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Thelotremoid lichen species recently described from Thailand: a re-evaluation

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Abstract: Twenty-six species recently described from Thailand are revised. Eleven taxa are reduced to synonymy with previously described species, including *Leptotrema phaeosporum* var. *vainiona* Räsänen. The following new combinations are proposed: *Chapsa calathiformis* (Vain.) Lumbsch & Papong, *C. laemensis* (Homchantara & Coppins) Lumbsch & Papong, *Melanotrema melanophthalmum* (Homchantara & Coppins) Lumbsch & Papong, *Ocellularia albocincta* (Hale) Divakar & Mangold, *O. guianensis* (Sipman) Divakar & Mangold, *O. khunantensis* (Homchantara & Coppins) Lumbsch & Papong, *O. percolumellata* (Sipman) Divakar & Mangold, *O. subcalvescens* (Nyl.) Divakar & Mangold and *Ocellularia subgranulosa* (Homchantara & Coppins) Lumbsch & Papong.

Key words: *Graphidaceae*, south-east Asia, synonymy, taxonomy, *Thelotremataceae*

Introduction

The major part of species diversity in tropical crustose discolichens consists of species currently placed in *Graphidaceae*. A morphological group within this largest family of crustose lichens, the thelotremoid lichens, is characterized by immersed-erumpent, rounded ascomata with non-branched to slightly branched paraphyses, mostly distoseptate ascospores, and mostly a trentepohlioid photobiont. More than 1000 species of thelotremoid lichens were described by Frisch *et al*. (2006) and Hale (1981). Previously, these lichens were classified as *Thelotremataceae*, but molecular studies have shown that the family is polyphyletic with several thelotremoid clades nested within *Graphidaceae* (Mangold *et al*. 2008*b*; Staiger *et al*. 2006). Hence, the family is now included in *Graphidaceae* and its species are informally accepted as thelotremoid lichens.

Traditionally, the *Thelotremataceae* was divided into large genera according to their spore septation and pigmentation following Müller Argoviensis (1887). This artificial classification was subsequently revised by Hale (1980) who produced a generic classification that relied largely on excipular characters, such as exciple pigmentation and presence of lateral paraphyses In a recent paper Frisch *et al*. (2006) provided a major revision of the generic concepts in thelotremoid lichens by proposing a classification based on combinations of several morphological character complexes. This new classification is largely followed here, with modifications as suggested by Mangold *et al*. (2009). These modifications include a wider concept of the genus *Ocellularia* to include the genus *Stegobolus*,which has been shown to be polyphyletic and clustered within *Ocellularia* in phylogenetic analyses (Mangold *et al*. 2008*b*).

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Based on a Ph. D. study on taxonomy and ecology of *Thelotremataceae* in south-east Asia by Natsurang Homchantara submitted in 1999, Homchantara & Coppins (2002) described numerous new species mainly from Thailand, and recorded several new records for south-east Asia. At that time, however, knowledge of the taxonomy of several tropical thelotremoid taxa was poor and hence some of the new species awaited comparison with poorly known previously described species. Recently, there has been a renewed interest in the taxonomy and systematics of thelotremoid lichens, resulting in a number of publications (Frisch & Kalb 2006; Frisch *et al*. 2006; Mangold *et al*. 2006; 2007*a*, *b*, 2008*a*, *b*, 2009; Lumbsch *et al*. 2008). Given this increased knowledge of the morphological and chemical variation of species and a re-evaluation of a large number of type specimens, we have re-evaluated the species described from Thailand by Homchantara & Coppins (2002). This contribution includes new synonyms and changes of generic placement of some species to follow the generic concepts of Mangold *et al*. (2009). Additional species described by Homchantara & Coppins (2002) from other Asian countries are not included in this study.

Materials and Methods

Material from the following herbaria was examined for this study: BM, C, E, H, RAMK, US. Types of all species mentioned in this paper have been studied by the authors. Thalli and apothecia were sectioned using a razor blade and a freezing microtome, and examined in water and lactophenol cotton blue. Thin-layer chromatography was carried out using solvent system B' (Lumbsch 2002) and high-performance liquid chromatography according to Feige *et al*. (1993).

