
NEW OR OTHERWISE INTERESTING LICHENS MAINLY FROM BRAZIL AND VENEZUELA WITH SPECIAL REFERENCE TO THE GENUS *MALMIDEA*

Klaus Kalb

Lichenologisches Institut Neumarkt
Im Tal 12, D-92318 Neumarkt/OPf., Germany
and Institute of Plant Sciences, Ecology and Conservation Biology
University of Regensburg, Universitätsstraße 31
D-93053 Regensburg, Germany.
Email: klauskalb@hotmail.com

ZUSAMMENFASSUNG

In Fortsetzung meiner Untersuchungen tropischer lichenisierter Pilze wird eine Abhandlung über neue oder anderweitig interessante Flechten, hauptsächlich aus Brasilien und Venezuela vorgelegt. Insgesamt wird hier über 34 Arten berichtet. Die meisten von ihnen stellen Neufunde für eines der beiden Länder oder wenigstens für einen Bundesstaat dar, einschließlich 11 für die Wissenschaft neuer Arten. Diese sind *Malmidea albomarginata* Kalb & Hernández aus Venezuela, die sich von *M. granifera* durch dünne, weiße Apothecienränder und ein weißes bis gelbliches Mark unterscheidet, *M. allobakeri* Kalb & M. Cáceres aus Brasilien, die sich von *M. bakeri* durch das Fehlen von Atranorin und kleinere Ascosporen unterscheidet, *M. allopapillosa* Kalb aus Venezuela, die sich von *M. papillosa* durch den Besitz von Atranorin als Hauptinhaltsstoff unterscheidet, *M. atlanticoides* Kalb & M. Cáceres aus Brasilien, die sich von *M. atlantica* durch den Besitz von Atranorin und ein unbekanntes Anthraquinon als Hauptinhaltsstoffe unterscheidet, *M. hechicerae* aus Venezuela, die sich von *M. coralliformis* durch ein K⁺ zitronengelbes Mark des Lagers unterscheidet, *M. hernandeziana* Kalb aus Venezuela, die sich von *M. fellhaneroides* durch ein schokoladebraunes Hypothecium, größere Apothecien und größere Ascosporen unterscheidet, *M. isidiifera* Kalb aus Brasilien und Venezuela, die sich von *M. piperis* durch den Besitz körniger bis corallinischer Isidien sowie Atranorin als Hauptinhaltsstoff unterscheidet, *M. leucopiperis* Kalb aus Brasilien und Venezuela, die sich von *M. piperis* durch ein hell gefärbtes Hypothecium unterscheidet, *M. rhodopisoides* Kalb aus Brasilien, die sich von *M. rhodopis* durch den Besitz körniger Isidien unterscheidet, *M. subcinerea* Kalb aus Venezuela, die sich von *M. cinerea* durch das Fehlen von Flechtenstoffen unterscheidet and *M. volcaniana* Kalb & Hernández aus Venezuela und Brasilien, die sich von *M. sulphureosorediata* durch den Besitz einer unterschiedlichen Anthraquinon-Chemie unterscheidet. Zusätzlich wird die neue Kombination *Stigmatochroma glaucothecum* (Fée) Kalb vorgeschlagen. Neufunde für Venezuela umfassen *Bacidiopsis microphylla* Kalb, *B. silvicola* (Malme) Kalb (ebenfalls neu für Guatemala), *Buellia albula* (Nyl.) Müll. Arg., *Coenogonium pyrophthalmum* (Mont.) Lücking, Aptroot & Sipman, *Dirinaria rhodocladonica* Kalb, Schumm & Elix, *Malmidea badimoides* (M. Cáceres & Lücking) M. Cáceres & Kalb (neu auch für Mexico), *M. leptoloma* (Müll. Arg.) Kalb & Lücking, *M. nigromarginata* (Malme) Lücking & Breuss, *M. perplexa* Kalb, *M. polycampia* (Tuck.) Kalb & Lücking, *M. rhodopis* (Tuck.) Kalb, Rivas Plata & Lumbsch, *M. sulphureosorediata* M. Cáceres, D. A. Mota & Aptroot, *M. vinosa* (Eschw.) Kalb, Rivas Plata & Lumbsch, *Psilolechia lucida* (Ach.) Choisy, *Rhizocarpon sipmanianum* Kalb & Aptroot, *Sipmaniella sulfureofusca* (Fée) Kalb, *Stigmatochro-*

ma glaucothecum (Fée) Kalb und *Vainionora aemulans* (Vain.) Kalb. Ein Beleg von *Pyxine caesiopruinosa* (Nyl.) Imsh. aus Venezuela wird erwähnt und die Unterschiede zu *P. albovirens* (G. Mey.) Aptroot wird diskutiert. Neunachweise für Brasilien umfassen *Malmidea atlantica* (M. Cáceres & Lücking) M. Cáceres & Kalb (für den Bundesstaat Bahia) and *M. sulphureosorediata* (für den Bundesstaat São Paulo). Ein morphologischer, anatomischer und chemischer Vergleich von Typusmaterial von *Malmidea polycampia* (Tuck.) Kalb & Lücking and *M. flavopustulosa* (M. Cáceres & Lücking) M. Cáceres & Kalb ergab, dass beide Namen synonym sind, wobei ersterer Priorität besitzt. Für viele Arten werden ausführlichere Beschreibungen, teilweise mit revidierter Chemie, basierend auf südamerikanischen Belegen, mitgeteilt. Um die Bestimmung von Anthraquinonen, die in *Malmidea*-Arten vorkommen können, zu erleichtern, ist eine Tabelle mit relativen R_f -Werten in den Fließmitteln A, B' and C beigefügt.

ABSTRACT

In a continuation of my investigation of tropical lichenized fungi, a treatment of new or otherwise interesting lichens mainly from Brazil and Venezuela is presented. A total of 34 species are reported here, most of them new discoveries for at least one the two countries or a new discovery for a state, including 11 species new to science. These are *Malmidea albomarginata* Kalb & Hernández from Venezuela, differing from *M. granifera* by the thin, white apothecial margins and a white to yellowish medulla, *M. allobakeri* Kalb & M. Cáceres from Brazil, differing from *M. bakeri* in lacking atranorin and in having smaller ascospores, *M. allopapillosa* Kalb from Venezuela, differing from *M. papillosa* in having atranorin as a major metabolite, *M. atlanticoides* Kalb & M. Cáceres from Brazil, differing from *M. atlantica* in containing atranorin and an unknown anthraquinone as major metabolites, *M. hechicerae* from Venezuela, differing from *M. coralliformis* by the K⁺ lemon-yellow medulla of the thallus, *M. hernandeziana* Kalb from Venezuela, differing from *M. fellhaneroides* in having a chocolate-brown hypothecium, larger apothecia and larger ascospores, *M. isidiifera* Kalb from Brazil and Venezuela, differing from *M. piperis* in having granular to coralloid isidia and atranorin as a major metabolite, *M. leucopiperis* Kalb from Brazil and Venezuela, differing from *M. piperis* in the pale-colored hypothecium, *M. rhodopisoides* Kalb from Brazil, differing from *M. rhodopis* in having granular isidia, *M. subcinerea* Kalb from Venezuela, differing from *M. cinerea* in producing no lichen substances, and *M. volcaniana* Kalb & Hernández from Venezuela and Brazil, differing from *M. sulphureosorediata* in having an alternative anthraquinone-chemistry. In addition, the new combination *Stigmatochroma glaucothecum* (Fée) Kalb is proposed. New reports for Venezuela include *Bacidopsis microphylla* Kalb, *B. silvicola* (Malme) Kalb (new also for Guatemala), *Buellia albula* (Nyl.) Müll. Arg., *Coenogonium pyrophthalmum* (Mont.) Lücking, Aptroot & Sipman, *Dirinaria rhodocladonica* Kalb, Schumm & Elix, *Malmidea badimoides* (M. Cáceres & Lücking) M. Cáceres & Kalb (new also for Mexico), *M. leptoloma* (Müll. Arg.) Kalb & Lücking, *M. nigromarginata* (Malme) Lücking & Breuss, *M. perplexa* Kalb, *M. polycampia* (Tuck.) Kalb & Lücking, *M. rhodopis* (Tuck.) Kalb, Rivas Plata & Lumbsch, *M. sulphureosorediata* M. Cáceres, D. A. Mota & Aptroot, *M. vinosa* (Eschw.) Kalb, Rivas Plata & Lumbsch, *Psilolechia lucida* (Ach.) Choisy, *Rhizocarpon sipmanianum* Kalb & Aptroot, *Sipmaniella sulfureofusca* (Fée) Kalb, *Stigmatochroma glaucothecum* (Fée) Kalb and *Vainionora aemulans* (Vain.) Kalb. A collection of *Pyxine caesiopruinosa* (Nyl.) Imsh. from Venezuela is mentioned and its differentiation from *P. albovirens* (G. Mey.) Aptroot is discussed. New reports for Brazil include *Malmidea atlantica* (M. Cáceres & Lücking) M. Cáceres & Kalb (for Bahia state) and *M. sulphureosorediata* (for São Paulo state). A morphological, anatomical and chemical comparison of type material of *Malmidea polycampia* (Tuck.) Kalb & Lücking and *M. flavopustulosa* (M. Cáceres & Lücking) M. Cáceres & Kalb revealed that both names are synonym, the first one having priority. For many species revised descriptions and revised chemistry are presented based on South American material. To facilitate the identification of anthraquinones occurring in *Malmidea* species a table of relative R_f -values in solvents A, B' and C is presented.

Key words: *Bacidiopsis*, *Coenogonium*, *Dirinaria*, Guatemala, lichen chemistry, *Malmidea*, Mexico, *Psilolechia*, *Pyxine*, *Rhizocarpon*, *Sipmaniella*, *Stigmatochroma*, *Vainionora*

INTRODUCTION

The most recent checklist for the lichens of Venezuela, compiled by FEUERER (2017), contains c. 1300 lichens. The author used mainly the papers by DENNIS (1965), HERTEL (1971, 1974), LÓPEZ-FIGUEIRAS (1986), SIPMAN (1994) and VARESCHI (1962, 1973, 2001) as source material. A search in the cumulative database for 'Recent literature on lichens' (<http://nhm2.uio.no/botanisk/lav/RLL/RLL.HTM>) with the search term 'Venezuela' for the last 10 years, yielded 41 hits. Although these papers were not included, it can be assumed that the number of lichens known from Venezuela did not increase significantly during this time. Compared to the number of species from neighbouring Brazil (more than 4100 currently accepted species have been reliably reported or described (Aptroot *in litt.* May 2021), and the search in 'Recent literature on lichens' with the relevant search term yielded 284 hits). The enormous differences in the numbers are certainly not due to a poorer lichen biota in Venezuela, but is mainly the result of less lichen research in the country. In this paper, 15 *Malmidea* species from Venezuela are treated, 14 of them are new records, including 7 species new to science. Most probably, detailed studies in other groups, e.g. Graphidaceae, Trypetheliaceae, will increase the number of new records by a similar percentage. This paper can be a tiny catalyst to stimulate lichen research in Venezuela.

METHODS

The material for this study was collected in Brazil and Venezuela, mainly by the author together with the following colleagues: M. López-Figueiras, A. Morales-Mendez, J. Hernández, M. Marceli, M. Cáceres and A. Kalb. Several lichens from Venezuela (MERF) were sent to Neumarkt for determination by A. Morales-Mendez (Mérida).

At the Lichenological Institute Neumarkt, the lichens were examined with a Wild M3Z Plan stereomicroscope and an Olympus BH-A research microscope. Photographs were taken with a Nikon Coolpix 995 digital camera adapted to both microscopes. Sections were usually cut by hand, but for special purpose a freezing microtome Leitz Kryomat 1321 was used and the sections mounted in tap water and lactophenol cottonblue. Natural compounds were characterized by thin-layer chromatography (TLC) in solvents A, B' and C, according to the methods standardized for lichen products by ELIX (2018). The TLC plates were read by J. Elix and/or identified by the computer program Wintab 64bit (LAFFERTY *et al.* 2021). If there was still a doubt, cochromatography with pure lichen substances was performed.

To ensure correct determinations, type specimens of many taxa were studied for comparison and photographs taken. For a concise citation of the literature, all protologues were checked.

The holotypes of the new species from Brazil are deposited in the lichen herbarium of the Departamento de Biociências, Universidade Federal de Sergipe (ISA) or in the lichen herbarium of the Instituto de Biociências, Universidade Federal de Mato Grosso do Sul (CGMS), the new species from Venezuela are deposited in the lichen herbarium of the Instituto Jardín Botánico Dr. Tobías Lasser, Universidad Central de Venezuela (VEN) or in the lichen herbarium of the Facultad de Farmacia, Universidade de los Andes, Mérida (MERF). A few other voucher specimens are preserved in the herbarium K. Kalb at the Lichenologisches Institut Neumarkt.

RESULTS

The study of lichens collected in Brazil and Venezuela mainly by M. Cáceres, R. Lücking, A. Morales-Mendez, M. López-Figueiras and the author revealed 11 new species to science, including *Malmidea albomarginata* Kalb & Hernández from Venezuela, *M. allobakeri* Kalb & M. Cáceres from Brazil, *M. allopapillosa* Kalb from Venezuela, *M. atlanticoides* Kalb & M. Cáceres from Brazil, *M. hechicerae* from Venezuela, *M. hernandeziana* Kalb from Venezuela, *M. isidiifera*

Kalb from Brazil, *M. leucopiperis* Kalb from Brazil and Venezuela, *M. rhodopisoides* Kalb from Brazil, *M. subcinerea* Kalb from Venezuela and *M. volcaniana* Kalb & Hernández from Venezuela and Brazil. All new species are accompanied by detailed descriptions and close-up photographs. The same applies for the new reports for Venezuela, namely *Bacidiopsis microphylla* Kalb, *B. silvicola* (Malme) Kalb (new also for Guatemala), *Buellia albula* (Nyl.) Müll. Arg., *Coenogonium pyrophthalmum* (Mont.) Lücking, Aptroot & Sipman, *Dirinaria rhodocladonica* Kalb, Schumm & Elix, *Malmidea badimioides* (M. Cáceres & Lücking) M. Cáceres & Kalb (new also for Mexico), *M. leptoloma* (Müll. Arg.) Kalb & Lücking, *M. nigromarginata* (Malme) Lücking & Breuss, *M. perplexa* Kalb, *M. polycampia* (Tuck.) Kalb & Lücking, *M. rhodopis* (Tuck.) Kalb, Rivas Plata & Lumbsch, *M. sulphureosorediata* M. Cáceres, D. A. Mota & Aptroot, *M. vinosa* (Eschw.) Kalb, Rivas Plata & Lumbsch, *Psilolechia lucida* (Ach.) Choisy, *Rhizocarpon sipmanianum* Kalb & Aptroot, *Sipmaniella sulfureofusca* (Fée) Kalb, *Stigmatochroma glaucothecum* (Fée) Kalb and *Vainionora aemulans* (Vain.) Kalb. As the lichen biota of Brazil is already much better known than that of Venezuela it is not surprising that only two new state records are added for Brazil, namely *Malmidea atlantica* (M. Cáceres & Lücking) M. Cáceres & Kalb from Bahia and *M. sulphureosorediata* from São Paulo. *Stigmatochroma glaucothecum* is a new combination [Bas.: *Lecidea glaucotheca* Fée, syn.: *Buellia glaucotheca* (Fée) Malme]. A morphological, anatomical and chemical comparison of type material of *Malmidea polycampia* (Tuck.) Kalb & Lücking and *M. flavopustulosa* (M. Cáceres & Lücking) M. Cáceres & Kalb revealed that both names are synonym. The chemistry of *Malmidea* species is notoriously difficult. The main substances are complexes of anthraquinones and/or many unknown xantholepinones. For the latter it is not possible to match the R_f values of the spots on TLC plates run in solvents A, B' and C so TLC profiles are used for specific identification. For the anthraquinones a table of R_f-values is provided. For some years, the names *Pyxine albovirens* (G. Mey.) Aptroot and *P. caesiopruinosa* (Nyl.) Imsh. have been treated as synonyms (APTROOT 1988). However, AMTOFT (2002) distinguished the two species by their alternative vegetative propagules (*P. albovirens* having soralia and *P. caesiopruinosa* having polysidiangia). Here, AMTOFT (2002) is followed and a collection of *P. caesiopruinosa* s. str. from Venezuela is recorded.

THE SPECIES

Bacidiopsis microphyllina Kalb

Fig. 1

Bibliotheca Lichenologica 88: 304 (2004b).

This species was previously reported from Venezuela for the states of Tachira and Lara in KALB (2004b). The locality given below is a new addition to the lichen biota for the state Mérida.

VENEZUELA. **Mérida**: Sierra Nevada de Mérida, above La Aquada, open rocky hillsides and forested ravines, on weathered bark of an unidentified tree, 3500 m, 6 February 1974, leg. M. E. Hale 43178 (MERF).

Bacidiopsis silvicola (Malme) Kalb

Fig. 2

Bibliotheca Lichenologica 88: 305 (2004b).—*Bacidia silvicola* Malme, Arkiv för botanik 27 A (5): 28 (1935).

This species was also previously reported from Venezuela from the state of Tachira in KALB (2004b). The localities given below are new additions to the lichen biota for the state of Mérida and for Guatemala. *B. silvicola* is also known from Puntarenas, Costa Rica; Azuay, Ecuador and from São Paulo and Mato Grosso in Brazil.



