

Some new lichen species from Sri Lanka, with a key to the genus *Heterodermia* in Sri Lanka

Gothamie WEERAKOON^a & André APTROOT^{b*}

^a Department of Botany, Field Museum, 1400 South Lakeshore Drive, Chicago, IL 60605-2496, U.S.A.

^b ABL Herbarium, G.v.d.Veenstraat 107, NL-3762 XK Soest, The Netherlands

Abstract – The following new species are described from Sri Lanka: *Heterodermia rubrotricha* which is similar to *Heterodermia leucomela* but with red, K + purple pigment on the cilia. *Malmidea sanguineostigma*, which is similar to *Malmidea chrysostigma* but has red anthraquinone in the thallus medulla, yellow xantholepinone in the excipulum medulla and smaller ascospores. *Protoparmelia megalosporoides* which is unique in the genus by the lecideine apothecia resembling those of *Megalospora*. A key to the species of *Heterodermia* in Sri Lanka is provided, applying a chemically and morphologically strict species concept.

Indian subcontinent / Malmidea / Malmideaceae / Parmeliaceae / Physciaceae / Protoparmelia

INTRODUCTION

The lichen flora of Sri Lanka is still incompletely known. That the lichen flora should be very species-rich was demonstrated by Hale (1981) who reported 110 (35 of which were newly described) species of thelotremoid *Graphidaceae* from Sri Lanka. At that time more thelotremoid *Graphidaceae* species were known from Sri Lanka than from any other country. There is still a vast undescribed lichen biodiversity as recently demonstrated by Weerakoon *et al.* (2012), who described further new *Graphidaceae* from Sri Lanka.

While examining lichens collected in the early 90s in the Central province in Sri Lanka, three undescribed species were found. One is a *Heterodermia* resembling *H. boryi* and *H. vulgaris* but with red pigment on the rhizines.

The second is a species of *Malmidea* that resembles *M. chrysostigma*, with which it grows side-by-side, but differs by the red instead of yellow anthraquinone pigment in the thallus medulla, and by the presence of an additional yellow xantholepinone pigment in the medulla of the excipulum, as well as by smaller ascospores.

The last is a species of *Protoparmelia* that differs markedly from all other species in the genus by the combination of multisporous asci and lecideine apothecia resembling those of *Megalospora*. All are described below, as they constitute remarkable elements of the Sri Lanka lichen flora. A key to the species of *Heterodermia* known from Sri Lanka is given, including some new country records.

* Corresponding author: andreaproot@gmail.com

MATERIAL AND METHODS

Identification and descriptive work was carried out in Soest using an Olympus SZX7 stereomicroscope and an Olympus BX50 compound microscope with interference contrast, connected to a Nikon Coolpix digital camera. Sections have been mounted in tap water, in which all measurements were taken. The specimens from this study are preserved in ABL and F. The chemistry of the type specimen has been investigated by thin-layer chromatography (TLC) using solvent A and by observing extract recrystallization in acetone with a compound microscope (Orange *et al.*, 2001). Chemical reactions were applied directly on the thallus, medulla and on acetone extracts on filter paper.

TAXONOMY

Heterodermia rubrotricha Weerakoon & Aptroot, **sp. nov.**

Figs 1-5

Mycobank: MB 807067

Thallus foliose, forming tufts up to 10 cm diam., divided into linear, ascending to pendulous or nearly erect, whitish lobes up to 4 cm long and 0.9-1.6 mm wide, at tips tapering to 0.4 mm width and recurved, dichotomously branched every 0.5-2.0 cm; upper surface smooth, shiny, flat to convex; lower surface without cortex or rhizines, arachnoid, whitish, margins corticate. Cilia black, dull, marginal, simple or with many perpendicular branchlets, 0.1-0.2 mm thick and up to 8 mm long, mostly covered by a pruina of dark peony red pigment, except usually at the base and the very tips; rhizines, soredia, isidia and pseudocyphellae absent. **Apothecia** common, 4-7 mm diam., laminal on the upper surface of the thallus lobes, not terminal, at their margins with 6-15 tapering lobes similar to the normal thallus lobes in morphology, the lobes up to 1 mm wide and up to 5 mm long, hyphae agglutinated; disc 2-4 mm diam., brownish grey, often, but not always, heavily white pruinose. **Hymenium** 100-180 μm high, not interspersed; Epihymenium pale yellowish, granular; hypothecium pale brown, c. 30 μm high. **Ascospores** 8 per ascus, brown, 1-septate, constricted at the septum, with few sporoblastidia, 35-43 \times 19-22 μm . **Pycnidia** not seen.

