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Willdenowia
Annals of the Botanic Garden and Botanical Museum Berlin

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The genus *Halegrapha* new to Hawaii, with the new and potentially endemic species *H. paulseniana* and an updated checklist of Hawaiian lirellate *Graphidaceae* (*Ascomycota*: *Ostropales*)

Version of record first published online on 16 November 2018 ahead of inclusion in December 2018 issue.

Abstract: The new species *Halegrapha paulseniana* Luch & Lücking is described from Hawaii, which constitutes the first report of the genus for this archipelago. The new species differs from the most similar taxon, *H. mexicana*, in the much larger lirellae featuring an apically complete, thin thalline margin, and from all other species in the genus by its laterally mostly uncarbonized excipulum. We provide nomenclatural updates for the 70 species of lirellate *Graphidaceae* reported from Hawaii so far, introducing the following nomenclatural novelties: *Allographa gracilescens* (Redinger) Luch & Lücking, comb. & stat. nov., *Fissurina homichlodes* (Redinger) Luch & Lücking, comb. nov., *Fissurina stromatoides* (H. Magn.) Luch & Lücking, comb. nov., *Fissurina zahlbruckneriana* Luch & Lücking, nom. nov., *Phaeographis caesiohians* (Nyl.) Luch & Lücking, comb. nov., *Phaeographis faurieana* (Zahlbr.) Luch & Lücking, comb. nov., *Phaeographis fulgurata* (Fée) Luch & Lücking, comb. nov., *Phaeographis oscitans* (Tuck.) Luch & Lücking, comb. nov., *Phaeographis rhodoplaca* (Müll. Arg.) Luch & Lücking, comb. nov., *Platygramme kaalensis* (Tuck.) Luch & Lücking, comb. & stat. nov., *Platygramme tumulata* (Nyl.) Luch & Lücking, comb. nov. and *Sarcographa dendroides* (Leight.) Tabaquero, Bawingan & Lücking, comb. nov. (validated from an earlier, intended new combination that was not validly published).

Key words: *Ascomycota*, checklist, conservation, *Graphidaceae*, *Halegrapha*, Hawaii, *Hedychium gardnerianum*, invasive plants, Magnusson, new species, *Ostropales*, Zahlbruckner

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Introduction

Hawaii is one of the most remote oceanic archipelagos on the planet, with at least 4000 km distance to any continent (Wagner & Funk 1995; Fleischer & al. 1998). As a result, a unique biota has evolved on these islands, with a high degree of endemism – up to 80 % in vascular plants – and striking radiations, such as in the lobeliads and silverswords (Baldwin & Sanderson 1998; Wagner & al. 1999; Barrier & al. 2001; Wagner & Herbst 2002; Carlquist & al. 2003; Givnish & al. 2009). The lichen biota of Hawaii has presumably been rather well-studied, mainly due to the work of Adolf Hugo Magnusson and Clifford Smith (Magnusson & Zahlbruckner 1943, 1944, 1945; Magnusson 1955; Smith 1991, 1993, 2001, 2013; Smith & al. 1997), with the most recent checklists including between 884 and 890 species (Elix & McCarthy 1998, 2008; Smith 2013). Lichens on islands have generally been believed to exhibit low degrees of endemism, around 20–30 % for Hawaii (Eldredge & Miller 1995), due to their supposedly easily dispersed spores and vegetative propagules (Smith 1995). However, recent molecular studies on the genera *Lobariella* Yoshim. and *Pseudocyphellaria* Vain. in Hawaii suggest that presumably

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widespread taxa in reality correspond to previously unrecognized, likely endemic species (Moncada & al. 2014; Lücking & al. 2017b); therefore, endemism in these two genera in Hawaii is now estimated at 75 %, comparable to that found in vascular plants.

The family *Graphidaceae* is a prominent example of how molecular data have reshaped fungal classifications, now including 79 genera compared to traditionally 12 that were distributed among two families (Staiger 2002; Frisch & al. 2006; Rivas Plata & al. 2012; Lumbsch & al. 2014; Lücking & al. 2017a). In addition, phylogenetic analyses helped to refine species concepts; an exemplary case are the *Ocellularia papillata* (Leight.) Zahlbr., *O. perforata* (Leight.) Müll. Arg. and *O. terebrata* (Ach.) Müll. Arg. morphodemes, now containing over 70 species (Lücking 2014). Based on these findings, it is expected that the approximately 100 species of *Graphidaceae* currently listed for Hawaii, with many presumably widespread taxa (Elix & McCarthy 1998, 2008; Smith 2013), hide numerous unrecognized endemics. In addition, due to lack of proper identification keys, Hawaiian *Graphidaceae* have never been critically inventoried, and additional species may await discovery. Currently, 70 species of lirellate *Graphidaceae* are reported for Hawaii (Table 1); of these, 13 (19 %) are considered endemic, nine eastern palaeotropical and one palaeotropical, 21 with neotropical affinities, and 27 pantropical to subcosmopolitan. The high proportion of taxa with neotropical affinities is likely an artefact of the availability of identification keys, which for a long time were more readily available for areas in the Neotropics, particularly Mexico and Brazil (Redinger 1933a, 1933b, 1935; Wirth & Hale 1963); Hawaiian material identified with these names may not actually represent these taxa.

