The Lichenologist **37**(6): 519–526 (2005)
doi:10.1017/S0024282905014726 *Printed in the United Kingdom*

Anisomeridium flavovulcanus, a new corticolous lichen from Costa Rica

Harald KOMPOSCH

Abstract: A corticolous species, *Anisomeridium flavovulcanus*, is described. It has so far been found in the Carribean and Pacific lowland rainforests of Costa Rica, where it is a frequent lichen in the understorey. This conspicuous lichen is characterized by large conical conidiomata, which release a yellow conidial mass at the apex. Dimorphic conidia occur in the same conidiomata: 1-septate microconidia and thick walled globose macroconidia. Ascomata were found only twice; the inconspicuous perithecia are hemispherical, semi-emergent with an apical ostiole, the asci are cylindrical with a cruciform ocular chamber and the ascospores are uniseriately arranged.

Key words: Central America, dimorphic conidia, lichenized ascomycetes, lowland rainforest, *Monoblastiaceae*, tropical, new species

Introduction

During a student field trip in 1999 to the Pacific lowland rainforests of Costa Rica material of a corticolous lichen with conspicuously large conidiomata that bore an apical yellow conidial mass was collected. On a second visit in 2001 more material was gathered. Although the species occurred frequently on the boles of rainforest trees, ascomata were found only twice. The ascomatal characters confirmed the placing of the species in *Anisomeridium* (Müll. Arg.) M. Choisy. Since it was not noted in publications from the Bosque Esquinas (Breuss 2000, 2001) nor mentioned in the monographic treatment of *Anisomeridium* (Harris 1995), it is likely to be new to science. It is, however, suprising that this conspicuous and frequently occurring species has not already been described and the possibility that it has been described elsewhere cannot be entirely excluded (compare Harris 1995: 133).

H. Komposch: OIKOS—Institute for Applied Ecology and Basic Research, Hartbergerstr. 40, 8200 Gleisdorf, Austria.

Material and Methods

Specimens were collected by the author during two field trips carried out in the Corcovado National Park in 1999 and 2001 and, unless stated otherwise, are deposited in the hb. Harald Komposch. Other specimens (GZU) originated from a study of sterile tropical lichens, also partly conducted in Costa Rica, by Barbara Emmerer and Josef Hafellner (both from the Institute for Plant Sciences in Graz) and one specimen, which was on loan from Othmar Breuss (Linz), was seen at the Institute for Plant Sciences in Graz. Additional specimens may be found in ABL, B, and F (A. Aptroot, *in litt.*).

The geography, topography, geology, climate, and physiognomy of the particular rainforests are characterized in Breuss (2000) and described in more detail by Weber (2001).

Microscopic characters were studied with a Leica MZ6 stereo-microscope (up to × 40 magnification) as well as with a Zeiss Axioscope (up to × 1000 magnification). Hand-cut sections of ascomata were generally mounted in distilled water. Drawings and measurements of ascoma structures were carried out using a Zeiss drawing-tube at × 100 magnification; details of asci and hamathecial elements were studied, measured, and drawn at × 1000 magnification. Measurements of ascomata, ascospores and conidia are given in the following order: (minimum–) mean ± standard deviation (–maximum); minimum and maximum values measured with the stereo-microscope are rounded off to the nearest whole number; mean and standard deviation are rounded off to one decimal place. Sections were not pre-treated with KOH before iodine staining (1% Lugol's solution). Secondary product chemistry was checked using TLC according to Orange *et al.* (2001).

The vertical zonation scheme for forest of Cornelissen & ter Steege (1989) was applied.

The Species

Anisomeridium flavovulcanus Komposch sp. nov.

A specie simillima, *Anisomeridium nidulans* (Müll. Arg.) R.C. Harris, differt ascomatibus nucleis majoribus, ascis longioribus cylindricisque, ascosporis uniseriatis. Plerumque solum conidiomata formantur. Conidiomata in verrucis conicis (vulcaniformibus) immersa; cavernis simplicibus vel lobatis; canalis ostioli longus, periphysatus. Conidia hyalina, dimorpha; macroconidia globosa, 0-septata, 11–12 µm diam., microconidia 1-septata, ellipsoidea, 6 × 3 µm.

