose, verrucae becoming sorediate 10
 Thallus not verrucose; soralia patchy or diffuse. 11
- 10(9) Medulla and soralia yellow-orange, K+ red; apothecial disc grey-brown, margin cream to yellow, thick; ascospores 10–16 × 6–8 µm.
 **M. atlantica** (Cáceres & Lücking) Cáceres & Kalb
 Medulla pale yellow, K+ yellow-orange; apothecial disc brown, margin grey, thin; ascospores 10–14 × 5–8 µm
 **M. flavopustulosa** (Cáceres & Lücking) Cáceres & Kalb
- 11(9) Medulla and soralia bright golden yellow; soralia pulverulent, confluent; thallus partly with small, grey, corticate dots (apothecia unknown)
 **M. sulphureosorediate** Cáceres *et al.*
 Medulla of thallus white. 12

- 12(11) Thallus and soralia grey-white; soralia roundish to irregularly patchy; excipulum compact; apothecial disc shades of brown, margin brown; ascospores $14-17 \times 8-10 \mu\text{m}$ **M. polycampia** (Tuck.) Kalb & Lücking
 Thallus and soralia yellowish white; soralia extensive, farinose; excipulum with medullary tissue, granules yellowish, K+ intense yellow; apothecial disc brown, margin yellowish white; ascospores $15-21 \times 7-12 \mu\text{m}$
 **M. ceylanica** (Zahlbr.) Kalb *et al.*
- 13(1) Ascospores $30-40 \times 12-18 \mu\text{m}$, 2-4 per ascus; thallus verrucose, white to grey; apothecial disc dark brown to blackish, excipulum paler.
 **M. indica** (Awasthi & Agarwal) Hafellner & T. Sprib.
 Ascospores $< 30 \mu\text{m}$ 14
- 14(13) Ascospores with distinct terminal wall thickenings 15
 Ascospores with evenly thickened walls 16
- 15(14) Thallus without verrucae, medulla white, K-; excipulum lacking medullary layer, compact, without granules; ascospores $12-17 \times 6-10 \mu\text{m}$
 **M. incrassata** Kalb
 Thallus verrucose, medulla cream to yellowish, K+ orange to pale purple; excipulum with medullary layer, with granules (K+ lemon yellow); ascospores $22-30 \times 12-15 \mu\text{m}$; medulla cream to yellowish **M. reunionis** Kalb
- 16(14) Ascospores $22-30 \times 11-15 \mu\text{m}$, 4 per ascus; medulla yellowish, K+ intense yellow-orange **M. sorsogona** (Vain.) Kalb *et al.*
 Ascospores smaller (mostly $< 20 \mu\text{m}$, rarely up to $25 \mu\text{m}$) 17
- 17(16) Apothecia with a continuous or granular thalline excipulum surrounding the proper excipulum; disc reddish brown; proper excipulum white to cream; ascospores $20-24 \times 11-15 \mu\text{m}$ **M. duplomarginata** (Papong & Kalb) Kalb & Papong
 Apothecia without thalline excipulum 18
- 18(17) Apothecial margin with medullary layer throughout or in papillae or internal chambers 19
 Apothecial margin lacking a medullary layer, compact, of conglutinated, radiating hyphae 36
- 19(18) Medulla of thallus and verrucae white 20
 Medulla of thallus and/or verrucae yellowish to orange or red 26
- 20(19) Apothecial discs orange-brown to brown-red; margin thick, cream to white; hypothecium orange-brown; ascospores $15-20 \times 6-10 \mu\text{m}$
 **M. badimioides** (Cáceres & Lücking) Cáceres & Kalb
 Apothecial discs grey-brown to dark brown or black 21
- 21(20) Apothecial margin thin, grey to blackish; epihymenium *c.* $25 \mu\text{m}$, dark brown; ascospores $10-14(-17) \times 6-8 \mu\text{m}$ **M. inflata** Kalb
 Apothecial margin thick, cream to dark grey, entire or papillose; epihymenium indistinct 22
- 22(21) Apothecial margin entire; excipulum with greyish granules 23
 Apothecial margin papillose; excipulum with yellowish or ochraceous-yellow granules 25
- 23(22) Thallus verrucae conspicuous ($0.1-0.3 \text{ mm diam.}$), often confluent; medulla K+ orange; ascospores $10-17 \times 6-10 \mu\text{m}$ **M. coralliformis** Kalb
 Thallus verrucae finer 24

