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## New or otherwise interesting lichens. VII, including a world key to the lichen genus *Heiomasia*

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### Abstract

Eight species new to science are described, *Allographa grandis* from Cameroon which is distinguished by its very large ascomata, richly muriform, large ascospores and an inspersed hymenium (type B); *Bapalmuia microspora* from Malaysia which differs from *B. consanguinea* in having shorter and broader ascospores and a granular thallus; *Diorygma cameroonense* from Cameroon which differs from *D. sticticum* in having larger ascospores with more septa; *Glyphis frischiana* which is similar to *G. atrofusca* but differs in producing secondary lichen compounds, the first species in *Glyphis* in doing so. Two new species are added to the genus *Heiomasia*, viz. *H. annamariae* from Malaysia, which differs from *H. sipmanii* in producing the stictic acid aggr. and *H. siamensis* from Thailand, distinguished from *H. sipmanii* in containing hypoprotocetraric acid as a major metabolite. The published chemistry of several species of *Heiomasia* is revised and a new substance, heiomaseic acid, with relative  $R_f$ -values 5/19/8, is demonstrated for *H. seavey-orum*, *H. siamensis* and *H. sipmanii*. A world-wide key to the known species of *Heiomasia* is presented. *Myriotrema squamiferum*, a fertile species from Malaysia, is distinguished from *M. frondosolucens* by lacking lichexanthone. As there are conflicting literature data concerning *Ocellularia crocea*, the type specimen was investigated and the results are reported. *Ocellularia macrocrocea*, a related species from Malaysia, differs from *O. rubropolydiscus* in lacking the red pigment covering the disc of the ascomata and in having a broad stump-shaped columella. A revised chemistry for *Ocellularia tanii*, a new record for Sarawak, is also given. A table of  $R_f$ -values and scans of relevant TLC runs facilitate the interpretation of the spots occurring on TLC plates of Graphidaceae.

### Introduction

Only a few papers are published, dealing with Graphidaceae from Borneo's East Malaysia (e.g. Krempelhuber 1875; Nagarkar & Hale 1989; Paukov *et al.* 2017; Sipman 1993) and Africa (e.g. Dodge 1953, 1964; Frisch *et al.* 2006; Joshi *et al.* 2016; Müller Arg. 1894; Vainio 1901, 1929). The study of my recent collections from Malaysia (Sabah, Sarawak) and collections by Dr. A. Frisch made in Africa during his PhD study revealed some interesting findings of Graphidaceae which are reported here in the seventh paper of this series.

## New Species

### *Allographa grandis* Kalb sp. nov.

**Fig. 1**

Mycobank MB 835611

Silimar to *Graphis insulana* (Müll. Arg.) Lücking & Sipman but differs in having much larger ascomata to 15 mm long, larger, richly muriform ascospores,  $110\text{--}175 \times 25\text{--}48 \mu\text{m}$ , and an interspersed hymenium of type B as well as other features.

Type: REPUBLIC OF CAMEROON. South Province: Begalanda Mountains near Nyangong Village,  $2^{\circ}57'30''$  N,  $10^{\circ}45'00''$  E, 850 m, corticolous in a  $\pm$  bright, pristine rainforest, 22 February 1999, leg. A. Frisch & T. Idi s.n. (B, holotype; hb. A. Frisch, isotype).

Description: Thallus corticolous, beige to greyish white, smooth, corticate, dull to slightly shiny. Lirellae erumpent to prominent, with a complete whitish thalline margin, elongate, straight, curved or sinuose, unbranched or irregularly branched, up to 15 mm long and 1 mm wide, labia convergent, entire (*illinata*-morph), disc not visible from above. Exciple apically carbonized; hymenium interspersed (type B); ascospores 1/ascus, hyaline, becoming slightly brownish with age, richly muriform,  $40\text{--}50 \times 8\text{--}12$ -septate,  $110\text{--}175 \times 25\text{--}48 \mu\text{m}$ , I+ blue.

Chemistry: Norstictic acid (major), connorstictic acid (minor), subnorstictic acid (trace).

Etymology: The specific epithet refers to the large ascomata and ascospores.



**Fig. 1:** *Allographa grandis* (holotype); thallus and ascomata, scale-bar 1 mm

Remarks: Using the world key to *Graphis* s. lat. (Lücking *et al.* 2009) or the key to African species of *Graphis* s. lat. (Joshi *et al.* 2016), the new species would key out as *Graphis insulana*. However, in addition to the aforementioned differences, *Allographa grandis* is distinguished by the apically carbonized exciple (laterally carbonized in *G. insulana*) and *illinata*-morph ascomata (*sub-*

*serpentina*-morph in *G. insulana*). The most important difference is the alternative type of insper-sion, which places the new species in the genus *Allographa*. Indeed, no other species in this genus seems to be similar to *A. grandis*.

***Bapalmuia microspora* Kalb sp. nov.**

**Fig. 2**

Mycobank MB 835612

Similar to *Bapalmuia consanguinea* (Müll. Arg.) Kalb & Lücking, but differs in having a thick, granular, greenish thallus, shorter and thicker ascospores and in growing on bark.

MALAYSIA. Borneo: Sabah; Kota Kinabalu, Sapi Island (Pulau Sapi); on bark of an unknown tree in a tropical rainforest, 06°00'17" N, 116°00'57" E, 30–50 m. 8 August 2014, leg. K. Kalb (KK 40367) & A. Mertens (B, holotype).

Description: Thallus corticolous, thick, granular, greenish. Apothecia scattered, sessile, 0.5–0.6 mm wide, 0.15–0.2 mm high; disc initially flat, becoming distinctly convex with age, ochraceous yellow to light brownish, without pruina or very slightly pruinose, margin chamois-coloured, distinct, persistent, but excluded in old apothecia. Exciple prosoplectenchymatous with radiating rows of cells, basally 55 µm thick, laterally 25 µm thick; hypothecium centrally 40–50 µm high, beige to brownish; epihymenium hyaline; hymenium c. 60 µm high, hyaline. Asci cylindrical, c. 50 × 12 µm. Ascospores 8/ascus, 4–5-septate, 20–25 × 4–5 µm.

Chemistry: 4,5-dichlorolichexanthone (= coronaton).

Etymology: The name of the species is derived from the small ascospores.