The Species

Myriotrema grandisporum Homchantara & Coppins

This species is a synonym of *Thelotrema patwardhanii* (Hale) Rivas Plata & Mangold described from India (Hale 1978*a*; Rivas Plata *et al*. 2010*b*). The types of the two species agree well in containing norstictic acid and having large, transversely septate ascospores that turn brown at maturity and inconspicuous lateral paraphyses. The hymenia of both species include numerous brown ascospores. The ascospore size in the protologue of *T. patwardhanii* is given as 150–210 × 21–25 μm with 20–30 transverse septa. However, we have also found up to 46 transverse septa in the type material and also ascospores up to 230 μm. These measurements fall within the variability recorded by Homchantara & Coppins (2002) for *M. grandisporum* (169·5–271·0 × 17·0–28·5 μm and 45–49 transverse septa). In addition, we found the transverse septation of ascospores in the type of *M. grandisporum* to be more variable (35–49). Accessory connorstictic acid was found in addition to norstictic acid.

Myriotrema khaoyaianum Homchantara & Coppins

Myriotrema khaoyaianum is a synonym of *Ocellularia perforata* (Leight.) Müll. Arg. The species was placed in *Myriotrema* by Homchantara & Coppins (2002) based on the lack of carbonization, following the generic concept of Hale (1980). As discussed by Frisch *et al*. (2006), however, *O. perforata* typically has only a weak carbonization and may lack it completely. *Myriotrema khaoyaianum* falls within the variability of *O. perforata* as circumscribed by Frisch *et al*. (2006) and hence it is placed into synonymy with this species. Conprotocetraric and virensic acids were found as accessory substances.

Myriotrema khuntanense Homchantara & Coppins

The species was placed in *Myriotrema* (Homchantara & Coppins 2002) based on the colourless exciple and columella. The species belongs to *Ocellularia sensu* Frisch *et al*. (2006) and Mangold *et al*. (2009). The new combination is proposed here: **Ocellularia khuntanensis (Homchantara & Coppins) Lumbsch & Papong comb. nov**. [Basionym: *Myriotrema khuntanense* Homchantara & Coppins, *Lichenologist* **34:**

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115, 2002]. The size of the ascospores is similar to that of *Ocellularia auberiana* (Mont.) Hale, but this species differs by the presence of a reticulate columella. Another similar species is *O. minutula* Hale, which, however, is readily distinguished by its smaller ascospores (Hale 1978*b*). Accessory substances, 2'-*O*-demethylpsoromic and subpsoromic acids were found.

Myriotrema rongklaense Homchantara & Coppins

Myriotrema rongklaense is a synonym of *Ocellularia papillata* (Leighton) Zahlbr. As discussed previously (Mangold *et al*. 2009), the ascomata of *O. papillata* vary from weakly or non-carbonized to distinctly carbonized. The type of *M. rongklaense* agrees well with specimens of *O. papillata* with weakly to non-carbonized ascomata and hence it is synonymized with that species here.

Myriotrema subanamaliense Homchantara & Coppins

Myriotrema subanamaliense is a synonym of *Wirthiotrema glaucopallens* (Nyl.) Rivas Plata & Kalb (Rivas Plata *et al*. 2010*a*).

Myriotrema subgranulosum Homchantara & Coppins

This species belongs to *Ocellularia* as currently circumscribed (Frisch *et al*. 2006; Mangold *et al*. 2009) and therefore we propose the new combination here: **Ocellularia subgranulosa (Homchantara & Coppins) Lumbsch & Papong comb. nov**. (Basionym: *Myriotrema subgranulosum* Homchantara & Coppins, *Lichenologist* **34:** 117, 2002). The taxon is characterized by perithecioid ascomata, 1–2-spored asci with hyaline, amyloid, transversely septate ascospores and by the presence of the norisonotatic and norsubnotatic acids (formerly named Chonestoma unknowns). Similar species include *O. chonestoma* (Leighton) Zahlbr. and *O. nylanderiana* Hale; the former species being readily distinguished by its smaller ascospores, while the latter has longer and thinner ascospores with up to 18 loculi (Hale 1981).

Myriotrema subminutum Homchantara & Coppins

Myriotrema subminutum is a further synonym of *Ocellularia perforata*; fumarprotocetraric acid occurs as minor constituent in several specimens of that species (Mangold *et al*. 2009). Conprotocetraric and virensic acids were found as accessory substances.