Fig. 1: *Bacidiopsora microphyllina*; thallus and apothecia; bar 1 mm



Fig. 2: *Bacidiopsora silvicola*; thallus and apothecia; bar 1 mm

VENEZUELA. **Mérida**: Páramo de los Granates, finca los Granates, alongside of the valley of the river los Granates, c. 3 km SE of Santo Domingo, on bark of an unidentified tree, 3000 m, 20 February 1985, leg. M. López-Figueiras & Dana Griffin 31740 (MERF).—GUATEMALA. **Quiché**: along the national highway 15, c. 15 km S of Chichicastenango, on *Pinus* sp. in a dry and dark *Pinus-Quercus* forest, 2400 m, 14°46' N, 91°07' W, 15 January 1979, leg. K. Kalb & G. Plöbst (herb. K. Kalb 42622).

Discussion: Based on molecular phylogenies of the Ramalinaceae (DAHL 2017, KISTENICH *et al.* 2018), species of *Bacidiopsis* were placed in *Bacidia* sens. str. This would lump together quite distinct natural groups and as the trees presented permit an alternative interpretation, this point of view is not followed here.

Buellia albula (Nyl.) Müll. Arg.

Fig. 3

Bulletin de l'Herbier Boissier 2, App. 1: 71 (1894).—*Lecidea albula* Nyl., Bulletin de la Société Linnéenne de Normandie, Sér. 2, 2: 517 (1868).

This saxicolous species, growing on limestone, is distinguished by a chalky white, subeffigurate thallus which becomes rimose to rimose-areolate with age, filled with calcium oxalate, forming needle-shaped crystals with H_2SO_4 , lecideine apothecia, initially immersed but becoming adnate to sessile, surrounded by a thalline collar, and often with white pruinose discs. The excipulum and epihymenium brown and HNO_3 –! It is remarkable that both chemical races occur at the same locality (see below).

TLC: Chemical race 1: norstictic acid (major), connorstictic acid (minor); Chemical race 2: no lichen substances by TLC.



Fig. 3: *Buellia albula*; thallus and apothecia; bar 0.5 mm

Buellia albula was previously known from Australia, New Zealand and Bolivia (Bungartz *et al.* 2011). The collections cited below are new additions to the lichen biota of Venezuela and the second report from South America.

VENEZUELA. **Lara:** Serrania de Bobara; Cerro de La Virgen, between Barquisimeto and la Encrucijada, in the dry zone, 670 m, saxicolous on limestone, 21 July 1976, leg. M. López-Figueiras & R. Smith (MERF 20952; 20954 (no lichen substances by TLC!); 20955; 20957; 20958).

Discussion: Not far from the localities mentioned above, two collections from limestone, very similar to *Buellia albula*, differ in having an alternative chemistry, namely atranorin (major), norstictic acid (submajor to minor) and connorstictic acid (minor to trace) and probably belong to an undescribed species.

VENEZUELA. **Lara:** Cerro Pávia, between Barquisimeto and la Encrucijada, in the dry zone, 500 m, saxicolous on limestone, 22 July 1976, leg. M. López-Figueiras & R. Smith (MERF 21108, 21109).

Coenogonium pyrophthalmum (Mont.) Lücking, Aptroot & Sipman

Fig. 4

Fungal Diversity 23: 298.—*Biatora pyrophthalma* Mont., Annales des Sciences Naturelles; Botanique, ser. 2, 20: 357 (1843).—*Dimerella pyrophthalma* (Mont.) Vězda, Folia Geobotanica et Phytotaxonomica 4: 446 (1969)—Syn. *Dimerella bonariensis* Malme, Arkiv för Botanik 26 A. 13: 4 (1934).

This species is distinguished in having a smooth thallus without isidia and soralia, relatively large apothecia (up to 2 mm diam., usually 0.8–1.3 mm diam.) with a thick prominent margin (up to 0.2 mm thick) and ascospores $9\text{--}12 \times 2.5\text{--}3 \mu\text{m}$.

The localities recorded below are new additions to the Venezuelan lichen biota.

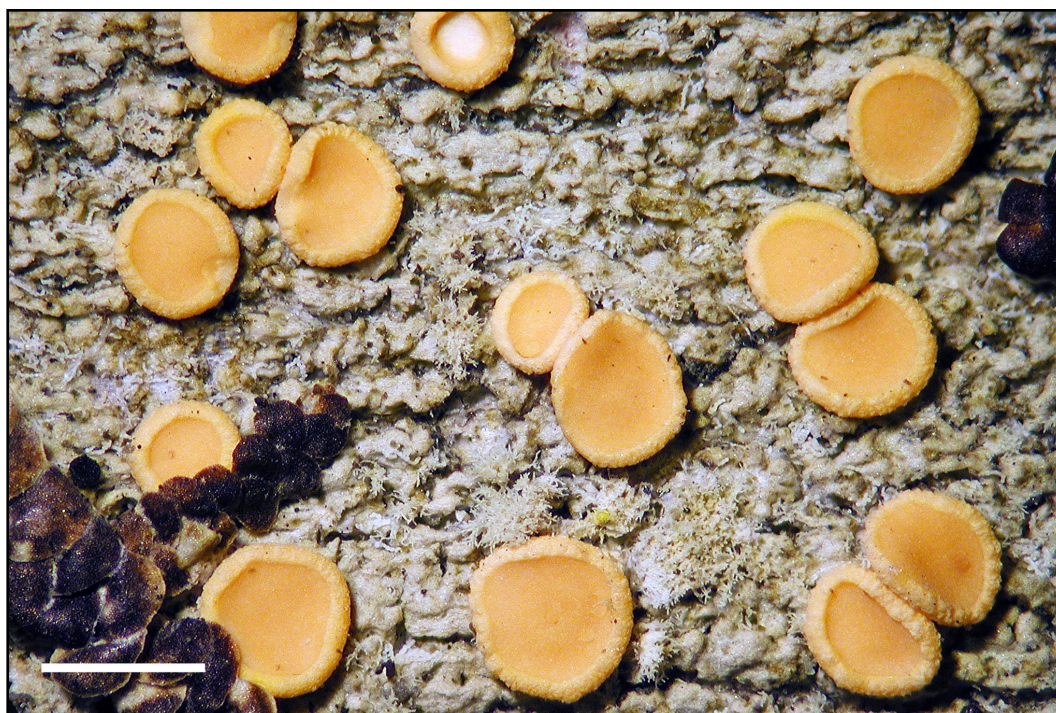


Fig. 4: *Coenogonium pyrophthalmum*; thallus and apothecia; bar 1 mm

VENEZUELA. **Mérida**: Distr. Libertador; 'El Valle', a few km E of Mérida, 8°40' N, 71°05' W, corticolous in a pasture along a river, 2600 m, 2 August 1989, leg. K. Kalb & M. López-Figueiras (herb. K. Kalb 24082); Surroundings of Mérida, Finca La Culata, upper part of the valley, 2800–2900 m, on bark of an unidentified tree, 12 April 1976, leg. M. López-Figueiras 13607 (MERF).—**Tachira**: Distr. Jauregui, near El Hato, between Bailadores and Pregonero, 8°05' N, 71°55' W, on bark of an unidentified tree, 2750 m, 13 August 1989, leg. K. & A. Kalb (herb. K. Kalb 29094).

Dirinaria rhodocladonica Kalb, Schumm & Elix

Australasian Lichenology 86: 8 (2020).—*Physcia aegialita* f. *coccinea* Lynge, Videnskapselskapets Skrifter I Matematisk-naturvidenskabelig Klasse 1924, 16: 43 (1925).

Discussion: This taxon was only recently elevated to species level (KALB *et al.* 2020). *Dirinaria rhodocladonica* is the only species with divaricatic acid and rhodocladonic acid. The latter substance can also be found in *Dirinaria leopoldii*, *D. coccinea* and *D. endocrocea*, but all of three produce sekikaic in lieu of divaricatic acid. In addition, *D. leopoldii* is sorediate and readily distinguished. *Dirinaria coccinea* and *D. endocrocea* can be readily separated because they produce the additional red pigment, canarione.

Previously, *D. rhodocladonia* was only known from Brazil. The collection reported below is a new addition to the lichen biota of Venezuela and was found growing admixed with *Stigmatochroma glaucothecum* (see below). A color photograph is provided in KALB *et al.* (2020).

TLC: atranorin (major), divaricatic acid (major), nordivaricatic acid (trace), rhodocladonic acid (minor).

VENEZUELA. **Trujillo**: Between Puente Villegas and Cerro Gordo, surroundings of Carache, on bark of an unidentified tree, 700–900 m, 23 September 1978, leg. M. López-Figueiras 16938 (MERF).

MALMIDEA Kalb, Rivas Plata & Lumbsch

Bibliotheca Lichenologica 106: 150 (2011).

Type species: *Malmidea piperis* (Spreng.) Kalb, Rivas Plata & Lumbsch, Bibliotheca Lichenologica 106: 165 (2011).

Thallus crustose, mostly corticolous, or foliicolous, very rarely saxicolous, smooth, warty or granulose to pustulate, often formed by gonocysts which develop on a whitish fibrous prothallus, sometimes isidiate or with soralia, medulla of thallus and/or thallus warts often pigmented by chemical compounds. *Photobiont* chlorococcoid, often in globular or flattened packages. *Apothecia* sessile, ± rounded, margin distinct, biatorine; the *excipulum* of *piperis*-type apothecia is paraplectenchymatous and formed by radiating hyphae (Fig. 5). Usually no lichen products except norsolorinic acid are deposited in this kind of apothecium; the *excipulum* of *granifera*-type apothecia is composed of a paraplectenchymatous ectal excipulum and a medullary excipulum (Fig. 6), formed by loosely arranged periclinal hyphae with constricted septa and incrustated with hydrophobic granules and/or pigments belonging in various substance classes, e.g. secalononic acid A, xantholepinones, anthraquinones; *hypothecium* prosoplectenchymatous, hyaline to dark brown; *hymenium* hyaline, I+ blue. *Asci* clavate with a tubular structure in the tholus which is usually very weakly or even not stained with Lugol's solution. *Ascospores* (1–2) 4–8 (often 6) per ascus, hyaline, ellipsoid to broadly fusiform, non-septate, wall evenly thickened or thickened at the ends, halonate. *Pycnidia* rare, in thallus warts, globose, whitish, 0.1 mm diam., conidia filiform, 17–25 × 0.8 µm (KALB *et al.* 2011).

Discussion: Great care must be taken when deciding whether a species is sorediate or not. In some species, e.g. *Malmidea atlantica* the cortex of the thallus warts is very thin and readily abraded so that large parts of the thallus appear sorediate.

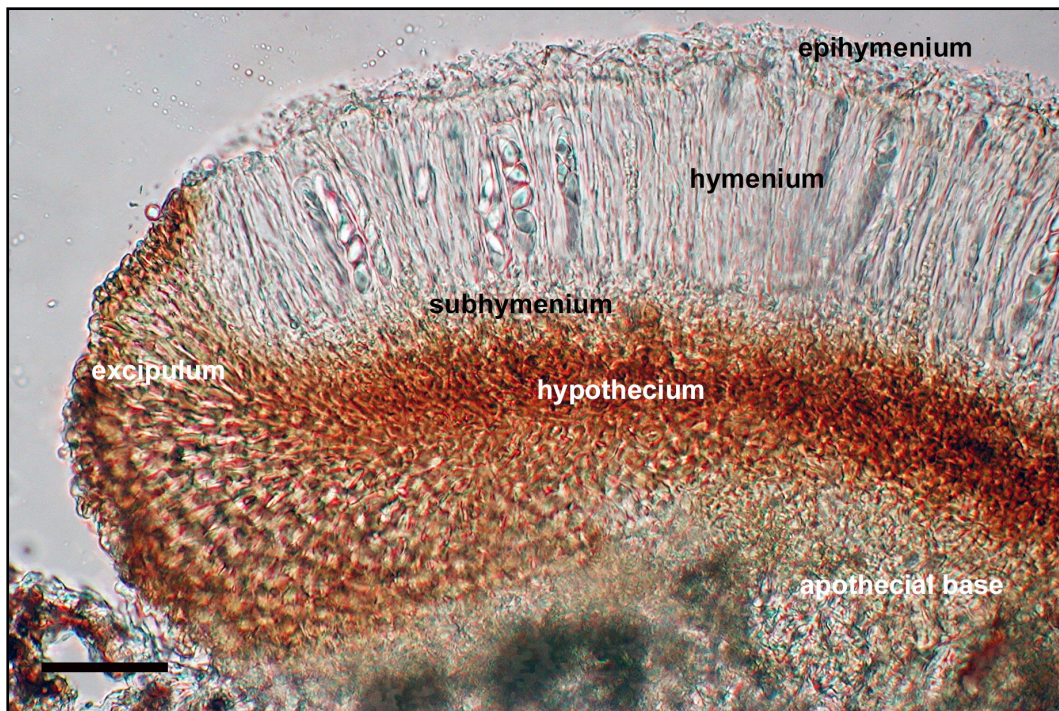


Fig. 5: *Malmidea furfurosa*; section through apothecium with *piperis*-type excipulum; bar 40 μm .

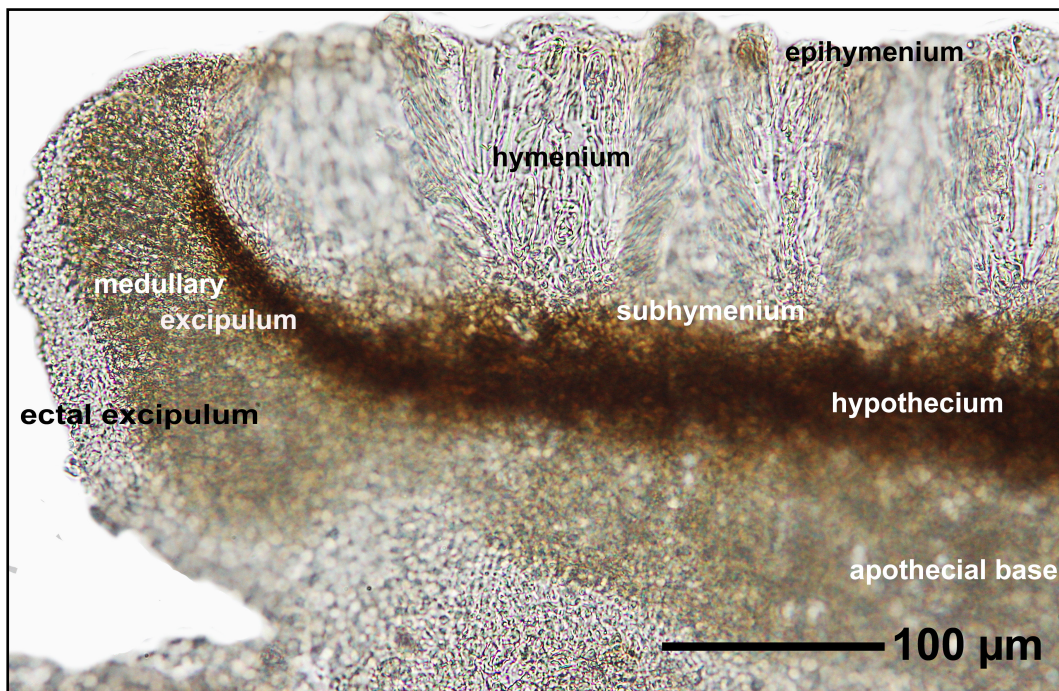


Fig. 6: *Malmidea subgranifera* (photo by F. Schumm); section through apothecium with *granifera*-type excipulum.

The genus *Malmidea* was relatively recently established (KALB *et al.* 2011) to accommodate some species formerly included in *Lecanora*, *Lecidea* or *Malcolmiella*. At that time, it was the only genus in the family Malmideaceae. In the meantime, not only were 16 new species described, but a further six genera have been placed in Malmideaceae, viz. *Crustospathula*, *Sprucidea* (CÁCERES *et al.* 2017), *Kalbionora* (SODAMUK *et al.* 2017), the lichenicolous genus *Zhurbenkoa* (FLAKUS *et al.* 2019) and the lichenized hyphomycetes, *Savoronala* (ERTZ *et al.* 2014) and *Cheiromycina* (MUGGIA *et al.* 2017).

Below, further new species of *Malmidea* are described and new discoveries for the lichen biota of Brazil and Venezuela are reported.

Malmidea albomarginata Kalb & Hernández, *sp. nov.*

Fig. 7

Index Fungorum number: IF558602

Similar to *Malmidea granifera* (Ach.) Rivas Plata & Lumbsch but differs in having very thin, white apothecial margins and a white to pale yellow, rather than a peach-coloured medulla.

Type: VENEZUELA. **Miranda**: Los Guayabitos; Cerro El Volcán, 10°24'59" N, 66°51'11" W, corticolous in a very disturbed tropical mountain rainforest (bosque nublado), 1460 m, 01. X. 2010, leg. K. Kalb 38380 & J. Hernández (VEN, holotype).

Etymology: The specific epithet refers to the white margins of the apothecia.



Fig. 7: *Malmidea albomarginata* (holotype); thallus and apothecia; bar 1 mm

Thallus crustose, corticolous, continuous, 200–300 μm thick, verrucose, verrucae rare and not equally distributed on the thallus 0.1–0.3 mm high and 0.15–0.3 mm wide, dull, grey to greenish grey, becoming coralloid granular with age, soralia and isidia absent. Medulla of verrucae and thallus white to faintly yellow, K+ orange to reddish (K+ orange-red in sections under the light microscope), P–. Photobiont chlorococcoid, cells 6–8 μm diam. Apothecia sessile, rounded, 0.8–1.8 mm diam. and 0.2–0.3 mm high; disc plane to slightly convex, ochre to light greyish brown;

excipulum of *granifera*-type, entire, thin, c. 0.05 mm thick (0.1–0.15 mm in holotype of *Malmidea granifera*), white. Ectal excipulum hyaline, medullary excipulum whitish to slightly yellowish, completely filled with opaque, greyish to yellowish granules, only partly dissolving in KOH with K+ orange-red efflux; subhymenium c. 25 µm high, hyaline to light brown; hypothecium centrally 100–150 µm high, narrowing to the margin, dark brown, K–; epihymenium indistinct; hymenium 75–90 µm high, hyaline. Asci 65–80 µm × 12–18 µm. Ascospores 6–8 per ascus, non-septate, wall equally thickened, halonate, ellipsoid, (10–)14 × 6–9 µm, halo 1.5–2 µm.