**Fig. 2:** *Bapalmuia microspora* (holotype); thallus and ascomata, bar 0.5 mm

Remarks: At present the new species is only known from the type locality, where it was collected on bark in a ± pristine coastal rainforest. It is distinguished by very short and relatively broad ascospores and a thick, granular thallus. The same type of thallus is known in *B. confusa* Kalb & Lücking from tropical America, but this species can readily be distinguished by its much longer and more septate ascospores (110–150 µm long and 35–40-septate). Another similar species with relatively small ascospores is *B. ivoriensis* R. Sant. & Lücking from Africa, but this species occurs on leaves and differs further in having a smooth thallus and much narrower ascospores (1.5–2.0 µm broad). Species of *Fellhanera* that externally resemble *Bapalmuia microspora* can be set apart in having a paraplectenchymatous exciple and a different chemistry (usnic acid and/or zeorin).

***Diorygma cameroonense* Kalb sp. nov.**

**Fig. 3**

Mycobank MB 835613

Similar to *Diorygma sticticum* Sutjaritturakan, Kalb & Lücking, but differs in having larger ascospores with more septa.

Type: REPUBLIC OF CAMEROON. East Province: Bewala II Village near Ngatto, 03°13' N, 14°54' E, 600 m, corticolous in a pristine rainforest along the Boumba River, 01 April 1999, leg. A. Frisch & T. Idi s.n. (B, holotype).

Description: Thallus corticolous, up to 10 cm diam., 100–125 µm thick, continuous, surface smooth to uneven, greenish grey. Thallus in section with c. 5 µm thick, loose pseudocortex, an irregular 20–25 µm thick algal layer and a 80–100 µm thick white medulla with scattered crystals. Lirellae single, unbranched or stellately to irregularly branched, immersed to erumpent with thick,



**Fig. 3:** *Diorygma cameroonense* (holotype); thallus and ascomata, bar 1 mm.

complete thalline margin, 0.5–2 mm long, 0.1–0.2 mm wide, 100–125  $\mu\text{m}$  high; disc initially concealed, wide open with age, pale brown with a  $\pm$  thick white pruina. Exciple entire, beige, 15–30  $\mu\text{m}$  thick, laterally covered by algiferous thallus, without or very few crystals; hypothecium 10–15  $\mu\text{m}$  high, yellowish; hymenium 60–80  $\mu\text{m}$  high, hyaline, clear, I–; epithecium granular, 5–10  $\mu\text{m}$  high, light brown. Paraphyses unbranched. Ascospores 8/ascus, ellipsoid, submuriform with 3–5 transverse and 0–1 longitudinal septa in 1 or 2 (very seldom 3) segments, (10–)15–20  $\times$  5–8  $\mu\text{m}$ , with thickened septa and lentiform lumina, hyaline, I+ strongly violet-blue.

Chemistry: Stictic acid (major), menegazziaic acid (minor), constictic acid (submajor).

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

Remarks: On a world level (Feuerstein *et al.* 2014), only three *Diorygma* species are thus far known with extremely small ascospores, *viz.* *D. microsporium* M. Cáceres & Lücking from Brazil, Colombia and U.S.A. (Florida), *D. pauciseptatum* Feuerstein, I. P. R. Cunha-Dias, Aptroot & M. Cáceres from Brazil and *D. sticticum* from Thailand. *Diorygma cameroonense* is distinguished from *D. microsporium* by the alternative chemistry (norstictic acid in *D. microsporium*) and from *D. sticticum* by longer and more septate ascospores (10–13  $\times$  6–8  $\mu\text{m}$  and only 3 transverse septa in *D. sticticum*) and the alternative shaped lirellae (clustered in *D. sticticum*; see photograph in Lumbsch *et al.* 2011: 47F) and from *D. pauciseptatum* by the smaller ascospores with at least a few longitudinal septa (28–32  $\times$  7  $\mu\text{m}$  and with 7–9 transverse septa in *D. pauciseptatum*).

### ***Glyphis frischiana* Kalb sp. nov.**

**Fig. 4**

Mycobank MB 835614

Similar to *Glyphis atrofusca* (Müll. Arg.) Lücking, but differs in having much larger ascospores, 1-spored asci and in containing stictic acid as a major metabolite.

REPUBLIC OF CAMEROON. North West Province: Donga-Mantung Division; Ndu Subdivision, Nkwentang Village, on trunk of *Eucalyptus* spec., in a small plantation, 06°25'40" N, 10°51'20" E, 1950 m. 17 March 1999, leg. A. Frisch (99/Ka3045) & T. Idi (B, holotype).

Description: Thallus corticolous, thin, smooth, corticate, dull, partly verrucose, verrucae densely filled with clusters of crystals, c. 75  $\mu\text{m}$  thick. Ascomata erumpent to sessile with a thick lateral margin, up to 4 mm long, 0.5 mm wide, straight, curved or sinuous, simple, trifurcate or irregularly branched (similar to *marginata*-morph); proper exciple black, distinctly visible from above, disc open, brown to dark-brown, often with a very thin or rarely thick whitish pruina; exciple laterally carbonized, hyaline to brownish at base; hymenium 110–150  $\mu\text{m}$  high, clear, I–, epithecium granular, light to dark brownish, hypothecium hyaline; paraphyses thin, surrounded by a thick jelly. Ascospores 1/ascus, hyaline, becoming very slightly brownish with age, densely muriform, 55–110  $\times$  28–35  $\mu\text{m}$ , I+ brownish blue or violet-blue.

Chemistry: Stictic acid (major), constictic acid (minor), menegazziaic acid (minor).

Etymology: The specific epithet is named after Dr. Andreas Frisch, a loyal friend and an expert in Ostropales and Arthoniales, who collected this species during his PhD studies.

Remarks: The new species belongs in *Glyphis* subgenus *Pallidoglyphis* Staiger (Staiger 2002), *i.e.* like *G. atrofusca* and *G. substriatula* (Nyl.) Staiger, as these species have a non-carbonized hypothecium. *Glyphis frischiana* can easily be confused with a *Graphis* sp., but it is distinguished from this genus by its brown, K– epithecium as well as by the thick-walled paraphyses embedded in a jelly. When using the world-wide key to *Graphis* s. lat. (Lücking *et al.* 2009), *Glyphis frischiana* would key out to *Graphis streblocarpa* (Bél.) Nyl. However, among other differences including the absence of a brown pruina, the latter has convergent labia and the disc is not visible.



