



Some pyronemataceous macrofungi from Ladakh (J&K), India

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Abstract

Six pyronemataceous macrofungi representing four genera (*Anthracobia*, *Geopora*, *Geopyxis* and *Pulvinula*) were collected from various locations of Leh district of Ladakh during 2012–2014. These include two species each of *Geopora* and *Pulvinula* (*Geopora arenicola*, *G. sepulta*, *Pulvinula convexella* and *P. miltina*) and one species each of *Anthracobia* and *Geopyxis* (*Anthracobia macrocystis* and *Geopyxis majalis* respectively). All these taxa are being reported for the first time from Ladakh. Also, *Geopora sepulta* and *Geopyxis majalis* constitute new records for India while as *Anthracobia macrocystis*, *Pulvinula convexella* and *P. miltina* are new additions to the macrofungal flora of Jammu and Kashmir.

Key words – Ascomycetes – Ladakh – New records – Pezizales – Taxonomy

Introduction

The Pyronemataceae is the largest family of the order Pezizales that includes 80 genera with approximately 662 species (Kirk et al. 2008). Members of the family are primarily temperate to arctic-alpine in distribution, with a few taxa known from the tropics. Varied ascomatal forms, with sessile to stipitate, cupulate, discoid, pulvinate, or turbinate epigeous apothecia, as well as sub-hypogeous to hypogeous with closed, folded, or solid tuber-like ascomata are the common features of the family (Perry et al. 2007). With respect to substrate preference, they show great diversity being humicolous, coprophilous, lignicolous and bryophilous. Besides, several genera have been found to be parasitic on bryophytes and an increasing number of species are being identified as ectomycorrhizal associates as well (Fujimura et al. 2005, Smith et al. 2006, Tedersoo et al. 2013).

While surveying the different localities of Leh district of Ladakh for the collection of ascomycetous macrofungi during the monsoon season, six species of the Pyronemataceae i.e *Anthracobia macrocystis* (Cooke) Snyder, *Geopora arenicola* (Lev.) Kers, *G. sepulta* (Fr.) Korf & Burds, *Geopyxis majalis* (Fr.) Sacc., *Pulvinula convexella* (P. Karst.) Pfister and *P. miltina* (Berk.) Rifai were recorded and taxonomically described along with field photographs, microphotographs and camera lucida drawings. All these taxa are being reported for the first time from Ladakh. Also, *Geopora sepulta* and *Geopyxis majalis* constitute new records for India while as *Anthracobia macrocystis*, *Pulvinula convexella* and *P. miltina* are new additions to the macrofungal flora of Jammu and Kashmir.

Materials & Methods

Ascocarps were collected from various locations of Leh district of Ladakh (32°15'–36°N latitude and 75°15'–80°15'E longitude with an altitude of 2300–5000m above the sea level) during July–September, 2012–2014. Macroscopic features of the ascoarps and their habitat were noted in the field. Sony Cyber-shot 14.1 MP digital camera was used for field photography. Micro morphological characters were recorded from dried sample, after reviving in 3% KOH solution, and then staining with 1% aqueous Congo red. Line drawings of microscopic details were drawn with the aid of Camera lucida fitted on Olympus CH 20i binocular microscope and measurements were recorded for each character for description of average dimensions. For colour terminology, Ridgeway (1912) was followed. The studied specimens were deposited in the Herbarium of Botany Department, University of Jammu (HBJU) with accession numbers. *Facesoffungi* numbers are also provided (Jayasiri et al. 2015).

Results

Anthracobia macrocystis (Cooke) Boud., *Hist. Class. Discom. Eur.* (Paris): 65 1907. Figs 1a, 2A
Facesoffungi Number: FoF03309

Synonymy: *Peziza subhirsuta* var. *macrocystis* Cooke, *Grevillea* 1(no.9): 129 1873.

Humaria macrocystis (Cooke) Snyder, *Mycologia* 28 (5): 484 1936.