Typus: Costa Rica, Prov. Puntarenas, Osa Peninsula, Corcovado National Park, on the summit of the coastal ridge, *c.* 700 m WNW of the camp La Leona; tropical, coastal, lightful, primary lowland rainforest, N 8°27′0″, W 83°29′51·4″ (WGS84), 120 m alt., on slightly fissured bark of unidentified tree, height zone 1, 13 July 2001, *H. & B. Komposch* 4859 (GZU—holotypus).

Paratypi: Costa Rica, Prov., Puntarenas, Esquinas rainforest area W of the village Villa Briceño (*c.* 10 km NNW of Golfito), hill NW of the village containing caves in limestone, 8°43′55″N/83°11′15″W, 160 m alt., 21 February 2003, on smooth bark of evergreen tree, height zone 1, *J. Hafellner & B. Emmerer* 1420 (GZU—paratypus); Piedras Blancas National Park (Esquinas Sector), Golfo Dulce, Dos Rios, Playa San Josecito, Punta Encanto, *c.* 13 km W of Golfito; coastal tropical lowland rainforest, N 8°39′, W 83°16′ (WGS84), 10 m alt.; 25 November 1999, on smooth bark of unidentified tree, height zone 1, *H. Komposch* 4581 (hb. Harald Komposch—paratypus).

(Figs 1, 2 & 3)

Thallus continuous, green to pale green, corticate with a dull, smooth surface, up to 14 cm across, with scattered conical calcium oxalate encrustations or not. *Cortex* (25–)40(–50) µm thick, consisting of one to several layers, sometimes separated and each then with an algal layer below. Bleached bark cells in between the cortical layers. *Medulla* either present, 10–80 µm thick, medullar hyphae loosely intermixed with brown bark cells, or hardly discernible. *Prothallus* very thin, corticoid layer without photobiont participation, more or less translucent, therefore its colour is determined by the overgrown bark; visible as a black borderline between adjacent thalli; when overgrowing other lichens up to 0·87 mm broad. *Photobiont* trentepohlioid alga in short chains, cells elongated 10–17 × 8–11 µm with 1–2 µm thick cell walls.

Ascoma perithecioid, solitary but aggregated in fertile areas, sometimes standing very close, semi-emergent, hemispherical but not constricted at the base, completely covered by a thalloid layer; ostiole apical, (25–)30(–38) µm diam., formed by a cortex-like dense colourless tissue, brighter than the thallus or pale brown with a yellowish tint; *inner perithecial* wall thin at the base and laterally, becoming thicker upward; *outer perithecial* wall dark brown to black, striate or not, cuplike, incompletely surrounding the nucleus and sometimes visible through the amorphous tissue at the ostiole as a brown ring; nucleus 0·63–0·74 mm high, 0·5–0·7 mm diam. *Hamathecium*, trabeculate pseudoparaphyses, 1–1·5 µm diam., regularly branched above the asci, few branches between the asci, not inspersed, I−. *Asci* long cylindrical, (280–)306·8 ± 23·7(–350) × (25–)27·5 ± 2·0(–32) µm (n=8), obliquely uniseriate, 8-spored but sometimes 1 or 2 spores aborted; ocular chamber regular to skewed or irregular cruciform. *Ascospores* colourless, oval to fusiform, constricted at the marked submedian septum, frequently the larger cell with a slight subapical constriction, (35–)40·6 ± 3·1(–49) × (15–)19·3 ± 1·9(–24) µm (n=69), the distal cell usually larger; *perispore* with extremely low warts (very inconspicuous and not seen in every developmental stage); ascospore wall 1–1·2 µm thick; ascospore protoplasm with refractive crystals, best seen in polarized light (Figs 1 & 3B).