Fig. 4: *Glyphis frischiana* (holotype); thallus and ascomata, bar 1 mm.

#### *Heiomasia* Nelsen, Lücking & Rivas Plata

The lichen genus *Heiomasia* Nelsen, Lücking & Rivas Plata (Graphidaceae) was recently established (Nelsen *et al.* 2010) to accommodate two species, viz. *H. sipmanii* (Aptroot, Lücking & Rivas Plata) Nelsen, Lücking & Rivas Plata, the generic type, and *H. seaveyorum* Nelsen & Lücking. The first was initially described as *Herpothallon sipmanii* Aptroot, Lücking & Rivas Plata from the Philippines (Luzon) and was characterized by peculiar disc-shaped vegetative propagules, obliquely upright and attached to the thallus with one side (Aptroot *et al.* 2009).

The second species, *H. seaveyorum*, was reported from U.S.A. (Florida) and was characterized in having cylindrical, sausage-shaped pseudisidia (Nelsen *et al.* 2010). Subsequently, a third species was described from India (Andaman Is.), viz. *H. pallescens* Jagadeesh Ram. It is habitually close to *H. sipmanii*, but is distinguished in containing norstictic acid and salazinic acid as major metabolites (Jagadeesh Ram 2014).

A further species similar to *H. sipmanii* was collected in Malaysia, containing stictic acid (major), hypostictic acid (submajor), peristictic acid (submajor) cryptostictic acid (minor), constictic acid (minor) and is described in this paper as *H. annamariae* Kalb.

As the chemistry of the holotype specimen from the Philippines and of the collections from Thailand is different, the specimens from Thailand are described as a new species, *H. siamensis* Kalb.

As a result, there are now five species of *Heiomasia* which can be separated partly by morphology and/or by their alternative chemistries.

***Heiomasia annamariae*** Kalb, sp. nov.**Fig. 5**

Mycobank MB 835615

Similar to *H. pallescens* Jagadeesh Ram, but differs in containing the stictic acid complex.

Type: MALAYSIA. Sarawak; c. 25 km NNE of Kuching, 01°42'36" N, 110°26'39" E, 50 m., 16. August 2014, leg. K. Kalb 40387 &amp; A. Mertens (B, holotype).

Description: Thallus corticolous, silver-grey to greenish grey, ecorticate. Schizidia disc-shaped, roundish to ellipsoid, originating from the upper part of thallus-warts, obliquely upright and attached to the thallus by one side, up to 0.3–0.5 mm wide. Ascomata unknown.

Chemistry: Stictic acid (major), hypostictic acid (submajor), peristictic acid (minor), cryptostictic acid (minor), constictic acid (minor).

Etymology: The new species is dedicated to my friend Anna-Maria Mertens for her companionship and assistance during collecting trips through the rainforests of Sabah and Sarawak.

Remarks: Habitually, this species is most similar to *H. pallescens* Jagadeesh Ram, but is distinguished by its chemistry.**Fig. 5:** *Heiomasia annamariae* (holotype); thallus with disc-shaped schizidia, bar 1 mm***Heiomasia pallescens*** Jagadeesh Ram

T. A. M. Jagadeesh Ram, Lichenologist 46(1): 46 (2014).

Type: INDIA. Andaman Islands: Little Andaman; Hut Bay, Nanjappa Nagar; 10°37' N, 92°31' E, 70 m, 2 May 2012, leg. T. A. M. Jagadeesh Ram 1550 (CAL, holotype; PBL, isotype, not seen).

Description: Thallus corticolous, pale mineral grey to greyish green, ecorticate. Schizidia disc-shaped, roundish to ellipsoid, originating from the upper part of thallus-warts, obliquely upright and attached to the thallus by one side, up to 0.4–0.8 mm wide. Ascomata unknown.

Chemistry: Salazinic acid (major), norstictic acid (major).

Remarks: MycoBank as well as Index Fungorum erroneously report 2013 as the year of effective publication. On the Cambridge University Press site [<https://www.cambridge.org/core/journals/lichenologist/issue/6BB6B78763ADA2AC6FA094026A0DD260>], the date of online publication is given 09 January 2014 and the date for the printed version is 21 January 2014.

### *Heiomasia seaveyorum* Nelsen & Lücking

in Nelsen *et al.*, The Bryologist 113(4): 748 (2010).

Type: U.S.A. Florida: Fakahatchee Strand Preserve State Park, Janes Scenic Drive, 6.5 mi NNW of ranger station at gate 12 along old tram road; 26°00'31" N, 81°24'41" W; *Taxodium-Sabal* hardwood hammock, on tree trunk in shaded understory; March 2009, leg. Lücking & Rivas Plata 26850 (not seen).

Description: Thallus corticolous, grey to greenish grey, ecorticate. Pseudisidia sausage-shaped (Aptroot *et al.* 2009) ± abundant, up to 1 mm long and 0.25 mm thick, constricted at the base and tapering towards the apex. Apothecia unknown. Thallus K+ very weakly yellow, P–, pseudisidia distinctly K+ yellow, P+ strong orange-red. No substance could be found which is responsible for these spot-reactions, although hypostictic, hypoconstictic and  $\alpha$ -acetylhypoconstictic acids all react K+ yellow, but P–!

Chemistry: Hypoprotocetraric acid (major), conhypoprotocetraric acid (submajor), heiomaseic acid (submajor), hypostictic acid (minor to trace), hypoconstictic acid (minor to submajor),  $\alpha$ -acetylhypoconstictic acid (minor).

Material analysed by TLC: U.S.A. Florida: Polk County; Green Swamp Wildlife Management Area, Strand Hammock, 28°18' N, 81°59' W; hardwood-*Sabal* hammock, 24 March 1998, leg. R. C. Harris 41577, det. J. C. Lendemer 2010.