The genus *Halegrapha* Rivas Plata & Lücking is one of the numerous new genera now recognized in *Graphidaceae*. It is characterized by a *Graphis*-like morphology, with whitish thalli and lirellae featuring thick, carbonized labia, but producing a *Phaeographis*-like hamathecium and *Phaeographis*-type ascospores that are brown-grey and usually small and with rounded ends (Lücking & al. 2011). To date, eight species are recognized in this group and, with the exception of *H. mucronata* (Stirt.) Lücking, all recent new discoveries are from North America, Mexico, Kenya, Sri Lanka, Malaysia, the Philippines and Japan (Lücking & al. 2011; Kashiwadani & al. 2014; Weerakoon & al. 2014). The genus has not previously been reported from Hawaii, and none of the names originally listed under *Phaeographis* Müll. Arg. or *Phaeographina* Müll. Arg. in the current checklists (Table 1) belongs to this genus.

Here we describe a new species of *Halegrapha* for the Hawaiian archipelago, discovered during a field expedition in 2013. The species is characterized by a unique set of characters and is putatively endemic to these islands; it is also the first record of the genus for Hawaii, which makes *Halegrapha* a truly pantropical genus present in all major tropical regions. As a result of this study, we also update the nomenclature of the species of lirellate *Graphidaceae* so far reported for Hawaii.

Material and methods

The work to describe the new species was done mostly by the first author, as part of a structured internship program between the Paulsen Gymnasium and the Botanischer Garten und Botanisches Museum, Freie Universität Berlin. The new taxon was detected as part of a revision by the first author of all specimens of *Graphis* Adans. collected during a 2013 field expedition to Hawaii by the second author and Bibiana Moncada (Universidad Distrital, Bogotá, Colombia) and locally coordinated by Clifford Smith (Oahu Army Natural Resources Program, Honolulu, Hawaii), Timothy Flynn (National Tropical Botanical Garden, Kauai, Hawaii), Patrick Bily (The Nature Conservancy Hawaii), Daniel Pomaikaʻi (Maui Soil and Water Conservation Districts, Maunalei Arboretum) and Philip Thomas (Research Corporation of the University of Hawaii and the Hawaiian Ecosystems at Risk Project). The material was examined with a LEICA Zoom 2000 dissecting microscope and sections of thallus and lirellae mounted in tap water were examined under a ZEISS Axioscop compound microscope. Secondary chemistry was initially assessed using KOH spot tests and subsequently verified with standardized thin-layer chromatography (TLC) using solvent system C (Orange & al. 2010). To update the nomenclature of the lirellate *Graphidaceae* reported from Hawaii, we consulted type material, in part via JSTOR Global Plants (https://plants.jstor.org) and protologues, partly via the Biodiversity Heritage Library (https://www.biodiversitylibrary.org), in addition to the monographic treatments by Magnusson & Zahlbruckner (1943) and Magnusson (1955).

Results and Discussion

Halegrapha paulseniana Luch & Lücking, **sp. nov.** – MycoBank MB 828103. – Fig. 1D–F.

Holotype: U.S.A., Hawaii, Maui, East Maui, Haleakalā Volcano, lower Waikamoi Preserve (The Nature Conservancy), 5 km SE of Pukalani and 18 km SE of Kahului, lower access trail to preserve off Olinda Road, 20°48'23"N, 156°15'19"E, 1200–1300 m, disturbed primary forest dominated by *Acacia koa* and *Campanulaceae*, with invasive *Hedychium gardnerianum* in lower portions, 11 Jun 2013, *R. Lücking, B. Moncada & P. Bily 35834* (BISH; isotypes: B, F).

Diagnosis — Differing from *Halegrapha mexicana* A. B. Peña & Lücking in the much larger lirellae featuring an apically complete, thin thalline margin, and from all other species in the genus in its laterally mostly uncarbonized excipulum.

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Fig. 1. A–C: Waikamoi Preserve, Maui, Hawaii, U.S.A., 11 June 2013; A: natural habitat of *Halegrapha paulseniana*; B: invasive ginger, *Hedychium gardnerianum*; C: persistent rhizomes of *Hedychium gardnerianum*; D–F: *Halegrapha paulseniana*; D: thallus with lirellae (type collection); E: section through lirella showing carbonized upper and basal excipulum; F: mature and (in lower left frame) post-mature (shrivelled) ascospores. – Scale bars: D = 1 mm; E = 100 µm; F = 10 µm.