Pycnidial conidiomata uni- to multilocular, without carbonization, prominently raised above the bark surface, steep conical but sometimes also flat conical or nearly sunken and extended into a cylindrical tube, pore apical; algae fading out toward the apex, therefore the apical region is pale green to beige or nearly white; basal diameter including thalline cover (0·6–)1(–1·5) mm, height above thallus surface (0·38–)0·84 (–1·25) mm; multilocular cavities join into a common ostiolar neck; cavities lined with

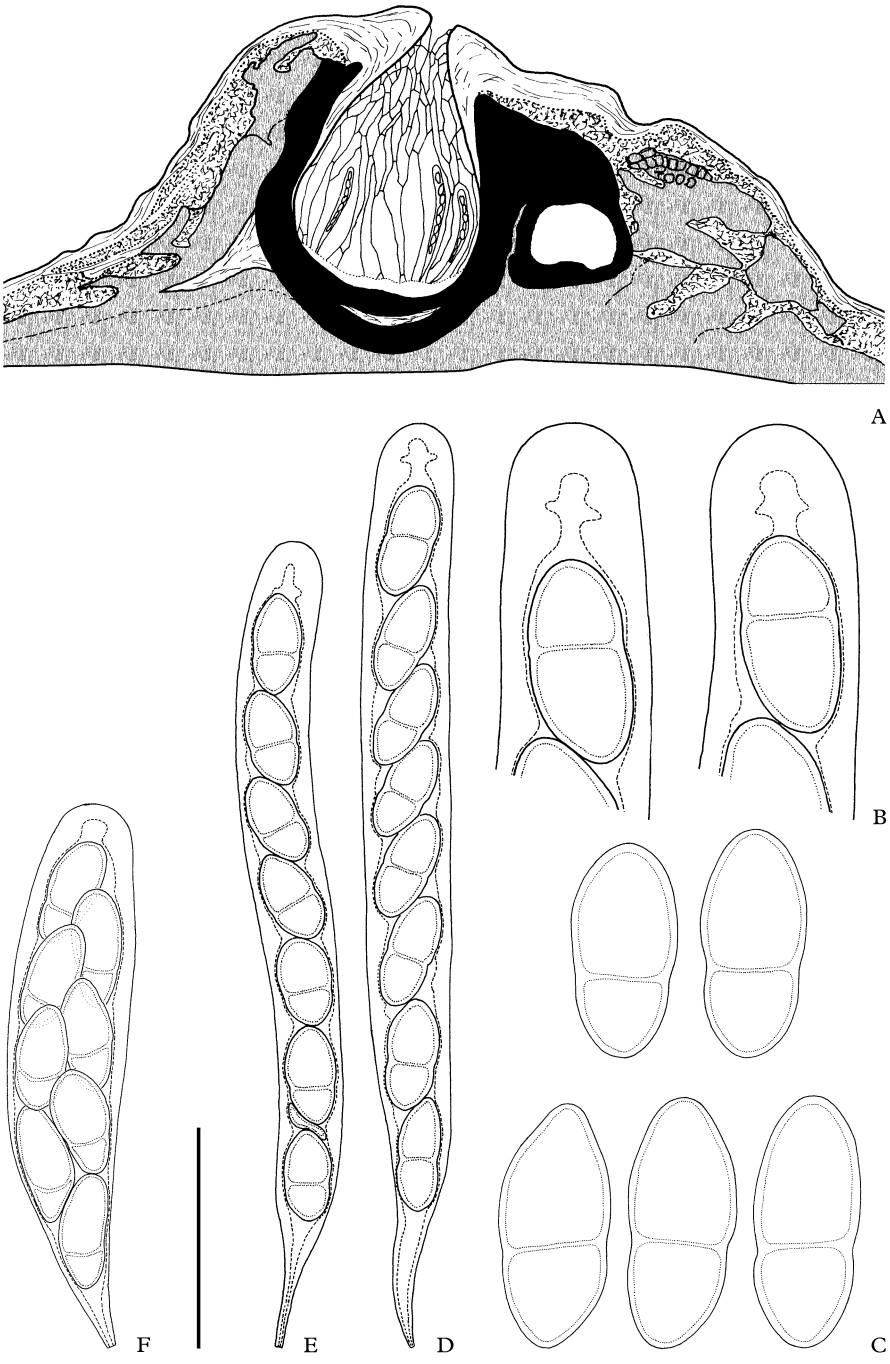

FIG. 1. *Anisomeridium flavovulcanus*. A, vertical section through ascoma (holotype); B, ascus tips of mature asci (*Komposch* 4581); C, ascospores (holotype); D, mature ascus (*Komposch* 4581); E, immature ascus (holotype); F, *Anisomeridium nidulans* (Müll. Arg) R.C. Harris, mature ascus (G—holotype). Scales: A=600 μm; B & C=40 μm; D–F=80 μm.