Ascocarp 0.2–0.8 cm in wide, disc concave, reddish orange (I i 5. OO-R.), inconspicuous hairs surrounding the margin and readily collapsing when dried; *Asci* cylindrical, 220.0–288.0 µm in length, 12.0–16.0 µm wide at the top, 12.0–18.0 µm at the middle and 6.0–8.0 µm at the bottom, hyaline, thin walled, operculate, 8- spored, uniseriate, tapering towards the base, not blueing in iodine; *Ascospores* ellipsoidal, 23.2–26.4 × 10.4–12.8 µm, avL= 24.8, avW= 11.6, Q= 2.2–2.0, hyaline, thick walled, smooth, mono- to biguttulate; *Paraphyses* filiform, 4.0–8.0 × 2.0–4.0 µm, hyaline, thin walled, septate, branched, bulbous at the apex; *Ectal excipulum* composed of globose to ellipsoid cells, 14.0–56.0 × 16.0–56.0 µm, hyaline, thick walled; *Medullary excipulum* composed of hyaline, thin walled, cylindrical to globose cells, 14.0–36.0 × 10.0–16.0 µm; *Marginal hairs* 4.0–8.0 µm in wide at the top, 6.0–10.25 µm at the middle, dark olive green, double walled, septate, pointed towards the tip.

Edibility – Not edible in the study area

Collection examined – Jammu and Kashmir, Leh, Likir village, humicolous, gregarious to scattered, Rigzin Yangdol and Y. P. Sharma, HBJU–461, 9th June 2014.

Distribution – Earlier reported from Britain (Yao et al. 1998) and from Dharamsala, Himachal Pradesh (Thind et al. 1975). A new report from Jammu and Kashmir.

Remarks – The above examined species corroborates well with the description given for *Anthracobia macrocystis* by Yao et al. (1998) from Britain.

Geopora arenicola (Lev.) Kers, *Svensk bot. Tidskr.* 68(3): 345 1974.

Figs 1b, 2B

Facesoffungi Number: FoF03771

Synonymy: *Peziza arenicola* Lev., *Annls Sci. Nat., Bot., Ser.* 39: 140 1848.

Lachnea arenicola (Lev.) Gillet, *Champignons de France*, *Discom.* (3): 68 1880.

Sepultaria arenicola (Lev.) Masee, *Brit. Fung.- Fl.* (London) 4: 390 1895.

Ascocarp 0.5–1.0 cm in diameter, 0.8 cm in height, spherical to depressed spherical, hollow with one single cavity, sessile, outer surface buff brown (XL i.17''O-Y.), minutely roughened, inner surface creamish to white; *Asci* cylindrical, 200.0–304.0 × 12.8–22.4 µm, hyaline, thick walled, operculate, 8- spored, uniseriate, tapering towards the base; *Ascospores* ellipsoidal to broadly ellipsoidal, 17.6–22.4 × 11.2–15.2 µm, avL= 20.0, avW = 13.2, Q = 1.6–1.5, hyaline, thick walled, smooth, monoguttulate; *Paraphyses* elongated, 6.0–8.0 µm wide at the top, 2.0–4.0 µm at the middle, hyaline, thin walled, septate, branched, bulbous at the tip; *Ectal excipulum* composed of oval to angular cells, 10.0–24.0 µm in wide, hyaline to brownish, thick walled; *Medullary*

excipulum composed of hyaline, thick walled densely compacted cylindrical to sub globose cells, $10.0\text{--}32.0 \times 6.0\text{--}18.0 \mu\text{m}$.

Edibility – Not consumed in the study area but edibility reported some in other area (Kumar & Sharma 2009).

Collection examined – Jammu and Kashmir, Leh, Stok village, growing gregarious to scattered on soil, Rigzin Yangdol and Y. P. Sharma, HBJU–462, 4th June, 2012.

Distribution – The species has earlier been reported from Himachal Pradesh (Thind & Sethi, 1957), from Jammu and Kashmir (Kaul 1971, Abraham 1991, Kumar & Sharma 2009). It constitutes a new report for Ladakh region of Jammu and Kashmir.

Remarks – The taxonomic details of above examined species is close to the details given for *Geopora arenicola* by Lars (1974) and Kumar & Sharma (2009) from Sweden and Jammu and Kashmir respectively.

Geopora sepulta (Fr.) Korf & Burds., in Burdsall, *Mycologia* 60(3): 500 1968. Figs 1c, 2C

Facesoffungi Number: FoF03296

Synonymy: *Peziza sepulta* Fr., *Nova Acta R. Soc. Scient, upsal.*, Ser. 31(1): 230 1851.

Sepultaria sepulta (Fr.) Masee, *Brit. Fung.-Fl.* (London) 4: 389 1895.