Myriotrema thailandicum Homchantara & Coppins

Myriotrema thailandicum is a synonym of *Ocellularia thelotremoides* (Leight.) Zahlbr. The type fits well into the variability of that species as circumscribed by Mangold *et al*. (2009).

Myriotrema whalleyanum Homchantara & Coppins

The type material of *Myriotrema whalleyanum* does not contain a thelotremoid lichen; it is a pyrenocarpous lichen. It is synonymous to *Porina exocha* (Nyl.) P. M. McCarthy.

Ocellularia brunneospora Homchantara & Coppins

This species is characterized by small, transversely septate ascospores and the presence of the norisonotatic chemosyndrome. It agrees chemically with *O. chonestoma* (Leight.) Zahlbr. but this species differs in having larger ascospores. Other *Ocellularia* spp. containing norisonotatic and norsubnotatic acids (formerly named Chonestoma unknowns) include *O. allosporoides* (Nyl.) Patw. & C. Kulk. and *O. baileyi* Müll. Arg. (Mangold *et al*. 2009). Both of these species have larger hyaline ascospores (50–130 and 18–40 μm, respectively).

Ocellularia diospyrosis Homchantara & Coppins

This species is characterized by large and hyaline, transversely septate ascospores, a simple columella and by the presence of the

stictic acid chemosyndrome. It is superficially similar to *O. pyrenuloides* Zahlbr., which, however is readily distinguished by smaller ascospores with less loculi (18–24 × 6–7 µm with 5–6 loculi). The South African *O. henatomma* (Ach.) Müll. Arg. differs in having longer ascospores and the presence of the hypoprotocetraric acid chemosyndrome (Frisch *et al.* 2006). α-acetylconstictic was found as accessory substance.

Ocellularia flavescens Homchantara & Coppins

This species is readily recognized by the presence of lichexanthone, which is rare in thelotremoid lichens. Similar species containing lichexanthone include *Ocellularia metaphorica* (Nyl.) Hale, *Melanotrema astrolucens* (Sipman) A. Frisch and *M. lirelliforme* (Tuck.) A. Frisch. The first differs in having a reticulate columella and brown, ornamented ascospores (Frisch *et al.* 2006), while the two *Melanotrema* species are distinguished by having brown, transversely septate ascospores.

Ocellularia inthanonensis Homchantara & Coppins

This species is characterized by 1-spored asci, large, muriform, hyaline ascospores, ecolumellate ascomata, and the presence of the (newly identified) 2-hydroxy-hypoprotocetraric and hypoprotocetraric acids. Similar species include *O. arecae* (Vain.) Hale and *O. eumorpha* (Stirt.) Hale. The latter has 1–2-spored asci, the ascospores turn brown when mature, and it contains convirensic acid as a major constituent in addition to hypoprotocetraric acid. *Ocellularia arecae* differs in having a columella.

Ocellularia kansriae Homchantara & Coppins

Ocellularia kansriae is a synonym of *Ocellularia microstoma* (Müll. Arg.) Hale. This species is characterized by ecolumellate, emergent, perithecioid ascomata, 1-spored asci with large, hyaline, muriform ascospores and the presence of the protocetraric acid chemosyndrome (Mangold *et al.* 2009). Conprotocetraric and virensic acids were found as accessory substances.

Ocellularia krathingensis Homchantara & Coppins

Homchantara & Coppins (2002) mentioned the presence of an unidentified substance in this species. We have been unable to detect any secondary metabolites in the type material. *Ocellularia krathingensis* can be recognized by the combination of ascomata with an only apically carbonized exciple and a complex, carbonized columella, 8-spored asci with hyaline, amyloid, transversely septate ascospores and the lack of secondary metabolites.

The Neotropical taxon, ***Ocellularia guianensis* (Sipman) Divakar & Mangold comb. nov**. [Basionym: *Myriotrema guianense* Sipman, *Trop. Bryol.* **5:** 83, 1992; syn. *Stegobolus guianensis* (Sipman) A. Frisch, *Bibl. Lichenol.* **92:** 464, 2006], is similar, but differs by containing 'guianensis unknown' and psoromic acid, larger ascomata with a more distinctly complex columella, and by a reddish pruina (Frisch *et al.* 2006). Another similar species is the Neotropical ***Ocellularia percolumellata* (Sipman) Divakar & Mangold comb. nov**. [Bas.: *Myriotrema percolumellatum* Sipman, *Acta Bot. Fenn.* **150:** 170, 1994; syn. *Stegobolus percolumellatus* (Sipman) A. Frisch, *Bibl. Lichenol.* **92:** 474, 2006]; it differs in having ascospores with fewer loculi and with acute to subacute ends. These two species, originally described in *Myriotrema*, and recently transferred to *Stegobolus*, have been transferred here to *Ocellularia* following the generic concept of Mangold *et al.* (2009), in which *Stegobolus* is included in *Ocellularia* and *Myriotrema* does not include species having a columella.

