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New records and an updated checklist of lichenicolous fungi from India

Joshi Y[1], Upadhyay S[1], Shukla S[1], Nayaka S[2] and Rawal RS[3]

[1] *Lichenology laboratory, Department of Botany, S.S.J. Campus, Kumaun University, Almora – 263601, Uttarakhand, India dryogeshcalo@gmail.com*
[2] *Lichenology laboratory, National Botanical Research Institute, Rana Pratap Marg, Lucknow – 226001, Uttar Pradesh, India*
[3] *G.B. Pant Institute of Himalayan Environment and Development, Kosi-Katarmal, Almora – 263643, Uttarakhand, India*

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Abstract

The present paper describes three new records of lichen inhabiting fungi belonging to the genera *Biatoropsis*, *Homostegia* and *Lichenodiplis*, and also report new hosts for *Homostegia hertelii* and range extensions of *Lichenodiplis lecanorae, Pyrenidium actinellum* and *Sphinctrina tubaeformis* in India. An updated checklist of all lichenicolous fungi known so far from India is also provided.

Key words – Biodiversity – checklist – distribution – mycobiota – parasymbiont

Introduction

Lichens are known to host a wide range of microorganisms including lichenicolous fungi that are parasitic fungi living on lichens. They are most commonly specific to a given fungus as the host, but also include a wide range of pathogens, saprotrophs and commensals. In the world so far about 1800 species of lichenicolous fungi have been identified and an occurrence of more than 3000 is being estimated (Lawrey & Diederich 2011). In India, lichenicolous fungi were hardly studied by lichenologists and the literature is scattered and scanty. Recently, Zhurbenko (2013) published the first list of lichenicolous fungi for India with 42 species including some taxa identified only up to generic level. However, few species of lichenicolous fungi reported earlier from India were missing in Zhurbenko's (2013) list, while, few are discovered recently. The list of missing fungi includes - *Arthonia diorygmae* S. Joshi & Upreti (Joshi et al. 2013), *Carbonea vitellinaria* (Nyl.) Hertel (Awasthi 1991), *Sphinctrina anglica* Nyl. and *Sphinctrina tubaeformis* A. Massal. (Pant & Awasthi 1989). Recently, Joseph and Sinha (unpbl.) reported two species of *Melaspilea* (*M. amarkantakensis* S. Joseph & G.P. Sinha and *M. insitiva* Stirt.) as lichenicolous fungi from India. In the present communication, we are reporting six interesting species of the lichenicolous fungi based on fresh collections from Kumaun Himalaya and herbarium specimen lodged at National Botanical Research Institute (LWG). Out of six species, three are new to India, while five are new to Uttarakhand (including two new records for India), and described in brief along with their host species and distribution within and outside India. After including the species missed out by Zhurbenko (2013) along with recent records, the total tally of lichenicolous fungi in

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Corresponding Author: Yogesh Joshi – e-mail – dryogeshcalo@gmail.com

India raises up to 51 (Table 1). This updated checklist would act as baseline information for further studies on lichenicolous fungi of India.

Materials & Methods

The study is based on 11 samples collected from Kumaun Himalaya during 2013-14 and one herbarium specimen deposited at LWG. The external morphology of the samples was examined under stereozoom microscope (OLYMPUS SZ2-ILST). The anatomical studies were carried out using hand cut sections using CX21iLEDFS1 microscope. Studied specimens are deposited in the herbarium of Kumaun University, Almora (ALM) and CSIR-National Botanical Research Institute, Lucknow (LWG).

Results

Biatoropsis usnearum Räsänen, Ann. Bot. Soc. Zool.-Bot. Fenn. "Vanamo" 5: 8 (1934).

Basidiomata club shaped, flat to convex, yellowish to brownish, constricted at base or subsessile, rarely with prominent short stalk. Hymenium hyaline, basidia clavate, up to 3 septate, 25–30 × 3–5 µm. Basidiospores subglobose to ellipsoidal, 4–7 × 3.5–7.5 µm.

