

TWO NEW SPECIES OF LICHENICOLOUS FUNGUS *SCLEROCOCCUM* (DACTYLOSPORACEAE, SCLEROCOCCALES) FROM INDIA

Y. JOSHI

Lab. no. 14, Department of Botany, University of Rajasthan, Jaipur 302004, Rajasthan, India
E-mail: dryogeshcalo@gmail.com

(Received: 29 April 2020; Accepted: 21 August 2020)

Two new species of *Sclerococcum*, viz. *S. dendriscostictae* and *S. physciae*, colonising members of *Dendriscosticta*, *Physcia* and *Sticta*, are described from Uttarakhand and Andhra Pradesh states of India, respectively. *S. dendriscostictae* colonising the host thallus as well as apothecial disc of *Dendriscosticta* and *Sticta* species is generally characterised by its small sized (0.1–0.4 mm) black apothecia, hyaline hymenium, paraphyses without dark apical caps, asci 8-spored, ascospores ellipsoid, hyaline at immature stage and brown at maturity, 1-septate, smooth walled, 9–10–11(–12) × (3–)3.8–5–6.1(–7) μm, while *S. physciae* colonising thallus of *Physcia* sp. is characterised by black, rounded to irregular sporodochia (40–100 μm diam.) having ellipsoid or angular, medium to dark brown, mostly simple, rarely 1-septate conidia [(5–)7.5–10–11.7(–14) × (4–)4.7–5.8–6.9(–7) μm]. A key to known Indian taxa is also being provided.

Key words: *Dactylospora*, lichens, Sclerococcaceae, taxonomy

INTRODUCTION

The genus *Sclerococcum* Fr. belonging to family Dactylosporaceae Körb. is the fourth species rich genus of lichenicolous fungi after *Arthonia* (140 species), *Stigmidium* (94 species) and *Opegrapha* (72 species), and is represented by 64 species of lichenicolous fungi throughout the world (Diederich *et al.* 2018). The members of this genus are saprobic on bark/wood, liverworts or are commensalistic fungi growing on lichens (Hafellner 2004, Hawksworth *et al.* 1995, Jaklitsch *et al.* 2016, Pang *et al.* 2014), and are characterised by superficial to stalked blackish apothecia, excipulum composed of textura angularis to globulosa cells, hymenium of thick gelatinous matrix, paraphyses sparingly branched with apices slightly swollen and pigmented, asci cylindrical to clavate, amyloid with I– tholus covered by an I+ blue external gelatinous cap, ascospores subglobose to ellipsoid with one to several transverse septa, mostly 8 per ascus (Bellemère and Hafellner 1982, Döbbeler and Buck 2017, Hafellner 1979), conidiomata blackish sporodochial-stromatic, conidiogenesis thallic, probably meristem thallic (meristem arthric) (Kiffer and Morelet 2000, Seifert *et al.* 2011), conidia dark brown, uni- to multi-cellular (Diederich *et al.* 2013, Miadlikowska *et al.* 2014). Recently the genus has been circumscribed

based on evidence from molecular phylogenetics (Diederich *et al.* 2013, 2018, Pino-Bodas *et al.* 2017), and all the previously described *Dactylospora* species are now synonymised under it and belong to family Dactylosporaceae in the recently described order Sclerococcales.

Till date six species of the genus (excluding *S. sphaerale* (Ach.) Fr.) are noticed in Indian flora colonising various lichens, i.e. *S. deminutum* (Th. Fr.) Ertz et Diederich, *S. homoclinellum* (Nyl.) Ertz et Diederich, *S. protothallinum* (Anzi) Ertz et Diederich, *S. rimulicola* (Müll. Arg.) Ertz et Diederich, *S. saxatile* (Schaer.) Ertz et Diederich and *S. simplex* D. Hawksw. (Joshi 2018, Joshi *et al.* 2016, 2018).