Chemistry: cortex K+ yellow, medulla K+ faintly yellow, red pigment on cilia K+ purple; TLC: atranorin the cortex, zeorin in the medulla, red anthraquinone with Rf 20 (in TDA) on the cilia.

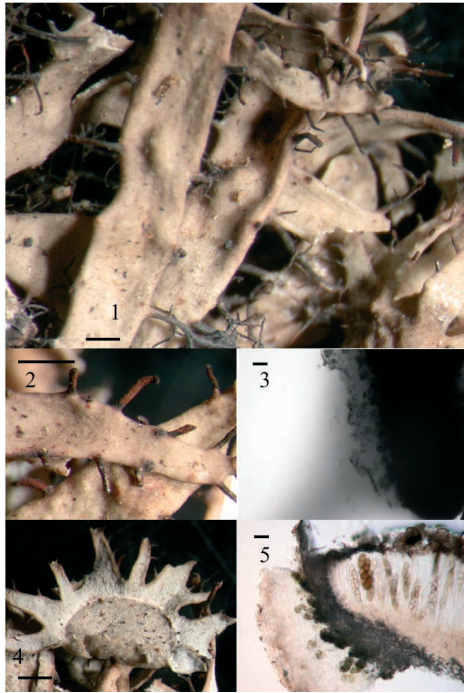
Type: SRI LANKA. **Central Province**. Nuwara Eliya, Pattipola, Mahagasthotte Upper division, 6°56'N, 80°47'E, elevation 1706 m, tea plantation, on *Camellia sinensis*, October 1990, *Collector unknown*, 157 (F-holotypus, ABL-isotypus).

Etymology: after the red hairs (cilia).

Ecology and distribution: On smooth bark of tea (*Camellia*) trees from a tea plantation. Known only from Sri Lanka.

Discussion: The genus *Heterodermia* is often common and species-rich in tropical mountain regions. Sri Lanka is no exception, it may even be the most speciose genus of foliose lichens in the country.

The new species is closely related to *Heterodermia boryi* (Fée) K.P. Singh & S.R. Singh, from which it is indistinguishable in lobe configuration. It differs in



Figs 1-5. *Heterodermia rubrotricha* (holotype).
1. Habitus. 2. Cilia with pigment. 3. Pigment
effluent reaction in KOH. 4. Apothecium.
5. Section through apothecium showing
agglutinated hyphae of lobe.
Scales: 1-2, 4 = 0.5 mm; 3, 5 = 50 μ m.

the red, K+ purple pigment on the cilia. *Heterodermia vulgaris* (Vain.) Follmann & Redón is also somewhat similar and has the same red pigment, but in that species the pigment is distributed all over the lower surface.