- 24(23) Ascospores mainly 4 per ascus, 10–15 × 6–9 µm; medulla of thallus verrucae K+ greenish to orange-yellow **M. psychotrioides** (Kalb & Lücking) Kalb *et al.*
Ascospores 6–8 per ascus, 11–18 × 7–12 µm; medulla of thallus verrucae K+ yellow
. **M. subgranifera** (Kalb & Elix) Kalb & Elix
- 25(22) Medulla of thallus and verrucae K+ yellowish; medullary portion of excipulum K+ lemon yellow to greenish; ascospores 11–16 × 8–10 µm
. **M. bakeri** (Vain.) Kalb *et al.*
Medulla of thallus and verrucae K+ deep orange; medullary portion of excipulum K+ orange-yellow; ascospores 9–12 × 6–8 µm **M. variabilis** Kalb
- 26(19) Hypothecium colourless or yellowish brown. 27
Hypothecium orange-brown to brown-black. 29
- 27(26) Medulla of thallus verrucae bright red; medulla of excipulum pale yellow; ascospores 10–13 × 5–7 µm **M. sanguineostigma** Weerak. & Aptroot
Medulla yellow 28
- 28(27) Medulla in verrucae and excipulum bright yellow, K+ red; ascospores 9–11 × 5–6 µm **M. pallidoatlantica** M. Cáceres *et al.*
Medulla in verrucae pale to bright yellow, K–, medulla in excipulum yellowish, K+ yellow; ascospores 10–15 × 6–8 µm. **M. trailiana** (Müll.Arg.) Kalb *et al.*
- 29(26) Ascospores 10–14 × 5–8 µm; medulla K+ orange to orange-red 30
Ascospores larger 31
- 30(29) Excipulum with a continuous medullary layer; medulla of thallus verrucae sulphur yellow **M. aurigera** (Fée) Kalb *et al.*
Excipulum with medullary chambers, therefore appearing papillate; medulla of thallus verrucae pale yellowish **M. piperina** (Zahlbr.) Aptroot & Breuss
- 31(29) Ascospores 12–18 × 7–10 µm, 8 per ascus. 32
Ascospores 14–25 × 8–15 µm, mainly less than 8 per ascus. 33
- 32(31) Apothecial discs dark brown to blackish, margin thickish, cream to whitish; medulla of excipulum K+ intensely yellow to orange; hypothecium dark brown to brown-black; medulla of thallus verrucae yellowish to peach-coloured, K+ orange.
. **M. granifera** (Ach.) Kalb *et al.*
Apothecial discs light orange-brown, margin thin, cream; medulla of excipulum K–; hypothecium orange-brown; medulla of thallus pale yellow, K+ dark yellow
. **M. leucogranifera** M. Cáceres & Lücking
- 33(31) Medulla of thallus white, K+ yellow; medulla of verrucae yellow, K+ red; apothecial discs black, margin grey-brown to blackish, thin; ascospores 6–8 per ascus
. **M. fenicis** (Vain.) Kalb *et al.*
Medulla of thallus cream to golden yellow; apothecial discs shades of brown to blackish, margin whitish to cream-coloured, thick, entire to granular 34
- 34(33) Excipulum granules and medulla of thallus and verrucae K+ blood red to red-violet; ascospores 6(–8) per ascus, 18–25 × 10–13 µm; medulla golden orange.
. **M. chryso stigma** (Vain.) Kalb *et al.*
Excipulum granules K+ orange-yellowish to greenish lemon yellow; medulla of thallus cream to orange-yellow, K+ orange to orange-red 35