https://doi.org/10.1017/S0024282905014726 Published online by Cambridge University Press

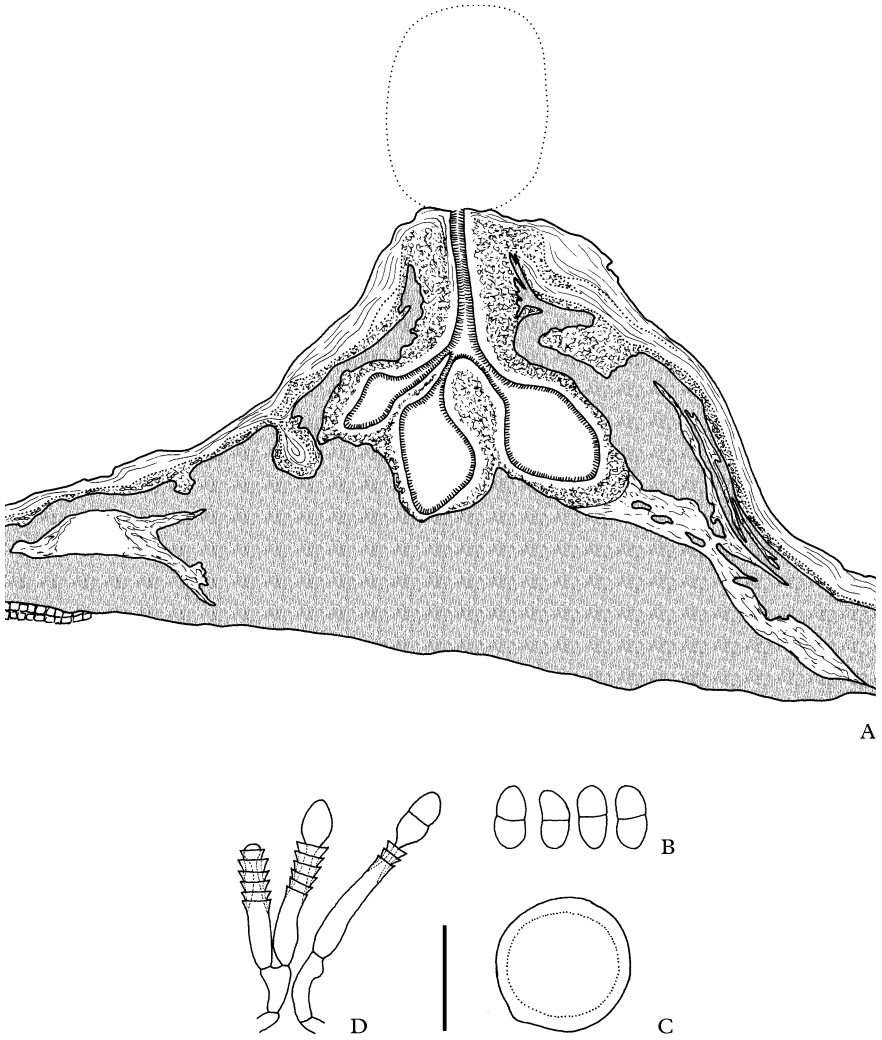

FIG. 2. *Anisomeridium flavovulcanus* (*Komposch* 3690). A, vertical section through conidioma with conidial mass indicated on the top; B, microconidia; C, macroconidium; D, conidiogenous cells with microconidia. Scale: A = 250 μm; B–D = 10 μm.