Chemistry: atranorin (major), several unknown xantholepinones.

Discussion: As stated previously in KALB *et al.* 2011, the type of *M. granifera* is in very poor condition with only two, eroded apothecia remaining. Nevertheless, TLC and HPLC of that material revealed no atranorin. Also the colour of the medullary excipulum and the thallus warts differs from that of the new species, i.e. peach-colored, reacting K+ lemon-yellow. Also similar is *M. attenboroughii* Kukwa, Guzow-Krzemińska, Kosecka, Jabłońska & Flakus, but this species differs in having smaller apothecia (up to 1 mm diam.) and by lacking atranorin.

In the world key presented by BREUSS & LÜCKING (2005), *M. albomarginata* keys out at couplet 30 (*M. aurigera*, *M. piperina*). *Malmidea albomarginata* differs from both of these species by having warts which become coralloid granular (remaining smooth in *M. aurigera* and *M. piperina*), larger apothecia (not surpassing 1.0 mm in *M. aurigera* and *M. piperina*) and a paler apothecial disc (dark brown, reddish brown or black in *M. aurigera* and *M. piperina*).

Malmidea allobakeri Kalb & M. Cáceres, *sp. nov.*

Fig. 8

Index Fungorum number: IF558603

Similar to *Malmidea bakeri* (Vain.) Kalb, Rivas Plata & Lumbsch, but differs in lacking atranorin and in having smaller ascospores, 10–14 × 7–8 µm (11–16 × 8–10 µm in *M. bakeri*).

Type: BRAZIL. **Bahia:** Itabuna, Centro de Pesquisa do Cacao (CEPLAC), 8°17' S, 35°58' W, corticolous on bark of an unidentified tree in Atlantic rainforest within the property, 0–20 m. leg. M. Cáceres (s.d., s.n.) (ISE, holotype!).

Etymology: The specific epithet refers to its variation from *Malmidea bakeri*.

Thallus crustose, corticolous, continuous, 40–70 µm thick, verrucose, verrucae 0.075–0.1 mm high and 0.07–0.1 mm wide, dull, greenish grey to brownish, soralia and isidia absent. Medulla of verrucae and thallus white to faintly yellow, K+ orange to reddish. Photobiont chlorococcoid, cells 6–8 µm diam. Apothecia sessile, rounded, 0.3–0.8 mm diam. and 0.2–0.3 mm high; disc plane to slightly convex, dark chocolate brown to blackish; excipulum of *granifera*-type, initially entire, becoming granular with age and/or almost partly or entirely disappearing, cream-coloured to greyish or black. Excipulum hyaline at periphery, internally with pockerts of medullary layer, filled with greyish to ochraceous-yellow hydrophobic granules, opaque, only partly dissolving in KOH with a K+ orange yellowish to greenish lemon yellow reaction. Subhymenium c. 25 µm high, light brown; hypothecium centrally 80–100 µm high, narrowing to the margin, dark brown, K–. Epihymenium indistinct. Hymenium 90–110 µm high, hyaline. Asci 70–80 µm × 15–20 µm. Ascospores 6 (–8) per ascus, non-septate, wall equally thickened, halonate, ellipsoid, 10–14 × 7–8 µm, halo 1–1.5 µm.

Chemistry: several unknown xantholepinones (different from *Malmidea bakeri*) and no atranorin!

Discussion: In the world key presented by BREUSS & LÜCKING (2015) this new species keys out at couplet 25 (*M. bakeri*, *M. variabilis*). It is characterized by apothecia with a *granifera*-type excipulum, i.e. at first entire, becoming granular with age and finally disappearing (Fig. 8) and especially by lacking atranorin. The latter character separates it from the very similar *M. bakeri*, *M. variabilis* and *M. piperina*, all with a (south-)east Asian distribution. In a recent list of lichen species from Pedra Talhada Biologica Reserve, Alagoas, Brazil (JUNIOR *et al.* 2021), *M. bakeri*

and *M. piperina* are reported as new for Brazil and Alagoas respectively without information about their chemistry. It could well be that these reports refer to the new species described above.



Fig. 8: *Malmidea allobakeri* (holotype): thallus and apothecia; bar 0.5 mm

Additional material studied: Brazil. **Sergipe:** Few km SE of Capela, c. 85 km ENE of Aracaju, 'Mata do Junco', 10°31' S, 37°03' W, growing on bark in a tropical rainforest (Mata Atlântica), 185 m, leg. M. Cáceres s.n., 29 March 2010 (ISE s.n.).—**Pernambuco:** Bonito, Parque Municipal de Bonito, 8°28'S, 35°43' W, on bark of an unidentified tree in a Brejo (high altitude rainforest), 800 m, October 2000, leg. M. Cáceres & R. Lücking 00-0331 (as *M. piperina*).—**Alagoas:** Municipality of Pilar, Reserva Particular do Patrimônio Natural (R.P.P.N.) Fazenda São Pedro, 09°37' S, 35°58' W, on bark of an unidentified tree in a tropical rainforest (Mata Atlântica), (closed forest), 50 m, leg. M. Cáceres & R. Lücking 01-0541a (as *M. piperina*).

Malmidea allopapillosa Kalb, *sp. nov.*

Fig. 9

Index Fungorum number: IF558604

Similar to *Malmidea papillosa* Weerakoon & Aptroot, but differs in having atranorin as a major metabolite.

Type: VENEZUELA. **Mérida:** Páramo de Mariño, surroundings of Tovar, c. 8°17' N, 71°41' W, corticolous in a montane cloud forest, 3000 m, 25 November 1980, leg. M. López-Figueiras 24745 (MERF, holotype!).

Etymology: The specific epithet refers to its similarity to *Malmidea papillosa*.

Thallus crustose, corticolous, continuous or cracked, 50–100 µm thick, smooth, dull with ± globose warts, 0.2–0.3 mm diam., whitish grey, isidia and soralia absent. Cortex of thallus K+ yellow, medulla of thallus white, K–, medulla of warts peach-coloured to pink, K+ orange-red, soon changing to lemon-yellow, P– (sometimes very faintly lemon-yellow). Photobiont chlorococ-coid, cells 6–8 µm diam. Apothecia sessile, rounded, 0.3–0.8 mm diam. and 0.4–0.5 mm high; disc plane, light to dark brown; margin thin, c. 0.05 mm thick, whitish grey to dark brownish grey, excluded with age and becoming a *piperis*-type excipulum, hyaline or brown at periphery, inner

part hyaline, without hydrophobic granules. Subhymenium *c.* 15 μm high, hyaline to light brown; hypothecium centrally 70–90 μm high, tapering to the margin, reddish- to dark brown, K–. Epihymenium brown. Hymenium 130–150 μm high, hyaline; apothecial base partly filled with opaque granules, K+ greenish yellow. Asci 90–120 \times 20–25 μm . Ascospores 6–8 per ascus, broadly ellipsoid, non-septate, wall equally thickened, halonate, 14–17 \times 8–10 μm , halo 1 μm .

Chemistry: atranorin (major), *c.* 10 unknown xantholepinones.

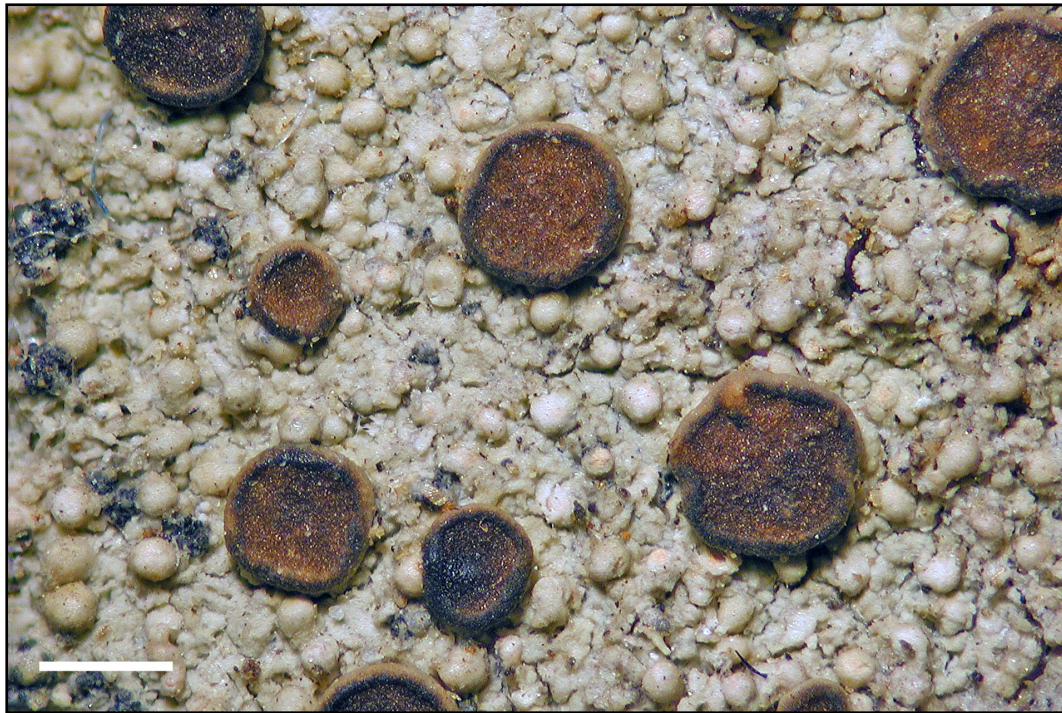


Fig. 9: *Malmidea allopapillosa* (holotype): thallus and apothecia; bar 0.5 mm

Discussion: *Malmidea papillosa* is very similar to the new species, but differs chemically and thus exhibits different spot reactions (WEERAKOON & APTROOT 2014). *Malmidea coralliformis* Kalb is also similar, but this species also lacks atranorin and all three species exhibit a different array of xantholepinones on TLC plates. In the world key presented by BREUSS & LÜCKING (2015), the new species keys out at couplet 32 (*M. granifera*, *M. leucogranifera*), but both of these species lack atranorin and *M. leucogranifera* differs further in having a pale yellow, K+ dark yellow thalline medulla.

Malmidea atlantica (M. Cáceres & Lücking) M. Cáceres & Kalb

Figs. 10, 11

Bibliotheca Lichenologica 106: 164 (2011).—*Malcolmiella atlantica* M. Cáceres & Lücking, Libri Botanici 22: 101 (2007). Type: Brazil. Sergipe: Areia Branca, Reserva Ecológica Serra de Itabaiana, 10°45' S, 37°20' W, Mata Atlântica (closed forest), 500 m, leg. M. Cáceres & Lücking 2209 (URM, holotype, ISE, isotype!, F, isotype!).

Etymology: The specific epithet refers to the occurrence of the species in the Atlantic rainforest (Mata Atlântica).

Thallus crustose, corticolous, continuous, 75–200 μm thick, verrucose, verrucae \pm globose, 0.15–0.30 mm diam., dull, greenish grey to brownish grey or olive, soralia and isidia absent. Medulla of verrucae and thallus orange-yellow, K+ purple, P+ vermillion. Photobiont chlorococcoid, cells 6–8

μm diam. Apothecia sessile, rounded, 0.3–2 mm diam. and 0.2–0.5 mm high; disc plane to convex with age, beige to grey-brown to blackish; excipulum of *granifera*-type, entire, cream-coloured to beige with a yellowish tinge. Ectal excipulum hyaline, medullary excipulum filled with greyish to ochraceous orange-yellow hydrophobic granules, opaque, K+ purple, P–. Subhymenium *c.* 20 μm high, light brown; hypothecium centrally 100–130 μm high, narrowing to the margin, dark brown, K–. Epihymenium indistinct. Hymenium 70–100 μm high, hyaline. Asci 60–80 μm \times 15–20 μm . Ascospores 6 (–8) per ascus, non-septate, wall equally thickened, halonate, ellipsoid, 10–15 \times 6–8 μm , halo 1–1.5 μm .

Chemistry: 7-chloroemodin (major), 5-chloroemodin (major), 7-chloroemodic acid (major).



Fig. 10: *Malmidea atlantica* (isotype): thallus and apothecia; note the densely crowded thallus warts, partly with abraded tips; bar 1 mm

Discussion: CÁCERES *et al.* (2013) correctly stated that *Malmidea atlantica*, *M. pallidoatlantica* and *M. sulphureosorediata* have identical chemistries and assumed that emodin was the major substance present. A revised chemistry is given above. It should also be noted, that the medulla of the thallus and of the thallus-warts react K+ purple and P+ vermilion. The latter spot-reaction was not mentioned in the protologue and also cannot be attributed to any of the anthraquinones mentioned. Contrary to the statements in various keys to *Malmidea* and descriptions of this species, (CÁCERES 2007, BREUSS & LÜCKING 2015) *M. atlantica* is treated here as a non-sorediate species (two isotypes and several additional specimens examined). With age, the upper cortex of the thallus warts becomes extremely thin and fragile. If not collected and stored with great care, these warts can be easily be abraded and soralia simulated (Fig. 10). In that case, *M. atlantica* can be misidentified as *M. sulphureosorediata*, but that species differs in having at least some well delimited soralia, especially in sheltered cracks of the bark. The size, distribution on the thallus and number of the thallus warts varies considerably, even within one collection. In the type specimens the warts are rather large (up to 0.30 mm diam.) and densely crowded, while in other material they are small (up to 0.2 mm diam.) and dispersed on the thallus (Figs. 10 and 11).

Additional material studied: BRAZIL. **Sergipe**: Santa Luzia, private property, 11°19' S, 37°27' W, Mata Atlântica (closed forest), leg. M. Cáceres & Lücking 00-0853, (URM, paratype!). dto: 'Mata do Crasto', near Santa Luzia do Itanhi, c. 80 km SSW of Aracaju, 11°22'26" S, 37°25'30" W, corticolous in a tropical rainforest (Mata Atlântica), c. 7 km from the Atlantic Ocean, 25 m; 17. IV. 2010, leg. K. Kalb & M. Cáceres (herb. K. Kalb 38282). **Bahia**: c. 10 km W of Porto Seguro, 16°30' S, 39° W, corticolous in an old coastal forest not subject to flooding (Restinga), 20 m, 23. VII. 1980, leg. K. Kalb & M.P. Marcelli (herb. K. Kalb 38240).

Paratypes of *Malmidea atlantica* assigned here to other species:

BRAZIL. **Pernambuco**: Bonito, Parque Municipal de Bonito, 8°28' S, 35°43' W, corticolous in a high altitude rain forest (Brejo), 800 m, leg. M. Cáceres & R. Lücking 00-0316 (F-1179059!).

This specimen was identified as *Malmidea volcaniana* Kalb & Hernández.

BRAZIL. **Pernambuco**: Caruaru; Brejo dos Cavalos, 8°20' S, 35°58' W, corticolous in a high altitude rainforest (Brejo), 800–900 m, leg. M. Cáceres & R. Lücking 00-0598 (F-1179214!).

This specimen was identified as *Malmidea sulphureosorediata* M. Cáceres, D. A. Mota & Aptroot.



Fig. 11: *Malmidea atlantica*; thallus and apothecia; note the dispersed thallus warts, partly with abraded tips; bar 1 mm

Malmidea atlanticoides Kalb & M. Cáceres, *sp. nov.*

Fig. 12

Index Fungorum number: IF558605

Similar to *Malmidea atlantica* (M. Cáceres & Lücking) M. Cáceres & Kalb, but differs in having an alternative chemistry, e.g. atranorin (major) and an unknown orange-yellow pigment.

Type: BRAZIL. **Sergipe**: Serra de Itabaiana, c. 45 km NE of Aracaju, 'Parque Nacional Serra de Itabaiana', 10°46'03" S, 37°20'22" W, in remnants of a tropical rainforest (Mata Atlântica) along a rivulet, 190 m, 14 April 2010, leg. K. Kalb (37894) & M. Cáceres (ISE, holotype).

Etymology: The specific epithet refers to its similarity to *Malmidea atlantica*.

Thallus crustose, corticolous, continuous, 75–100 μm thick, verrucose, verrucae \pm globose, 0,1–0,25 mm diam., dull, ash-grey, greenish grey to light olive, soralia and isidia absent. Medulla of verrucae and thallus orange-yellow, K+ orange to reddish, P+ vermilion. Photobiont chlorococcoid, cells 6–8 μm diam. Apothecia sessile, rounded, 0,5–0,8 mm diam. and 0,3–0,4 mm high; disc plane to slightly concave, beige to light brownish; excipulum of *granifera*-type, first entire, becoming granular with age, whitish to cream-coloured, bulging, towering the disc. Ectal excipulum hyaline, medullary excipulum filled with orange-yellow hydrophobic granules, nubilous, dissolving in KOH with K+ lemon-yellow efflux, apothecial base K+ orange-red. Subhymenium *c.* 25 μm high, light brown; hypothecium centrally 80–100 μm high, narrowing to the margin, dark brown, K–. Epihymenium indistinct. Hymenium 100–110 μm high, hyaline. Asci 60–80 μm \times 15–20 μm . Ascospores (4–)6–8 per ascus, non-septate, wall equally thickened, haloate, broadly ellipsoid, 12–15 \times 8–9 μm , halo 1–1,5 μm .

Chemistry: atranorin (major), unknown anthraquinone (major) with R_f -values 45–48, 30, 35–38 in solvents A, B' and C.