During the course of studies on lichenicolous fungi of India, the author found some interesting *Sclerococcum* species colonising *Dendriscosticta*, *Physcia* and *Sticta* species, which resulted in the discovery of two new species, *Sclerococcum dendriscostictae* Y. Joshi and *S. physciae* Y. Joshi, thus raising number of species to 8 from India and 66 from the world.

MATERIALS AND METHODS

The studied specimens are deposited in the herbaria of CSIR-National Botanical Research Institute (LWG) including the personal herbarium of D. D. Awasthi (AWAS) and Lucknow University (LWU). The materials were examined and measured under stereozoom dissecting microscope (Olympus SZ61). Hand-made sections were made for studying the anatomy of fruiting bodies and examined under a compound microscope (Olympus BX53) equipped with Olympus differential interference contrast optics. Microscopical examination was done in water, 10% KOH (K), lactophenol cotton blue (LCB), Lugol's iodine, directly (I) or after a KOH pre-treatment (K/I). Ascospores and conidia measurements are presented as: arithmetic mean – standard deviation, arithmetic mean, and arithmetic mean + standard deviation, flanked by the minimal and maximal measurements in parentheses, and the length/breadth ratio of conidia is indicated as Q and presented in the same way, followed by the number of measurements (n). Values in italics (e.g., *-11.6-*) are arithmetic means.

RESULTS AND DISCUSSION

Sclerococcum dendriscostictae Y. Joshi, *spec. nova* (Fig. 1a–d)

MycoBank No.: MB 836702

Similar to Sclerococcum homoclinellum (Nyl.) Ertz et Diederich (on species of *Lecanora* and *Tephromela*) in having similar ascospore size but differs in lacking paraphyses with dark apical caps and different host.

Type: India. NW Himalaya (now Uttarakhand), Tehri Garhwal, below Jamunotri, alt. 2,743 m, on *Sticta nylanderiana* (now *Dendriscosticta platyphylla*) colonising bark of *Quercus*, 21 June 1951, D. D. Awasthi 901 (holotype: LWG-AWAS 12950; isotype: RUBL).

Lichenicolous fungus growing on the thallus and apothecial disc of *Dendriscosticta* and *Sticta* species (Fig. 1a–b). Ascomata apothecia, rounded, 0.1–0.3(–0.4) mm in diameter; numerous, sessile to rarely constricted at base, arising singly, disc flat, rough, black; margin distinct, raised above the level of disc, concolorous (Fig. 1a–b). Lateral exciple 30–40 µm wide, composed of large, thin-walled, cells of textura angularis, outer cell layer is dark brown, inner cells are hyaline to pale brown K–, N– (Fig. 1c). Lower exciple (hypothe-cium) (25–)30–40(–60) µm wide, medium reddish brown, composed of thick walled isodiametric cells, K–, N– (Fig. 1c). Hymenium hyaline, (25–)35–50(–75) µm high (Fig. 1c). Epihymenium brown, (6–)10–15(–18) µm, K–, N– (Fig. 1c). Paraphyses filamentous, septate, branched to anastomosed, 1–1.5 µm thick, slightly swollen at the tips. Asci with a K/I+ blue outer layer, 8-spored, unitunicate, cylindrical to subclavate, rounded at the apex, sessile, (28–)32.7–38.4–44(–50) × (9–)9.7–11.6–13.5(–15) µm (n = 40) (Fig. 1d). Ascospores ellipsoid, hyaline at immature stage and brown at maturity, 1-septate, smooth walled, 9–10–11(–12) × (3–)3.8–5–6.1(–7) µm (n = 40), perispore present, 0.5 µm. Coni-diomata not observed.

Host: On thallus and apothecial disc of foliose cyanolichens *Dendriscosticta* and *Sticta*.

Etymology: The epithet refers to the host lichen genera *Dendriscosticta* and *Sticta* on which the fungus is colonising.

Ecology and distribution: *Sclerococcum dendriscostictae* is known from two collections in the Himalaya, found growing on the thallus and apothecial disc of different *Dendriscosticta* and *Sticta* species colonising tree bark and rocks. Since no pathogenicity was observed, hence it is a commensalistic species.