Ocellularia melanophthalma Homchantara & Coppins

This species is characterized by a broad, simple carbonized columella and carbonized, free exciple, hyaline, transversely septate

ascospores, an ecorticate thallus, and by the presence of the protocetraric acid chemosyndrome. The species belongs to *Melanotrema* A. Frisch, which was described in Frisch *et al.* (2006) to accommodate species with a broad, carbonized columella, carbonized ascomata and a thallus covered by a protocortex. Hence, the following new combination is proposed: **Melanotrema melanophthalmum (Homchantara & Coppins) Papong & Lumbsch comb. nov**. (Basionym: *Ocellularia melanophthalma* Homchantara & Coppins, *Lichenologist* **34:** 125, 2002). The pantropical *Melanotrema platystomum* (Mont.) A. Frisch is similar but differs in lacking secondary metabolites and having smaller ascospores. Conprotocetraric and virensic acids were found as accessory substances.

Ocellularia neoleucina Homchantara & Coppins

This taxon is characterized by hyaline, submuriform ascospores, a reticulate columella and the presence of the stictic acid chemosyndrome. *Ocellularia leucina* (Müll. Arg.) Hale and *O. subleucina* are similar species. The latter differs by having larger ascospores and lacking secondary metabolites, while the former taxon contains psoromic acid. Constictic acid was found as accessory substance.

Ocellularia peremergens Homchantara & Coppins

Ocellularia peremergens is another synonym of the palaeotropical *Ocellularia microstoma*. For characters to recognize this species, see under *O. kansriae*. Conprotocetraric and protocetraric acids were found as accessory substances.

Ocellularia pluriporoides Homchantara & Coppins

This taxon is characterized by a continuous thallus, ascomata with a reticulate columella, transversely septate, hyaline ascospores and by the presence of psoromic acid. It is similar to *O. terebrata* (Ach.) Müll. Arg. but differs in having larger ascospores (17–32 × 7–10 μm, with 6–10 locules in *O. terebrata*). 2'-*O*-demethylpsoromic and subpsoromic acids were found as accessory substances.

Ocellularia rhicnoporoides Homchantara & Coppins

This taxon is characterized by immersed, perithecioid, ecolumellate ascomata, an apically carbonized exciple, 8-spored asci with hyaline, transversely septate ascospores and by the lack of secondary metabolites. **Ocellularia albocincta (Hale) Divakar & Mangold comb. nov**. [Basionym: *Myriotrema albocinctum* Hale, *Bull. Brit. Mus.* (*Nat. Hist.*), *Bot. ser.* **8:** 273 (1981); type: Sri Lanka, Sabaragamuwa Prov., Ratnapura Distr., Gilimale Forest Reserve, 150 m elev., 12 ii 1976, *M. E. Hale* 46331 (US—holotype)] is similar, but differs in having a non-carbonized exciple and a shorter hymenium (Hale 1981).

Ocellularia subleucina Homchantara & Coppins

This taxon is characterized by perithecioid ascomata with a simple columella, 8-spored asci with hyaline, amyloid, submuriform ascospores and by the lack of secondary metabolites. A similar species is **Ocellularia subcalvescens (Nyl.) Divakar & Mangold comb. nov**. [Basionym: *Thelotrema subcalvescens* Nyl., *Bull. Soc. Linn. Normand.* III **7:** 168, (1873); type: India, Andaman Islands, Kurz, 1867 (H-NYL 22726—holotype)]. It is distinguished by faintly amyloid ascospores that do not exceed 21μm in length.