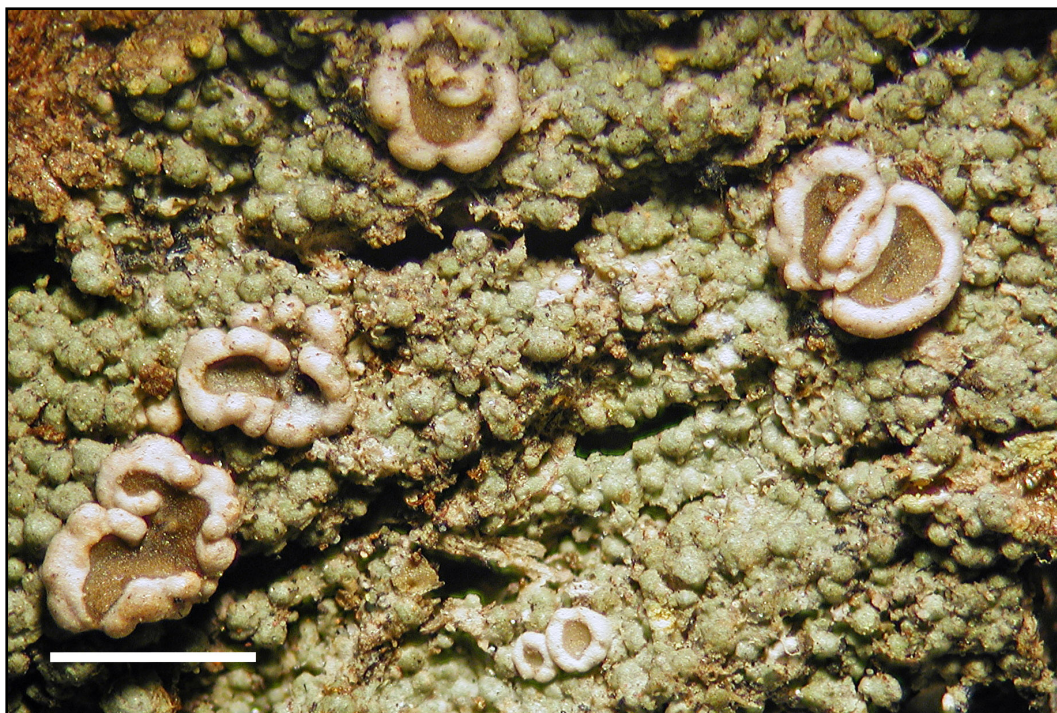


Fig. 12: *Malmidea atlanticoides* (holotype); thallus and apothecia; bar 1 mm

Discussion: The new species is habitually very similar to *M. atlantica* and was initially identified as such. However, TLC revealed clear differences. Atranorin is never present in *M. atlantica* and the anthraquinones were identified as 7-chloroemodin (major), 5-chloroemodin (major), 7-chloroemodic acid (major). Although the R_f -values of the major anthraquinone present in *M. atlanticoides* are very close to that of teloschistin, cochromatography with *Teloschistes flavicans*, the standard lichen for teloschistin, confirmed that they were not identical. In the world key presented by BREUSS & LÜCKING (2015) this new species keys out at couplet 32 (*M. granifera*, *M. leucogranifera*). However, both of these species lack atranorin as well as the unknown anthraquinone.

At present *M. atlanticoides* is only known from the type locality.

Malmidea badimioides (M. Cáceres & Lücking) M. Cáceres & Kalb

Fig. 13

Bibliotheca Lichenologica 106: 164 (2011).—*Malcolmiella badimioides* M. Cáceres & Lücking, Libri Botanici 22: 102 (2007). Type: BRAZIL. Pernambuco: Cabo de Santo Agostinho, Reserva Ecológica de Gurjaú 8°19' S, 35°04' W, Mata Atlântica (closed forest), 30 m, leg. M. Cáceres & Lücking 00-0212 (F, holotype!, B, isotype).

Thallus crustose, corticolous, continuous, 40–60 μm thick, verrucose, verrucae \pm globose, 0.1–0.2 mm diam., dull, grey, whitish grey to greenish grey, soralia and isidia absent. Medulla of verrucae and thallus white, K+ lemon-yellow, P+ orange (best seen in sections under the light microscope). Photobiont chlorococcoid, cells 6–8 μm diam. Apothecia sessile, rounded, 0.4–1 mm diam. and 0.2–0.3 mm high; disc \pm plane, orange-brown or brown-red; excipulum of *granifera*-type, first entire, becoming granular with age, whitish to cream-coloured, bulging, elevated above the disc; ectal excipulum hyaline; medullary excipulum and apothecial base completely filled with colourless opaque granules or granules confined to medullary pockets, partly dissolving in KOH with K+ greenish yellow efflux; subhymenium *c.* 20 μm high, pale orange or hyaline; hypothecium centrally 70–100 μm high, narrowing to the margin, orange, K+ red, P+ red; epihymenium partly orange, K+ red, P+ orange-red; hymenium 80–100 μm high, hyaline. Asci 70–90 \times 10–15 μm . Ascospores 6–8 per ascus, non-septate, wall equally thickened, halonate, broadly ellipsoid, 14–20 \times 7–10 μm , halo 1 μm .

TLC: 3–6 unknown spots on TLC plates, probably xantholepinones, no atranorin present.



Fig. 13: *Malmidea badimioides*; thallus and apothecia; bar 1 mm

Discussion: As our spot tests did not conform with the chemistry given in the protologue, i.e. "no substances detected by TLC", the TLC was re-examined and the results are reported as above. The collections cited below are new additions to the lichen biota of Mérida state in Venezuela and Mexico.

VENEZUELA. **Mérida**: Distr. Libertador, Monte Zerpa, a few km N of Mérida, above of 'La Hechicera', 8°40' N, 71°10' W, in a pristine cloud forest, 2200 m, 14 August 1989, leg. K. Kalb & M. Lopez-Figueiras (herb. K. Kalb 29469).—MEXICO. **Chiapas**: surroundings of Palenque, 17°29' N, 92°03' W, in a very dark and humid ± pristine rainforest near the Maya ruins, 150 m, 22 January 1979, leg. K. Kalb & G. Plöbst (herb. K. Kalb 38239); TLC: identical spots on TLC plates in solvents A, B' and C to the holotype (F!).

Malmidea hechicerae Kalb, *sp. nov.*

Fig. 14

Index Fungorum number: IF558606

Similar to *Malmidea coralliformis* Kalb, but differs in having an alternative chemistry, e.g. medulla of the thallus K+ lemon-yellow (orange in *M. coralliformis*).

Type: VENEZUELA. **Mérida**: Distr. Libertador, Monte Zerpa, a few km N of Mérida, above of 'La Hechicera', 8°40' N, 71°10' W, in a pristine cloud forest, 2200 m, 14 August 1989, leg. K. Kalb (29429) & M. Lopez-Figueiras (VEN, holotype).

Etymology: The specific epithet refers to the locality where the new species was collected.

Thallus crustose, corticolous, continuous, 40–60 µm thick, verrucose, verrucae ± globose, 0,1–0,25 mm diam., dull, whitish grey, soralia and isidia absent. Medulla of verrucae and thallus white, K+ lemon-yellow rarely slightly orange-yellow, P+ orange (best seen in sections under the light microscope). Photobiont chlorococcoid, cells 6–8 µm diam. Apothecia sessile, rounded, 0,6–1,3 mm diam. and 0,3–0,4 mm high; disc ± plane, beige to brownish or dark brown; excipulum of *granifera*-type, entire, whitish to cream-coloured, bulging, elevated above the disc. Ectal excipulum hyaline to brownish, especially at the edges, medullary excipulum filled with colourless opaque granules, partly dissolving in KOH with K+ greenish yellow efflux. Subhymenium *c.* 20 µm high, light brown; hypothecium centrally 50–70 µm high, narrowing to the margin, dark brown, K–. Epihymenium light brown. Hymenium 70–80 µm high, hyaline. Asci 55–65 µm × 8–15 µm. Ascospores 6–8 per ascus, non-septate, wall equally thickened, halonate, broadly ellipsoid, 13–17 × 7–9 µm, halo 1–1,5 µm.

Chemistry: a characteristic array of 4–5 xantholepinones observed on TLC plates in solvents A, B', C (no atranorin could be detected).

Discussion: The new species is habitually similar to *Malmidea coralliformis* which also lacks atranorin. They are best separated by cochromatography due to the different arrays of xantholepinones. In the world key presented by BREUSS & LÜCKING (2015) the new species keys out at couplet 23 (*M. coralliformis*), but this species differs chemically.



Fig 14: *Malmidea hechicerae* (holotype); thallus and apothecia; note K+ lemon-yellow reaction of the medulla (black arrow on the right side); bar 1 mm

Malmidea hernandeziana Kalb, *sp. nov.*

Fig. 15

Index Fungorum number: IF558607

Similar to *Malmidea fellhaneroides* (Lücking) Kalb & Lücking, but differs in having a chocolate-brown hypothecium, larger ascomata, 0.5–1.3 mm wide (0.25–0.7 mm in *M. fellhaneroides*) and larger ascospores, 14–22 × 8–10 μm (9–11 × 4–6 μm in *M. fellhaneroides*).

Type: VENEZUELA. **Aragua:** Parque Nacional Henry Pittier, km 12 on the road from Maracay to Ocumare de la Costa, Estacion Biologica Dr. Alberto Fernandez Y. 'Andrew Field trail', 10°21' N, 67°40' W, in a ± pristine tropical mountain rainforest (selva nublada), 1100–1200 m, 2 August 2010, leg. K. Kalb (38548) & J. Hernández (VEN, holotype).

Etymology: The specific epithet honours the Venezuelan lichenologist Jesús Hernández.

Thallus crustose, corticolous, ± continuous, 30–70 μm thick, smooth, dull, without warts, isidiate, isidia granular to coralloid, 0.05–0.1 mm long, 0.05 mm wide, densely covering the thallus, soralia absent. Medulla of thallus white, K–. Photobiont chlorococcoid, cells 6–8 μm diam. Apothecia sessile, rounded, 0.5–1.3 mm diam. and 0.4–0.5 mm high; disc initially plane then slightly convex, beige; margin thin, c. 0.1 mm thick, slightly prominent, whitish grey; excipulum *piperis*-type, ± hyaline, without hydrophobic granules; subhymenium c. 10–15 μm high, hyaline to light brownish; hypothecium centrally 80–100 μm high, chocolate-brown, K–; epihymenium indistinct; hymenium 110–130 μm high, hyaline. Asci 90–110 × 15–22 μm. Ascospores 6–8 per ascus, broadly ellipsoid to fusiform, non-septate, wall often slightly thickened at ends, halonate, 14–22 × 8–10 μm, halo 1–1.3 μm.

Chemistry: no lichen substances detected by TLC.



Fig. 15: *Malmidea hernandeziana* (holotype); thallus and apothecia; bar 1 mm

Discussion: The new species is characterized by the coralloid-isidiate thallus, light-coloured ascomata with a *piperis*-type excipulum, comparatively large ascospores, partly with slightly thickened walls at the ends and the lack of lichen products. No other species of *Malmidea* is known to have this combination of characters. Most similar are *M. isidiifera* Kalb which differs in producing atranorin and norsolorinic acid, and *M. fellhaneroides* (Lücking) Kalb & Lücking which differs in having much smaller ascomata and ascospores. Furthermore, the latter is foliicolous (LÜCKING 2008). Habitually also similar is *M. leucogranifera* M. Cáceres & Lücking, but this species differs in the verrucose thallus without isidia, a *granifera*-type excipulum, smaller ascospores ($12\text{--}16 \times 7\text{--}10 \mu\text{m}$) and the chemistry (two xantholepinones are present in *M. leucogranifera*). In the world key presented by BREUSS & LÜCKING (2015) the new species keys out at couplet 7 (*M. perisidiata*), but that species differs in having more slender isidia and brown to grey-brown apothecial discs.

At present *M. hernandeziana* is only known from the type locality, where it was found growing on bark of an unidentified tree in a \pm pristine tropical mountain rainforest (selva nublada) between 1100 and 1200 m.

Malmidea* aff. *hernandeziana* Kalb & Hernández, *ined.

Fig. 16

Similar to *Malmidea hernandeziana* Kalb & Hernández, but differs in having longer isidia, apothecia with a thick, bulging margin and in producing atranorin in the thallus.

VENEZUELA. **Aragua:** Parque Nacional Henry Pittier, km 12 of the road from Maracay to Ocumare de la Costa, Estacion Biologica Dr. Alberto Fernandez Y. 'Andrew Field trail', $10^{\circ}21' \text{N}$, $67^{\circ}40' \text{W}$, in a \pm pristine tropical mountain rainforest (selva nublada), 1100–1200 m, 2 August 2010, leg. K. Kalb & J. Hernández (herb. K. Kalb 38574).

Thallus crustose, corticolous, \pm continuous, 30–70 μm thick, smooth, dull, without warts, isidia densely covering the thallus, granular to coralloid, 0.4–0.5 mm long, 0.05 mm wide, soralia absent.

Medulla of thallus white, K⁻. Photobiont chlorococcoid, cells 6–8 μm diam. Apothecia sessile, rounded, 0.6–0.7 mm diam. and 0.3–0.4 mm high; disc plane, beige; margin thick, bulging, c. 0.1–0.15 mm thick, prominent, bluish grey; excipulum *piperis*-type, \pm hyaline, without hydrophobic granules; subhymenium c. 10–15 μm high, hyaline to light brownish; hypothecium centrally 100–125 μm high, chocolate-brown, K⁻; epihymenium slightly brownish to indistinct; hymenium 90–110 μm high, hyaline. Asci 60–70 \times 16–22 μm . Ascospores 2–6 per ascus, broadly ellipsoid to fusiform, non-septate, wall without thickenings, halonate, 14–22 \times 7–10 μm , halo 1 μm .

Chemistry: atranorin (major).



Fig. 16: *Malmidea* aff. *hernandeziana*; thallus and apothecia; bar 0.5 mm

Discussion: The new species is very similar to *M. hernandeziana*, but differs in having longer isidia and in producing atranorin. It was collected near the type locality of that species and we have found only one apothecium which was destroyed in preparing the above description. Although we are rather confident that the collection represents a new species, we hesitate describing it formally until more material is available.

***Malmidea isidiifera* Kalb sp. nov.**

Fig. 17

Index Fungorum number: IF558608

Similar to *Malmidea piperis* (Spreng.) Kalb, Rivas Plata & Lumbsch, but differs in having a thallus with granular to coralloid isidia and in containing atranorin as a major substance.

Type: BRAZIL. **Rio de Janeiro:** Serra da Mantiqueira; Itatiaia, Parque Nacional do Itatiaia, near the Maromba waterfall, 22°20' S, 44°35' W, corticolous in a humid and dark primary rainforest (Mata Atlântica), 1100 m, 21 July 1978, leg. K. Kalb (42610) & G. Plöbst (CGMS, holotype).

Etymology: The specific epithet refers to the isidiate thallus of this species.

Thallus crustose, corticolous, continuous, 30–70 μm thick, smooth to slightly granular, dull without warts, grey, or orange-red when cortex of thallus is abraded, isidia granular to coralloid,

0.05–0.1 mm long, 0.05 mm wide, densely covering the thallus. Medulla of thallus orange-red, K+ purple. Photobiont chlorococcoid, cells 6–8 μm diam. Apothecia sessile, rounded, 0.7–1.5 mm diam. and 0.4–0.5 mm high; disc initially plane then distinctly convex, light brown-grey to dark brown; margin thin, c. 0.1 mm thick, slightly prominent, whitish grey to dark brownish grey. Excipulum *piperis*-type, hyaline at periphery, inner part reddish- to dark brown, without hydrophobic granules. Subhymenium c. 20 μm high, hyaline to light brown; hypothecium 150–200 μm high, reddish- to dark brown, K-. Epihymenium indistinct. Hymenium 100–140 μm high, hyaline. Asci 70–100 \times 20–25 μm . Ascospores (6–) 8 per ascus, broadly ellipsoid to fusiform, non-septate, wall equally thickened, halonate, 17–23 \times 7–10 μm , halo c. 1 μm thick.

Chemistry: atranorin (major), norsolorinic acid (major).



Fig. 17: *Malmidea isidiifera* (holotype); thallus and apothecia; bar 1 mm

Discussion: The new species is habitually similar to a luxuriant specimen of *Sprucidea gymnopiperis* (Kalb) M. Cáceres, Aptroot & Lücking, but differs in having alternatively sized and shaped spores (bacillar in *Sprucidea* instead of ellipsoid or fusiform in *Malmidea* and only 1–2.5 μm broad) as well as in lacking atranorin (no species of *Sprucidea* are known to contain atranorin). In the world key presented by BREUSS & LÜCKING (2015) the new species keys out at couplet 7 (*M. perisidiata*), but this species differs in lacking norsolorinic acid. The specimen cited below is a new addition to the lichen biota of Venezuela.

VENEZUELA. **Mérida:** La Mucuy, bosques y piedras, on bark of an unidentified tree, 2000–2300 m, 4 February 1974, leg. M. E. Hale 42990 (MERF).

Malmidea leptoloma (Müll. Arg.) Kalb & Lücking

Fig. 18

Bibliotheca Lichenologica 106: 165 (2011).—*Lecidea leptoloma* Müll. Arg., Flora (Regensburg) 64 (32): 518 (1881), (G, photograph seen!).—*Biatora leptoloma* (Müll. Arg.) Hellb., Bihang till Kongliga Svenska Vetenskapsakademiens Handlingar 21, III (13): 105 (1896).—*Malcolmiella leptoloma* (Müll. Arg.) Cáceres & Lücking, Libri Botanici 22: 106 (2007).