conidiogenous hyphae, the tube-like neck and the central upper sides of the cavities covered by sterile hyphae protruding into the channel, (20–)25(–50) μm long, about twice as long as the conidiogenous ones. *Conidia* dimorphic. *Microconidia* colourless, oblong, thin walled, one septate, (5–)6 ± 0·4(–7) × (2·5–)3·1 ± 0·3(–4) μm (n = 17); conidiogenesis enteroblastic with annelidic type of development (according to Hawksworth 1988); microconidia mainly produced in the central and distal parts of the cavities. *Macroconidia* colourless, globose, (10–)11·7(–13) × (10–)11·1(–12) μm (n = 6), wall *c.* 1.8 μm thick, produced especially at the junctions/invaginations down to the bottom of the cavities, scattered occurrence in between the microconidia. Conidia agglutinated by a gelatinous matrix and released in yellow drop-like packages, KOH −, 480 × 350 μm when dry; if moisturized and squeezed under a cover slip breaking apart

https://doi.org/10.1017/S0024282905014726 Published online by Cambridge University Press

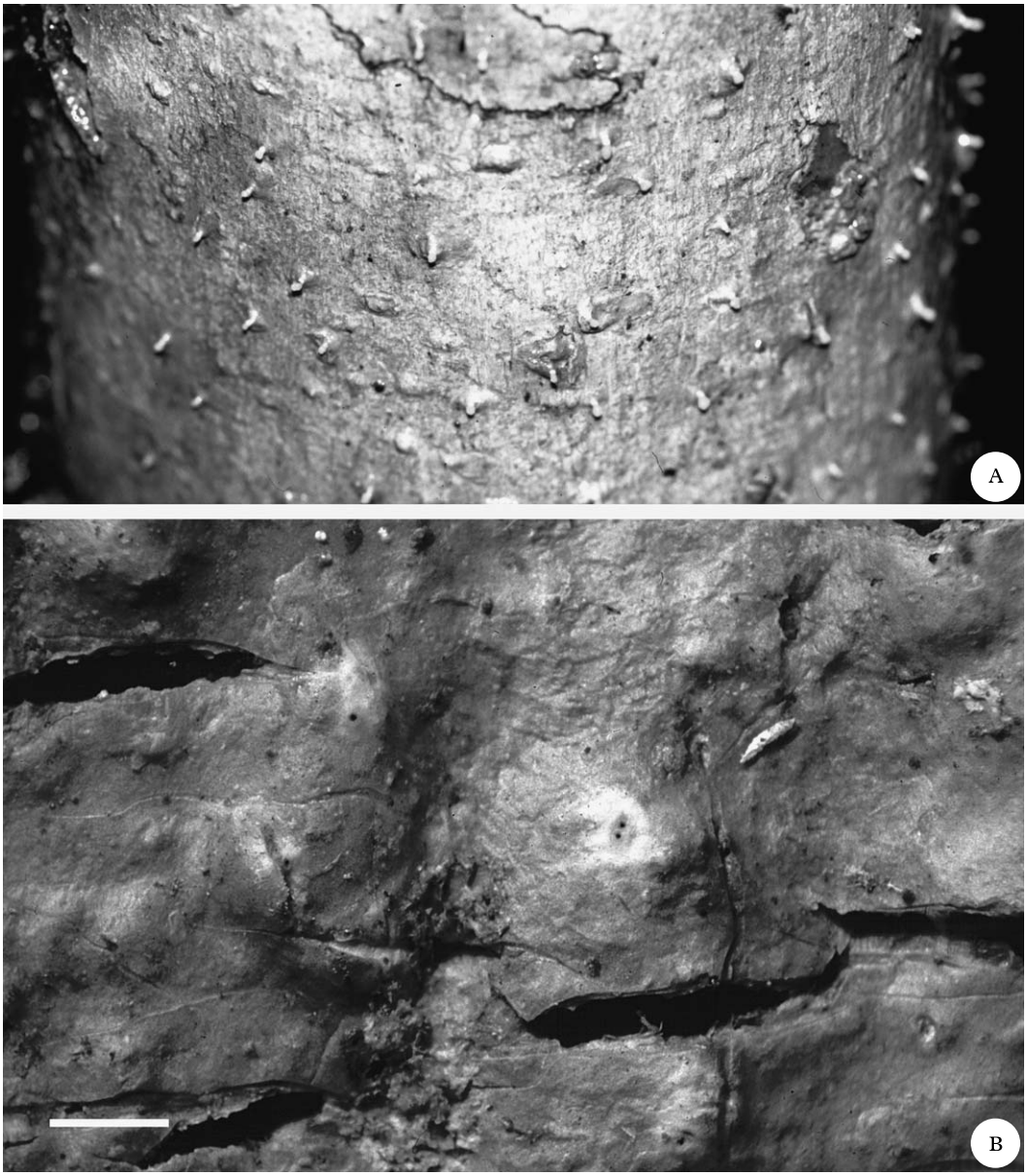

FIG. 3. *Anisomeridium flavovulcanus*. A, habit of a sterile thallus at the type locality (4732); B, ascomata on the holotype. Scales: A=*c*. 10 mm (valid in centre); B=1 mm.

into smaller irregular packages or long strands (Figs 2 & 3A).

Chemistry. No lichen substances detected using TLC.

Etymology. The term 'flavovulcanus' refers to the steep conical conidiomata and the drop-like yellow-orange mass of conidia which gives them the appearance of an erupting volcano.

https://doi.org/10.1017/S0024282905014726 Published online by Cambridge University Press

Distribution and ecology. Specimens have been collected from the Caribbean rainforests (not seen!, A. Aptroot, *in litt.*) and the interior of the Pacific lowland rainforests in the Golfo Dulce Region of Costa Rica where *Anisomeridium flavovulcanus* is a common species. The presumably primary rainforests are found on hilly terrain with low ridges and narrow gullies at altitudes ranging from 50 to 390 m above sea level. *Anisomeridium flavovulcanus* grows mainly on the boles of trees in the shady understorey (height zone 1) together with *Porina exasperatula* Vain., *Porina* spp., *Coenogonium* sp., *Leptogium* sp., *Mazosia* sp., and *Ocellularia* sp. It has been collected once from a stilt root of *Socratea exorrhiza* (Mart.) H. Wendl. The large thalli and its ability to overgrow other lichens, bryophytes and even small ferns suggest that it grows rapidly and is highly competitive.