Apothecia 0.9–1.7 cm in diameter, 0.7–1.7 cm in depth, subglobose, hypogeous in development and buried in soil at first, opening by a small pore then expanding somewhat and emerging at the ground surface, external surface buff brown, minutely roughened with flexuous, pale brown hairs, inner surface creamish to pure white, smooth; *Asci* cylindrical, $260.0\text{--}304.0 \times 18.0\text{--}20.0 \mu\text{m}$ wide at the top, $16.0\text{--}24.0 \mu\text{m}$ at the middle and $12.0\text{--}14.0 \mu\text{m}$ at the base, hyaline (in Congo red), light brownish (in 3% KOH), thick walled, operculate, uniseriately arranged, 8-spored, tapering towards the base; *Ascospores* ellipsoid to broadly ellipsoidal, $21.6\text{--}25.6 \times 14.4\text{--}17.6 \mu\text{m}$, $a_vL = 23.6$, $a_vW = 16.0$, $Q = 1.5\text{--}1.5$, hyaline to watery colour, thick walled, smooth, monoguttulate; *Paraphyses* filiform, $2.0\text{--}4.0 \mu\text{m}$ wide, hyaline, septate, slightly bulbous at the tip; *Ectal excipulum* of globose to sub globose, $11.2\text{--}14.4 \times 5.6\text{--}8.0 \mu\text{m}$, hyaline, thin walled; *Medullary excipulum* of densely intertwined globose to elongated cells, $14.0\text{--}36.0 \times 12.0\text{--}24.0 \mu\text{m}$, hyaline to light brown, thin walled.

Edibility – Not eaten in the study area.

Collection examined – Jammu and Kashmir, Leh, Phey village, humicolous, gregarious to scattered, growing among temperate forest, Rigzin Yangdol and Y. P. Sharma, HBJU–463, 21st September 2014.

Distribution – The species has earlier been reported from Britain (Yao & Spooner 1996). It constitutes new fungal report from India.

Remarks – The presence of subglobose, externally pale brown to fawn apothecia with flexuous hairs and hypogeous development are typical features of *Geopora sepulta*. On comparing the macro- and microscopic details, the above examined specimen is found close to the description given for *Geopora sepulta* by Yao & Spooner 1996a.

Geopyxis majalis (Fr.) Sacc., *Syll. fung.* 8: 72 (1889) Figs 1d, 2D

Facesoffungi Number: FoF03295

Synonymy: *Peziza majalis* Fr., *Nova Acta R. Soc. upsal.*, Ser. 31 (1): 120 1851.

Apothecia cup to saucer shaped, 0.2–0.3 cm in diameter, upto 0.5 cm in depth, deep chrome (III b 17. O-Y.), margin whitish and crenate; *Asci* cylindrical, $180.0\text{--}232.0 \times 12.0\text{--}20.0 \mu\text{m}$, hyaline, thin walled, inoperculate, each ascus contain eight ascospores, uni- to biseriately arranged in an ascus, tapering towards the base; *Ascospores* ellipsoidal, $17.6\text{--}22.4 \times 9.6\text{--}12.8 \mu\text{m}$, $a_vL = 20.0$, $a_vW = 11.2$, $Q = 1.8\text{--}1.8$, hyaline, thick walled, mono- to biguttulate; *Paraphyses* filiform, $4.0\text{--}5.6 \mu\text{m}$ at the top, $2.0\text{--}4.0 \mu\text{m}$ at the middle, hyaline, septate, thin walled, enlarged at the tip; *Ectal excipulum* composed of light brownish, globose to angular, narrow diameter cells; *Medullary excipulum* of hyaline, septate hyphae, $4.0\text{--}10.0 \mu\text{m}$ wide.

Edibility – Not edible in the study area.

Collection examined – Jammu and Kashmir, Leh, Phey village, humicolous, on soil among mosses, Rigzin Yangdol and Y. P. Sharma, HBJU-464, 21st June, 2014.

Distribution – Earlier reported to grow on sandy soil from south eastern Lithuania and Turkey (Kutorga 2002, Kaya et al. 2016). A new report for India.

Remarks – The diagnostic characters of the Ladakh collection are in agreement to those given for *Geopyxis majalis* by Kaya et al. 2016. from Turkey.

Pulvinula convexella (P. Karst.) Pfister, *Occ. Pap. Farlow Herb. Crypt. Bot.* 9: 9 1976. Figs 1e, 2E
Facesoffungi Number: FoF03323

Synonymy: *Peziza convexella* P. Karst., *Not. Sallsk. Fauna et Fl. Fenn. Forh.*, 10:123 1869.

Leucoloma convexellum (P. Karst.) Rehm, *Ascom, Loikani*: no. 21 1882.

Humaria convexella (P. Karst) Quel., *Enchir. fung.* (Paris): 289 1886.