Description — Thallus corticolous, to 5 cm in diam., 100–150 µm thick, continuous; surface uneven, cream-white; prothallus absent. Thallus in section with thick, prosoplectenchymatous upper cortex, irregular algal layer and distinct medulla, partially encrusted with greyish crystals, when covering lirellae with a layer of large calcium oxalate crystal clusters. Photobiont *Trentepohlia*; cells rounded to irregular in outline, in irregular groups, yellowish green, 8–11 × 7–10 µm. Lirellae flexuose, irregularly branched, erumpent, with complete, laterally thick and apically thin thalline margin, 3–8 mm long, 0.3–0.5 mm wide, 0.25–0.35 mm high; disc partially exposed, dark brown to blackish brown, labia entire. Excipulum entire, ± completely carbonized but lateral portions partially uncarbonized and then leaving an apically carbonized and basally massively carbonized portion, 50–150 µm wide

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and high, laterally covered by corticate, algiferous thallus including a thick layer of calcium oxalate crystal clusters; hypothecium prosoplectenchymatous, 10–20 µm high, pale brownish; hymenium 100–120 µm high, colourless, strongly inspersed along paraphyses, inspersion composed of rather large, irregular droplets, dissolving in K (*Phaeographis* type or type B according to Lücking 2009), epihymenium granulose, 5–10 µm high, brownish. Paraphyses unbranched; asci fusiform to clavate, 100–110 × 20–25 µm. Ascospores 8 per ascus, oblong-oval, 5(–7)-septate, 20–25 × 7–8 µm, 2.5–3.5 × as long as wide, becoming brown when mature and dark brown and shrivelled when post-mature, I+ violet-blue when immature and hyaline, I+ red-brown when mature and pigmented. Secondary chemistry: no substances detected by TLC.

Distribution and ecology — The new species is a putative Hawaiian endemic, so far known only from the Waikamoi Preserve on Maui (Fig. 1A). Parts of this preserve are heavily threatened by the invasive ginger *Hedychium gardnerianum* Sheppard ex Ker Gawl. (Fig. 1B, C), which can quickly overtake entire forest ecosystems and lead to extinction of local, endemic species (Holt 1992; Medeiros & al. 1995; Wood 2012).

Eponymy — The new species is dedicated to Friedrich Paulsen (1846–1909), a German pedagogue and philosopher, one of the founders of modern higher school education in Germany and name giver of the Paulsen-Gymnasium.

Remarks — The genus *Halegrapha* until now included eight species, which can be distinguished mainly based on hymenial inspersion, ascospore septation and secondary chemistry, together with aspects of thallus and lirellae morphology (Lücking & al. 2011; Kashiwadani & al. 2014; Weerakoon & al. 2014). Three species differ from *H. paulseniana* in the clear hymenium, namely *H. kenyana* Kalb & Lücking, *H. mucronata* A. B. Peña & Lücking and *H. yakushimensis* M. Nakan. & al.; the first also deviates by its smaller, 3–5-septate ascospores, the stictic acid chemistry, and the smaller lirellae with concealed disc and exposed, black labia. *Halegrapha mucronata* has much longer, 7–9-septate ascospores, norstictic acid, and black lirellae with only a basal thalline margin, while *H. yakushimensis* lacks secondary compounds, produces small, submuriform ascospores, and its much shorter lirellae have a concealed disc and exposed, black labia. Among the five taxa with inspersed hymenium, as in *H. paulseniana*, *H. masoniana* G. Weerakoon & al. can be distinguished by its much longer, 9–13-septate ascospores, the norstictic acid chemistry, and the lirellae with concealed disc and exposed, black labia. The remaining three species all lack secondary compounds, as in *H. paulseniana*, with *H. chimaera* Rivas Plata & Lücking and *H. floridana* Common & Lücking having slightly smaller ascospores and largely exposed, black labia, whereas *H. mexicana* differs chiefly in the much smaller lirellae lacking a thalline margin. *Halegrapha paulseniana* differs from all other species in the genus also by its often laterally uncarbonized excipulum, a pattern found in a few *Graphis* species, namely *G. gregmuelleri* Sipman & Lücking, *G. immersoides* Lücking and *G. mirabilis* Lücking & al. (Lücking & al. 2009).

The massively carbonized basal excipulum is reminiscent of species of *Leiorreuma* Eschw. (Staiger 2002), which differ from *Halegrapha* in the thin, indistinct labia and lack of lateral or apical carbonization. The only two species of *Leiorreuma* reported from Hawaii, *L. exaltatum* (Mont. & Bosch) Staiger and *L. sericeum* (Eschw.) Staiger (Table 1), both differ from the new species in the fully carbonized excipulum and the weakly developed labia, and *L. sericeum* also in the much smaller, often stellate ascomata and the smaller, consistently 3-septate ascospores (Staiger 2002). The well-developed, carbonized labia of the new species are shared with the genus *Platygramme* Fée (Staiger 2002), which lacks basal carbonization and the thallus is usually not whitish and *Graphis*-like. An exception is *P. pachnodes* (Fée) Fée (Tripp & Lendemer 2010), which has a *Graphis*-like appearance; it differs from the new species in the consistently exposed, thickly white-pruinose disc and the larger, submuriform ascospores. Thus far, two species of *Platygramme* are known from Hawaii: *P. kaalensis* (Tuck.) Luch & Lücking and *P. tumulata* (Nyl.) Luch & Lücking (Table 1; see also below). Both differ from the new species in the yellowish thallus and completely concealed disc, and *P. kaalensis* also in the thallus-covered labia appearing bluish, whereas *P. tumulata* deviates in the very small, submuriform ascospores. Phylogenetic relationships in the clade that includes these and other genera with brown ascospores (*Halegrapha*, *Phaeographis*, *Platygramme*, *Sarcographa* Fée, *Thecaria* Fée, *Thecographa* A. Massal.) are far from being settled (Rivas Plata & al. 2013) and it is possible that these genus concepts will not hold up.