Taxonomic remarks: The new taxon is generally characterised by its small sized (0.1–0.4 mm) black apothecia, hyaline hymenium, epihymenium brown K–, N–, paraphyses without dark apical caps, asci 8-spored, ascospores ellipsoid, hyaline at immature stage and brown at maturity, 1-septate, smooth walled, 9–10–11(–12) × (3–)3.8–5–6.1(–7) µm and colonising the host thallus, as well as rarely apothecial disc of *Dendriscosticta* and *Sticta* species.

The following eleven species of *Sclerococcum* having 8-spored asci and 1-septate ascospores of somewhat similar size differs from the new taxon in various ways: *S. acarosporicola* Ertz et Diederich differs in having paraphyses with dark apical caps, narrower ascospores, 8–11 × 3.5–5 µm and used to colonise *Acarospora* species; *S. aeruginosum* (Holien et Ihlen) Ertz et Diederich, which used to infect various crustose lichens and also bark and wood differs

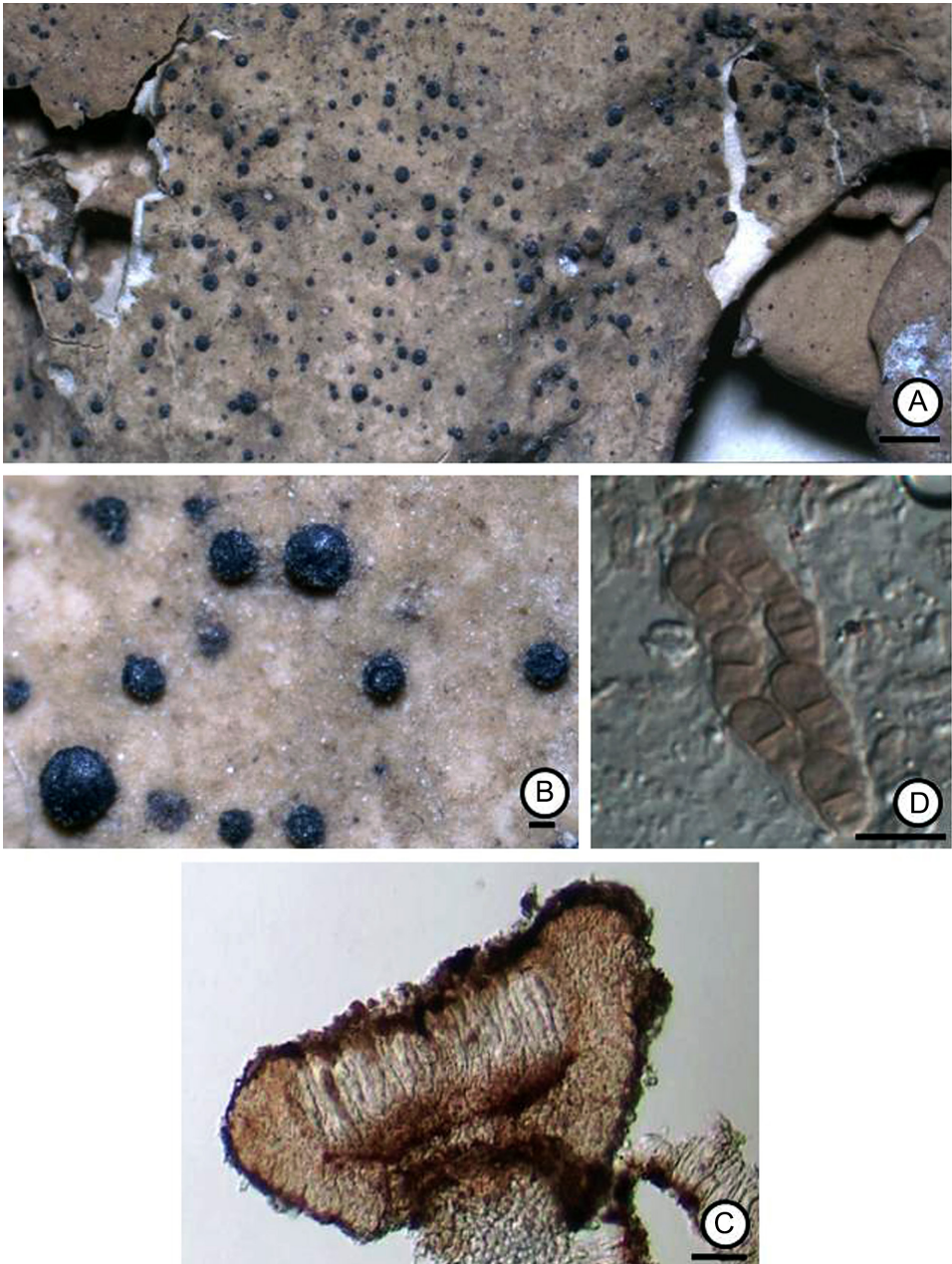


Fig. 1. *Sclerococcum dendriscostictae* (holotype): a = thallus of *Dendriscosticta platyphylla* infected by *Sclerococcum* (scale bar: 1 mm); b = magnified view of infected part (scale bar: 0.1 mm); c = section through apothecium (scale bar: 50 μm); d = ascus with ascospores 60 \times (scale bar: 10 μm)

by the presence of violet blue, K+ aeruginose patches in apothecial sections; *S. amygdalariae* (Triebel) Ertz et Diederich has paraphyses with dark apical caps and colonises thallus of *Amygdalaria* species; *S. anziae* (Zhurb., Ezhkin, Skirina et Y. Ohmura) Ertz et Diederich colonising thallus and apothecial disc of various *Anzia* species has K+ brown to greyish brown epihymenium and somewhat bigger asci [(42–)44–56(–60) μm]; *S. athallinum* (Müll. Arg.) Ertz