***Malmidea sanguineostigma* Weerakoon & Aptroot, sp. nov.**

Fig. 6

Mycobank: MB 807068

Thallus thin, dull, grey, with numerous corticate grey warts of 0.1-0.2 mm diam. of which the medulla is bright blood red, without prothallus. Warts hemispherical, sometimes abraded at the top, but not developing into soralia. Algae green, c. $7 \times 5 \mu$ m. **Apothecia** sessile, 0.4-0.8 mm diam., disc flat, smooth, dull, medium brown. Margin dull, c. 0.1 mm wide, chamois coloured to ochraceous, higher than the disc, often partly with pale yellow medulla exposed. **Hymenium** hyaline, not inspersed, 45-55 μ m high; epihymenium hyaline to very pale brownish, 4-6 μ m high; hypothecium hyaline to yellowish brown, 35-45 μ m thick; excipulum not corticate, mostly filled with pale yellow crystals, at least sideways and at the lower part of the excipulum underneath the apothecium. Paraphyses unbranched, not thickened at the tips, c. 1 μ m wide. Asci cylindrical, $45-60 \times 10-13.5 \mu$ m, with 8 ascospores. **Ascospores** hyaline, IKI-, simple, ellipsoid, $10.5-12.5 \times 5.5-6.5 \mu$ m, ends somewhat pointed but not thickened. **Pycnidia** not observed.

Chemistry: Thallus UV-, C-, K-, KC-, P-. Apothecium medulla K+ yellow, UV-negative. Thallus medulla K+ blood red, UV+ orange. TLC: xantholepinone in excipulum medulla, the anthraquinone norsolorinic acid in thallus medulla.

Type: SRI LANKA. **Central Province**. Knuckles Conservation Area, NNE of Matala, Riverston tower, $7^{\circ}31'N$, $80^{\circ}48'E$, elevation 1437 m, montane forest, on

bark of *Elaeocarpus* sp., February 1990, *Collector unknown*, 113 (F-holotypus, ABL-isotypus).

Etymology: after the blood red dots on the thallus.

Ecology and distribution: On smooth bark of trees in primary montane forest. Known only from Sri Lanka.

Discussion: The genus *Malmidea* in the separate family *Malmideaceae* was only recently described and is still incompletely known, with 43 known species worldwide (Lücking, 2008; Kalb *et al.*, 2011; 2012; Cáceres *et al.*, 2012; 2013; Schumm & Aptroot, 2012), but many additional, already described species in this group are still hidden under *Lecidea* and new species are now described quite regularly.

The new species was found side-by-side with the species it is closest to, *Malmidea chrysostigma*. The latter species has a golden orange medullary pigment (emodin and emodin-bisanthrone, see Schumm & Aptroot, 2012), and a hyaline excipulum medulla. There is a further difference in the ascospore size, which are twice as long and wide in *M. chrysostigma* as compared to the new species. This co-occurrence is further proof that the new species is not a strange morph of *M. chrysostigma*.

***Protoparmelia megalosporoides* Weerakoon & Aptroot, sp. nov.**

Figs 7-9

Mycobank: MB 807069

Thallus thin, dull, greyish white, dull, consisting of numerous confluent areoles of 0.1-0.2 mm diam. that coalesce, but remain dissected by darker grey linear/branched depressions, surrounded by a dark grey prothallus line. Algae green, c. 10 × 7 µm. **Apothecia** sessile, 0.4-1.3 mm diam., disc flat, smooth, dull, brownish grey. Margin dull, c. 0.2-0.3 mm wide, whitish at the outside, dark grey at the top and the inside, higher than the disc. **Hymenium** hyaline, but irregularly infused with fuscous brown epihymenium pigment from above, extending occasionally all the way downward, heavily interspersed with tiny oil droplets, up to 100 µm high; epihymenium fuscous brown, pigmented zone irregularly delimited; hypothecium hyaline, c. 50 µm thick; excipulum hyaline throughout, with a 5-15 µm thick layer of pseudocortex without crystals, inside densely incrustated with two types of hyaline crystals (tiny crystals of c. 1 µm diam., and larger angular crystals of c. 7-15 µm diam.), without algae, extending below the hypothecium. Paraphyses occasionally branched or anastomosing, somewhat wavy, not thickened at the tips, c. 3 µm wide. Asci cylindrico-clavate, I+ blue, up to 55 × 12 µm, with c. 50 ascospores. **Ascospores** hyaline, IKI-, simple, ellipsoid, 4-5 × 1.5-2 µm. **Pycnidia** not observed.