Barlaea convexella (P. Karst.) Sacc., *Syll. fung.* (Abellini) 8: 114 1889.

Apothecia 1.0–1.5 cm in diameter, disc concave to flat, yellowish orange (III b 15. Y-O.), smooth, sessile; *Asci* cylindrical, 228.0–280.0 µm in long, 10.0–18.0 µm wide at the top, 12.0–18.0 µm at the middle and 6.0–14.0 µm at the bottom, hyaline, thick walled, ascospores 8, sometimes fewer per ascus, uniseriately arranged, narrower towards the base; *Ascospores* globose to subglobose, 9.6–19.2 × 9.6–16.0 µm, $a_vL=14.4$, $a_vW=12.8$, $Q=1.0-1.2$, hyaline, thick walled, smooth, mono- to multiguttulate,; *Paraphyses* filiform, 2.0–6.0 µm in wide, hyaline, thin walled, septate, multiguttulate, moderately curved at the apex; *Pubescent hairs* 6.0–14.0 µm wide, hyaline, septate; *Ectal excipulum* of globose to subglobose cells, 8.0–10.0 × 10.0–16.0 µm, hyaline, thin walled; *Medullary excipulum* composed of 2.0–4.0 µm wide septate hyphae, hyaline, thin walled.

Edibility – Not edible in the study area.

Collection examined – Jammu and Kashmir, Leh, Basgo village, humicolous, gregarious to scattered, Rigzin Yangdol and Y. P. Sharma, HBJU-465, 21st June, 2013.

Distribution – The species has earlier been reported from Uttar Pradesh (Pant & Das 1992). A new record for Jammu and Kashmir.

Remarks – The macro-micro morphological details of the examined species are in line with the description mentioned for *Pulvinula convexella* by Pfister 1976.

Pulvinula miltina (Berk.) Rifai, *Verh. K. ned. Akad. Wet., tweede sect.* 57(3): 204 1968. Figs 1f, 2F
Facesoffungi Number: FoF03316

Synonymy: *Peziza miltina* Berk., in Hooker, *Bot. Antarct. Voy. Erebus Terror* 1839-1843, II, FI. Nov. Zeal.: 199 (1855).

Barlaea miltina (Berk.) Sacc., *Syll. fung.* (Abellini) 8: 113 1889.

Humaria miltina (Berk.) Cooke, *Handb. Austral. fungi*: 256 1892.

Apothecia 0.3–0.7 cm in diameter, sessile, disc concave to flat, smooth, capucine yellow (III b 15. Y-O.); *Asci* cylindrical, 220.0–240.0 × 14.0–18.0 µm wide at the top, 14.0–16.0 µm at the middle and 10.0–14.0 µm at the base, hyaline, thin walled, operculate, eight ascospores per ascus, uniseriately arranged, tapering towards the base; *Ascospores* globose to subglobose, 10.4–15.2 × 10.4–13.6 µm, $a_vL=12.8$, $a_vW=12.0$, $Q=1.0-1.1$, hyaline, thick walled, smooth, monoguttulate; *Paraphyses* elongated, 1.6–2.4 µm in wide, hyaline, thin walled, septate, unbranched, curved at the apex; *Pubescent hairs* inconspicuous; *Ectal excipulum* of hyaline, globose to subglobose cells, 6.0–10.0 × 8.0–14.0 µm; *Medullary excipulum* consisting of inconspicuous, narrow diameter hyphae, hyaline, thin walled.

Edibility – Not edible in the study area.

Collection examined – Jammu and Kashmir, Leh, Phey village, on soil among mosses, Rigzin Yangdol and Y. P. Sharma, HBJU-466, 22nd June, 2014.

Distribution – The species has earlier been reported on soil among mosses in Ranikhet and Dhakuri on the way of Pindhari (Uttarakhand) (Pant & Das 1992). This constitutes a new report to Jammu and Kashmir.

Remarks – The macro- and microscopic description of the Ladakh collection is in agreement with the details given by Yao & Spooner 1996b.



Fig. 1 – Ascocarps in natural habitat: a. *Anthracobia macrocystis* b. *Geopora arenicola* c. *G. sepulta* d. *Geopyxis majalis* e. dense group of *Pulvinula convexella* f. *P. miltina*

Discussion

Interestingly, the occurrence of pyronemataceous members in this unique ecosystem of Leh district of Ladakh, which is quite hostile for the growth of organisms because of extreme dryness, barrenness, low humidity and low annual precipitation, indicates the presence of some stress emulators in these macrofungi. During the present investigation, it was realized that ascospores were thick walled and guttulated. (Mundkur 1959). observed that guttulation i.e. oil droplets,

remain unfrozen even at sub-zero temperature and also serve as reserve food whereas thickened walls of the ascospores might protect the inner contents from desiccation.