et Diederich differs in having K+ purple epihymenium, somewhat longer ascospores (9–14.5 μm) and different host (*Baeomyces rufus* (Huds.) Rebert.); *S. australe* (Triebel et Hertel) Ertz et Diederich infecting *Lecidea*, *Paraporpidia*, *Poeltiaria*, *Poeltidea*, *Porpidia*, *Rimularia* and *Tremolecia* spp., has paraphyses with dark apical cap and somewhat longer and narrower ascospores (7.5–13.5 \times 4–6 μm); *S. homoclinellum* has paraphyses with dark apical caps and colonises *Lecanora* and *Tephromela* spp.; *S. protohallinum* differs in having bigger ascospores (9–15 \times 4.5–7.5 μm) and host selection (*Fuscopannaria* and *Parmeliella*); *S. rimulicola* colonising *Lecanora* and possibly *Pertusaria* spp., differs in having a hyaline hymenium and paraphyses with dark apical caps; *S. saxatile* differs in having initially immersed apothecia, paraphyses with dark apical caps, longer ascospores, 9–15 \times 4.5–7.5 μm and host preference (*Ochrolechia* and *Pertusaria*); *S. tegularum* (Arnold) Ertz et Diederich, which colonises *Caloplaca* species differs in having immersed apothecia and paraphyses with dark apical caps (Zhurbenko *et al.* 2017).

Additional specimens examined: India, Uttarakhand, Almora district (now Bageshwar), en route to Pindari Glacier, Dhakuri ridge, alt. 2,895 m, on *Sticta nylanderiana* (now *Dendriscosticta platyphylla*) colonising tree bark, 19 May 1950, D. D. Awasthi & A. M. Awasthi 651 (LWG); *ibid.*, on *Sticta henryana* colonising tree bark, D. D. Awasthi & A. M. Awasthi 651 (LWG); *ibid.*, alt. 2,850 m, s.d., on *Sticta wrightii* (now *Dendriscosticta wrightii*) colonising rock, D. D. Awasthi & A. M. Awasthi 651 (LWG).