Remarks: In the protologue, the chemistry is reported as 2-hydroxynornotatic acid (major), 4-*O*-demethylnotatic acid (major to minor). However, in the material analyzed here (see above), as well as in *H. siamensis* and *H. sipmanii*, an unknown substance with the  $R_f$ -values 5/19/8 in solvent systems A/B/C was found (brownish spot after H<sub>2</sub>SO<sub>4</sub> and charring; for the TLC method applied, see Elix 2018). For this substance, Elix (in litt. 2020) proposes to use the name heiomaseic acid. The  $R_f$ -value in solvent C of 2-hydroxynornotatic acid is very similar, but the two substances can readily be separated by co-chromatography (Figs. 12, 13).

### *Heiomasia siamensis* Kalb, sp. nov.

**Fig. 6**

Mycobank MB 835616

Similar to *H. sipmanii* (Aptroot, Lücking & Rivas Plata) Nelsen, Lücking & Rivas Plata, but differs in containing hypoprotocetraric acid (major) but lacking 4-*O*-methylhypoprotocetraric acid.

Type: THAILAND. Nakhon Ratchasima Province: Pak Chong District; Khao Yai National Park, at km 33, 14°27'48" N, 101°22'14" E, 810 m, corticolous in a pristine dry evergreen forest, 12 March 2011, leg. K. Kalb 38797, K. Buaruang, V. Poengsunnoen, P. Nirongbut and S. Meesim (RAMK, holotype).



Description: Thallus corticolous, silver-grey to greenish grey, ecorticate. Schizidia disc-shaped, roundish to ellipsoid, originating directly from the thallus, obliquely upright and attached to the thallus by one side, up to 0.3–0.5 mm wide. Ascomata unknown.

Chemistry: Hypoprotocetraric acid (major), conhypoprotocetraric acid (minor to submajor), heiomaseic acid (submajor).

Etymology: The specific epithet is derived from Siam, the former name for Thailand.

Additional material examined: Thailand. Trang Province: Yantakhao district; Tambon Thung Khai, 07°28' N, 99°38' E, 25 m, on bark of an unidentified tree in a tropical rainforest, 17 December 2016, J. & K. Kalb 41758 (RAMK, paratype).

Remarks: Nelsen *et al.* (2010) report *H. sipmanii* from the Philippines (type locality), Papua New Guinea and from two provinces of Thailand (Nakhon Ratchasima and Uthai Thani). My TLC studies on Thai collections and the type specimen from the Philippines revealed that they have alternative chemistries. The specimens with hypoprotocetraric acid as a major metabolite and lacking 4-*O*-methylhypoprotocetraric acid are described here as the new species, *H. siamensis*.



Fig. 6: *Heiomasia siamensis* (holotype); thallus with disc-shaped schizidia, bar 0.5 mm

***Heiomasia sipmanii*** (Aptroot, Lücking & Rivas Plata) Nelsen, Lücking & Rivas Plata

in Nelsen *et al.*, The Bryologist 113(4): 748 (2010). Syn.: *Herpothallon sipmanii* Aptroot, Lücking & Rivas Plata in Aptroot *et al.*, Bibliotheca Lichenologica 99: 64 (2009).

Type: PHILIPPINES. Luzon: Nueva Vizcaya province, Mt. Palali, March 2007, leg. Rivas Plata & Lücking 1155 (fragment seen and tested by TLC).

Description: Thallus corticolous, chalk-white, ecorticate. Schizidia disc-shaped, roundish to ellipsoid, originating directly from the thallus, obliquely upright and attached to the thallus by one side, up to 0.3–0.7 mm wide. Ascomata unknown.

Chemistry: Hypoprotocetraric acid (minor), 4-*O*-methylhypoprotocetraric acid (major), heiomaseic acid (major); (Fig. 14).

Remarks: Aptroot *et al.* (2009) and Nelsen *et al.* (2010) reported the presence of protocetraric acid and/or hypoprotocetraric acid respectively in *H. sipmanii*. A restudy of the type material revealed the chemistry given above. The major 4-*O*-methylhypoprotocetraric acid is a rare substance in the Graphidaceae *sensu lato*, known e.g. from *Ocellularia poschlodiana* Sutjaritt. & Kalb.

#### A world-wide key to the species of *Heiomasia*

- |    |  |                             |
|----|--|-----------------------------|
| 1  | Thallus with sausage-shaped pseudisidia; Neotropics  | <i>Heiomasia seaveyorum</i> |
| 1* | Thallus with disc-shaped schizidia, originating from thallus warts or directly from the thallus                    | 2                           |
| 2  | Disc-shaped schizidia originating from thallus warts, stictic acid aggr. or norstictic and salazinic acids present | 3                           |
| 2* | Disc-shaped schizidia originating directly from the thallus, hypoprotocetraric acid or related substances present  | 4                           |
| 3  | Stictic, hypostictic, peristictic, cryptostictic and constictic acids present; Malaysia                            | <i>Heiomasia annamariae</i> |
| 3* | Norstictic and salazinic acids present; India (Andaman Islands)  | <i>Heiomasia pallescens</i> |
| 4  | Hypoprotocetraric acid present as major metabolite; Thailand   | <i>Heiomasia siamensis</i>  |
| 4* | 4- <i>O</i> -Methylhypoprotocetraric acid present as major metabolite; Philippines                                 | <i>Heiomasia sipmanii</i>   |