This species is distinguished by having a \pm thin, granular, rimose-areolate thallus, apothecia 0.5–0.9 mm diam. with an ochre-brown disc, a *piperis*-type excipulum, ascospores $9\text{--}12 \times 5\text{--}7 \mu\text{m}$ and in lacking lichen substances.

The locality given below is a new addition to the Venezuelan lichen biota.

VENEZUELA. **Aragua:** Descent on the road from Ocumare de la Costa to Maracay, below the Estacion Biologica Dr. Alberto Fernandez Y., $10^{\circ}22'01''$ N, $67^{\circ}42'40''$ W, in a very disturbed, bushy rainforest, 500 m, 5 August 2010, leg. K. Kalb & J. Hernández (herb. K. Kalb 38306).

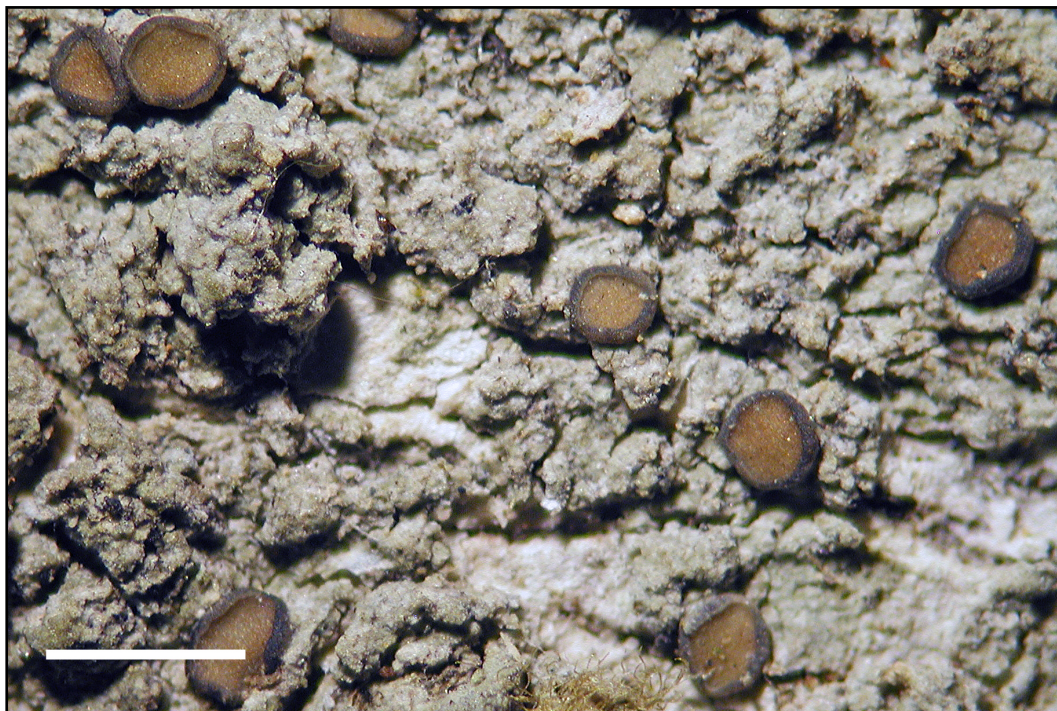


Fig. 18: *Malmidea leptoloma*; thallus and apothecia; bar 1 mm

Malmidea leucopiperis Kalb, *sp. nov.*

Fig. 19

Index Fungorum number: IF558609

Similar to *Malmidea piperis*, but differs in having a light greyish to beige hypothecium (dark brown in *M. piperis*).

Type: BRAZIL. **Rio de Janeiro:** Serra da Mantiqueira; Itatiaia, Parque Nacional do Itatiaia, $22^{\circ}22'$ S, $44^{\circ}35'$ W, in a humid and dark primary rainforest (Mata Atlântica), 850 m, 21 July 1978, leg. K. Kalb 42612 & G. Plöbst, (CGMS, holotype).

Etymology: The specific epithet refers to the light-coloured hypothecium of this new species.

Thallus crustose, corticolous, continuous, $50\text{--}80 \mu\text{m}$ thick, smooth, dull, without warts, grey, greenish grey or orange-red when cortex of thallus is abraded, isidia and soralia absent. Medulla of thallus orange-red, K+ purple. Photobiont chlorococcoid, cells $6\text{--}8 \mu\text{m}$ diam. Apothecia sessile, rounded, $0.3\text{--}0.6$ mm diam. and $0.15\text{--}0.2$ mm high; disc initially plane then slightly convex, light beige, brown-grey to brown; margin thin, *c.* 0.1 mm thick, slightly prominent, whitish grey to dark brownish grey or black. Excipulum *piperis*-type, \pm hyaline, brownish or blackish at upper periphery, without hydrophobic granules. Subhymenium *c.* $10 \mu\text{m}$ high, hyaline; hypothecium centrally $40\text{--}50 \mu\text{m}$ high, light greyish to beige, K-. Epihymenium indistinct or slightly granular.

Hymenium 60–70 μm high, hyaline. Asci 40–50 \times 8–10 μm . Ascospores 6–8 per ascus, broadly ellipsoid to fusiform, non-septate, wall equally thickened, halonate, 9–12 \times 4–6 μm , halo 1 μm .

Chemistry: norsolorinic acid (major); (no atranorin detected by TLC).



Fig. 19: *Malmidea leucopiperis*; thallus and apothecia; bar 0.5 mm

Discussion: The new species is easily recognized by its light-coloured hypothecium together with the presence of norsolorinic acid in the thallus. At present it is only known from the Atlantic rainforest (Mata Atlântica) in southern Brazil. In the world key presented by BREUSS & LÜCKING (2015) the new species keys out at couplet 38 (*M. fellhaneroides*, *M. fuscella*), but both species differ in lacking norsolorinic acid.

Additional material studied: BRAZIL. **São Paulo:** Ilha de São Sebastião: ca. 130 km E of São Paulo; western slope of Morro das Tacas, 23°50' S, 45°20' W, in a very humid and dark rainforest along a rivulet, 400 m, 6 July 1979, leg. K. Kalb (37816) & J. Poelt (CGMS).—Serra do Mar; Canto Moreira near Maresias, c. 30 km W of São Sebastião, 23°50' S, 45°40' W, at the edge of a coastal rainforest (Restinga), 1 m, 16 February 1980, leg. K. Kalb (10813) & G. Plöbst (CGMS).—Fazenda São João near Rio Claro 22°25' S, 47°35' W, in a gallery forest, 600 m, 16 August 1980, leg. K. Kalb (CGMS).

Malmidea nigromarginata (Malme) Lücking & Breuss

Fig. 20

Lichenologist 47 (1): 19 (2015). Type: *Lecidea nigromarginata* Malme: BRAZIL. Rio Grande do Sul: Silveira Martins, leg. G. A. Malme 1107 (S, holotype; photograph seen!).

This species is readily recognized by its smooth thallus, the presence of norsolorinic acid, apothecia 0.1–1.0 mm diam. with a beige to greyish brown disc, black margin, small ascospores, 10–12 \times 4–6 μm , greyish brown hypothecium and a blackish brown excipulum which is sometimes hyaline at the margins.

TLC: norsolorinic acid (major), no atranorin detected.

The localities mentioned below are new additions to the Venezuelan lichen biota.

VENEZUELA. **Aragua:** Parque Nacional Henry Pittier, km 12 on the road from Maracay to Ocumare de la Costa, Estacion Biologica Dr. Alberto Fernandez Y. 'Andrew Field trail', 10°21' N, 67°40' W, in a ± pristine tropical mountain rainforest (selva nublada), 1100–1200 m, 2 August 2010, leg. K. Kalb & J. Hernández (herb. K. Kalb 38484);—Descent on the road from Ocumare de la Costa to Maracay, below the Estacion Biologica Dr. Alberto Fernandez Y. 10°22'01" N, 67°42'40" W, in a very disturbed, bushy rainforest, 500 m, leg. K. Kalb & J. Hernández, 5 August 2010 (herb. K. Kalb 38496).

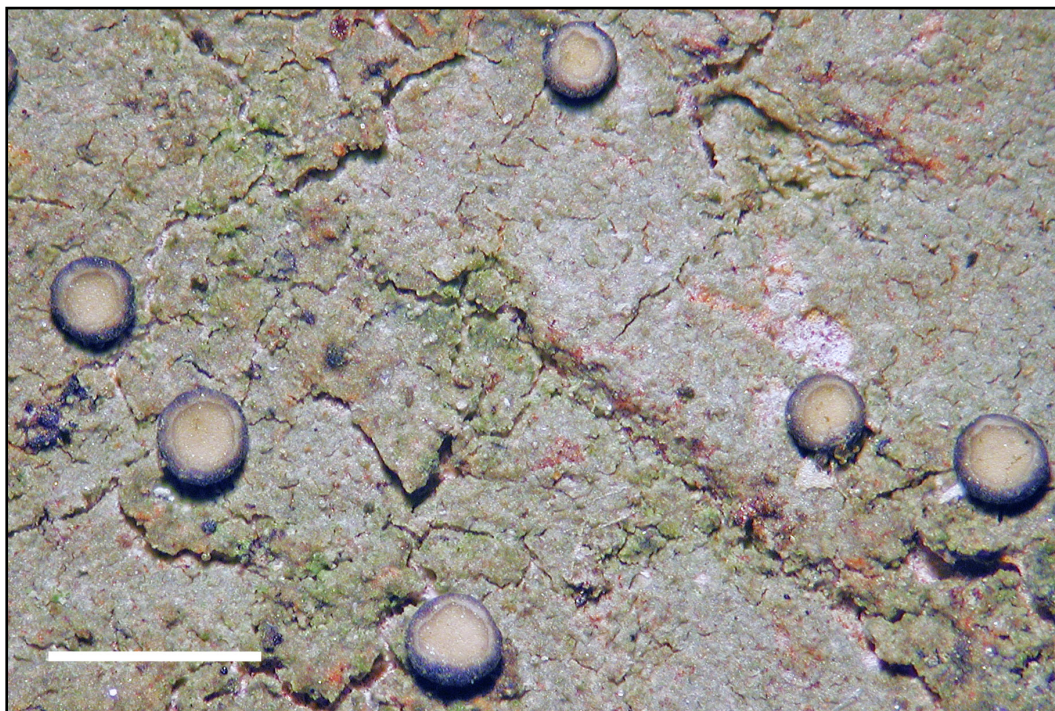


Fig. 20: *Malmidea nigromarginata*; thallus and apothecia; bar 1 mm

Malmidea perplexa Kalb

Fig. 21

Bibliotheca Lichenologica 106: 160 (2011), Type: THAILAND. **Chiang Mai Province:** Lumphun, Mae On, ESE of Chiang Mai; descent from Doi Mon Lam to Mae Kam Pong village, in an evergreen mountain forest dominated by *Lithocarpus*, *Quercus*, *Castanopsis*, 18°51'22" N 99°22'02" E, c. 1500 m, 19 March 2008. leg. K. Kalb 36892, K. Buaruang, W. Saipunkaew & W. Polyiam (RAMK, holotype!).

This species is distinguished by a smooth, continuous or slightly cracked thallus without warts, apothecia with a light brown-grey or beige disc, a *piperis*-type excipulum, a hyaline to light or greyish brown hypothecium, small ascospores, 9–13 × 5–7 μm, and the absence of lichen substances. It is similar to *M. leptoloma* (Müll. Arg.) Kalb & Lücking, but this species has apothecia with a darker brown disc, usually with a blackish margin and often a ± rugulose thallus. Previously, *M. perplexa* was known from Brazil and Thailand (KALB *et al.* 2011). The locality presented below is a new addition to the Venezuelan lichen biota.

TLC: no lichen substances detected by TLC.

VENEZUELA. **Aragua:** Descent on the road from Ocumare de la Costa to Maracay, below the Estacion Biologica Dr. Alberto Fernandez Y., 10°22'01" N, 67°42'40" W, in a very disturbed, bushy rainforest, 500 m, 5 August 2010, leg. K. Kalb & J. Hernandez (herb. K. Kalb 38311).

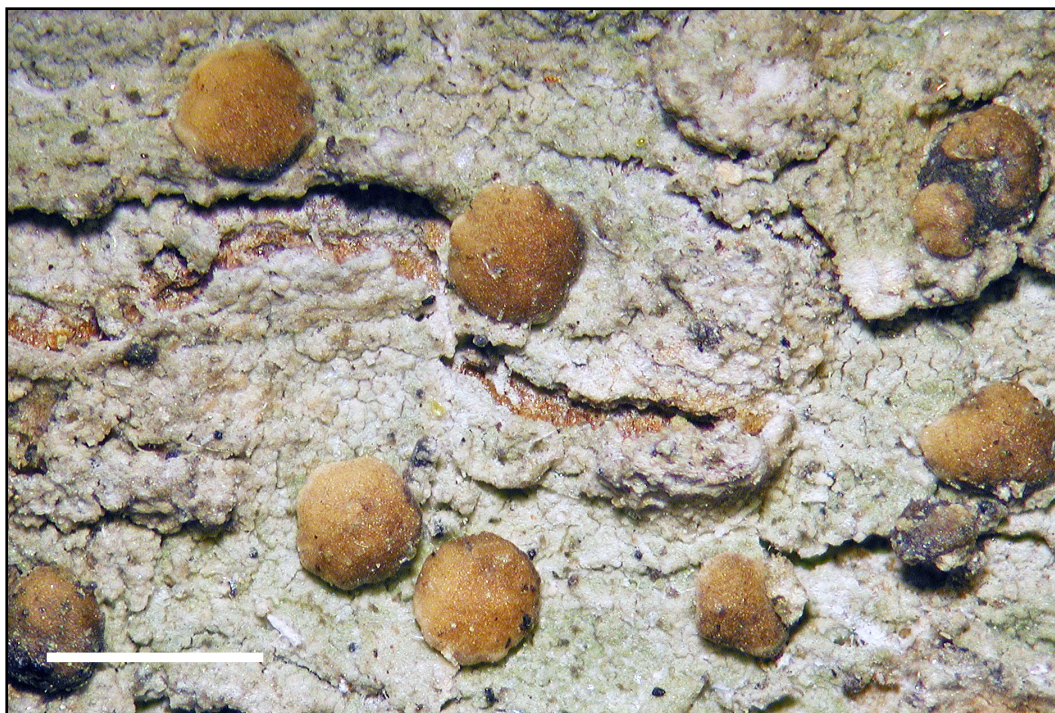


Fig. 21: *Malmidea perplexa*; thallus and apothecia; bar 1 mm

Malmidea polycampia (Tuck.) Kalb & Lücking

Fig. 22

Bibliotheca Lichenologica 106: 165 (2011).—*Lecidea polycampia* Tuck., Proceedings of the American Academy of Arts and Sciences 6: 274 (1864).—New synonym: *Malmidea flavopustulosa* (M. Cáceres & Lücking) M. Cáceres & Kalb, Bibliotheca Lichenologica 106: 165 (2011).—*Malcolmiella flavopustulosa* M. Cáceres & Lücking, Libri Botanici 22: 103 (2007).

Thallus crustose, corticolous, continuous, 20–40 μm thick, partly verrucose, verrucae mainly at the periphery of the thallus, \pm globose, c. 0.1 mm diam., coalescing with age and forming coralloid clumps of thin, isidia-like outgrowths, dull, greenish grey to ash-grey, soralia \pm punctiform, 0.01 mm diam., white to yellowish (depending on the concentration of xantholepinones), originating from warts which break off at the tips, K+ lemon-yellow, P–. Medulla of verrucae and thallus white to yellowish, K+ lemon-yellow, P–. Photobiont chlorococcoid, cells 6–8 μm diam. Apothecia sessile, rounded, 0.3–1 mm diam. and 0.3–0.4 mm high; disc plane at first, becoming slightly convex with age, beige to brown; excipulum of *granifera*-type, entire, becoming granular, whitish, cream-coloured to greyish, paler than the disc; ectal excipulum hyaline, medullary excipulum completely filled with greyish, opaque granules, or granules only in medullary pockets, dissolving in KOH, K+ lemon-yellow to orange-yellow; subhymenium c. 20 μm high, light brown; hypothecium centrally 100–115 μm high, narrowing to the margin, dark brown, K–; epihymenium indistinct. Hymenium 85–110 μm high, hyaline; asci 50–70 μm \times 10–15 μm . Ascospores (6–) 8 per ascus, non-septate, wall equally thickened, halonate, broadly ellipsoid, 11–15 \times 6–8 μm , halo c. 1 μm thick.

TLC: atranorin (major), unknown xantholepinones.