Sclerococcum physciae Y. Joshi, *spec. nova*
(Fig. 2a–b)

Mycobank No.: MB 836703

Differs from Sclerococcum aptrootii Diederich by bigger conidia [(5–)7.5–10–11.7(–14) \times (4–)4.7–5.8–6.9(–7) μm vs 5–6.5 \times 4–5 μm] and a different host selection (*Physcia* vs *Fissurina dumastii* Fée).

Type: India. Andhra Pradesh, Visakhapatnam, 3 km above Simhachalam, near microwave station, on thallus of *Physcia* sp. colonising twigs, 09 March 1986, D. D. Awasthi, G. Awasthi, R. Mathur & P. Srivastava 86-309 (holotype: LWG-LWU 12718; isotype: RUBL).

Colonies lichenicolous on *Physcia* sp., forming erumpent minuscule convex sporodochia, black, rounded to irregular, 40–100 μm diam., solitary to confluent. Vegetative hyphae hyaline to brown, immersed in the host thallus, indistinct. Conidiophores aggregated into dense sporodochia, not or sparsely branched, hyaline or pale brown. Conidiogenesis meristem thallic. Conidiogenous cells terminal, integrated, hyaline or pale brown, not very distinct. Conidia produced in short basipetal chains, separating easily, dry, acrogenous, subspherical, ellipsoid or angular, medium to dark brown, mostly simple, rarely 1-septate, but then cells separating easily, the resulting part-conidia of-