Known distribution – Cosmopolitan, known from all continents except Antarctica (Diederich 2004a). New to India.

Material examined – INDIA, Tamil Nadu, Kanya Kumari, Upper Kodayar, alt. 1050 m, on thallus of corticolous *Usnea austroindica*, May 2011, Ravichandran, *s.n.* (LWG).

Homostegia hertelii D. Hawksw., V. Atienza & M.S. Cole, Biblioth. Lichenol. 88: 189 (2004).

Stroma arising on the surface of the host thallus, black, matt to slightly shiny, orbicular to irregular. Perithecioid locules arising deep in the stroma. Hamathecium well developed. Asci elongate to clavate, 8 spored. Ascospores 3 septate, olivaceous brown, the tips of the end cells often somewhat paler to subhyaline, smooth walled, 20–27.5 × 7–13.5 µm.

Known distribution – U.S.A. (Hawksworth et al. 2004). New to Asia and India.

Material examined – INDIA, Uttarakhand, Almora district, Jhakar Saim Forest, on thallus of *Flavoparmelia caperata* and *Punctelia rudecta* colonizing *Quercus* tree, 06 July 2014, M. Tripathi, K. Chandra & S. Upadhyay, *s.n.* (ALM); Dol Ashram, on thallus of *Punctelia rudecta* colonizing *Quercus* tree, 15 March 2014, M. Tripathi & party, *s.n.* (ALM).

Lichenodiplis lecanorae (Vouaux) Dyko & D. Hawksw., Lichenologist 11(1): 52 (1979).

Pycnidia present, arising singly, dark brown, subglobose, 50–120 µm in diameter. Conidiophores absent, conidiogenous cells hyaline to pale brown, lageniform to subcylindrical, 5.5–12 × 2–3 µm. Conidia pale brown, 1 septate, elongate to ellipsoid, 4–7.5 × 2–3 µm.

Known distribution – Europe, North and South America, possibly cosmopolitan (Diederich 2004b). Previously the species was reported by Zhurbenko (2013) from Jammu & Kashmir, where it was colonizing on apothecia and thallus of *Caloplaca cerina* and *Xanthoria candelaria* respectively. It is new to Uttarakhand and found growing on apothecial discs of *Lecanora* species.

Material examined – INDIA, Uttarakhand, Almora district, G.B. Pant Institute of Himalayan Environment and Development, on apothecia of *Lecanora* sp. colonizing bark of *Ligustrum nepalense*, 16-18 March 2014, G. Bhakuni, *s.n.* (ALM).

Lichenodiplis lichenicola Dyko & D. Hawksw., Lichenologist 11(1): 56 (1979).

Pycnidia present, arising singly, dark brown, subglobose, 50–60 µm in diameter. Conidiophores absent, conidiogenous cells hyaline to pale brown, lageniform to subcylindrical, 5–10 × 2–3 µm. Conidia pale brown, 1 septate, elongate to ellipsoid, 9–12 × 4–5 µm.

Known distribution – Alaska (Zhurbenko et al. 1995), British Isles (Coppins & Coppins 1996), Norway (Hawksworth & Dyko 1979), Spain (Calatayud et al. 1995). New to Asia and India.

Table 1 Updated checklist of lichenicolous fungi from India along with their host lichens and distribution