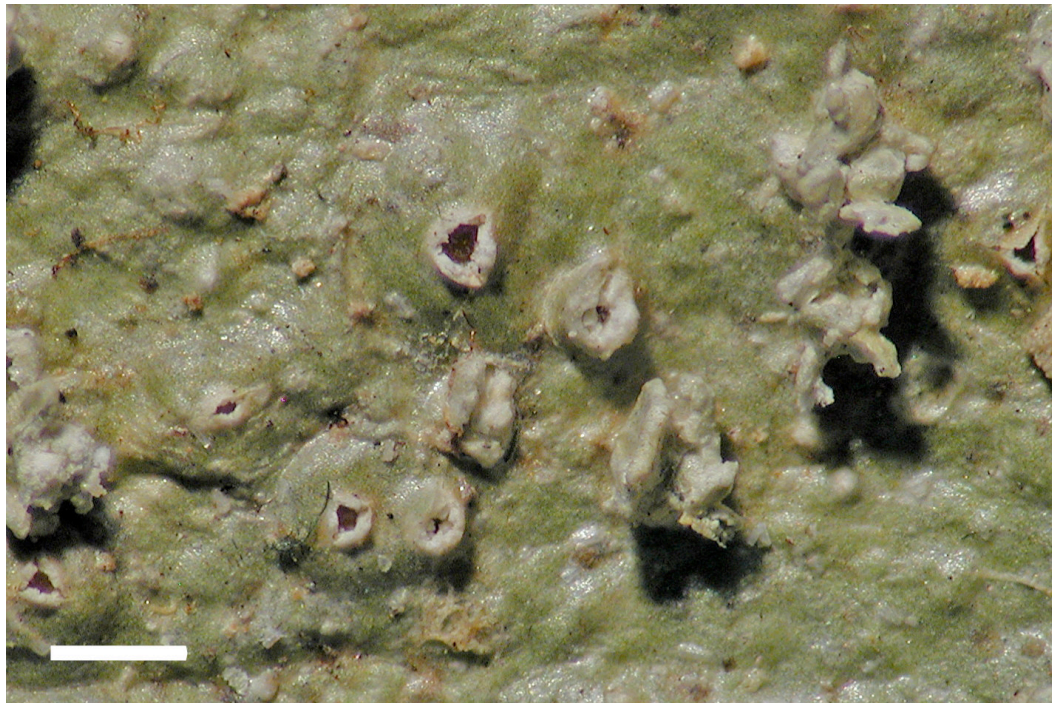


Fig. 7: *Myriotrema squamiferum* (holotype); thallus with ascomata and schizidia, bar 0.5 cm

***Myriotrema squamiferum*** Kalb sp. nov.

Figs. 7, 8

Mycobank MB 835617

Similar to *M. frondosolucens* Lücking but lacking lichexanthone.

Type: MALAYSIA. Sarawak; c. 25 km NNE of Kutching, 01°42'36" N, 110°26'39" E, 50 m, corticolous in a coastal rainforest, 16 August 2014, leg. K. Kalb 34032 & A. Mertens (B, holotype).

Description: Thallus corticolous, covering almost the whole trunk, light grey-olive, smooth to uneven, producing squamule-like schizidia originating from thallus warts; cortex in section 12–25  $\mu\text{m}$  thick, photobiont layer 10–20  $\mu\text{m}$  thick, medulla 100–150  $\mu\text{m}$  thick, filled with clusters of crystals; ascomata sparse and inconspicuous, immersed in the medulla, 0.2–0.3 mm diam., exciple hyaline, fused, pore round to angular, 50–100  $\mu\text{m}$  diam. Ascospores 4–8/ascus (only few seen), submuriform, 18–22  $\times$  7–9  $\mu\text{m}$ , 4–5  $\times$  0–1-septate, I+ bluish.

Chemistry: Stictic acid (major), cryptostictic acid (minor), hypostictic acid (trace).

Etymology: The specific epithet refers to the squamiform schizidia present in this species.

Remarks: On a world level (Lücking *et al.* 2016), three *Myriotrema* species are known with these peculiar schizidia present, i.e. *M. frondosolucens* from Costa Rica, a species which lacks ascomata but differs in producing both stictic acid and lichexanthone, *M. frondosum* Hale from Sri Lanka containing psoromic acid and *M. neofrondosum* Sipman from Guyana producing hypoprotocetraric acid, 4-*O*-demethylnotatic acid and lichexanthone. This type of schizidia is also found in *Anomomorpha tuberculata* Lücking, Umaña & Will-Wolf (Lumbsch *et al.* 2011).



**Fig. 8:** *Myriotrema squamiferum* (holotype); thallus with squamiform schizidia, originating from thallus warts, bar 0.5 cm.

### Remarks on some *Ocellularia* species

*Ocellularia crocea* (Kremp.) Overeem & D. Overeem

**Figs. 9, 10**

Bulletin du Jardin Botanique Buitenzorg, Série 3, Volume 4(1): 118 (1922); *Ascidium croceum* Kremp., Nuovo Giornale Botanico Italiano, Volume 7, Fascicolo 1: 25 (1875).

Type: MALAYSIA. Sarawak; leg. Beccari 31c (M! lectotype designated by Hale 1978: 17).

According to the annotation labels, the type was investigated by various lichenologists with different results (in brackets is the year of investigation of the material):

Hale (1972): "cinchonarium unknown"; no columella (published in Hale 1978: 17).

Nagarkar & Hale (1988): columella thin, 32–40  $\mu\text{m}$ .

Matsumoto (1996): no lichen substances by TLC; columella present, completely carbonized.

Mangold & Lumbsch (2006): no further information, but in Mangold *et al.* (2009: 301) this species is treated as a synonym of *Ocellularia cavata* (Ach.) Müll. Arg. Therefore, one can assume that the "cinchonarium unknown" and a columella were detected.

My present investigation of the tiny (and unfortunately heavily abraded) type revealed the following:

Description: Thallus corticolous, lead-grey to olive-grey, with scattered verrucae, 0.1–0.15  $\mu\text{m}$  thick; the warts filled with orange-yellow medulla. Ascumata 0.3–0.5 mm diam., in part slightly impressed apically; exciple carbonized in the upper c. 50% of the apothecium,



**Fig. 9:** *Ocellularia crocea* (lectotype, M): thallus and apothecia; most of them abraded and showing the orange-yellow medulla, bar 0.5 mm.

medulla orange-red; columella present, completely carbonized, 40  $\mu\text{m}$  wide in the centre, 60  $\mu\text{m}$  wide at the top (see annotation label by Matsumoto). Ascospores hyaline, 8/ascus, 3–6-septate (most spores 6-loculate) 15–20  $\times$  6–8  $\mu\text{m}$ , I+ violet.

Medulla K+ violet, P+ blood-red.

Remarks: The scarce original material does not allow to remove even a very small piece for TLC. Therefore, we rely on the results of Hale and Mangold *et al.*, who found cinchonaric acid. Where the columella is rather narrow and if the apothecium is not sectioned horizontally through the center and vertically to the base, the columella may be overlooked or considered as being only carbonized in the upper part.

In Sarawak (type locality), we found a small, but very well developed specimen of *O. crocea* as follows:

MALAYSIA. Sarawak: Kuching; Permai Rainforest resort jungle trail (red/blue) near Damai Beach, c. 30 km N of Kuching, 01°44'51" N, 110°18'39" E, c. 40 m, corticolous in a coastal rainforest, 15 August 2014, leg. K. Kalb & A. Mertens (hb. K. Kalb 42558).