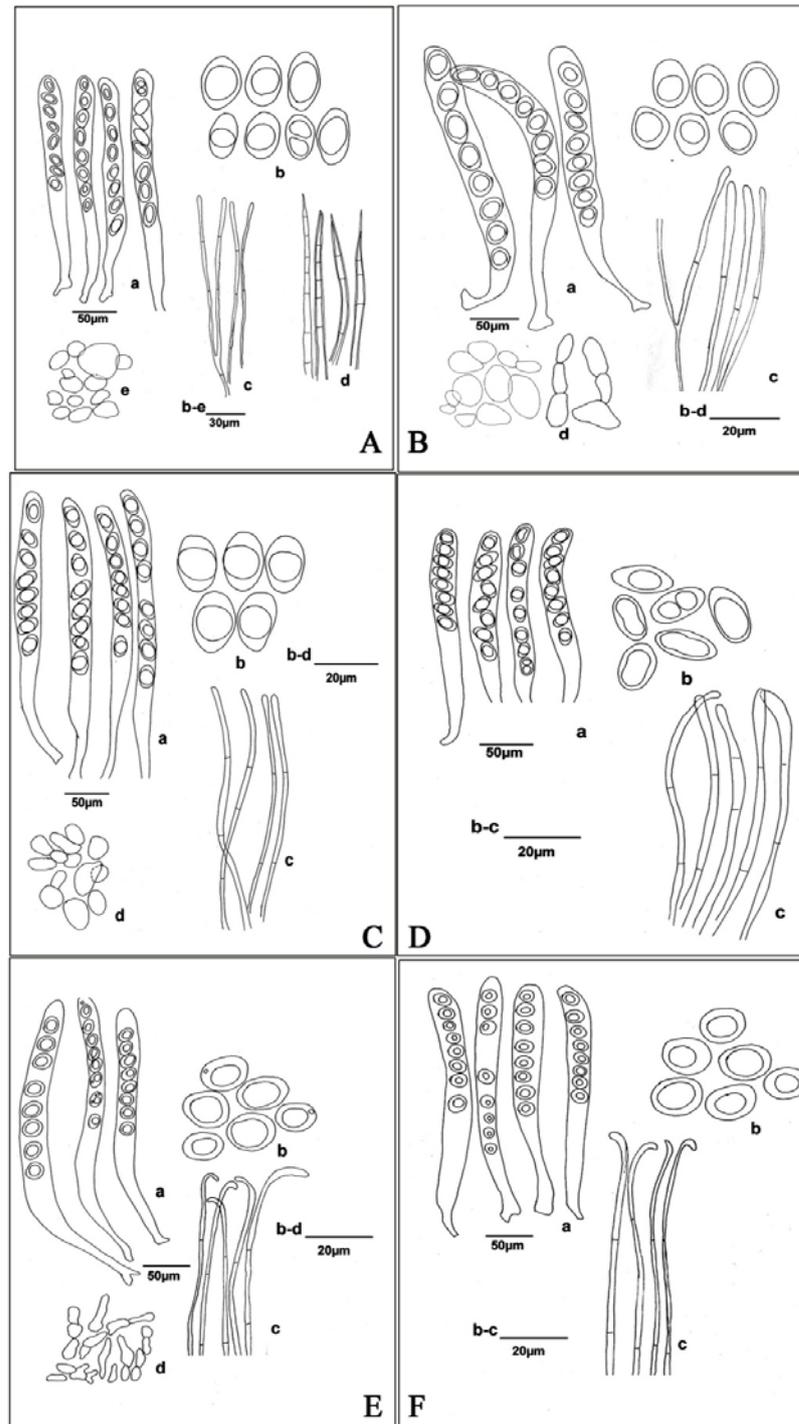


Fig. 2 – A: *Anthracobia macrocystis*: a. asci b. ascospores c. paraphyses d. marginal hairs e. ectal excipulum
 B: *Geopora arenicola*: a. asci b. ascospores c. paraphyses d. ectal excipulum
 C: *G. sepulta*: a. asci b. ascospores c. paraphyses d. ectal excipulum
 D: *Geopyxis majalis*: a. asci b. ascospores c. paraphyses
 E: *Pulvinula convexella*: a. asci b. ascospores c. paraphyses d. pubescent hairs
 F: *P. miltina*: a. asci b. ascospores c. paraphyses