S. No.	Lichenicolous fungi	Host	Distribution	Reference(s)
1.	*Abrothallus peyritschii* (Stein) I. Kotte	*Vulpicida pinastri*	Himachal Pradesh	Alstrup & Ahti (2007)
2.	*Arthonia diorygmae* S. Joshi & Upreti	*Diorygma junghuhnii*	Tamil Nadu	Joshi et al. (2013)
3.	*A. molendoi* (Heufl. ex Frauenf.) R. Sant.	*Xanthoria elegans*	Jammu & Kashmir	Zhurbenko (2013)
4.	*Biatoropsis usnearum* Räsänen	*Usnea austroindica*	Tamil Nadu	This manuscript
5.	*Carbonea vitellinaria* (Nyl.) Hertel	*Candelaria vitellina*	Jammu & Kashmir	Awasthi (1991)
6.	*Cercidospora macrospora* (Uloth) Hafellner & Nav.-Ros.	*Lecanora* sp.	Jammu & Kashmir	Zhurbenko (2013)
7.	*C. melanophthalmae* Nav.-Ros., Calat. & Hafellner	*Rhizoplaca melanophthalma*	Jammu & Kashmir	Zhurbenko (2013)
8.	*C. xanthoriae* (Wedd.) R. Sant.	*Xanthoria elegans*	Jammu & Kashmir	Zhurbenko (2013)
9.	*Cercidospora* sp.	*Lecanora* sp.	Jammu & Kashmir	Zhurbenko (2013)
10.	*Cladosporium licheniphilum* Heuchert & U. Braun	*Xanthoria Candelaria*	Jammu & Kashmir	Zhurbenko (2013)
11.	*Corticifraga peltigerae* (Fuckel) D. Hawksw. & R. Sant.	*Peltigera elisabethae* & *P. ponojensis*	Jammu & Kashmir	Zhurbenko (2013)
12.	*Endococcus incrassatus* Etayo & Breuss	*Endocarpon pusillum*	Jammu & Kashmir	Zhurbenko (2013)
13.	*E. rugulosus* (Borrer ex Leight.) Nyl.	*Rhizocarpon disporum*	Jammu & Kashmir	Triebel (1989)
		Aspicilia sp.	Jammu & Kashmir	Zhurbenko (2013)
14.	*Homostegia hertelii* D. Hawksw., V. Atienza & M.S. Cole	*Flavoparmelia caperata* & *Punctelia rudecta*	Uttarakhand	This manuscript
15.	*H. piggotii* (Berk. & Broome) P. Karst.	*Parmelia* sp.	Uttarakhand	Alstrup & Ahti (2007)
16.	*Intralichen christiansenii* (D. Hawksw.) D. Hawksw. & M.S. Cole	*Candelariella aurella*	Jammu & Kashmir	Zhurbenko (2013)
17.	*Lichenoconium usneae* (Anzi) D. Hawksw.	*Flavoparmelia caperata*	Jammu & Kashmir	Zhurbenko (2013)
18.	*L. xanthoriae* M.S. Christ.	*Melanelixia subargentifera*	Jammu & Kashmir	Zhurbenko (2013)
19.	*Lichenodiplis lecanorae* (Vouaux) Dyko & D. Hawksw.	*Caloplaca cerina* & *Xanthoria candelaria*	Jammu & Kashmir	Zhurbenko (2013)
		Lecanora sp.	Uttarakhand	This manuscript
20.	*L. lichenicola* Dyko & D. Hawksw.	*Rinodina* sp.	Uttarakhand	This manuscript
21.	*Lichenopeltella swaminathaniana* Harih., Mibey & D. Hawksw.	*Porina* sp.	Tamil Nadu	Hariharan et al. (1996)
22.	*Lichenostigma alpinum* (R. Sant., Alstrup & D. Hawksw.) Ertz & Diederich	*Pertusaria albescens*	Jammu & Kashmir	Zhurbenko (2013)
23.	*L. cosmopolites* Hafellner & Calat.	*Xanthoparmelia stenophylla*	Jammu & Kashmir	Zhurbenko (2013)
24.	*L.* cf. *elongatum* Nav.-Ros. & Hafellner	*Lecanora* sp. & *Lobothallia praeradiosa*	Jammu & Kashmir	Zhurbenko (2013)
25.	*L.* subgen. *Lichenogramma* sp.	*Seirophora contortuplicata*	Jammu & Kashmir	Zhurbenko (2013)
26.	*Marchandiomyces corallinus* (Roberge) Diederich & D. Hawksw.	*Physcia aipolia* & *Xanthoria candelaria*	Jammu & Kashmir	Zhurbenko (2013)
27.	*Melaspilea amarkantakensis* S. Joseph & G.P. Sinha	*Pertusaria amarkantakana*	Madhya Pradesh	Joseph & Sinha (unpbl.)
28.	*M. insitiva* Stirt.	*Pertusaria leioplaca*	West Bengal	Joseph & Sinha (unpbl.)