Further nomenclatural novelties

Updating the nomenclature of the lirellate *Graphidaceae* reported from Hawaii (Table 1) requires the following new combinations:

Allographa gracilescens (Redinger) Luch & Lücking, **comb. & stat. nov.** [MycoBank MB 828104] ≡ *Graphina incerta* var. *gracilescens* Redinger in Ark. Bot. 26A(1): 60. 1935.

Fissurina homichlodes (Redinger) Luch & Lücking, **comb. nov.** [MycoBank MB 828105] ≡ *Graphis homichlodes* Redinger in Ark. Bot. 27A(3): 61. 1935.

Fissurina stromatoides (H. Magn.) Luch & Lücking, **comb. nov.** [MycoBank MB 828106] ≡ *Graphis stromatoides* H. Magn. in Ark. Bot., n.s., 3(10): 260. 1955.

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Table 1. Species of lirellate *Graphidaceae* reported from Hawaii (Elix & McCarthy 1998, 2008; Smith 2013), under their traditional classification and with updated nomenclature; origin of the type and presumed world distribution are indicated. Nomenclatural novelties are formally introduced in the Results and Discussion section. Names not included here (e.g. *Gyrostomum dactyliferum* Zahlbr.) do not belong in *Graphidaceae*.

Traditional name	Updated name	Type	Distribution
Glyphis achariana Tuck.	*Glyphis cicatricosa* Ach.	U.S.A.	pantropical
Glyphis cicatricosa Ach.	*Glyphis cicatricosa* Ach.	Guinea	pantropical
Graphina acharii (Fée) Müll. Arg.	*Graphis acharii* Fée	Brazil	pantropical
Graphina aggregans (Nyl.) Zahlbr.	*Anomomorpha aggregans* (Nyl.) Staiger	Colombia	neotropical-Hawaii
Graphina albotecta Redinger	*Graphis albotecta* (Redinger) Staiger	Brazil	neotropical-Hawaii
Graphina analoga (Nyl.) Zahlbr.	*Graphis analoga* Nyl.	Tahiti	palaeotropical
Graphina bipartita Müll. Arg.	*Graphis bipartita* (Müll. Arg.) Lücking	Paraguay	neotropical-Hawaii
Graphina chlorocarpa (Fée) Müll. Arg.	*Allographa chlorocarpa* (Fée) Lücking & Kalb	South America	pantropical
Graphina chloroleuca Müll. Arg.	*Graphis gracillima* Kremp.	Brazil, Argentina	neotropical-Hawaii
Graphina cinereoalba (Vain.) Zahlbr.	*Fissurina globulifica* (Nyl.) Staiger	Philippines	eastern palaeotropical
Graphina columbina (Tuck.) M. Wirth & Hale	*Fissurina columbina* (Tuck.) Staiger	U.S.A.	neotropical-Hawaii
Graphina cremicolor H. Magn.	*Graphis cremicolor* (H. Magn.) Lücking & Archer	Hawaii	pantropical
Graphina globulifica (Nyl.) Zahlbr.	*Fissurina globulifica* (Nyl.) Staiger	New Caledonia	eastern palaeotropical
Graphina incerta var. *gracilescens* Redinger	*Allographa gracilescens* (Redinger) Luch & Lücking, comb. & stat. nov.	Paraguay	neotropical-Hawaii
Graphina nuda H. Magn.	*Graphis nuda* (Magn.) Staiger & Lücking	Hawaii	pantropical
Graphina pringlei Zahlbr.	*Graphis parilis* Kremp.	Mexico, Brazil	neotropical-Hawaii
Graphina pseudosophistica (Vain.) Zahlbr.	*Graphis consanguinea* (Müll. Arg.) Lücking	Brazil	neotropical-Hawaii
Graphina substriatula (Nyl.) Zahlbr.	*Glyphis substriatula* (Nyl.) Staiger	Nicaragua	neotropical-Hawaii
Graphina sulphurella Zahlbr.	*Graphis sulphurella* (Zahlbr.) Lücking	Hawaii	Hawaii
Graphina virginalis (Tuck.) Müll. Arg.	*Fissurina columbina* (Tuck.) Staiger	U.S.A.	neotropical-Hawaii
Graphis anfractuosa Eschw.	*Graphis anfractuosa* (Eschw.) Eschw.	Brazil	pantropical
Graphis apertella A. W. Archer	*Graphis apertella* Archer	Australia	eastern palaeotropical
Graphis duplicata Ach.	*Graphis duplicata* Ach.	South America	pantropical
Graphis elegans (Sm.) Ach.	*Graphis elegans* (Sm.) Ach.	England	subcosmopolitan
Graphis grammitis Fée	*Platythecium grammitis* (Fée) Staiger	Peru	neotropical-Hawaii
Graphis homichlodes Redinger	*Fissurina homichlodes* (Redinger) Luch & Lücking, comb. nov.	Brazil	neotropical-Hawaii
Graphis hypolepta Nyl.	*Thalloloma hypoleptum* (Nyl.) Staiger	Colombia	neotropical-Hawaii
Graphis illinata var. *apoda* Zahlbr.	*Graphis apoda* (Zahlbr.) Lücking	Hawaii	Hawaii
Graphis immersa Fink	*Graphis aurita* Eschw.	Puerto Rico, Brazil	neotropical-Hawaii
Graphis intricata Fée	*Graphis intricata* Fée	South America	pantropical
Graphis jatrophae Müll. Arg.	*Graphis jatrophae* Müll. Arg.	Paraguay	neotropical-Hawaii
Graphis leptocarpa Fée	*Graphis leptocarpa* Fee	South America	pantropical
Graphis lineola Ach.	*Graphis lineola* Ach.	Lesser Antilles	pantropical
Graphis noumeana Müll. Arg.	*Graphis calcea* (Fée) A. Massal.	New Caledonia, Americas	pantropical
Graphis radiata (Mont.) Nyl.	*Fissurina radiata* Mont.	French Guiana	neotropical-Hawaii
Graphis rimulosa (Mont.) Trevis.	*Graphis rimulosa* (Mont.) Trevis.	Guyana	pantropical
Graphis scripta Ach.	*Graphis scripta* Ach.	Sweden	subcosmopolitan