Ocellularia wolseleyana Homchantara & Coppins

This species is characterized by perithecioid ascomata lacking a columella, hyaline, muriform ascospores and the presence of psoromic acid. Morphologically it resembles *O. profunda* (Stirt.) Mangold, Elix & Lumbsch, which, however, is readily distinguished by its brown ascospores at late

maturity, a cone-shaped columella, and larger ascospores (Mangold *et al*. 2007*b*). 2'-*O*-demethylpsoromic was found as accessory substance.

Thelotrema laemense Homchantara & Coppins

This species is characterized by chroodiscoid ascomata, hyaline, 8-spored asci with muriform ascospores and by the presence of the stictic acid chemosyndrome. The species belongs to *Chapsa* as circumscribed by Frisch *et al*. (2006). Hence, the following new combination is proposed here: **Chapsa laemensis (Homchantara & Coppins) Lumbsch & Papong comb. nov**. (Basionym: *Thelotrema laemense* Homchantara & Coppins, *Lichenologist* **34:** 130, 2002). A similar species is *C. alstrupii* A. Frisch, which differs in having larger ascomata (up to 2 mm), a higher hymenium and lacking secondary metabolites (Frisch *et al*. 2006).

Thelotrema mongkolsukii Homchantara & Coppins

Thelotrema mongkolsukii has lepadinoid ascomata, 8-spored asci with hyaline, transversely septate ascospores and contains the hypostictic acid chemosyndrome. Morphologically similar species include *T. bicinctulum* Nyl. and *T. kamatii* (Patw. & C.R. Kulk.) Hale. The latter differs in having larger ascospores (70–110 µm long) and lacking secondary metabolites (Patwardhan & Kulkarni 1977; Nagarkar *et al*. 1988). *Thelotrema bicinctulum* has smaller ascomata and faintly amyloid ascospores (Frisch *et al*. 2006; Mangold *et al*. 2009).

Thelotrema phliuense Homchantara & Coppins

Thelotrema phliuense and also *Leptotrema phaeosporum* var. *vainiona* Räsänen, *Arch. Soc. Zool. Bot. Fenn. Vanamo* **3:** 87 (1949); type: Philippines, Distr. Mindanao, Zamboanga, Malangas, Oct-Nov 1919, *M. Ramos & G. Edano* (TUR-V 35049-holotype) are synonyms of *Thelotrema calathiforme* Vain. The species belongs to *Chapsa* as circumscribed by Frisch *et al*. (2006); consequently, the following new combination is proposed: **Chapsa calathiformis (Vain.) Lumbsch & Papong comb. nov**. [Basionym: *Thelotrema calathiforme* Vain., *Hedwigia* **46:** 174 (1907); type: Thailand, Koh Chang island, "ad truncos arb.", 1899–1900, *J. Schmidt* XXIII (C—holotype)]. This species is readily identified by its shiny, greenish grey, continuous thallus, 8-spored asci and muriform ascospores that become brown when mature. The species is distinctive and difficult to confuse with any other taxon.

Thelotrema rhododiscum Homchantara & Coppins

Thelotrema rhododiscum is synonymous to *Ocellularia cruentata* (Mont.) Hafellner & Magnes, which is described elsewhere (Magnes 1997; Mangold *et al*. 2009).

Summary of synonyms

Myriotrema grandisporum Homchantara & Coppins = *Thelotrema patwardhanii* (Hale) Rivas Plata & Mangold.
Myriotrema khaoyaianum Homchantara & Coppins = *Ocellularia perforata* (Leight.) Müll. Arg.
Myriotrema rongklaense Homchantara & Coppins = *Ocellularia papillata* (Leighton) Zahlbr.
Myriotrema subanamaliense Homchantara & Coppins = *Wirthiotrema glaucopallens* (Nyl.) Rivas Plata & Kalb.
Myriotrema subminutum Homchantara & Coppins = *Ocellularia perforata*
Myriotrema thailandicum Homchantara & Coppins = *Ocellularia thelotremoides* (Leight.) Zahlbr.

Myriotrema whalleyanum Homchantara & Coppins = *Porina exocha* (Nyl.) P. M. McCarthy.

Ocellularia kansriae Homchantara & Coppins = *Ocellularia microstoma* (Müll. Arg.) Hale.

Ocellularia peremergens Homchantara & Coppins = *Ocellularia microstoma*

Thelotrema rhododiscum Homchantara & Coppins = *Ocellularia cruentata* (Mont.) Hafellner & Magnes.

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