Acta Mycologica

ORIGINAL RESEARCH PAPER Acta Mycol 49(2):237–247 DOI: 10.5586/am.2014.021
Received: 2014-04-15 Accepted: 2014-10-14 Published electronically: 2014-12-01

Wentiomyces sp. from plant litter on poor fen in northeastern Poland

Mateusz Wilk[1,2]*, Julia Pawłowska[3], Marta Wrzosek[3]

[1] Department of Plant Ecology and Environmental Protection, Faculty of Biology, University of Warsaw, Al. Ujazdowskie 4, 00-478 Warsaw, Poland

[2] College of Inter-faculty Individual Studies in Mathematics and Natural Sciences, University of Warsaw, Żwirki i Wigury 93, 00-089 Warsaw, Poland

[3] Department of Plant Systematics and Geography, Faculty of Biology, University of Warsaw, Al. Ujazdowskie 4, 00-478 Warsaw, Poland

Abstract

During research carried on peatlands in northeastern Poland, small leaf-litter ascomycete identified as *Wentiomyces* sp. was found on decaying litter of *Sphagnum* sp. and *Vaccinium oxycoccos*. The taxonomy of this genus remains obscure, and there are still few and incidental published records in the mycological literature. This taxon is therefore described in the present paper in more detail and a short overview on the current knowledge regarding ecology and systematics of *Wentiomyces* spp. is provided.

Keywords: leaf-litter ascomycetes; peatlands; Pseudoperisporiaceae; *Sphagnum*; *Vaccinium oxycoccos*; *Oxycoccus palustris*

Introduction

The results of the extensive literature survey published by Thormann and Rice [1] have shown that more than 600 species of fungi were already recorded from various types of peatland habitats. Peatlands are one of the major carbon-sequestrating ecosystems (e.g. [2]), and the apparent negative influence of various anthropogenic disturbances, e.g. global warming and water-level drawdown on decomposition processes, has stimulated research on many interconnected ecological aspects, including interactions with microbial decomposers, and especially fungi (e.g. [3]).

* Corresponding author. Email: mwilk@student.uw.edu.pl

Handling Editor: Maria Rudawska

Fungi are described to be the most important group of decomposers in these ecosystems [4,5], and growing interest regarding different aspects of fungal diversity and role on peatlands can be observed (e.g. [6,7]). However, still surprisingly few of those studies concern the diversity and potential role of the leaf-litter microfungal communities (e.g. [8]). Our knowledge and understanding of the factors involved in the decomposition processes on peatlands and the possible interactions of these with climate change and anthropogenic disturbances are therefore incomplete without more research on peatland mycobiota.

During our research on leaf-litter microfungi from peatlands, interesting specimens were found, which were identified as *Wentiomyces* sp. The concept of this genus is still little understood, therefore the aim of this paper was to provide some details concerning our findings and review the current knowledge regarding the taxonomy and biology of the genus *Wentiomyces*.

Material and methods

Findings described in this paper originate from a research project carried in 2010–2014 on peatlands in the Szeroki Bór mire complex, near town of Pisz, the Warmińsko-Mazurskie Voivodeship, northeastern Poland. The study site, where the presented fungal specimens were found, was located on open poor fen, being in fact a small lake completely overgrown by dense cover of *Sphagnum* spp. with *Carex limosa* L., *Eriophorum vaginatum* L., *Vaccinium oxycoccos* L. and *Drosera rotundifolia* L.; dead pine trees occur on the banks. The material collected in October 2010 for preliminary screening, comprised of mixed litter of moribund and healthy *Sphagnum* spp. fragments with addition of dead leaves and stems of *Vaccinium oxycoccos*.

The method of incubation of plant litter samples in damp chambers was employed for the study [9]. Material was observed under dissecting microscope SMZ800, and semi-permanent prep-slides were made in lactophenol-blue or glycerin, and observed under Nikon Eclipse E200 light microscope. All prep-slides and photographs are housed in the mycological laboratory of the Department of Plant Systematics and Geography, Faculty of Biology, The University of Warsaw. Taxonomic system and nomenclature for fungi follow MycoBank [10], and for plants follow Integrated Taxonomic Information System [11] except for the table, where they are given as in original publications.