Chemistry: Thallus UV-, C-, K-, KC-, P-. TLC: no substances detected.

Type: SRI LANKA. **Central Province**. Hunasgiriya, Galhiriya Tea plantation, 7°25'N, 80°42'E, elevation 1360 m, tea plantation, on *Camellia sinensis*, September 1989, *Collector unknown*, 917 (F-holotypus, ABL-isotypus).

Etymology: after the apothecia that resemble those of a *Megalospora*.

Ecology and distribution: On smooth bark of tea (*Camellia*) trees from a tea plantation. Known only from Sri Lanka.

Discussion: This species is characterized within the genus *Protoparmelia* by the combination of the multispored asci with c. 50 ascospores each and its sessile, lecideine apothecia without algae, a combination which is not known from any species described so far. Most *Protoparmelia* species have lecanorine apothecia containing algae, including all with multispored asci (Papong *et al.*, 2011). Most tropical species of the genus contain lobaric acid (Aptroot *et al.*, 1997; 2013), but species without secondary chemistry are already known (Brodo & Aptroot, 2005).



Figs 6-9. **6.** *Malmidea sanguineostigma* (holotype), habitus. **7-9.** *Protoparmelia megalosporoides* (holotype). **7.** Habitus. **8.** Hymenium in KOH. **9.** Ascus with ascospores in KOH. Scales: 6-7 = 0.5 mm; 8-9 = 20 μ m.

The cupular excipulum, a character of all Parmeliaceae and a distinguishing character towards the sister family Lecanoraceae, is recognizable in the new species, even though algae are absent.

This species has the external appearance of a small *Megalospora*, because of the sessile, lecideoid apothecia that have a white outer region and a nearly black inner region, without having a clear parathecium. Also most internal characters match, especially the dense hymenium inspersion with tiny oil droplets. The ascospores are however one or two orders of magnitude smaller, simple instead of septate, and they are with c. 50 in the ascus instead of 1-8 as in *Megalospora* (Sipman, 1983).

Multispored asci are a rare character in lichenized ascomycetes (and in ascomycetes in general). They occur more or less consistently in three families and 16 genera (Aptroot & Schumm, 2012), but isolated or clustered multispored species are also rather widely dispersed over 40 other, totally unrelated, genera, 39 of which were listed by Aptroot & Schumm (2012), to which *Amandinea* should be added. More and more genera with occasional multispored species become known, most recently *Protoparmelia* (Papong *et al.*, 2011) and *Thelenella* (Aptroot & Schumm, 2012).

KEY TO THE *HETERODERMIA* SPECIES IN SRI LANKA

This key contains all species of *Heterodermia* known from Sri Lanka, mostly based on local collections examined by us. It applies the restricted species concept which is now often accepted in the genus (Elix 2010, 2011a, 2011b) and in which species are morphologically and chemically rather uniform. This follows the findings by Lücking *et al.* (2008) that the presence or absence of norstictic acid is phylogenetically informative within at least part of the genus *Heterodermia*. Please note that this character should be observed on the (upper) lobe tips: if they react K+ yellow, only atranorin and terpenoids are present, of the reaction is K+ yellow > red, norstictic acid is present (or salazinic acid in one or two species not keyed out here).

1. Lower surface corticated throughout; lobe tips K+ yellow 2
1. Lower surface at most with a corticated margin; lobe tips K+ yellow
or yellow > red 4
 2. Soredia, isidia, and phyllidia absent ... *H. diademata* (Taylor) D.D. Awasthi
 2. Soredia, isidia, or phyllidia present 3
3. Soredia present, isidia absent *H. speciosa* (Wulf.) Trevis
3. Soredia absent, isidia present *H. isidiophora* (Nyl.) D.D. Awasthi
 4. Branching dichotomous, with two equal lobes, lobes elongate 5
 4. Branching sympodial, with short lateral lobes, lobes shorter 6
5. Cilia with red pigment; lobe tips K+ yellow. . . *H. rubrotricha* Weerakoon & Aptroot
5. Cilia lacking pigment; lobe tips K+ yellow > red. *H. leucomelos* (L.) Poelt
 6. Lobes bearing phyllidia 7
 6. Lobes lacking phyllidia (or isidia) 8
7. Lobe tips K+ yellow > red; ascospores with sporoblastidia