- 35(34) Apothecial discs light brown to tawny; ascospores 4–6(–8) per ascus, 15–20 × 8–11 μm; hypothecium 50–75 μm high; medulla of thallus cream to sulphur yellow . . .
 **M. eeunae** Kalb
 Apothecial discs orange-brown or dark brown to blackish; ascospores (4–)6(–8) per ascus, (12–)16–21 × 9–13 μm; hypothecium 100–120 μm high; medulla of thallus and verrucae orange-yellow **M. subaurigera** (Vain.) Kalb *et al.*
- 36(18) Hypothecium pale 37
 Hypothecium dark brown to brown-black. 42
- 37(36) Apothecial discs brown 38
 Apothecial discs brownish grey, beige or yellowish to orange 39
- 38(37) Apothecia 0.25–0.50 mm diam., discs reddish brown, margins pale brown to chamois; thallus strongly granulose; ascospores 9–11 × 4–6 μm
 **M. fellhaneroides** (Lücking) Kalb & Lücking
 Apothecia 0.4–1.0 mm diam., discs brown, margins pale to dark brown or blackish; thallus smooth to rugulose; ascospores 12–20 × 6–10 μm.
 **M. fuscella** (Müll.Arg.) Kalb & Lücking
- 39(37) Discs pale orange-yellow to orange, margin pale yellow to chamois, soon disappearing; ascospores 8–14 × 4–6 μm **M. bacidinoides** (Lücking) Kalb & Lücking
 Discs beige or brown-grey, margin persistent 40
- 40(39) Apothecial margin thick and prominent when young, paler than disc; ascospores 9–14 × 3.5–4.5 μm **M. gyalectoides** (Vain.) Kalb & Lücking
 Apothecial margin thin, of same colour as disc or darker; ascospores 9–13 × 5–7 μm 41
- 41(40) Apothecial margin yellowish brown or often apically blackish, disc beige; thallus rugulose. **M. leptoloma** (Müll.Arg.) Kalb & Lücking
 Apothecial margin whitish grey to dark brownish grey; disc brown-grey; thallus ± smooth **M. perplexa** Kalb
- 42(36) Medulla partly or completely pale yellow, orange or red, K+ orange or purple . . 43
 Medulla white, K- 47
- 43(42) Thallus verrucose. 44
 Thallus smooth 45
- 44(43) Medulla of verrucae pale yellow, K+ orange; medulla of thallus white; apothecial discs brown, margin grey; ascospores 15–18 × 9–11 μm
 **M. papillosa** Weerak. & Aptroot
 Medulla of verrucae yellow-orange and K+ red; medulla of thallus orange-red and K+ purple; apothecial discs brown, margin at least in parts red and K+ purple; ascospores 10–16 × 6–8 μm **M. amazonica** (Redinger) Kalb *et al.*
- 45(43) Apothecial margins red or partly reddish; excipulum with red crystals, K+ purple; ascospores 9–15 × 5–8 μm **M. rhodopsis** (Tuck.) Kalb *et al.*
 Apothecial margins not red; excipulum lacking red crystals, K- 46
- 46(45) Apothecial margins brownish grey; ascospores 10–16 × 6–9 μm
 **M. piperis** (Spreng.) Kalb *et al.*
 Apothecial margins black; ascospores narrower, 10–14 × 4–6 μm.
 **M. nigromarginata** (Malme) Lücking & Breuss
- 47(42) Ascospores 20–25 × 10–14 μm; apothecial discs grey-brown to black-brown, margin pale to dark brown **M. hypomela** (Nyl.) Kalb & Lücking
 Ascospores smaller. 48

- 48(47) Thallus granulose (to ± smooth in parts), green to green-grey; apothecial disc dark brown, margin black; ascospores $9\text{--}13 \times 5\text{--}6 \mu\text{m}$
 **M. tratiana** Kalb & Mongkolsuk
 Thallus smooth to wrinkled or slightly verrucose; ascospores $10\text{--}17 \times 6\text{--}8 \mu\text{m}$. . 49
- 49(48) Thallus pale greenish grey; apothecial discs dark reddish to purplish brown; margin rather thick, blackish grey **M. vinosa** (Eschw.) Kalb *et al.*
 Thallus yellowish white; apothecial discs blackish; margin thin, dark grey
 **M. cinereonigrella** (Vain.) Kalb

New combinations

Malmidea nigromarginata (Malme) Lücking & Breuss comb. nov.

MycoBank No.: MB 807111

Basionym: *Lecidea nigromarginata* Malme, *Ark. Bot.* **28A**(7): 25 (1936).

Malmidea piperina (Zahlbr.) Aptroot & Breuss comb. nov.

MycoBank No.: MB 807110

Basionym: *Lecidea piperina* Zahlbr., *Fedde Repert.* **33**: 40 (1933).

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