Description: Thallus olive-grey, warty; the warts filled with yellow-orange medulla. Ascomata 0.4–0.6 mm diam., 150–180  $\mu\text{m}$  high, in part slightly impressed apically; exciple carbonized in the upper c. 50% of the apothecium, medula orange-yellow; columella present, completely carbonized, up to 90  $\mu\text{m}$  wide, 100–130  $\mu\text{m}$  high. Ascospore hyaline, 8/ascus, 4–7-septate (most spores 6-loculate), 17–22  $\times$  6–7  $\mu\text{m}$ .

Chemistry: Medulla K+ violet, P+ blood-red; cinchonaric acid, concinchonaric acid (trace).



Fig. 10: *Ocellularia crocea* (hb. KK 42558): thallus and apothecia, bar 0.5 mm

*Ocellularia macrocrocea* Kalb, sp. nov.

Fig. 11

Mycobank MB 835618

Similar to *Ocellularia rubropolydiscus* M. Cáceres, Aptroot & Lücking but differs in lacking red pigment covering the ascomatal disc and in having a broad, stump-shaped columella.

Type: MALAYSIA. Sabah; Kota Kinabalu, Gaya Island (Pulau Gaya); 06°00'44" N, 116°00'35" E, 10–20 m, corticolous in a coastal rainforest, 6 August 2014, leg. K. Kalb (40390) & A. Mertens (B, holotype).

Description: Thallus corticolous, up to 5 cm diam., surface strongly and coarsely verrucose, olive to olive grey; verrucae 0.2–0.5 mm diam., with orange-yellow medulla; prothallus present as a distinct black line. Thallus in section 100–500 µm thick, with a paraplectenchymatous cortex, 10–15 µm thick, an irregular photobiont layer, 30–40 µm thick, and a well-developed medulla, up to 500 µm thick in the verrucae, filled with orange-yellow pigment. Ascomata rounded to irregular in outline, prominent to sessile, with entire thalline margin, 0.6–1.2 mm diam., 0.3–0.5 mm high; pore up to 0.5 mm wide, disc hidden by the black columella, light brownish; proper margin indistinct, entire, visible as blackish rim around the pore; thalline margin entire, verrucose, olive. Excipulum entire, carbonized, 50–80 µm wide; laterally covered by thick algiferous, corticate thallus containing orange-yellow medulla and brown periderm layers, 100–200 µm thick; columella present, broad stump-shaped, completely carbonized, c. 350 µm wide at the base, 250 µm at the top, c. 200 µm high; hypothecium prosoplectenchymatous, 8–15 µm high, hyaline; hymenium 100–120 µm high, hyaline, clear; epithecium indistinct, 5–8 µm high, hyaline. Paraphyses unbranched, apically smooth; periphysoids absent. Ascospores 8 per ascus, ellipsoid to oblong, (3–)5(–7)-septate, 15–23 × 6–8 µm, distoseptate with lens-shaped lumina, I+ violet-blue.



Fig. 11: *Ocellularia macrocrocea* (holotype); thallus and ascomata, bar 0.5 mm

Chemistry: Medulla K+ violet, P+ blood-red; cinchonaric acid (major), spot 3 (minor), orange pigment (minor) with R<sub>F</sub>-values 35/34/22.

Etymology: The specific epithet refers to the similarity with a luxuriant *Ocellularia crocea*.

Remarks: This material appeared as a luxuriant form of *O. crocea*, but after the study of the lectotype of *O. crocea*, it is here described as new. The ascomata of *O. crocea* are only 0.3–0.6 mm diam., the columella 90 µm wide and up to 130 µm high, and the thallus warts are scattered and only 0.1–0.15 µm thick.

### ***Ocellularia tanii* Sipman**

Bibliotheca Lichenologica 86: 183 (2003).

Type: SINGAPORE. Nee Soon, SE of Upper Selatar Reservoir; 01°23.5' N, 103°48.5' E, 20 m, freshwater swamp forest, on trunk and canopy of fallen tree, 16 November 2000, Sipman, Murphy & Tan 46151 (B!, holotype).

When working on our collections of *Ocellularia* species from Malaysia, a specimen which matched all characters with *O. tanii* was detected, except the chemistry. In the protologue, Sipman (loc. cit.) reported 4-*O*-methylconhypoprotocetraric acid and conhypoprotocetraric acid.

Therefore, the type specimen was re-investigated, and co-chromatography with the sample from Borneo showed an identical chemistry, viz. hypoprotocetraric acid (major), 2-hydroxynorotatic acid (major), conhypoprotocetraric acid (minor); (Figs. 12, 13).

Sipman (2003) also reported a finding from Malaysia, but not from Sarawak.

MALAYSIA. Sarawak; Kuching, Permai Rainforest resort jungle trail (red/blue) near Damai Beach, c. 30 km N of Kuching, 01°44'51" N, 110°18'39" E, c. 40 m, corticolous in a coastal rainforest, 15 August 2014, leg. K. Kalb & A. Mertens (hb. K. Kalb 40441).

### **R<sub>F</sub>-values for substances of the hypoprotocetraric acid complex occurring in the Graphidaceae**

Isonotatic acid .....	38 .....	42 .....	43 .....	yellow
4- <i>O</i> -Methylhypoprotocetraric acid .....	35–38 .....	51 .....	45 .....	grey
Hypoprotocetraric acid.....	27–32 .....	39–40.....	19–22 .....	yellow, blue, margin or blue
2-Hydroxyhypoprotocetraric acid.....	15 .....	29 .....	10 .....	dark blue-grey
4- <i>O</i> -Demethylnotatic acid.....	14 .....	35 .....	14 .....	yellow, blue margin or blue
Norisonotatic acid .....	12 .....	23 .....	14 .....	brown
2-Hydroxynorotatic acid .....	8–12 .....	27–29 .....	5–7 .....	yellow
Heiomaseic acid (= possibly 2-Hydroxynorisonotatic acid) .....	5 .....	19 .....	8 .....	brown
Conhypoprotocetraric acid.....	2–4 .....	12–16 .....	2–3 .....	orange
Olivaceic acid.....	3 .....	15 .....	3 .....	grey

The R<sub>F</sub>-values of almost all these substances depend on the concentration of the metabolite, i.e. the higher the concentration, the higher the R<sub>F</sub>-value. This property is less pronounced by most other lichen substances occurring in Graphidaceae.