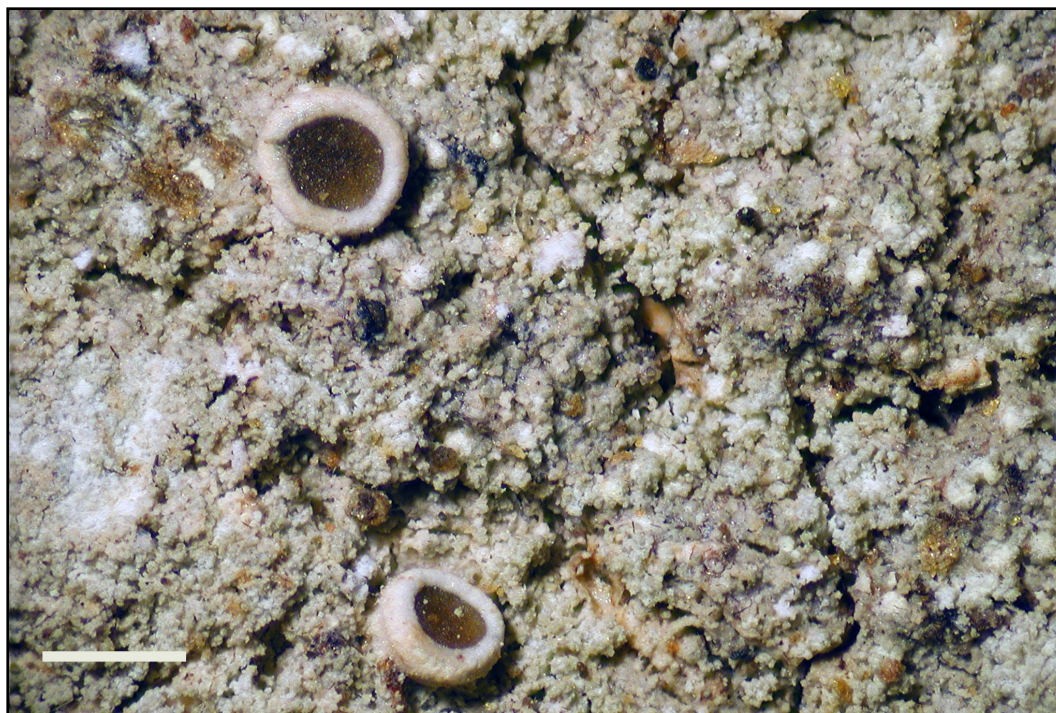


Fig. 22: *Malmidea polycampia* (isotype, M); thallus and apothecia; bar 0.5 mm

Discussion: The species is morphologically very similar to *M. volcaniana* but it differs in lacking anthraquinones. *Malmidea albomarginata* is also similar, but this species lacks soralia. It is not possible to elucidate the chemistry by TLC, because of the numerous spots (probably more than ten) at least some of them caused by substances from the bark. A morphological, anatomical and chemical comparison of type material of *Malmidea polycampia* (Tuck.) Kalb & Lüicking and *M. flavopustulosa* (M. Cáceres & Lüicking) M. Cáceres & Kalb revealed that both names are synonym. The localities reported below are new additions to the Venezuelan lichen biota.

Material studied: VENEZUELA. **Aragua:** Parque Nacional Henry Pittier, km 12 on the road from Maracay to Ocumare de la Costa, Estacion Biologica Dr. Alberto Fernandez Y. "Andrew Field trail", 10°21' N, 67°40' W, in a ± pristine tropical mountain rainforest (selva nublada), 1100–1200 m, 2 August 2010, leg. K. Kalb & J. Hernández (herb. K. Kalb 38536).—**Miranda:** Los Guaya-bitos; Cerro El Volcán, 10°24'59" N, 66°51'11" W, corticolous in a very disturbed tropical mountain rainforest (bosque nublado), 1460 m, 1 October 2010, leg. K. Kalb 38380 & J. Hernández (growing together with the type specimen of *Malmidea albomarginata*).

Malmidea rhodopis (Tuck.) Kalb, Rivas Plata & Lumbsch

Fig. 23

Bibliotheca Lichenologica 106: 165 (2011).—*Biatora rhodopis* Tuck., American Journal of Science and Arts 28: 205 (1859).

This species is distinguished in having a ± smooth, continuous to cracked-areolate thallus containing norsolorinic acid. This anthraquinone is also present in the excipulum of the apothecium. These characters make *M. rhodopis* distinctive.

TLC: norsolorinic acid (major); no other substances detected by TLC.

The collection cited below is a new addition to the Venezuelan lichen biota.

VENEZUELA. **Mérida**: Distr. Libertador, Monte Zerpa, a few km N of Mérida, above of 'La Hechicera', 8°40' N, 71°10' W, in a pristine cloud forest, 2200 m, 14 August 1989, leg. K. Kalb & M. López-Figueiras (herb. K. Kalb 29441).



Fig. 23: *Malmidea rhodopis*; Thallus and apothecia; bar 1 mm

Malmidea rhodopisoides Kalb, *sp. nov.*

Fig. 24

Index Fungorum number: IF558610

Similar to *Malmidea rhodopis* (Tuck.) Kalb, Rivas Plata & Lumbsch and *M. isidiifera* Kalb. It differs from *M. rhodopis* in having a granular to isidiate thallus and from *M. isidiifera* in containing norsolorinic acid in the medulla and inner excipulum of the apothecia.

Type: BRAZIL. **São Paulo**: Grande Anel Rodoviário between Via dos Imigrantes and Via Anchieta, in a dry forest on sand dunes, 670 m, 23°50' S, 46°35' W, 1. VII. 1979, leg: K. Kalb 42618. (CGMS, holotype).

Etymology: The specific epithet refers to its similarity to *Malmidea rhodopis*.

Thallus crustose, corticolous, 20–40 µm thick, composed of clumps of isidia-like granules, ± densely covering the orange-red prothallus, dull, grey to greenish grey, or orange-red when the cortex of thallus is abraded. Medulla orange-red, K+ purple. Photobiont chlorococcoid, cells 6–8 µm diam. Apothecia sessile, rounded, 0.7–1.5 mm diam. and 0.4–0.5 mm high; disc plane at first then slightly convex, beige to dark brown; margin *c.* 0.1 mm thick, bulging, elevated above the disc, orange-red, rarely partly blackish. Excipulum *piperis*-type, hyaline at periphery, inner part filled with hydrophobic granules of norsolorinic acid. Subhymenium *c.* 20 µm high, hyaline to light brown; hypothecium 200–400 µm high, reddish- to dark brown, K–. Epihymenium indistinct or slightly granular. Hymenium 70–80 µm high, hyaline. Asci 60–70 × 20–25 µm. Ascospores 6–8 per ascus, broadly ellipsoid to fusiform, non-septate, wall equally thickened, halonate, 15–20 × 9–12 µm, halo *c.* 1 µm thick.

Chemistry: norsolorinic acid (major), no atranorin!



Fig. 24: *Malmidea rhodopisoides*; thallus and apothecia; bar 1 mm

Discussion: The new species appears to be intermediate between *M. rhodopis* and *M. isidiifera*. The first species always has a smooth thallus which usually remains corticate (Fig. 23) and is distinguished further in having smaller ascospores ($9\text{--}15 \times 5\text{--}8 \mu\text{m}$), while *M. isidiifera* lacks norsolorinic acid in the inner part of the excipulum and the thallus is covered by elongate, non-granular isidia (Fig. 17). In the world key presented by BREUSS & LÜCKING (2015) the new species keys out at couplet 7 (*M. perisidiata*), but that species lacks norsolorinic acid and has lender isidia.

Malmidea subcinerea Kalb, *sp. nov.*

Fig. 25

Index Fungorum number: IF558611

Similar to *Malmidea cinerea* Breuss & Lücking, but differs in lacking lichen metabolites.

Type: VENEZUELA. **Mérida**: Distr. Libertador, Monte Zerpa, a few km N of Mérida, above of 'La Hechicera', $8^{\circ}40' \text{N}$, $71^{\circ}10' \text{W}$, in a pristine cloud forest, 2200 m, 14 August 1989, leg. K. Kalb (29428) & M. López-Figueiras (VEN, holotype).

Etymology: The specific epithet refers to its similarity to *Malmidea cinerea*.

Thallus crustose, corticolous, continuous, $80\text{--}120 \mu\text{m}$ thick, smooth, dull, without warts, grey, greenish grey to olive, isidia and soralia absent. Medulla of thallus white, K-. Photobiont chlorococcoid, cells $10\text{--}12 \mu\text{m}$ diam. Apothecia sessile, rounded, $0.4\text{--}0.9 \text{ mm}$ diam. and $0.2\text{--}0.3 \text{ mm}$ high; disc at first plane then slightly convex, light beige to light greyish brown; margin *c.* 0.15 mm thick, slightly prominent, whitish grey to brownish grey. Excipulum *piperis*-type, \pm hyaline at periphery, centrally and at upper periphery brownish, without hydrophobic granules; subhymenium *c.* $10 \mu\text{m}$ high, hyaline or slightly brownish; hypothecium centrally $50\text{--}70$ ($\text{--}125$) μm high, dark brown to reddish brown, K-; epihymenium indistinct or light brown; hymenium $100\text{--}120 \mu\text{m}$ high, hyaline; asci $60\text{--}75 \times 10\text{--}15 \mu\text{m}$. Ascospores 6–8 per ascus, broadly ellipsoid to fusiform, non-septate, wall equally thickened, halonate, $9\text{--}12 \times 5\text{--}7 \mu\text{m}$, halo *c.* $1 \mu\text{m}$ thick.

Chemistry: no lichen substances detected by TLC.

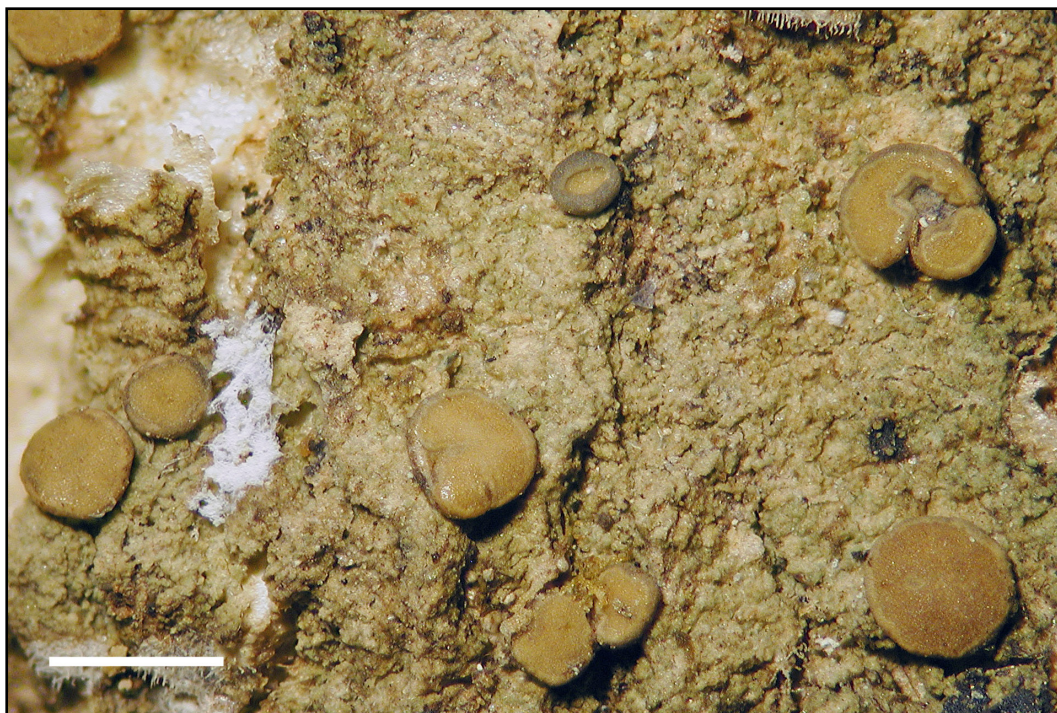


Fig. 25: *Malmidea subcinerea*; thallus and apothecia; bar 1 mm

Discussion: In a world key to *Malmidea* species presented by BREUSS & LÜCKING (2015), the new species keys out at couplet 49 (*M. vinosa*, *M. cinereonigrella*). However, it can be distinguished from both species by its beige to greyish brown apothecial discs. It is similar to *M. cinerea*, but according to the protologue of that species, the apothecia belong to the *granifera*-type. Furthermore, that species produces at least two xantholepinones.

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

Fig. 26

Lichenologist 45 (5): 620 (2013).—Type: BRAZIL. Bahia, Santa Teresinha, Serra da Jobóia, corticolous on bark of tree, c. 700 m, IX. 2010, leg. M. E. S. Cáceres 7645 (ISE, holotype, n.v.).

Etymology: The specific epithet refers to the bright golden yellow soredia.

Thallus crustose, corticolous, continuous, granular to finely microsquamulose, partly verrucose, verrucae orbicular, c. 0.01 mm diam., dull, greenish grey, soralia intense orange-yellow, originating from apically disrupting verrucae, isidia absent. Medulla of verrucae and thallus intense orange-yellow, K+ purple, P+ wine-red. Photobiont chlorococcoid, cells 6–8 µm diam. Apothecia sessile, rounded, 0.3–1 mm diam. and 0.4–0.5 mm high; disc plane to slightly convex, beige to chocolate brown or blackish; excipulum of *granifera*-type, entire, cream-coloured to greyish or black. Ectal excipulum hyaline, medullary excipulum orange-yellow, completely filled with orange-yellow hydrophobic granules, nubilous, only partly dissolving in KOH with K+ purple efflux. Subhymenium c. 15–20 µm high, light brown; hypothecium centrally 80–100 µm high, narrowing to the margin, dark brown, K–. Epihymenium indistinct. Hymenium 90–120 µm high, hyaline. Asci 70–80 µm × 15–20 µm. Ascospores 6 (–8) per ascus, non-septate, wall equally thickened, halonate, ellipsoid, 11–15 × 7–9 µm, halo 1–1.5 µm.

Chemistry: 7-chloroemodin (major), 5-chloroemodin (major), 7-chloroemodic acid (major).

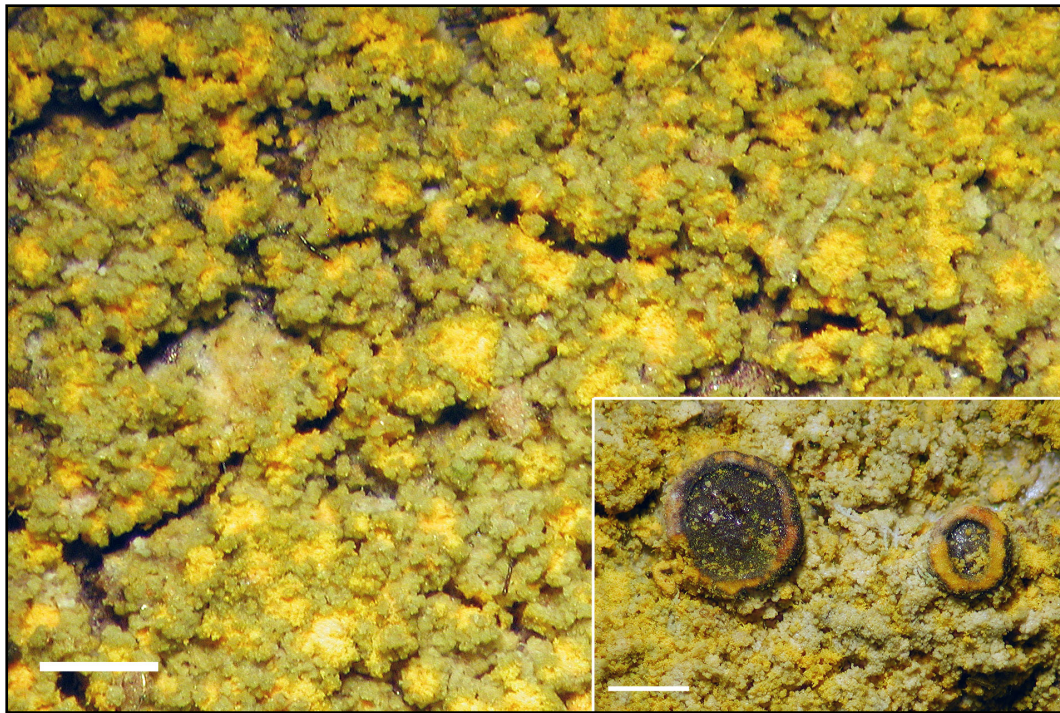


Fig. 26: *Malmidea sulphureosorediata*; thallus with soralia; bar 0.25 mm; inlet: thallus with soralia and apothecia; bar 0.5 mm

Discussion: Previously this species was only known from infertile material from the type locality. The localities cited below are new findings for the Brazilian states of Pernambuco, Espírito Santo and São Paulo and for Venezuela. In the protologue (CÁCERES *et al.* 2013), the authors suspected this species contained emodin, but I found 7-chloroemodin, which was identified by cochromatography with *Heterodermia obscurata* (Nyl.) Trevis., together with two additional major spots on the TLC plates (Rf-values 64, 56, 51 and 52–53, 38, 38–39 in solvent systems A, B', C). These spots were identified as 5-chloroemodin and 7-chloroemodic acid by Prof. J.A. Elix.

Additional material studied: VENEZUELA. **Miranda:** Los Guayabitos; Cerro El Volcán, 10°24' 59" N, 66°51'11" W, corticolous in a very disturbed tropical mountain rainforest (bosque nublado), 1460 m, 01 September 2010, leg. K. Kalb & J. Hernández (herb. K. Kalb 38413, 38405, fertile!).—**Bolivar:** Gran Sabana; just S of the southern limits of Parque Nacional Canaima, S of river Kukenan, 4°42'46" N, 61°03'35" W, corticolous in a gallery forest, 800 m, 27. VII. 2010, leg. K. Kalb & J. Hernandez (herb. K. Kalb 38526).—BRAZIL. **Pernambuco:** Caruaru; Brejo dos Cavalos, 8°20' S, 35°58' W, corticolous in a high altitude rainforest (Brejo), 800–900 m, leg. M. Cáceres & R. Lücking 00-0598 (F-1179214!) This specimen was published as *Malmidea atlantica* (Cáceres 2007).—**Espírito Santo:** Domingos Martins; Rod. BR 262, near the river Araguaia, corticolous on a tree trunk in a rainforest, 800–1000 m, 12 October 1992, leg. G. Hatschbach 58001, A. C. Cervi & J. M. Silva (B!, fertile!).—**São Paulo:** Serra do Mar; Serra de Paranapiacaba, c. 40 km SW of São Paulo, 23°50' S, 47°00' W, in a dark and humid rainforest (Mata Atlântica), 800 m, 19 March 1978, leg. K. Kalb & G. Plöbst (herb. K. Kalb 21125), growing together with *Malmidea polycampia*).