H. appendiculata (Kurok.) Swinscow & Krog
7. Lobe tips K+ yellow; ascospores without sporoblastidia

H. microphylla (Kurok.) Skorepa
8. Lobes with white cilia on upper surface; lobe tips K+ yellow

H. comosa (Eschw) Follman & Redón
8. Lobes lacking cilia on upper surface. 9
9. Soredia present 10
9. Soredia absent 12
 10. Lower surface with superficial yellow to orange pigment (sometimes patchy) 11
 10. Lobes lacking yellow or orange pigment; lobe tips K+ yellow

H. japonica (M. Satô) Swinscow & Krog
11. Pigment covering most of the lower surface; lobe tips K+ yellow.

H. obscurata (Nyl.) Trevis
11. Pigment in tiny spots; lobe tips K+ yellow > red

H. propagulifera (Vain.) J.P. Dey
12. Lower surface with superficial yellow to orange pigment (sometimes patchy) 13
12. Lobes lacking yellow or orange pigment 15

13. Thallus attached to substrate at base of lobes; apothecia subapical to apical; lobe tips K+ yellow. *H. hypochraea* (Vain). Swinscow & Krog
13. Thallus attached to substrate along the lobes except at apices; apothecia laminal. 14
 14. Lobe tips K+ yellow > red. *H. corcovadoensis* (Kurok.) Elix
 14. Lobe tips K+ yellow. *H. flabellata* (Fée) D.D. Awasthi
15. Lobes stiff, branching ± digitate; lower surface with corticate margin; lobe tips K+ yellow. *H. dactyliza* (Nyl.) Swinscow & Krog
15. Lobes softer, main lobes with short lateral branches 16
 16. Apothecia apical or subapical, longly stipitate; lobes ± ascending at apices . . 17
 16. Apothecia laminal to subapical, sessile to shortly stipitate; lobes ± adnate . . 19
17. Lobe tips K+ yellow *H. pellucida* (D.D. Awasthi) D.D. Awasthi
17. Lobe tips K+ yellow > red 18
 18. Marginal cilia mostly unbranched *H. podocarpa* (Bél.) D.D. Awasthi
 18. Marginal cilia densely branched. *H. barbifera* (Nyl.) K.P. Singh
19. Lobe tips K+ yellow>red; ascospores with sporoblastidia
H. magellanica (Zahlbr.) Swinscow & Krog
19. Lobe tips K+ yellow; ascospores without sporoblastidia
H. hypoleuca (Ach.) Trevis.

Acknowledgements. The research work carried out by the first author in Sri Lanka was supported by a research fund from the University of Sri Jayawardenepura, Sri Lanka Research Grant ASP/06/Re/2008/11 to Prof. S.C. Wijeyaratne. A Scholarship from the Field Museum, Chicago, USA enabled the first author to work on material at the Field Museum. The NSF-funded project “ATM – Assembling a taxonomic monograph: The lichen family Graphidaceae” (DEB-1025861 to The Field Museum; PI T. Lumbsch, CoPI R. Lücking) funded the travel expense to the first author which she gratefully acknowledges. Thorsten Lumbsch and Robert Lücking are warmly thanked for helping to make the stay of the first author at the Field Museum pleasant and productive.