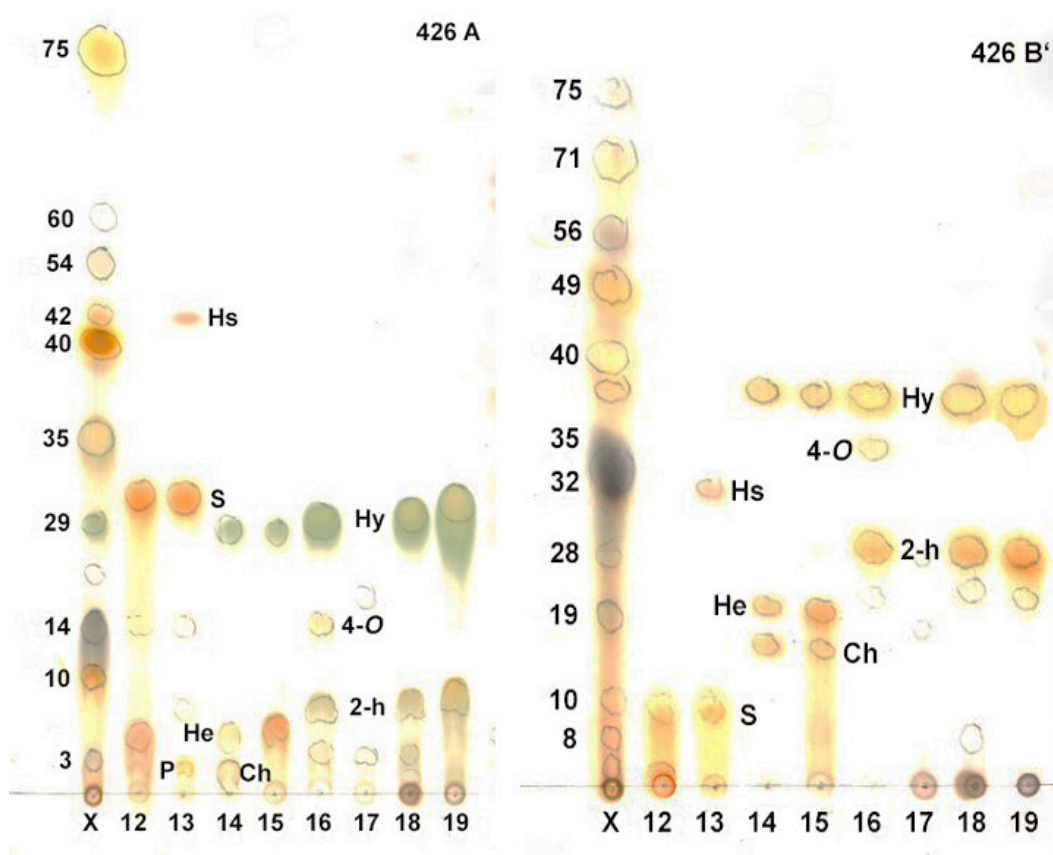


Fig. 12: Scans of TLC plates 426 in solvents A and B' (for TLC methods see Elix 2018).

#### Explanations to the TLC plates

Runs X show relative R<sub>f</sub>-values of a standard mixture.

Runs 12–19 show the chemical profiles of the following species:

12: *Leucodecton subcompunctum* (KK 40889)

13: *Heiomasia annamariae* (holotype)

14: *Heiomasia siamensis* (KK 42064)

15: *Heiomasia seaveyorum* (KK 39647) TLC from thallus without pseudisidia

16: *Ocellularia* sp. (KK 40469)

17: *Myriotrema olivaceum* (Frisch 99/Ka668)

18: *Ocellularia tanii* (holotype)

19: *Ocellularia tanii* (KK 40441)

#### Abbreviations

α-a = α-acetylhyloconstictic acid  
 2-h = 2-hydroxynornotatic acid  
 4-O = 4-O-demethylnotatic acid  
 4-O-M = 4-O-Methylhypoprotocetraric a.  
 Ch = Conhypoprotocetraric acid  
 Hcs = Hypoconstictic acid

He = Heiomaseic acid  
 Hs = Hypostictic acid  
 Hy = Hypoprotocetraric acid  
 P = Peristictic acid  
 S = Stictic acid



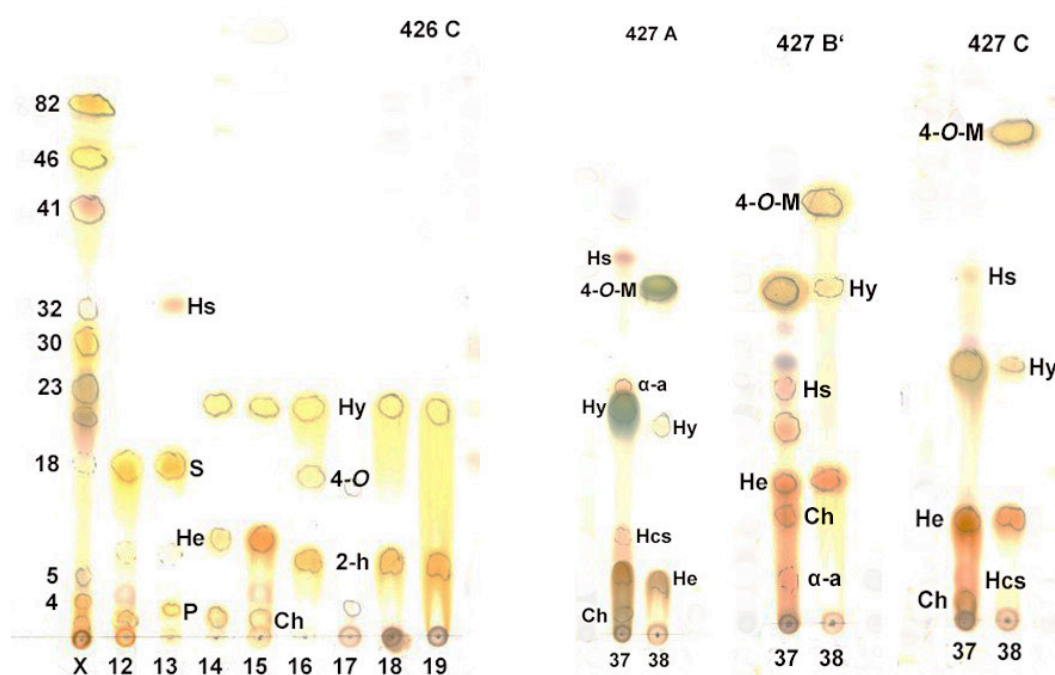


Fig. 13: Scans of TLC plate 426 in solvent C and TLC plates 427 in solvents A, B' and C

#### Explanations to the TLC plates

Run X shows relative R<sub>f</sub>-values of a standard mixture.