The small number of fertile specimens (3 out of 31) indicates that conidia play a major role in dispersal, as they do in *Lecanactis abietina* (Ach.) Körb., *Opegrapha vermicellifera* (Kunze) J. R. Laundon and *Anisomeridium polypori* (Ellis & Everh.) M. E. Barr (*cf.* Vobis & Hawksworth 1981; Hawksworth 1988). Because the conidia packages are not disintegrated by rain drops or stem flow water, they are likely to be distributed as a single unit, a feature which has also been reported to occur in *Caprettia* Bat. & H. Maia (Sérusiaux & Lücking 2003) and *Anisomeridium polypori* (Ellis & Everh.) M. Barr (Sutton & Alcorn 1983; Poelt & Türk 1994). Animal dispersal is suggested (*cf.* Poelt & Türk *loc. cit.*).

Notes. In some of its characters, *A. flavovulcanus* holds a unique position within the genus, for example, micro- and macroconidia occurring in the same conidioma, frequently multilocular conidiomata which is anomalous for the genus, the cruciform shape of the ocular chamber and septate microconidia. Despite these distinguishing unique features, *A. flavovulcanus* cannot be distinguished from that genus, because it shows characters known to occur in *Anisomeridium*, for example, the hamathecial characters; ascus shape; septation, size, shape and arrangement of ascospores; dimorphic conidia; thallus anatomy; photobiont type. Moreover, some of the stated 'unique' characters have also been occasionally and exceptionally observed in other *Anisomeridium* species, for example, micro- and macroconidia in the same conidioma, which Harris (pers. comm.) has already seen in other species, but had to regard it as atypical because in these species micro- and macroconidia were normally produced in separate conidiomata; the cruciform shape of the ocular chamber, which is illustrated for *A. musaesporoides* Etayo & Lücking by Etayo & Lücking (1999) and photographed for *A. hydei* Aptroot in Aptroot & Seaward (1999: 64); the septate microconidia (septate macroconidia occur occasionally in *A. tuckeri* R.C. Harris (R. C. Harris, pers. comm.).