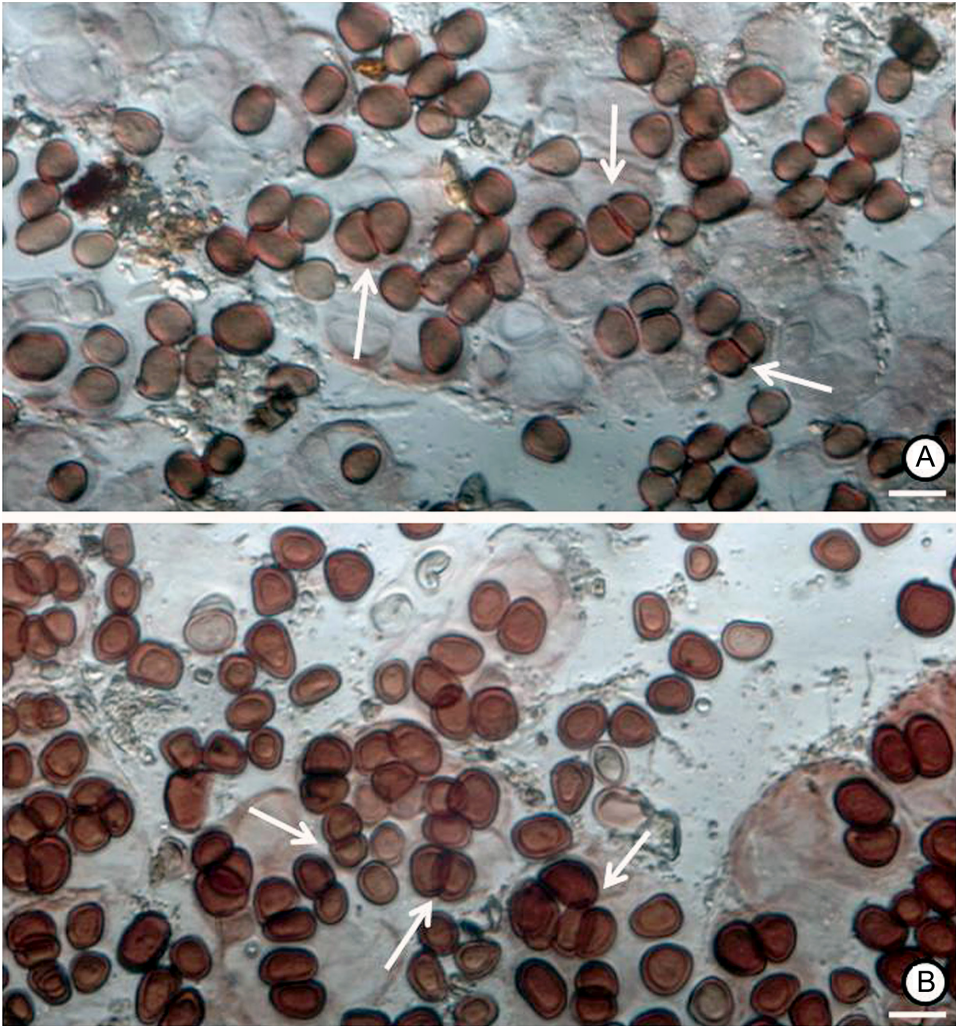


Fig. 2. *Sclerococcum physciae*: a = simple to 1-septate conidia 60 \times (in water); b = in KOH (arrows indicating septation) (scale bar: 10 μm)

ten more or less triangular (Fig. 2a–b), septum 1.5–3 μm thick, dark brown, often with a distinct blackish lamella, (5–)7.5–10–11.7(–14) \times (4–)4.7–5.8–6.9(–7) μm , $Q = (0.8\text{--}1.1\text{--}1.4\text{--}1.7\text{--}2)$ ($n = 40$), with a rather thick, smooth wall, (0.5–)0.7–1–1.3(–1.5) μm thick. All parts K– (becoming slightly darker).

Host: On thallus of foliose phycolichen *Physcia*.

Etymology: The epithet is derived from the name of the host.

Ecology and distribution: The new taxon is the first species of lichenicolous fungus from the state of Andhra Pradesh and is known only from the type locality collected in 1986, inhabiting corticolous species of lichen genus *Physcia*. Since no pathogenicity was observed, it is supposedly a commensalistic species.

Taxonomic remarks: In having somewhat similar conidiomata size (up to 100 μm) and simple to 1-septate conidia which separates easily apart, the new taxon resembles *Sclerococcum aptrootii*, which differs in having smaller conidia [5–6.5 \times 4–5 μm vs (5–)7.5–10–11.7(–14) \times (4–)4.7–5.8–6.9(–7) μm] and a different host (*Fissurina dumastii* vs *Physcia*). *Sclerococcum phaeophysciae* Diedrich et van den Boom, another species of the genus, which used to colonise members of lichen family Physciaceae, differs in having bigger conidiomata (200–600 μm diam.), bigger conidia [(9.7–)11.1–14.6(–17) \times (8–)9.1–10.9(–12) μm] and a different host selection (*Phaeophyscia orbicularis* (Neck.) Moberg). The new taxon has smaller conidiomata (40–100 μm diam.), smaller conidia [(5–)7.5–10–11.7(–14) \times (4–)4.7–5.8–6.9(–7) μm] and a different host selection (*Physcia*). *Sclerococcum simplex* differs in having bigger conidiomata (50–)100–300 μm diam., smaller conidia (4–7 μm diam.) which do not get separated, and corticolous *Ochrolechia* and *Pertusaria* species as hosts. *Sclerococcum montagnei* Hafellner, differs in having mainly 1-septate often irregularly catenate conidia, bigger conidiomata (200–300 μm diam.) and a different host, viz. *Lecanora rupicola* (L.) Zahlbr. (Hafellner 1996).

Key to the species of *Sclerococcum* in India

- | | | |
|----|--|--------------------|
| 1a | Fructifications are sporodochial conidiomata | 2 |
| 1b | Fructifications are apotheciid ascomata | 3 |
| 2a | Conidiomata 40–100 μm diam., conidia [(5–)7.5–10–11.7(–14) \times (4–)4.7–5.8–6.9(–7) μm], when 1-septate, then cells separating easily, the resulting part-conidia often more or less triangular; on thallus of <i>Physcia</i> sp. | |
| | | <i>S. physciae</i> |
| 2b | Conidiomata (50–)100–300 μm diam., conidia 4–7 μm diam., when 1-septate, not separating in part-conidia; on thallus, soredia and apothecial disc of <i>Lepora albescens</i> , <i>L. amara</i> , <i>L. multipuncta</i> , <i>Ochrolechia subpallescens</i> , <i>O. yasudae</i> var. <i>corallina</i> , <i>Pertusaria coronata</i> , <i>P. leioplaca</i> , <i>P. melastomella</i> | |
| | | <i>S. simplex</i> |