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Traditional name	Updated name	Type	Distribution
Graphis sitiana Vain.	*Graphis sitiana* Vain.	Brazil	pantropical
Graphis striatula (Ach.) Spreng.	*Graphis striatula* (Ach.) Spreng.	Guinea	pantropical
Graphis stromatoides H. Magn.	*Fissurina stromatoides* (H. Magn.) Luch & Lücking, comb. nov.	Hawaii	Hawaii
Graphis tachygrapha Nyl.	*Fissurina tachygrapha* (Nyl.) Staiger	Colombia	neotropical-Hawaii
Graphis tapetica Zahlbr.	*Graphis intricata* Fée	Hawaii, South America	pantropical
Graphis tenella Ach.	*Graphis tenella* Ach.	Guinea	pantropical
Graphis triticea Nyl.	*Fissurina triticea* (Nyl.) Staiger	New Zealand	eastern palaeotropical
Graphis triticea f. *lactea* Zahlbr.	*Fissurina zahlbruckneriana* Luch & Lücking, nom. nov.	Hawaii	Hawaii
Phaeographina caesiohians (Nyl.) Redinger	*Phaeographis caesiohians* (Nyl.) Luch & Lücking, comb. nov.	Malaysia	eastern palaeotropical
Phaeographina chrysentera (Mont.) Müll. Arg.	*Pallidogramme chrysenteron* (Mont.) Staiger & al.	Guyana	pantropical
Phaeographina faurieana Zahlbr.	*Phaeographis faurieana* (Zahlbr.) Luch & Lücking, comb. nov.	Hawaii	Hawaii
Phaeographina fulgurata (Fée) Müll. Arg.	*Phaeographis fulgurata* (Fée) Luch & Lücking, comb. nov.	Peru	neotropical-Hawaii
Phaeographina oscitans (Tuck.) Zahlbr.	*Phaeographis oscitans* (Tuck.) Luch &Lücking, comb. nov.	Hawaii	Hawaii
Phaeographina rhodoplaca Müll. Arg.	*Phaeographis rhodoplaca* (Müll. Arg.) Luch & Lücking, comb. nov.	Costa Rica	neotropical-Hawaii
Phaeographina tumulata (Nyl.) Müll. Arg.	*Platygramme tumulata* (Nyl.) Luch & Lücking, comb. nov.	New Caledonia	eastern palaeotropical
Phaeographis aggregata Redinger	*Phaeographis aggregata* Redinger	Indonesia	eastern palaeotropical
Phaeographis caesioradians (Leight.) A. W. Archer	*Phaeographis caesioradians* (Leight.) A. W. Archer	Sri Lanka	eastern palaeotropical
Phaeographis dendritica (Ach.) Müll. Arg.	*Phaeographis dendritica* (Ach.) Müll. Arg.	Spain	subcosmopolitan
Phaeographis dendroides (Leight.) Müll. Arg.	*Sarcographa dendroides* (Leight.) Tabaquero, Bawingan & Lücking, comb. nov.	Sri Lanka	eastern palaeotropical
Phaeographis discurrens var. *kaalensis* (Tuck.) Zahlbr.	*Platygramme kaalensis* (Tuck.) Luch & Lücking, comb. & stat. nov.	Hawaii	Hawaii
Phaeographis exaltata (Mont. & Bosch) Müll. Arg.	*Leiorreuma exaltatum* (Mont. & Bosch) Staiger	Indonesia	pantropical
Phaeographis hawaiiensis H. Magn.	*Phaeographis hawaiiensis* H. Magn.	Hawaii	Hawaii
Phaeographis intercedens H. Magn.	*Phaeographis intercedens* H. Magn.	Hawaii	Hawaii
Phaeographis inusta (Ach.) Müll. Arg.	*Phaeographis inusta* (Ach.) Müll. Arg.	Canada	subcosmopolitan
Phaeographis leucocheila (Fée) Müll. Arg.	*Phaeographis leucocheila* (Fée) Müll. Arg.	South America	neotropical-Hawaii
Phaeographis lobata (Eschw.) Müll. Arg.	*Phaeographis lobata* (Eschw.) Müll. Arg.	Brazil	pantropical
Phaeographis punctiformis (Eschw.) Müll. Arg.	*Phaeographis punctiformis* (Eschw.) Müll. Arg.	Brazil	neotropical-Hawaii
Phaeographis sericea (Eschw.) Müll. Arg.	*Leiorreuma sericeum* (Eschw.) Staiger	Brazil	pantropical
Phaeographis substellata Zahlbr.	*Phaeographis substellata* Zahlbr.	Hawaii	Hawaii
Sarcographa heteroclita (Mont.) Zahlbr.	*Sarcographa heteroclita* (Mont.) Zahlbr.	French Guiana	pantropical
Sarcographa rechingeri Zahlbr.	*Sarcographa rechingeri* Zahlbr.	Hawaii	Hawaii
Sarcographa tricosa (Ach.) Müll. Arg.	*Sarcographa tricosa* (Ach.) Müll. Arg.	Jamaica	pantropical
Sarcographina sandwicensis Zahlbr.	*Sarcographina sandwicensis* Zahlbr.	Hawaii	Hawaii