Anisomeridium nidulans (Müll. Arg.) R.C. Harris is closely related to *A. flavovulcanus* with ascospores that are similar in size, septation and shape. However, *A. nidulans* is so far known only from the type specimen from Sri Lanka (Müller Argau 1885) and conidia were not reported. It can be distinguished by its clearly smaller ascomata and asci [e.g. nucleus diameter (175–)241·7(–300) µm; ascus size is (187–)218·8 ± 22·0(–250) × (40–)43·5 ± 1·8(–45) µm; ascus shape is clavate; the ocular chamber is broad elliptic to rectangular; ascospores, contrary to the holotype description by Müller Argau, are mainly arranged biseriately, infrequently incompletely uniseriate (compare Fig. 1F)]. *Anisomeridium infernale* (Mont.) R.C. Harris, known from French Guiana, Trinidad, and St. Vincent differs in having larger ascospores, smaller microconidia and lichexanthone.

Refractive crystals are reported here for the first time in the ascospores of *Anisomeridium*, namely in *A. flavovulcanus* and *A. nidulans*. Such crystals are already known from *Musaespora* Aptroot & Sipman, where they are called polyhedral or needle-shaped crystals on the ascoplasm surface of the ascospores (Lücking & Sérusiaux 1997), and from *Architrypethelium* Aptroot, *Megalotremis* Aptroot, *Phyllobathelium* (Müll. Arg.)

Müll. Arg., and *Thelenella* Nyl. (Aptroot *et al.* 1997). Because of the presence of these crystals and also large, few-septate ascospores, Lücking & Sérusiaux (*loc. cit.*) assumed a close relationship between *Architrypethelium*, *Musaespora*, and *Megalotremis*. Harris (1995: 112) considered the last to be synonymous with *Anisomeridium*, which the occurrence of these crystals in the ascospores of both genera seems to confirm (*cf.* Aptroot *et al.* 1997: 105). The taxonomic value of this character is yet to be evaluated.

Anisomeridium flavovulcanus is similar to the genus *Musaespora* Aptroot & Sipman in thallus architecture and the clustering of ascomata. Nevertheless, it cannot be placed in *Musaespora* Aptroot & Sipman because several features are not congruent with its generic circumscription (Aptroot & Sipman 1993). The genus *Musaespora* differs in having *Cephaleuros*-like algae, obclavate to clavate asci, a rounded ocular chamber, campylidial conidiomata, irregularly arranged, curved ascospores with a ± median septum. The genus *Megalotremis* Aptroot, which shares a couple of characters with *A. flavovulcanus*, cannot be convincingly separated from *Anisomeridium* (see Harris *loc. cit.*). The genus *Caprettia* Bat. & H. Maia differs by its photobiont type, clavate asci, hardly visible ocular chamber and the distinctive hair-like pycnidial tubes.

Anisomeridium flavovulcanus might be an extreme modification in the genus of a group of species with a cortex and large ascospores for which molecular data might provide support for separating out a fairly large clade. Molecular studies should, however, be carried out in conjunction with a comprehensive survey of this large genus and its relatives. In the absence of such studies, a premature splitting of *Anisomeridium* might only enhance confusion.

Other specimens examined. **Costa Rica:** *Prov. Puntarenas*: Osa peninsula, Corcovado National Park, coastal region near the mouth of river Madrigal, *H. & B. Komposch* 4701, 4722, 4731, 4732, 4733; Piedras Blancas National Park, Esquinas rainforest area SW of the village La Gamba (*c.* 8 km NNW of Golfito), *J. Hafellner & B. Emmerer* 1257, 1259, 1489, 1506, 1507, 1510, 1564, 1577, 1579, 1598, 1635, 1637, 1642, 1654 (GZU); *ibid.*, *H. Komposch* 3690, 4482; *ibid., H. & B. Komposch* 4614, 4647; Esquinas rainforest area W of the village Villa Briceño (*c.* 10 km NNW of Golfito), *J. Hafellner & B. Emmerer* 1422, 1425 (GZU); ridge W of Golfito, *c.* 1·5 km W of the town, *J. Hafellner & B. Emmerer* 1283, 1286 (GZU).