REFERENCES

- APTROOT A. & SCHUMM F., 2012 – The genus *Melanophloea*, an example of convergent evolution towards polyspory. *Lichenologist* 44: 501-509.
- APTROOT A., DIEDERICH P., SÉRUSIAUX E. & SIPMAN H.J.M., 1997 – Lichens and lichenicolous fungi from New Guinea. *Bibliotheca Lichenologica* 64: 1-220.
- APTROOT A., OLIVEIRA M.M. DE & CÁCERES M.E.S., 2013 – *Protoparmelia capitata* (Ascomycota: Parmeliaceae): new record for South America. *Acta Botanica Brasiliica* 27: 498-501.
- BRODO I.M. & APTROOT A., 2005 – Corticolous species of *Protoparmelia* (lichenized Ascomycotina) in North America. *Canadian Journal of Botany* 83: 1075-1081.
- CÁCERES M.E.S., 2007 – Corticolous crustose and microfoliose lichens of northeastern Brazil. *Libri Botanici* 22: 1-168.
- CÁCERES M.E.S., SANTOS VIEIRA T. DOS, JESUS L.S. DE & LÜCKING R., 2012 – New and interesting lichens from the Caxiuana National Forest in the Brazilian Amazon. *Lichenologist* 44: 807-812.
- CÁCERES M.E.S., SANTOS V.M. DOS, GÓES D.T. , MOTA D.A. & APTROOT, A., 2013 – Two new species of *Malmidea* from north-eastern, Brazil. *Lichenologist* 45: 619-622.
- ELIX J.A., 2010 – Two new species, a new combination and new data for *Heterodermia* (Physciaceae: Ascomycota). *Australasian Lichenology* 67: 3-9.
- ELIX J.A., 2011a – Three new species of *Heterodermia* (Physciaceae: Ascomycota) from Australia. *Australasian Lichenology* 68: 16-21.

- ELIX J.A., 2011b — Further new species and new records of *Heterodermia* (Physciaceae: Ascomycota) from Australia. *Australasian Lichenology* 69: 12-24.
- KALB K., RIVAS PLATA E., LÜCKING R. & LUMBSCH H.T., 2011 — The phylogenetic position of *Malmidea*, a new genus for the *Lecidea piperis*- and *Lecanora granifera*-groups (Lecanorales, Malmideaceae), inferred from nuclear and mitochondrial ribosomal DNA sequences, with special reference to Thai species. *Bibliotheca Lichenologica* 106: 143-168.
- KALB K., BUARUANG K., MONGKOLSUK P. & BOONPRAGOB K., 2012 — New or otherwise interesting lichens VI, including a lichenicolous fungus. *Phytotaxa* 42: 35-47.
- LÜCKING R., 2008 — Foliicolous lichenized fungi. *Flora Neotropica* 103: 1-866.
- LÜCKING R., PRADO R. DEL, LUMBSCH H.T., WILL-WOLF S., APTROOT A., SIPMAN H.J.M., UMAÑA L. & CHAVES J.L., 2008 — Phylogenetic patterns of morphological and chemical characters and reproductive mode in the *Heterodermia obscurata* group in Costa Rica (Ascomycota, Physciaceae). *Systematics and Biodiversity* 6: 31-41.
- ORANGE A., JAMES P.W. & WHITE F.J., 2001 — *Microchemical Methods for the Identification of Lichens*. London: British Lichen Society.
- PAPONG K., KANTVILAS G. & LUMBCH H.T., 2011 — Morphological and molecular evidence places *Maronina* into synonymy with *Protoparmelia* (Ascomycota: Lecanorales). *Lichenologist* 43: 561-567.
- SCHUMM F. & APTROOT A., 2012 — *A microscopical atlas of some tropical lichens from SE-Asia*. 2 vols. Norderstedt: Books on Demand. 881 p.
- SIPMAN H. J.M., 1983 — A monograph of the lichen family Megalosporaceae. *Bibliotheca lichenologica* 18: 1-241.
- WEERAKOON G., WIJEYARATNE S.C., WOLSELEY P.A., RIVAS PLATA E., LÜCKING R. & LUMBSCH H.T., 2012 — Six new species of Graphidaceae from Sri Lanka. *The Bryologist* 115: 74-83.