Runs 12–19 show the chemical profiles of the following species (see above):

Run 37: *Heiomasia seaveyorum* (KK 39647) TLC from pseudisidia only

Run 38: *Heiomasia sipmanii* (holotype)

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#### References

- APTROOT, A., THOR, G., LÜCKING, R., ELIX, J. A. & CHAVES, J. L. (2009): The lichen genus *Herpothallon* reinstated. *Bibliotheca Lichenologica* 99: 19–66.  
 DODGE, C. W. (1953): Some lichens of tropical Africa. *Annals of the Missouri Botanical Garden* 40: 271–412.

- DODGE, C. W. (1964): Some lichens of tropical Africa. IV. Dermatocarpaceae to Pertusariaceae. *Nova Hedwigia, Beiheft* 12: 1–282.
- ELIX, J. A. (2018): A catalogue of standardized chromatographic data and biosynthetic relationships for lichen substances. Fourth Edition. Published by the author, Canberra.
- FEUERSTEIN, S. C., CUNHA-DIAS, I. P. R., APTROOT, A., ELIASARO, S. & CÁCERES, M. (2014): Three new *Diorygma* (Graphidaceae) species from Brazil, with a revised world key. *Lichenologist* 46(6): 753–761.
- FRISCH, A., KALB, K. & GRUBE, M. (2006): Contributions towards a new systematics of the lichen family Thelotremataceae. *Bibliotheca Lichenologica* 92: 1–556.
- HALE, M. E. (1978): A revision of the lichen family Thelotremataceae in Panama. *Smithsonian Contributions to Botany* 38: 1–60.
- JAGADEESH RAM, T. A. M. (2014): The genus *Herpothallon* (Arthoniaceae) in the Andaman Islands, India. *Lichenologist* 46(1): 39–49.
- JOSHI, S., UPRETI, D. K., EGBE, A. E. & HUR, J.-S. (2016): New records of *Graphis* from Cameroon, with a key to African species of *Graphis*. *Mycotaxon* 131(4): 925–937.
- KREMPELHUBER, A. (1875): Lichenes quos legit O. Beccari in insulis Borneo et Singapore annis 1866 et 1867. *Nuovo Giornale Botanico Italiano*, Volume 7, Fascicolo 1: 5–67.
- LÜCKING, R., ARCHER, A. W. & APTROOT, A. (2009): A world-wide key to the genus *Graphis* (Ostropales: Graphidaceae). *Lichenologist* 41(4): 363–452.
- LÜCKING, R., MANGOLD, A. & LUMBSCH, H. T. (2016): A worldwide key to species of the genera *Myriotrema* and *Glaucotrema* (lichenized Ascomycota: Graphidaceae), with a nomenclatural checklist of species published in *Myriotrema*. *Herzogia* 29(2), Teil 1: 493–513.
- LUMBSCH, H. T. & 102 further authors (2011): One hundred new species of lichenized fungi: a signature of undiscovered global diversity. *Phytotaxa* 18: 1–127.
- MANGOLD, A., ELIX, J. A. & LUMBSCH, H. T. (2009): Thelotremataceae. *Flora of Australia* 57: 195–420.
- MÜLLER ARG., J. (1894): Lichenes Usambarenses. *Botanische Jahrbücher* 20: 238–298.
- NAGARKAR, M. B. & HALE, M. E. (1989): New species in the lichen family Thelotremataceae from Asia (Ascomycotina). *Mycotaxon* 35(2): 437–447.
- NELSEN, M. P., LÜCKING, R., RIVAS PLATA, E. & MBATCHOU, J. S. (2010): *Heiomasia*, a new genus in the lichen-forming family Graphidaceae (Ascomycota: Lecanoromycetes: Ostropales) with disjunct distribution in Southeastern North America and Southeast Asia. *The Bryologist* 113(4): 742–751.
- PAUKOV, A., SIPMAN, H. J. M., KUKWA, M., REPIN, R. & TEPTINA, A. (2017): New lichen records from the mountains Kinabalu and Tambuyukon (Kinabalu Park, Malaysian Borneo). *Herzogia* 30(1): 237–252.
- SIPMAN, H. J. M. (1993): Lichens from Mount Kinabalu. *Tropical Bryology* 8: 281–314.
- SIPMAN, H. J. M. (2003): New species of *Cryptothecia*, *Lepraria*, and *Ocellularia* (lichenized Ascomycetes) from Singapore. *Bibliotheca Lichenologica* 86: 177–184.
- SIPMAN, H. J. M., LÜCKING, R., APTROOT, A., CHEVES, J. L., KALB, K. & TENORIO, L. U. (2012): A first assessment of the Ticolichen biodiversity inventory in Costa Rica and adjacent areas: the thelotremoid Graphidaceae (Ascomycota: Ostropales). *Phytotaxa* 55: 1–214.
- STAIGER, B. (2002): Die Flechtenfamilie Graphidaceae. Studien in Richtung einer natürlicheren Gliederung. *Bibliotheca Lichenologica* 85: 1–526.
- VAINIO, E. A. (1901): Lichenes. In: Hiern, W. P. (edit.): *Catalogue of the African plants collected by Dr. Friedrich Welwitsch in 1853–61*, vol. II(2): 396–463.
- VAINIO, E. A. (1926) Lichenes Africani novi. *Annales Universitatis Fennicae Aboensis* A, 2(3): 1–33.