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Fissurina zahlbruckneriana Luch & Lücking, **nom. nov.** [MycoBank MB 828119] ≡ *Graphis triticea* f. *lactea* Zahlbr. in Denkschr. Kaiserl. Akad. Wiss., Wien Math.-Naturwiss. Kl. 88: 27. 1911 [non *Fissurina lactea* Fée, Essai Crypt. Écorc.: 47. 1825].

Phaeographis caesiohians (Nyl.) Luch & Lücking, **comb. nov.** [MycoBank MB 828107] ≡ *Graphis caesiohians* Nyl., Sert. Lich. Trop. Labuan Singapore: 13. 1891 ≡ *Phaeographina caesiohians* (Nyl.) Redinger in Rev. Bryol. Lichénol. 9: 100. 1936.

Phaeographis faurieana (Zahlbr.) Luch & Lücking, **comb. nov.** [MycoBank MB 828108] ≡ *Phaeographina faurieana* Zahlbr. in Ark. Bot. 31A(1): 40. 1943.

Phaeographis fulgurata (Fée) Luch & Lücking, **comb. nov.** [MycoBank MB 828109] ≡ *Graphis fulgurata* Fée, Essai Crypt. Écorc.: 35, t. XI, fig. 4. 1825 ≡ *Phaeographina fulgurata* (Fée) Müll. Arg. in Mém. Soc. Phys. Genève 29: 51. 1887.

Phaeographis oscitans (Tuck.) Luch & Lücking, **comb. nov.** [MycoBank MB 828110] ≡ *Graphis oscitans* Tuck. in Proc. Amer. Acad. Arts 7: 231. 1868 ≡ *Phaeographina oscitans* (Tuck.) Zahlbr., Cat. Lich. Univ. 2: 442. 1923.

Phaeographis rhodoplaca (Müll. Arg.) Luch & Lücking, **comb. nov.** [MycoBank MB 828111] ≡ *Phaeographina rhodoplaca* Müll. Arg. in Bull. Soc. Roy. Bot. Belgique 32: 157. 1893.

Platygramme kaalensis (Tuck.) Luch & Lücking, **comb. & stat. nov.** [MycoBank MB 828120] ≡ *Graphis discurrens* var. *kaalensis* Tuck. in Proc. Amer. Acad. Arts 7: 230. 1868 ≡ *Phaeographis discurrens* var. *kaalensis* (Tuck.) Zahlbr., Cat. Lich. Univ. 2: 371. 1923.

Platygramme tumulata (Nyl.) Luch & Lücking, **comb. nov.** [MycoBank MB 828112] ≡ *Graphis tumulata* Nyl. in Ann. Sci. Nat., Bot., sér. 4, 20: 266. 1863 ≡ *Phaeographina tumulata* (Nyl.) Müll. Arg. in Hedwigia 31: 285. 1892.

Sarcographa dendroides (Leight.) Tabaquero, Bawingan & Lücking, **comb. nov.** [MycoBank MB 828113] ≡ *Platygrapha dendroides* Leight. in Trans. Linn. Soc. London 27: 179. 1869 ≡ *Phaeographis dendroides* (Leight.) Müll. Arg. in Flora 65: 336. 1882.

– "*Sarcographa dendroides"* Tabaquero & al. in Philipp. J. Syst. Biol. 7: 27. 2013, nom. inval. (Turland & al. 2018: Art. F.5.1).

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References

Baldwin B. G. & Sanderson M. J. 1998: Age and rate of diversification of the Hawaiian silversword alliance (*Compositae*). – Proc. Natl Acad. Sci. U.S.A. **95:** 9402–9406.

Barrier M., Robichaux R. H. & Purugganan M. D. 2001: Accelerated regulatory gene evolution in an adaptive radiation. – Proc. Natl Acad. Sci. U.S.A. **98:** 10208–10213.