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

Fig. 27

Bibliotheca Lichenologica 106: 166 (2011).—*Lecidea vinosa* Eschw., Flora Brasiliensis seu enumeratio plantarum 1: 251 (1833), (M!, holotype).

This species is distinguished in having a thick, granular and rimose-areolate thallus, apothecia up to 0.9 mm diam. with a *piperis*-type excipulum, a brown disc with a violet tinge, ascospores $13\text{--}17 \times 7\text{--}9 \mu\text{m}$ and without any lichen substances by TLC.

The localities given below are new additions to the Venezuelan lichen biota.

VENEZUELA. **Mérida**: Distr. Campo Elias, La Carbonera, Finca San Isidro, c. 50 km WNW of Mérida, $8^{\circ}40' \text{ N}$, $71^{\circ}20' \text{ W}$, 4 August 1989, leg. K. Kalb (24152) & M. López-Figueiras.—Distr. Libertador, Monte Zerpa, a few km N of Mérida, above of 'La Hechicera', $8^{\circ}40' \text{ N}$, $71^{\circ}10' \text{ W}$, in a pristine cloud forest, 2200 m, 14 August 1989, leg. K. Kalb (29441) & M. López-Figueiras (VEN).



Fig. 27: *Malmidea vinosa*; thallus and apothecia, note the violet tinge of the apothecial discs; bar 1 mm

Malmidea volcaniana Kalb & Hernández *sp. nov.*

Fig. 28

Index Fungorum number: IF558612

Similar to *Malmidea sulphureosorediata* but differs in having an alternative chemistry (7-chloroemodin, 5-chloroemodin, 7-chloroemodic acid in *M. sulphureosorediata*) and in having coralloid clumps of isidia-like outgrowths (granular to microsquamulose in *M. sulphureosorediata*).

Type: VENEZUELA. **Miranda**: Los Guayabitos; Cerro El Volcán, $10^{\circ}24'59'' \text{ N}$, $66^{\circ}51'11'' \text{ W}$, corticolous in a very disturbed tropical mountain rainforest (bosque nublado), 1460 m, 01. X. 2010, leg. K. Kalb 38379 & J. Hernández (VEN, holotype).

Etymology: The specific epithet refers to the type locality.

Thallus crustose, corticolous, continuous, $20\text{--}40 \mu\text{m}$ thick, verrucose, verrucae \pm globose, c. 0.1–0.15 mm diam., coalescent with age and forming coralloid clumps of thin, isidia-like outgrowths, dull, greenish grey to ash-grey, soralia \pm punctiform, 0.01 mm diam., intense orange-yellow, originating from warts which break off at the tips, K+ purple, P+ wine-red. Medulla of verrucae and thallus orange-yellow, K+ purple, P+ wine-red. Photobiont chlorococcoid, cells $6\text{--}8 \mu\text{m}$ diam.

Apothecia sessile, rounded, 0.3–0.8 mm diam. and 0.2–0.3 mm high; disc initially plane, becoming distinctly convex with age, beige to chocolate–brown; excipulum of *granifera*-type, entire, whitish, cream-coloured to greyish, paler than the disc. Ectal excipulum hyaline, medullary excipulum orange-yellow, filled with orange-yellow anthraquinones, opaque, only partly dissolving in KOH, K+ golden-yellow to golden-orange. Subhymenium *c.* 20 µm high, light brown; hypothecium centrally 75–85 µm high, narrowing to the margin, dark brown, K–. Epihymenium indistinct. Hymenium 75–100 µm high, hyaline. Asci 50–60 µm × 15–20 µm. Ascospores 6 (–8) per ascus, non-septate, wall equally thickened, halonate, broadly ellipsoid, 11–17 × 7–10 µm, halo 1–1.5 µm thick.

Chemistry: atranorin (minor), emodin (major), emodic acid (submajor), emodin bisanthrone (minor), some unknown xantholepinones.



Fig. 28: *Malmidea volcaniana* (holotype); thallus and apothecia; bar 1 mm

Discussion: Even though they are more or less the same colour, i.e. orange-yellow, the pigments present in the thallus and warts differ from those present in the medullary excipulum of the apothecia. This can readily be demonstrated by their alternative K+ reactions (see above). If the specimens are not collected with great care, the thalline cortex can be easily abraded exposing the orange-yellow medulla. In that case, *M. volcaniana* looks very similar to *M. sulphureosorediata*, although they can readily be separated by their alternative chemistries. The specimen from Brazil, cited below, was published as a paratype of *M. atlantica* (CÁCERES 2007), but this species, like *M. sulphureosorediata*, contains 7-chloroemodin, 5-chloroemodin and 7-chloroemodic acid as major metabolites. In the world key presented by BREUSS & LÜCKING (2015) the new species keys out at couplet 10 (*M. atlantica*, *M. flavopustulosa* = *M. polycampia*), but it differs from the former in its true soralia and from the latter by the presence of anthraquinones.

Additional material studied: VENEZUELA. **Miranda:** same locality as the type (herb. K. Kalb 38576, isotype). BRAZIL. **Pernambuco:** Bonito, Parque Municipal de Bonito, 8°28' S, 35°43' W,

corticolous in a high altitude rain forest (Brejo), 800 m, leg. M. Cáceres & R. Lücking 00-0316 (F-1179059!).

To facilitate the identification of anthraquinones which often occur in *Malmidea* species the following table is presented (R_f -values from the laboratory of Lichenologisches Institute Neumarkt).

Yellow to orange or red pigments occurring in *Malmidea*

(Names marked with the same sign, usually occur together)

Name of pigment [R_f in]	A	B'	C	colour
#5-chloroemodin	64	56	51	yellow
norsolorinic acid	55	66–68	41	pink-orange
+catenarin	54–55	62	36–40	deep orange
+7-chlorocatenarin	55	60	48	yellow
#7-chloroemodin	55–56	56	44–47	yellow
*emodin	52–53	56	38–39	yellow
#7-chloroemodic acid	52–53	38	38–39	yellow
*emodic acid	50	50	37	(grey) orange
atlantoides unknown	45–48	30	35–38	yellow to pink
&teloschistin	44	31–33	36–38	yellow
&7-chloroteloschistin	41–43	33–35	32–33	yellow
*emodin bisanthron	33–34	32–33	12	(grey) yellow
emodinal	32	37	25	orange

Psilolechia lucida (Ach.) Choisy

Fig. 29

Bulletin Mensuel de la Société Linnéenne de Lyon 18 (2): 142 (1949).—*Lichen lucidus* Ach., Lichenographiae Sueciae Prodrumus: 39 (1799).

Discussion: This cosmopolitan species is distinguished in having a leprose-granular yellow to greenish yellow thallus, convex, *Micarea*-like apothecia and small, oblong to clavate, simple ascospores, $4-6 \times 1-2 \mu\text{m}$.

TLC: rhizocarpic acid.

The locality recorded below is a new addition to the Venezuelan lichen biota and the first mention of a *Psilolechia* species for the country. It was found growing on non-calcareous pebbles or rock and dead plant debris in shady situations. Sterile specimens can be confused with *Chrysothrix* species, but all can be separated by their alternative chemistry or ecology, i.e. growing on bark. The specimen cited below was richly fertile.

VENEZUELA. **Mérida**: on the way from Mérida to La Azulita, remnants of a pristine Andean forest, in a paddock, 2200 m, 11 January 1979, leg. M. López-Figueiras (17881), T. Ahti & P. M. Jørgensen (MERF).

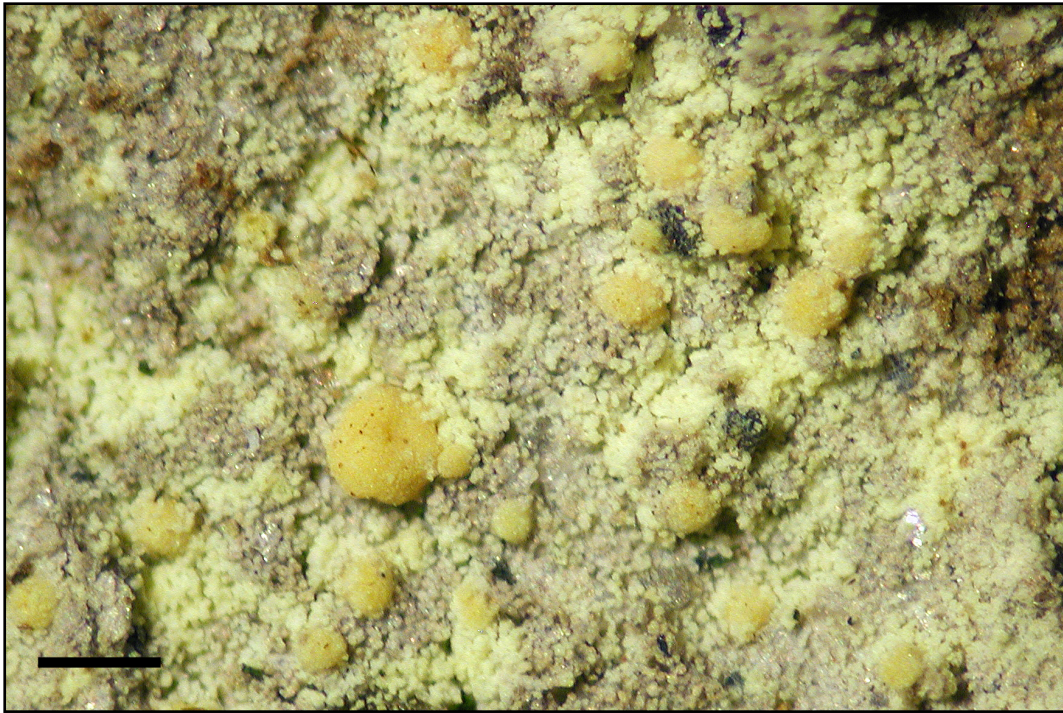


Fig. 29: *Psilolechia lucida*; thallus and apothecia; bar 0.25 mm

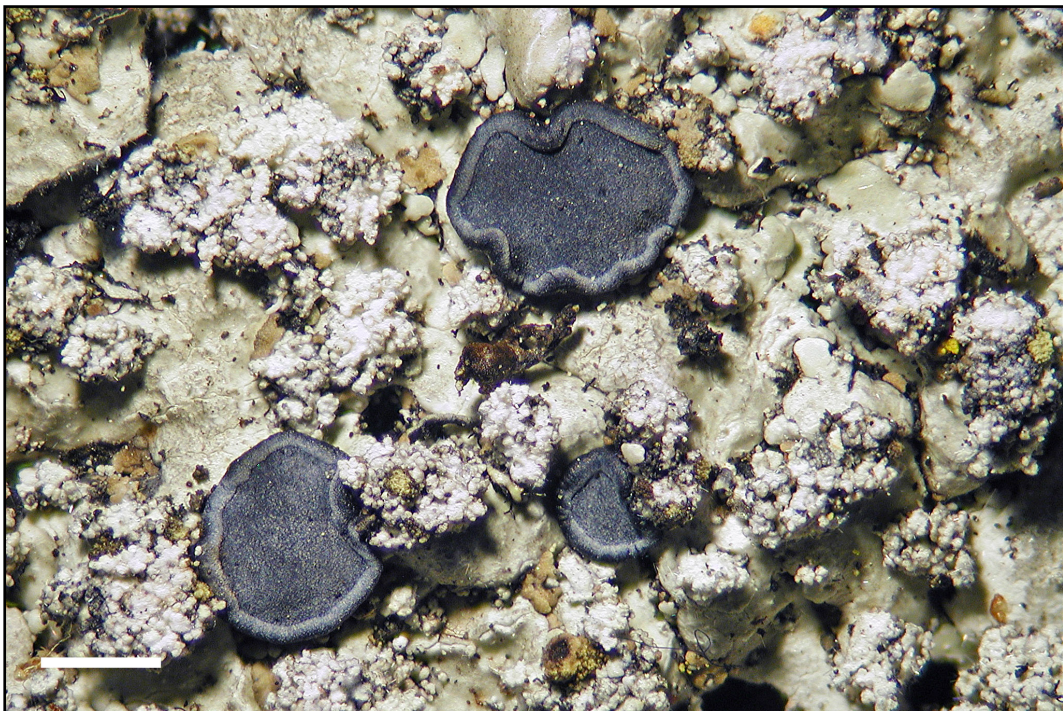


Fig. 30: *Pyxine caesiopruinosa*; thallus and apothecia, note the polysidiangia on the thallus and the pruinose margins and discs of the apothecia; bar 1 mm

Pyxine caesiopruinosa (Nyl.) Imsh.

Fig. 30

Transactions of the American Microscopical Society 76 (3): 257 (1957).—*Pyxine cocoes* var. *caesiopruinosa* Nyl., Synopsis Methodica Lichenum 2: 2 (1863).

Discussion: APTROOT (1987) proposed synonymizing *P. caesiopruinosa* and *P. albovirens* (G. Mey.) Aptroot, the latter name having priority. But a reinvestigation of the holotypes by AMTOFT (2002) showed that the two species differ morphologically and chemically with *P. albovirens* having soralia and *P. caesiopruinosa* having polysidiangia (KALB 1987, 2004a). Available herbarium material should be checked to decide whether both species occur in Venezuela or not. The collection cited below represents *P. caesiopruinosa* s.str.

VENEZUELA. **Mérida**: Distr. Sucre; San Juanito, few km ENE of Chiguara, above the Hacienda 'Los Topes', 8°30' N, 71°30' W, on bark of an unidentified tree, 1500 m, 3 August 1989, leg. K. Kalb & A. Morales-Mendez (herb. K. Kalb 42621).

Rhizocarpon sipmanianum Kalb & Aptroot

Lichenes Neotropici 16: 9 (2017).

Discussion: This species was only recently described (KALB & APTROOT 2017) from Brazil where it was collected at the edge of a dense rainforest at 1900 m. It is similar to *Rhizocarpon eupetraeum* (Nyl.) Arnold, but differs by the smaller ascospores with fewer cells and a ± flat thallus. While the type material was growing on granitic boulders, the specimen cited below originates from organic compact detritus. But morphological, anatomical and chemical characters are identical. A color photograph is provided in KALB & APTROOT (2017).

TLC: norstictic acid (major), connorstictic acid (minor).

The locality recorded below is a new addition to the Venezuelan lichen biota.

VENEZUELA. **Mérida**: district Miranda, 8°55' N, 70°50' W, paramo vegetation between Almorzadero and Piñango, on compact detritus, 4200 m, 17 August 1989, leg. K. & A. Kalb (herb. K. Kalb 34537).

Sipmaniella sulfureofusca (Fée) Kalb

Fig. 31

Bibliotheca Lichenologica 99: 243 (2009).—*Lecanora sulfureofusca* Fée, Essai sur les cryptogames des écorces exotiques officinales: 116 (1825).—*Lecania sulfureofusca* (Fée) Müll. Arg., Revue mycologique (Toulouse) 9 (35): 133 (1887).

Discussion: This species resembles a *Lecanora* species, but differs in having 1-spored asci with a large 1-septate ascospore 70–90 × 20–25 µm .

TLC: usnic acid (major), zeorin (minor).

The locality recorded below is a new addition to the Venezuelan lichen biota.

VENEZUELA. **Tachira**: Betania; upper part of the Tamá valley, zone of 'bosques primitivos', on bark of an unidentified tree, 2300–2400 m, 2 August 1981, leg. M. López-Figueiras 25958 (MERF).

Stigmatochroma glaucothecum (Fée) Kalb, *comb. nov.*

Fig. 32

Index Fungorum number: IF558613

Bas.: *Lecidea glaucotheca* Fée, Essai sur les cryptogames des écorces exotiques officinales. Deuxième partie. Supplément et révision: 109 (1837).—*Buellia glaucotheca* (Fée) Malme, Arkiv för Botanik 21 A, 14: 20 (1927).



Fig. 31: *Sipmaniella sulfureofusca*; thallus and apothecia; bar 1 mm

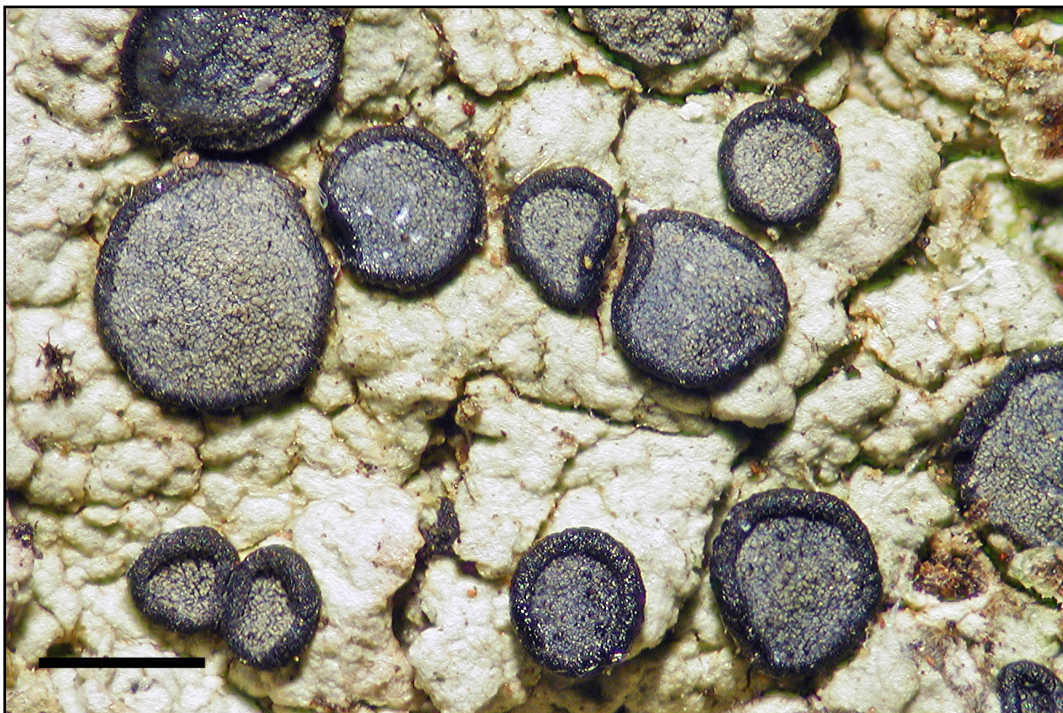


Fig. 32: *Stigmatochroma glaucothecum*; thallus and apothecia; bar 0.5 mm

Discussion: This species is distinguished in having a whitish to yellowish grey wrinkled or cracked thallus, lecideine apothecia with a flat to slightly convex disc and white to yellowish pruina, and a yellow-orange pigment present within and below the hypothecium, K+ yellow efflux, ascospores 8/ascus, 17–24 × 6–8 μm (in the specimen cited below).