I thank Richard Harris (New York) for the critical reading, valuable comments and suggestions on the manuscript, André Aptroot (Utrecht) and an anonymous reviewer for comments on the taxonomic placement, as well as Philippe Clerc (G) for arranging the quick loan of type material. I would also like to express my gratitude to Christian Scheuer (Institute for Plant Sciences, Graz) for the revision of the latin diagnosis. TLC was kindly undertaken by Barbara Emmerer at the Institute for Plant Sciences. This research received no financial support.

References

Aptroot, A. & Seaward, M. R. D. (1999) Annotated checklist of Hong Kong lichens. *Tropical Bryology* **17:** 57–101.

Aptroot, A. & Sipman, H. J. M. (1993) *Musaespora*, a genus of pyrenocarpous lichens with campylidia, and other additions to the foliicolous lichen flora of New Guinea. *Lichenologist* **25:** 121–135.

Aptroot, A., Diederich, P., Sérusiaux, E. & Sipman, H. J. M. (1997) Lichens and lichenicolous fungi from New Guinea. *Bibliotheca Lichenologica* **64:** 1–220.

Breuss, O. (2000) Flechten aus Costa Rica. I. Regenwald der Österreicher (Bosque Esquinas). *Linzer Biologische Beiträge* **32:** 1043–1051.

Breuss, O. (2001) Flechten aus Costa Rica II. *Linzer Biologische Beiträge* **33:** 1025–1034.

Cornelissen, J. H. C. & ter Steege, H. (1989) Distribution and ecology of epiphytic bryophytes and lichens in dry evergreen forest of Guyana. *Journal of Tropical Ecology* **5:** 131–150.

Etayo, J. & Lücking, R. (1999) *Anisomeridium musaesporoides*, a new foliicolous lichen from tropical America. *Lichenologist* **31:** 145–148.

Harris, R. C. (1995) *More Florida Lichens. Including the 10c Tour of the Pyrenolichens*. New York: published by the author.

Hawksworth, D. L. (1988) Conidiomata, conidiogenesis, and conidia. In *CRC Handbook of Lichenology. Volume I* (M. Galun, ed.): 181–193. Boca Raton: CRC Press.

Lücking, R. & Sérusiaux, E. (1997) *Musaespora kalbii* (lichenized Ascomycetes: Melanommatales), a new foliicolous lichen with a pantropical distribution. *Nordic Journal of Botany* **16:** 661–668.

Müller Argau, J. (1885) Lichenologische Beiträge 21. *Flora* **68:** 311–352.

Orange, A., James, P. W. & White, F. J. (2001) *Microchemical Methods for the Identification of Lichens*. London: The British Lichen Society.

Poelt, J. & Türk, R. (1994) *Anisomeridium nyssaegenum*, ein Neophyt unter den Flechten, in Österreich und Süddeutschland. *Herzogia* **10:** 75–81.

Sérusiaux, E. & Lücking, R. (2003) The lichen genus *Caprettia* Bat. & H. Maia. *Bibliotheca Lichenologica* **86:** 161–176.

Sutton, B. C. & Alcorn, J. L. (1983) *Sarcinulella banksiae* gen. et sp. nov., a coelomycete with a unique method of conidial dispersal. *Mycotaxon* **16:** 557–564.

Vobis, G. & Hawksworth, D. L. (1981) Conidial lichen forming fungi. In *Biology of Conidial Fungi* (G. T. Cole & B. Kendrick, eds): 245–273. New York: Academic Press.

Weber, A. (ed.) (2001) An introductory field guide to the flowering plants of the Golfo Dulce rain forests—Costa Rica. Corcovado National Park and Piedras Blancas National Park ('Regenwald der Österreicher'). *Stapfia* **78:** 1–462.

Accepted for publication 4 *July* 2005