Carlquist S., Baldwin B. G. & Carr G. D. (ed.) 2003: Tarweeds & silverswords: evolution of the *Madiinae* (*Asteraceae*). – St. Louis: Missouri Botanical Garden Press.

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Eldredge L. G. & Miller S. E. 1995: How many species are there in Hawaii? – Bishop Mus. Occas. Pap. **41:** 3–18.

Elix J. A. & McCarthy P. M. 1998: Catalogue of the lichens of the smaller Pacific Islands. – Biblioth. Lichenol. **70:** 1–361.

Elix J. A. & McCarthy P. M. 2008: Checklist of Pacific Island lichens. Australian Biological Resources Study, Canberra. Version 21 August 2008. – Published at https://www.anbg.gov.au/abrs/lichenlist/PACIFIC_introduction.html [accessed 20 Jun 2018].

Fleischer R. C., McIntosh C. E. & Tarr C. L. 1998: Evolution on a volcanic conveyor belt: using phylogeographic reconstructions and K–Ar-based ages of the Hawaiian Islands to estimate molecular evolutionary rates. – Molec. Ecol. **7:** 533–545.

Frisch A., Kalb K. & Grube M. 2006: Contributions towards a new systematics of the lichen family *Thelotremataceae*. – Biblioth. Lichenol. **92:** 1–539.

Givnish T. J., Millam K. C., Theim T. T., Mast A. R., Patterson T. B., Hipp A. L., Henss J. M., Smith J. F., Wood K. R. & Sytsma K. J. 2009: Origin, adaptive radiation, and diversification of the Hawaiian lobeliads (*Asterales*: *Campanulaceae*). – Proc. Roy. Soc. London, Ser. B, Biol. Sci. **276:** 407–416.

Holt R. A. 1992: Control of alien plants on Nature Conservancy preserves. – Pp. 525–535 in: Stone C. P., Smith C. W. & Tunison J. T. (ed.), Alien plant invasions in native ecosystems of Hawai'i: management and research. – Honolulu: University of Hawaii Cooperative National Park Resources Studies Unit.

Kashiwadani H., Nakanishi M. & Moon K. H. 2014: Two new species of *Graphis* and *Halegrapha* (*Graphidaceae*, *Ostropales*) from southern Japan. – J. Jap. Bot. **89:** 12–16.

Lücking R. 2014: A key to species of the *Ocellularia papillata*, *perforata* and *terebrata* morphodemes (*Ascomycota*: *Graphidaceae*). – Glalia **6(3):** 1–35.

Lücking R., Archer A. W. & Aptroot A. 2009: A worldwide key to the genus *Graphis* (*Ostropales*: *Graphidaceae*). – Lichenologist **41:** 363–452.

Lücking R., Hodkinson B. P. & Leavitt S. D. 2017a: The 2016 classification of lichenized fungi in the *Ascomycota* and *Basidiomycota* – Approaching one thousand genera. – Bryologist **119:** 361–416.

Lücking R., Moncada B. & Smith C. W. 2017b: The genus *Lobariella* (*Ascomycota*: *Lobariaceae*) in Hawaii: late colonization, high inferred endemism and three new species resulting from "micro-radiation". – Lichenologist **49:** 673–691.

Lücking R., Rivas Plata E., Kalb K., Common R. S., Barcenas-Peña A. & Duya M. V. 2011: *Halegrapha* (*Ascomycota*: *Graphidaceae*), an enigmatic new genus of tropical lichenized fungi dedicated to Mason E. Hale Jr. – Lichenologist **43:** 331–343.

Lumbsch H. T., Kraichak E., Parnmen S., Rivas Plata E., Aptroot A., Cáceres M. E. S., Ertz D., Feuerstein S. C., Mercado-Díaz J. A., Staiger B., Van den Broeck D. & Lücking R. 2014: New higher taxa in the lichen family *Graphidaceae* (lichenized *Ascomycota*: *Ostropales*) based on a three-gene skeleton phylogeny. – Phytotaxa **189:** 39–51.

Magnusson A. H. 1955: A catalogue of Hawaiian lichens. – Ark. Bot., n.s., **3(10):** 223–402.

Magnusson A. H. & Zahlbruckner A. 1943: Hawaiian lichens I. The families *Verrucariaceae* to *Peltigeraceae*. – Ark. Bot. **31A(1):** 1–96.

Magnusson A. H. & Zahlbruckner A. 1944: Hawaiian lichens. II. The families *Lecideaceae* to *Parmeliaceae*. – Ark. Bot. **31A(6):** 1–109.

Magnusson A. H. & Zahlbruckner A. 1945: Hawaiian lichens III. The families *Usneaceae* to *Physciaceae*. Index. – Ark. Bot. **32A(2):** 1–89.

Medeiros A. C., Loope L. L. & Hobdy R. W. 1995: Conservation of cloud forests in Maui County (Maui, Moloka'i, and Lana'i), Hawaiian Islands. – Pp. 223–233 in: Hamilton L. S., Juvik J. O. & Scatena F. N. (ed.), Tropical montane cloud forests. – New York: Springer.