TLC: norstictic acid (major), connorstictic acid (submajor), *cf.* thiophaninic acid (minor).

APTROOT (1988) synonymized *Buellia glaucotheca* (Fée) Malme and *B. gerontoides* (Stirt.) Imsh. MARBACH (2000) suspected that this synonymy was incorrect because he found that *B. gerontoides* had smaller ascospores [(12–) 13–15 (–16) × 5–6 (–6.5) μm versus (16–) 20–23 (–25) × 7–9 μm in *B. glaucotheca* (MALME 1927) who had examined the type specimen which is presently lost]. MARBACH (2000) assumed that *Buellia glaucotheca* could be an earlier synonym of *Stigmatochroma metaleptodes* (Nyl.) Marbach because of their ± identical spore size (16–) 18–21 × 6.5–9 μm in the latter). Both species also have yellow-orange pigments in and below the hypothecium. However, their alternative reactions with KOH suggest that they have different chemistry. The pigment(s) in *S. metaleptodes* react K+ purple (similar to parietin), while in the specimen from Trujilla cited below the reaction is K+ lemon-yellow or orange-yellow. The different reactions were confirmed in a collection of *S. metaleptodes* from Venezuela, viz. state **Bolivar**: Gran Sabana; south of the southern limits of Parque Nacional Canaim, S of river Kuke-nan, 4°42'46" N, 61°03'35" W, on bark of an unidentified tree in a gallery forest, 800 m, 27 July 2010, leg. K. Kalb & J. Hernández (herb. K. Kalb 38522). *Stigmatochroma glaucothecum* is a new addition to the Venezuelan lichen biota.

VENEZUELA. **Trujillo**: Between Puente Villegas and Cerro Gordo near Carache, corticolous on bark of an unidentified tree, 700–900 m, 23 September 1978, leg. M. López-Figueiras 16938 (MERF).

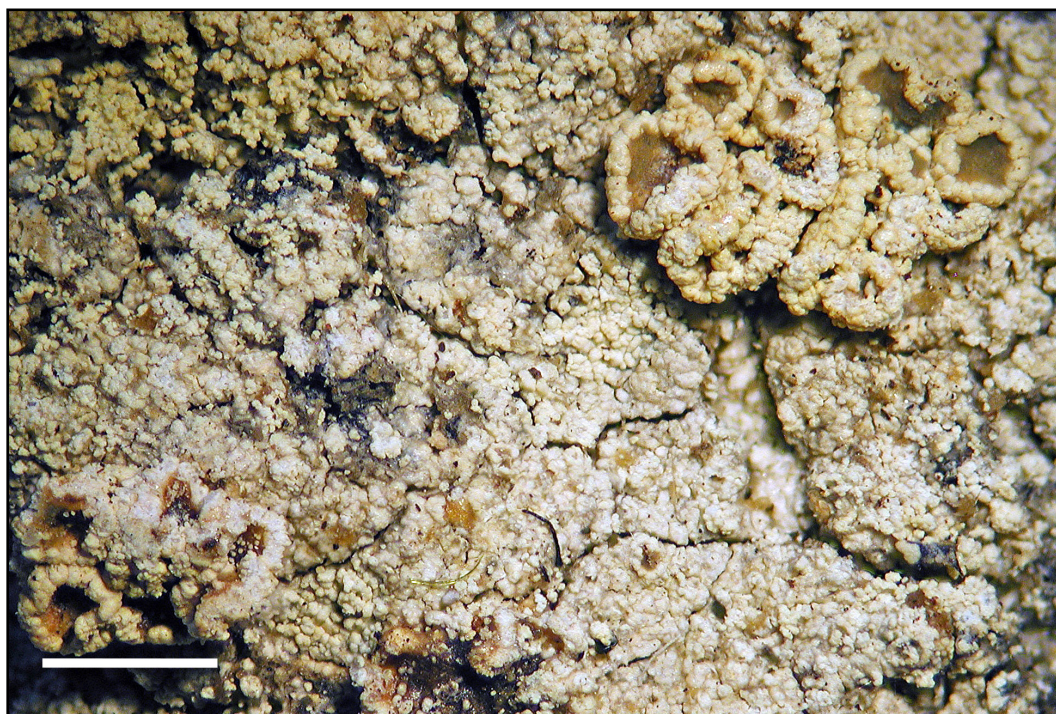


Fig. 33: *Vainionora aemulans*; thallus and apothecia; bar 1 mm

Vainionora aemulans (Vain.) Kalb

Fig. 33

Lichenes Neotropici 12 (No. 476–525): 3 (1991).—*Lecanora aemulans* Vain., Acta societatis pro Fauna et Flora Fennica 7 (1): 84 (1890).

Discussion: This species is distinguished in having a granular sorediate yellowish grey thallus, *Lecanora*-like apothecia with a crenulate, often sorediate margin and a reddish brown hypothecium.

TLC: atranorin (major), thuringione (major), arthothelin (submajor), 3-*O*-methylthiophanic acid (submajor), 4,5-dichloronorlichexanthone (minor), 2,5-dichloronorlichexanthone (trace). This is almost the same chemistry which Lumbsch (1996) reported for the lectotype of this species.

The locality recorded below is a new addition to the Venezuelan lichen biota and the first mention of a *Vainionora* species for the country.

VENEZUELA. **Falcon**: Serra de San Luis, mountains of Paraguariba, in savanna and humid forest, 1400 m, 13 August 1979, leg. M. López-Figueiras (21447) & H.H. van der Werff (MERF).

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References

- ACHARIUS, E. 1799. *Lichenographiae Sueciae Prodrromus*. Lincopiae, 264 pp.
- AMTOFT, A. 2002. *Pyxine subcinerea* in the Eastern United States. *The Bryologist* 105 (2), 270–272.
- APROOT, A. 1988 [1987]. Pyxinaceae (Lichens). *Flora of the Guianas, Ser. E: Fungi and Lichens* 1: 1–53.
- BUNGARTZ, F., U. GRUBE, J. A. ELIX, C. HEINIGER, & H. MAYRHOFER. 2011. A taxonomic revision of the *Buellia subalbula*-group in the southern hemisphere using fluorescence microscopy. *Bibliotheca Lichenologica* 106: 21–39.
- CÁCERES, M. E. S. 2007. Coticolous crustose and microfoliose lichens of northeastern Brazil. *Libri Botanici* 22: 1–168.
- CÁCERES, M. E. S., V. M. DOS SANTOS, D. T. DE GÓES, A. A. MOTA & A. APROOT. 2013. Two new species of *Malmidea* from north-eastern Brazil. *Lichenologist* 45 (5): 619–622
- CÁCERES, M. E. S., A. APROOT, C. O. MENDONÇA, L. A. SANTOS & R. LÜCKING. 2017. *Sprucidea*, a further new genus of rain forest lichens in the family Malmideaceae (Ascomycota). *The Bryologist* 120(2): 202–211
- CHOISY, M. 1949. Catalogue des lichens de la region lyonnaise. [Fasc. 2]. *Bulletin Mensuel de la Société Linnéenne de Lyon* 18 (2): 137–152.
- DAHL, M. S. 2017. [Thesis:] *Molecular systematics and taxonomy of Sporacestra and relatives (Ramalina-ceae, Ascomycota)*. Representralen, University of Oslo. i–ix, 1–52.
- DENNIS, R. W. G. 1965. Fungi Venezuelani: VII. *Kew Bulletin* 19(2): 231–273.
- ELIX, J. A. 2018. *A catalogue of standardized chromatographic data and biosynthetic relationships for lichen substances, fourth edition*. Published by the author, Canberra.

- ERTZ, D., E. FISCHER, D. KILLMANN, T. RAZAFINDRAHAJA & E. SÉRUSIAUX. 2014. *Savoronala*, a new genus of Malmideaceae (Lecanorales) from Madagascar with stipes producing sporodochia. *Mycological progress* 12: 645–656.
- ESCHWEILER, F. 1833. Lichenes. in: Eschweiler, F., C.F. Martius, & C.G. Nees ab Esenbeck, Flora Brasiliensis seu enumeratio plantarum in Brasilia tam sua sponte quam accedente cultura provenientum I (1): 53–292.
- FÉE, A. L. A. 1825. *Essai sur les cryptogames des écorces exotiques officinales*, Paris, 167 pp., 34 tab.
- FÉE, A. L. A. 1837. *Essai sur les cryptogames des écorces exotiques officinales. Deuxième partie. Supplément et révision*. Paris, Strasbourg, 178 pp.
- FEUERER, T. 2017. Checklist of lichens of Venezuela, Version 31 December 2017; https://web.archive.org/web/20180829194750/http://www.lichens.uni-hamburg.de/lichens/south-america/venezuela_1.htm
- FLAKUS, A., J. ETAYO, S. PÉREZ-ORTEGA, M. KUKWA, Z. PALICE & P. RODRIGUEZ-FLAKUS. 2019. A new genus, *Zhurbenkoa*, and a novel nutritional mode revealed in the family Malmideaceae (Lecanoromycetes, Ascomycota). *Mycologia* 111(4): 593–611.
- GUZOW-KRZEMIŃSKA, A. FLAKUS, M. KOSECKA, A. JABŁOŃSKA, P. RODRIGUEZ-FLAKUS & M. KUKWA. 2019. New species and records of lichens from Bolivia. *Phytotaxa* 397 (4): 257–279.
- HELLBOM, P.J. 1896. Lichenaea Neo-Zelandica seu Lichenes Novae Zeelandiae a Sv. Berggren annis 1874–1875 collecti, additis ceteris speciebus indidem huc usque cognitiss, breviter commemoratis. *Bihang till Kongliga Svenska Vetenskapsakademiens Handlingar* 21, III (13): 1–150.
- HERTEL, H. 1971. Über holarktische Krustenflechten aus den venezuelanischen Anden. *Willdenowia* 6: 225–272.
- HERTEL, H. 1974. Krustenflechten aus Venezuela. *Mitteilungen der Botanischen Staatssammlung München* 11: 405–430.
- IMSHAUG, H. 1957. The Lichen Genus *Pyxine* in North and Middle America. *Transactions of the American Microscopical Society* 76 (3): 246–269.
- JUNIOR, I. O., A. APTROOT, L. A. DOS SANTOS, J. C. CAVALCANTE, A. KOŠUTHOVÁ & M. E. S. CÁCERES. 2020. Two further new lichen species from the Atlantic Forest remnant Pedra Talhada (Alagoas, Brazil), with a species list. *The Bryologist* 123(4): 617–632.
- KALB, K. 1988. *Lichenes Neotropici* 10 (401–450), 16 pp; Neumarkt i.d.OPf.
- KALB, K. 1991. *Lichenes Neotropici* 12 (476–525), 16 pp; Neumarkt i.d.OPf.
- KALB, K. 2004a. Brasilianische Flechten I. Die Gattung *Pyxine*. *Bibliotheca Lichenologica* 24: 1–89, 28 figs.
- KALB, K. 2004b. New or otherwise interesting lichens II. *Bibliotheca Lichenologica* 88: 301–329.
- KALB, K., A. APTROOT. 2017. *Lichenes Neotropici* 16 (628–650), 12 pp; Neumarkt i.d.OPf.
- KALB, K., A.W. ARCHER, J. SUTJARITTURAKAN & K. BOONPRAGOB. 2009. New or otherwise interesting lichens V. *Bibliotheca Lichenologica* 99: 225–246.
- KALB, K., E. RIVAS PLATA, R. LÜCKING & H. T. LUMBSCH. 2011. The phylogenetic position of *Malmidea*, a new genus of 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., F. SCHUMM & J. A. ELIX. 2020. Pigments and new lichen substances in the lichen genus *Dirinaria*. *Australasian Lichenology* 86: 6–9.
- KISTENICH, S., E. TIMDAL, M. BENDIKSBY, & S. EKMAN. 2018. Molecular systematics and character evolution in the lichen family Ramalinaceae (Ascomycota: Lecanorales). *Taxon* 67: 871–904.
- LAFFERTY, D., F. BUNGARTZ & J. A. ELIX. 2021. Wintab 64bit - a program developed at Arizona State University for the analysis of secondary metabolites of lichens, based on an original concept published by E. Mietzsch, H.T. Lumbsch & J.A. Elix. *Help & Resources for the Consortium of Lichen Herbaria*, available at <https://help.lichenportal.org/index.php/en/resources/metabolites/>
- LÓPEZ-FIGUEIRAS, M. 1986. *Censo de macrolíquenes venezolanos de los estados Falcon, Lara, Merida, Tachira y Trujillo*. Facultad de Farmacia, Universidad de Los Andes, Merida, 521 pp.

- LUMBSCH, H.T., R.GUDERLEY & J.A. ELIX. 1996. A revision of some species in *Lecanora* sensu stricto with a dark hypothecium (Lecanorales, Ascomycotina). *The Bryologist* 99(3): 269–291.
- MALME, G. O. A. 1897. Die Flechten der ersten Regnell'schen Expedition. I. Die Gattung *Pyxine* (Fr.) Nyl. *Bihang till Kongliga Svenska Vetenskapsakademiens Handlingar* 23, 3 (13): 13–52.
- MALME, G. O. A. 1927. *Buellia* itineris Regnelliani primi. *Arkiv för Botanik* 21 A, 14: 1–42.
- MALME, G. O. A. 1934. Die Gyalectazeen der ersten Regnell'schen Expedition. *Arkiv för Botanik* 26 A. 13: 1–10.
- MALME, G. O. A. 1935. *Bacidia* itineris Regnelliani primi. *Arkiv för botanik* 27 A (5): 1–40.
- MARBACH, B. 2000. Corticole und lignicole Arten der Flechtengattung *Buellia* sensu lato in den Subtropen und Tropen. *Bibliotheca Lichenologica* 74: 1–384.
- MÜLLER, J. 1881. Lichenologische Beiträge 14. *Flora (Regensburg)* 64: 505–511, 513–527.
- MÜLLER, J. 1887. Revisio lichenum Féeanorum. *Revue mycologique (Toulouse)* 9 (35): 82–89, 133–140.
- MUGGIA, L., R. MANCINELLI, T. TØNSBERG, A. JABŁOŃSKA, M. KUKWA & Z. PALICE. 2017. Molecular analyses uncover the phylogenetic placement of the lichenized hyphomycetous genus *Cheiromycina*. *Mycologia* 109(4): 588–600.
- RIVAS PLATA, E., R. LÜCKING, A. APTROOT, H. J. M. SIPMAN, J. L. CHAVES, L. UMAÑA & D. LIZANO. 2006. A first assessment of the Ticolichen biodiversity inventory in Costa Rica: the genus *Coenogonium* (Ostropales: Coenogoniaceae), with a world-wide key and checklist and a phenotype-based cladistic analysis. *Fungal Diversity* 23: 255–321.
- SIPMAN, H. J. M. 1994. New Graphidales (lichenized Ascomycotina) from the Guianas and nearby areas. Studies on the flora of the Guianas no. 79. - *Acta Botanica Fennica* 150: 165–172.
- SODAMUK, M., K. BOONPRAGOB, P. MONGKOLSUK, A. TEHLER, S. D. LEAVITT & H. T. Lumbsch. 2017. *Kalbionora palaeotropicalis*, a new genus and species from coastal forests in Southeast Asia and Australia (Malmideaceae, Ascomycota). *MycKeys* 22: 15–25.
- TUCKERMAN, E. 1864. Observationes lichenologicae. Observations on North American and other lichens. Proceedings of the American Academy of Arts and Sciences 6: 263–287.
- VAINIO, E. A. 1890. Étude sur la classification naturelle et la morphologie des lichens du Brésil. *Acta societatis pro Fauna et Flora Fennica* 7 (1): 1–247.
- VARESCHI, V. 1962. Resultados liquenológicos de excursiones efectuadas en Venezuela. No. 2. *Acta Biologica Venezuelica* 3: 201–232.
- VARESCHI, V. 1973. Resultados lichenológicos de excursiones efectuadas en Venezuela. No. 3. Catalogo de los líquenes de Venezuela. - *Acta Botanica Venezuelica* 8(1–4): 177–245.
- VARESCHI, V. 2001. El genero *Usnea* en Venezuela. *Boletín de la Academia de Ciencias Físicas Matemáticas y Naturales de Venezuela* 61(4): 9–63.
- VĚZDA, A. 1969. Neue Taxa und Kombinationen in der Familie Gyalectaceae (Lichenisierte Fungi). *Folia Geobotanica et Phytotaxonomica* 4: 443–446.
- WEERAKOON, G. & A. APTROOT. 2014. Over 200 new lichen records from Sri Lanka, with three new species to science. *Cryptogamie Mycologie* 35 (1): 51–62.