S. No.	Lichenicolous fungi	Host	Distribution	Reference(s)
29.	*Monodictys epilepraria* Kukwa & Diederich	*Lepraria* sp.	Jammu & Kashmir	Zhurbenko (2013)
30.	*Muellerella erratica* (A. Massal.) Hafellner & Volk. John	*Lecidea lapicida* & *Lecanora* sp.	Jammu & Kashmir	Zhurbenko (2013)
31.	*M. pygmaea* (Körb.) D. Hawksw.	*Xanthoria elegans* & *Acarospora* sp.	Jammu & Kashmir	Zhurbenko (2013)
32.	*Nectriopsis lecanodes* (Ces.) Diederich & Schroers	*Peltigera elisabethae* & *P. scabrosa*	Jammu & Kashmir	Zhurbenko (2013)
33.	*Opegrapha foreaui* (Moreau) Hafellner & R. Sant.	*Heterodermia leucomelos*	Tamil Nadu	Coppins & Kondratyuk (1998)
34.	*Phoma* sp.	*Xanthoria elegans*	Jammu & Kashmir	Zhurbenko (2013)
35.	*Phyllosticta galligena* Moreau	*Parmotrema perforatum*	Tamil Nadu	Moreau (1951)
36.	*Polycoccum clauzadei* Nav.-Ros. & Cl. Roux.	*Xanthoria elegans*	Jammu & Kashmir	Zhurbenko (2013)
37.	*P. pulvinatum* (Eitner) R. Sant.	*Physcia dubia*	Jammu & Kashmir	Zhurbenko (2013)
38.	*Pronectria subimperspicua* (Speg.) Lowen	*Punctelia borreri*	Jammu & Kashmir	Zhurbenko (2013)
39.	*Pyrenidium actinellum* Nyl.	*Peltigera elisabethae* & *P. praetextata*	Jammu & Kashmir	Zhurbenko (2013)
		Punctelia rudecta	Uttarakhand	This manuscript
40.	*Rosellinula frustulosae* (Vouaux) R. Sant..	*Lecanora argopholis*	Jammu & Kashmir	Zhurbenko (2013)
41.	*Sarcogyne sphaerospora* J. Steiner	*Candelariella* sp.	Jammu & Kashmir	Zhurbenko (2013)
42.	*Skyttea fusispora* Sherwood, D. Hawksw. & Coppins	*Ochrolechia trochophora*	Assam	Sherwood et al. (1981)
43.	*Sphaeropezia* cf. *lecanorae* (Diederich & G. Marson) Baloch & Wedin	*Lecanora muralis*	Jammu & Kashmir	Zhurbenko (2013)
44.	*Sphinctrina anglica* Nyl.	*Pertusaria* sp.	Tamil Nadu & Uttar Pradesh	Pant & Awasthi (1989) and Awasthi & Singh (1975)
45.	*S. tubaeformis* A. Massal.	*Pertusaria* sp.	Assam, Manipur, Tamil Nadu	Pant & Awasthi (1989)
			Uttarakhand	This manuscript
46.	*Stigmidium gyrophorarum* (Arnold) D. Hawksw.	*Umbilicaria vellea*	Jammu & Kashmir	Zhurbenko (2013)
47.	*S. pumilum* (Lettau) Matzer & Hafellner	*Phaeophyscia ciliata*	Jammu & Kashmir	Zhurbenko (2013)
48.	*S. tabacinae* (Arnold) Triebel	*Toninia tristis*	Jammu & Kashmir	Zhurbenko (2013)
49.	*Vouauxiella lichenicola* (Linds.) Petr. & Syd.	*Lecanora* sp.	Jammu & Kashmir	Zhurbenko (2013)
50.	*Zwackhiomyces coepulonus* (Norman) Grube & R. Sant.	*Xanthoria elegans*	Jammu & Kashmir	Zhurbenko (2013)
51.	*Z.* cf. *kiszkianus* D. Hawksw. & Miadl.	*Peltigera elisabethae*	Jammu & Kashmir	Zhurbenko (2013)