- 3a Ascospores always 1-septate 4
- 3b Ascospores 3-7 septate, 14–22 × 5–7 μm; on thallus of *Parmotrema kamatii*
S. deminutum
- 4a On thalli and ascomata of foliose cyanobacterial lichens 5
- 4b On thalli and/or ascomata of crustose lichens 6
- 5a Ascospores 9–15 × 4.5–7.5 μm; on thallus of *Parmeliella tryptophylla*
S. protothallinum
- 5b Ascospores 9–10–11(–12) × (3–)3.8–5–6.1(–7) μm; on thallus and apothecial disc of *Dendriscosticta platyphylla*, *D. wrightii* and *Sticta henryana*
S. dendriscostictae
- 6a Hypothecium hyaline to brown or olivaceous green 7
- 6b Hypothecium dark brown to almost black, apothecia slightly stalked; on thallus of *Lecanora flavidofusca*
S. rimulicola
- 7a Ascospores > 5–6 μm broad; on thallus and apothecial disc of *Pertusaria indica*, *P. leioplaca*, *P. pertusa*, *P. quassiae*
S. saxatile
- 7b Ascospores < 5–6 μm broad; on thallus of *Lecanora fimbriatula*, *L. impudens*, *Protoparmeliopsis muralis*
S. homoclinellum

*

Acknowledgements – The author thank G. B. Pant National Institute of Himalayan Environment and Sustainable Development (GBPI/IERP/16-17/16/175) and Council for Scientific and Industrial Research [38(1441)/17/EMR-II] for financial assistance. Director, CSIR-National Botanical Research Institute, Lucknow and Dr D. K. Upreti are acknowledged for providing lichen samples.

REFERENCES

- Bellemère, A. and Hafellner J. (1982): Ultrastructure des asques de genre *Dactylospora* (Discomycetes) et son intérêt taxonomique. – *Cryptogamie, Mycologie* 3: 71–93.
- Diederich, P., Ertz, D., Lawrey, J. D., Sikaroodi, M. and Untereiner, W. A. (2013): Molecular data place the hyphomycetous lichenicolous genus *Sclerococcum* close to *Dactylospora* (Eurotiomycetes) and *S. parmeliae* in *Cladophialophora* (Chaetothyriales). – *Fungal Diversity* 58: 61–72. <https://doi.org/10.1007/s13225-012-0179-4>
- Diederich, P., Lawrey, J. D. and Ertz, D. (2018): The 2018 classification and checklist of lichenicolous fungi, with 2000 non lichenized, obligately lichenicolous taxa. – *Bryologist* 121: 340–425. <https://doi.org/10.1639/0007-2745-121.3.340>