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References

- Abraham SP. 1991 – Kashmir fungal flora- An overview. *Indian Mushroom Floristic Studies* 4, 13–24.
- Fujimura KF, Smith JE, Horton TR, Weber NS et al. 2005 – Pezizalean mycorrhizas and sporocarps in ponderosa pine (*Pinus ponderosa*) after prescribed fires in eastern Oregon, USA. *Mycorrhiza* 15, 79–86.
- Jayasiri SC, Hyde KD, Ariyawansa HA, Bhat J et al. 2015 – The faces of fungi database: fungal names linked with morphology, phylogeny and human impacts. *Fungal Diversity* 74, 3–18.
- Kaul TN. 1971 – Mushroom research at Regional Research Laboratory, Jammu. 2nd International Symposium on Plant Pathology, New Delhi, 136 p.
- Kaya A, Uzun Y, Karacan IH, Yakar S. 2016 – Contributions to Turkish Pyronemataceae from Gaziantep Province. *Turkish Journal of Botany* 40, 298–307.
- Kirk P, Cannon PF, Minter DW, Stalpers JA. 2008 – Ainsworth & Bisby's Dictionary of the Fungi. (10th edition). CAB International, Wallingford, UK, 771 p.
- Kumar S, Sharma YP. 2009 – Some potential wild edible macrofungi of Jammu Province (Jammu and Kashmir), India. *Indian Journal of Forestry* 32, 113–118.
- Kumar S, Stecher G, Tamura K. 2016 – MEGA7: Molecular evolutionary genetics analysis version 7.0 for bigger datasets. *Molecular Biology and Evolution* 33, 1870–1874.
- Kutorga E. 2002 – Discomycetes from the environs of Puvociai. *Biologia*. 2, 53–55.
- Lars EK. 1974 – The Swedish Geopora and their Pyrenomycete Infections. *Svensk Botanisk Tidskrift* 68, 344–354.
- Mundkur BB. 1959 – Fungi and plant disease. Macmillan and co. Ltd. London, New York, 239 p.
- Pant DC, Das CM. 1992 – New records of *Pulvinula* species from India. *Indian Phytopathology* 45, 1–137.
- Perry BA, Hansen K, Pfister DH. 2007 – A phylogenetic overview of the family Pyronemataceae (Ascomycota, Pezizales). *Mycological Research* 111, 549–571.
- Pfister DH. 1976 – A synopsis of the genus *Pulvinula*. *Occasional Papers of the Farlow Herbarium Cryptogamic Botany* 9, 1–19.
- Ridgeway R. 1912 – Color standards and color nomenclature. Washington DC, 6 p.
- Saitou N, Nei M. 1987 – The neighbour-joining method: A new method for reconstructing phylogenetics trees. *Molecular Biology and Evolution* 4, 406–425.
- Smith ME, Trappe JM, Rizzo DM. 2006 – *Genea*, *Genabea* and *Gilkeya* gen. nov.: ascomata and ectomycorrhiza formation in a *Quercus* woodland. *Mycologia* 98, 699–716.
- Tamura K, Nei M, Kumar S. 2004 – Prospects for inferring very large phylogenies by using the neighbor-joining method. *Proceedings of the National Academy of Sciences (USA)* 101, 11030–11035.
- Tedersoo L, Arnold AE, Hansen K. 2013 – Novel aspects in the life cycle and biotrophic interactions in Pezizomycetes (Ascomycota, Fungi). *Molecular Ecology* 22, 1488–1493.
- Thind KS, Sethi JS. 1957 – The Pezizaceae of Mussoorie hills III. *Indian Phytopathology* 10, 26–37.
- Thind TS, Saksena SB, Agarwal SC. 1975 – Soft rot of apple caused by *Clathridium corticola* (Fuckl.) Shoem. and Muller. *Current Science* 44, 1–714.
- Yao YJ, Spooner BM. 1996a – Notes on British species of *Geopora*. *Mycoogical Research* 100, 72–74.
- Yao YJ, Spooner BM. 1996b – Notes on British species of *Pulvinula*, with two newly recorded species. *Mycoogical Research* 100, 883–884.

Yao YJ, Spooner BM, Legon NW. 1998 – An extraordinary species of *Anthracobia*, *A. subatra*, new to Britain, with a key to British species of the genus. *Mycologia* 12, 32–34.