Material examined – INDIA, Uttarakhand, Champawat district, Shivalaya temple, on apothecia of *Rinodina* sp. colonizing rocks, 17 July 2014, K. Chandra, *s.n.* (ALM).

Pyrenidium actinellum Nyl., Flora (Regensburg) 48: 210 (1865).

Gall forming fungi on host thalli. Ascomata perithecioid pseudothecia. Ascomata wall entirely brown to dark brown. Paraphysoids filiform, hyaline, septate. Periphyses hyaline, green pigmented at ostiolar region. Asci cylindrical to clavate, 4-8 spored. Ascospores brown with the tips of the end cells often pale brown to subhyaline, ellipsoid to broadly fusiform, 3 septate, rarely 2 or 4, 22.5–25 × 7.5–10 µm.

Known distribution – Cosmopolitan (Navarro-Rosinés & Roux 2007). Previously Zhurbenko (2013) reported the species from Jammu & Kashmir, where it was colonizing thallus of *Peltigera elisabethae* and *P. praetextata*. It is new to Uttarakhand and found growing on thallus of *Punctelia rudecta*, thus extending its range distribution as well as host preference.

Material examined – INDIA, Uttarakhand, Almora district, Syahi Devi Forest, on thallus of *Punctelia rudecta* colonizing *Quercus* tree, 27 July 2014, S. Upadhyay & N. Rana, *s.n.* (ALM).

Sphinctrina tubaeformis A. Massal., Memor. Lich.: 155 (1853).

Apothecia immersed in the host thallus. Stalk absent to short. Capitulum spherical, shiny black or dark brown. Asci cylindrical. Ascospores ellipsoid with pointed ends, non septate, (9–)12–15.5(–20) × 6–8(–9) µm.

Known distribution – Europe, Asia, Africa, North and Central America (Tibell 2004). Previously Pant & Awasthi (1989) and Singh (1981) reported the species from Assam, Manipur and Tamil Nadu states of India, where it was colonizing thallus of *Pertusaria*. It is new to Uttarakhand and found growing on thallus of *Pertusaria* sp., thus extending its range distribution within India.

Material examined – INDIA, Uttarakhand, Almora district, Jhakar Saim Forest, on thallus of *Pertusaria* colonizing *Quercus* tree, 06 July 2014, M. Tripathi, K. Chandra & S. Upadhyay, *s.n.* (ALM); Syahi Devi Forest, on thallus of *Pertusaria* colonizing *Quercus* tree, 27 July 2014, S. Upadhyay & N. Rana, *s.n.* (ALM).

Discussion

The present study raises the tally of lichenicolous fungi up to 51 in India and opens a new horizon to study this group since there are several possibilities of finding new species and new records of lichenicolous fungi from India, because a lot of work has been conducted on lichens of India, but this group has remained untouched. Besides this, this group need to be explored out extensively for their host preference, since they are generally named after the host lichen on which they colonize, but there are some species that colonizes various lichens. For example, *Homostegia hertelii* and *Pyrenidium actinellum* were previously reported by earlier workers colonizing *Flavoparmelia* spp. and *Peltigera* spp. respectively, but present study extends their host range to *Punctelia rudecta*.

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