Moncada B., Reidy B. & Lücking R. 2014: A phylogenetic revision of Hawaiian *Pseudocyphellaria* sensu lato (lichenized *Ascomycota*: *Lobariaceae*) reveals eight new species and a high degree of inferred endemism. – Bryologist **117:** 119–160.

Orange A., James P. W. & White F. J. 2001: Microchemical methods for the identification of lichens. Second Edition. – London: British Lichen Society.

Redinger K. 1933a: Die Graphidineen der ersten Regnell'schen Expedition nach Brasilien 1892–1894. I. *Glyphis*, *Medusulina* und *Sarcographa*. – Ark. Bot. **25A(13):** 1–20.

Redinger K. 1933b: Die Graphidineen der ersten Regnell'schen Expedition nach Brasilien 1892–1894. II. *Graphina* und *Phaeographina*. – Ark. Bot. **26A(1):** 1–105.

Redinger K. 1935: Die Graphidineen der ersten Regnell'schen Expedition nach Brasilien 1892–1894. III. *Graphis*, *Phaeographis*, nebst einem Nachtrage zu *Graphina*. – Ark. Bot. **27A(3):** 1–103.

Rivas Plata E., Lumbsch H. T. & Lücking R. 2012: A new classification for the lichen family *Graphidaceae* s.lat. (*Ascomycota*: *Lecanoromycetes*: *Ostropales*). – Fungal Diversity **52:** 107–121.

Rivas Plata E., Parnmen S., Staiger B., Mangold A., Frisch A., Weerakoon G., Hernández M. J. E., Cáceres M. E. S., Kalb K., Sipman H. J. M., Common R. S., Nelsen M. P., Lücking R. & Lumbsch H. T. 2013: A molecular phylogeny of *Graphidaceae* (*Ascomycota*: *Lecanoromycetes*: *Ostropales*) including 428 species. – MycoKeys **6:** 55–94.

Smith C. W. 1991: Lichen conservation in Hawaii. – Pp. 35–45 in: Galloway D. J. (ed.), Tropical lichens: their systematics, conservation, and ecology. – Oxford: Clarendon Press [The Systematics Association Special Volume No. 43].

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Smith C. W. 1993: Notes on Hawaiian parmelioid lichens. – Bryologist **96:** 326–332.

Smith C. W. 1995: Notes on long-distance dispersal in Hawaiian lichens: ascospore characters. – Cryptog. Bot. **5:** 209–213.

Smith C. W. 2001: The lichen genus *Umbilicaria* in the Hawaiian Islands. – Biblioth. Lichenol. **78:** 389–394.

Smith C. W. 2013: Checklist of lichens of the Hawaii Islands (USA). Preliminary version 1 December 2016. – Published at http://www.lichens.uni-hamburg.de/lichens/oceania/usa_hawaii_l.htm [accessed 20 Jun 2018].

Smith C. W., Gardner D. E. & Hoe W. J. 1997: Foliicolous Hawaiian cryptogams. – Abstr. Bot. (Budapest) **21:** 163–167.

Staiger B. 2002: Die Flechtenfamilie *Graphidaceae*. Studien in Richtung einer natürlicheren Gliederung. – Biblioth. Lichenol. **85:** 1–526.

Tripp E. A. & Lendemer J. C. 2010: The genus *Platygramme* in North America. – Castanea **75:** 388–393.

Turland N. J., Wiersema J. H., Barrie F. R., Greuter W., Hawksworth D. L., Herendeen P. S., Knapp S., Kusber W.-H., Li D.-Z., Marhold K., May T. W., McNeill J., Monro A. M., Prado J., Price M. J. & Smith G. F. (ed.) 2018: International Code of Nomenclature for algae, fungi, and plants (Shenzhen Code) adopted by the Nineteenth International Botanical Congress Shenzhen, China, July 2017. – Glashütten: Koeltz Botanical Books [= Regnum Veg. **159**].

Wagner W. L. & Funk V. A. (ed.) 1995: Hawaiian biogeography: evolution on a hot spot archipelago. – Washington DC: Smithsonian Institution Press.

Wagner W. L. & Herbst D. R. 2002: Electronic supplement to the manual of the flowering plants of Hawai'i. – Published at http://rathbun.si.edu/botany/pacificislandbiodiversity/hawaiianflora/supplement.htm [accessed 20 Jun 2018].

Wagner W. L., Herbst D. R. & Sohmer S. H. 1999: Manual of the flowering plants of Hawai'i. Revised edition. – Honolulu: University of Hawai'i Press & Bishop Museum Press.

Weerakoon G., Lücking R. & Lumbsch H. T. 2014: Thirteen new species of *Graphidaceae* (lichenized *Ascomycota*: *Ostropales*) from Sri Lanka. – Phytotaxa **189:** 331–347.

Wirth M. & Hale M. E. Jr. 1963: The lichen family *Graphidaceae* in Mexico. – Contr. U. S. Natl. Herb. **36:** 63–119.

Wood K. R. 2012: Possible extinctions, rediscoveries, and new plant records within the Hawaiian Islands. – Bishop Mus. Occas. Pap. **113:** 91–102.

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