- Döbbeler, P. and Buck, W. R. (2017): *Dactylospora inopina* (Lecanorales), a new biotrophic parasite on *Radula* (Hepaticae) from the Cape Horn Archipelago, Chile. – *Nova Hedwigia* **105**: 87–93. https://doi.org/10.1127/nova_hedwigia/2017/0403
- Hafellner, J. (1979): *Karschia*. Revision einer Sammelgattung an der Grenze von lichenisierten und nichtlichenisierten Ascomyceten. – *Beih. Nova Hedwigia* **62**: 1–248.
- Hafellner, J. (1996): Bemerkenswerte Funde von Flechten und lichenicolen Pilzen auf makaronesischen Inseln V. Über einige Neufunde und zwei neue Arten. – *Herzogia* **12**: 133–145.
- Hafellner, J. (2004): *Dactylospora*. – In: Nash III, T. H., Ryan, B. D., Diederich, P., Gries, C. and Bungartz, F. (eds): *Lichen flora of the Greater Sonoran Desert Region, Vol. 2. Lichens*. Unlimited, Arizona State University, Tempe, Arizona, pp. 645–648.
- Hawksworth, D. L., Kirk, P. M., Sutton, B. C. and Pegler, D. N. (1995): *Ainsworth & Bisby's dictionary of the fungi*. 8th ed. – CAB International, Wallingford.
- Jaklitsch, W., Baral, H. O., Lücking, R. and Lumbsch, H. T. (2016): *Ascomycota*. – In: Frey, W. (ed.): *Syllabus of plant families*. Adolf Engler's Syllabus der Pflanzenfamilien. Borntraeger, Stuttgart, 290 pp.
- Joshi, Y. (2018): Documentation of lichenicolous fungi from India. Some additional reports. – *Kavaka* **51**: 30–34.
- Joshi, Y., Falswal, A., Tripathi, M., Upadhyay, S., Bisht, A., Chandra, K., Bajpai, R. and Upreti, D. K. (2016): One hundred and five species of lichenicolous biota from India: An updated checklist for the country. – *Mycosphere* **7**(3): 268–294. <https://doi.org/10.5943/mycosphere/7/3/3>
- Joshi, Y., Tripathi, M., Bisht, K., Upadhyay, S., Kumar, V., Pal, N., Gaira, A., Pant, S., Rawat, K. S., Bajpai, R. and Halda, J. P. (2018): Further contributions to the documentation of lichenicolous fungi from India. – *Kavaka* **50**: 26–33.
- Kiffer, E. and Morelet, M. (2000): *The Deuteromycetes, mitosporic fungi, classification and generic keys*. – Science Publishers, Enfield.
- Miadlikowska, J., Kauff, F., Högnabba, F., Oliver, J. C., Molnár, K., Fraker, E., Gaya, E., Hafellner, J., Hofstetter, V., Gueidan, C., Otálora, M. A., Hodkinson, B., Kukwa, M., Lücking, R., Björk, C., Sipman, H. J., Burgaz, A. R., Thell, A., Passo, A., Myllys, L., Goward, T., Fernández-Brime, S., Hestmark, G., Lendemer, J., Lumbsch, H. T., Schmull, M., Schoch, C. L., Sérusiaux, E., Maddison, D. R., Arnold, A. E., Lutzoni, F. and Stenroos, S. (2014): A multigene phylogenetic synthesis for the class Lecanoromycetes (Ascomycota): 1307 fungi representing 1139 infrageneric taxa, 317 genera and 66 families. – *Mol. Phyl. Evol.* **79**: 132–168. <https://doi.org/10.1016/j.ympev.2014.04.003>
- Pang, K. L., Guo, S. Y., Alias, S. A., Hafellner, J. and Jones, E. B. G. (2014): A new species of marine *Dactylospora* and its phylogenetic affinities within the Eurotiomycetes, Ascomycota. – *Botanica Marina* **57**: 315–321. <https://doi.org/10.1515/bot-2014-0025>
- Pino-Bodas, R., Zhurbenko, M. P. and Stenroos, S. (2017): Phylogenetic placement within Lecanoromycetes of lichenicolous fungi associated with *Cladonia* and some other genera. – *Persoonia* **39**: 91–117. <https://doi.org/10.3767/persoonia.2017.39.05>
- Seifert, K., Morgan-Jones, G., Gams, W. and Kendrick, B. (2011): The genera of hyphomycetes. – *CBS Biodiversity Series* **9**: 1–997.
- Zhurbenko, M., Ezhkin, A. K., Skirina, I. F. and Ohmura, Y. (2017): *Dactylospora anziae*, a new lichenicolous ascomycete on *Anzia* from East Asia. – *Folia Cryptog. Estonica* **54**: 13–16. <https://doi.org/10.12697/fce.2017.54.03>