Descriptions of specimens

Wentiomyces Koorders, Pseudoperisporiaceae, Dothideomycetidae, Dothideomycetes.

Wentiomyces sp., specimen A (Fig. 1a). Superficial spherical pseudothecium, ca. 42 µm in diameter, brown; peridium composed of polyhedral cells, often 4–6 µm in diameter; around conspicuous ostiole few characteristic, rigid, dark brown and thick walled setae, ca. 10–11 µm long, 3–4 µm wide, mostly twice dichotomously branched and blunt at the apices. Setae have one septum, and are paler to hyaline towards the tips. Pseudothecium grows on sparse, superficial, melanized mycelium; on the bottom part of ascomata melanized, thread-like hyphae emerge, ca. 2–5 µm in diameter. No asci or ascospores observed.

HABITAT. On moribund *Sphagnum* spp. leaves collected in October 2010; poor fen in Szeroki Bór peatland complex, 53°36′20.77″N, 21°37′56.79″E. First record from this host.

Wentiomyces sp., specimen B (Fig. 1b). Pseudothecium superficial, spherical, ca. 50 µm in diameter, brown, peridium composed of polyhedral cells. Ostiole conspicuous, surrounded by eight characteristic, rigid, dark brown and thick walled setae, ca. 11–14 µm long, 4–5 µm wide, with one septum, at the apex mostly twice dichotomously branched, paler to hyaline towards the tips. On the bottom part of the ascomata, melanized thread-like hyphae emerge, ca. 2–5 µm in diameter. No asci or ascospores observed.

HABITAT. On dead leaf of *Vaccinium oxycoccos* collected in October 2010; Szeroki Bór peatland complex, 53°36′20.77″N, 21°37′56.79″E. First published record from this host.

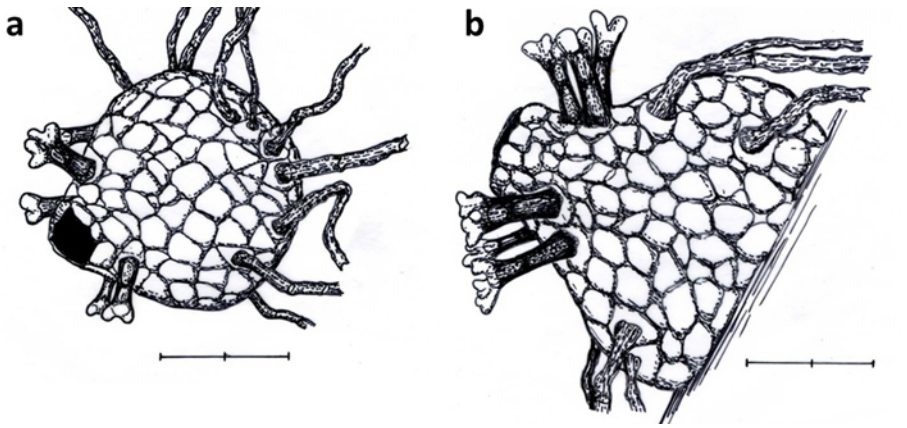

Fig. 1 Specimens of *Wentiomyces* sp. collected on poor fen. Pseudothecium with characteristic dichotomously lobed setae around ostiole; specimen from *Sphagnum* sp. (**a**). Specimen from *Vaccinium oxycoccos* (**b**). Scale bars: 20 µm.

Discussion

Despite of more than a century since its discovery, the taxonomy of the genus *Wentiomyces* remains extremely complicated. It was raised by Koorders [12], to encompass a single species, *W. javanicus* Koord., characterized by superficial, hypophyllous mycelium with superficial pseudothecia (perithecia in original description) possessing in the upper part characteristic, melanized, dichotomously branched at the apex setae, and on the lower part of the ascomata brownish, long hair-like hyphal appendages (although called setae in the original description); asci clavate with eight ascospores; ascospores hyaline, with median septa; no paraphyses. Koorders himself mentions, however, that his material is sparse, and mostly immature, and that the color of mature ascospores could potentially change to brownish, although he states this was unlikely [12]. The original herbarium material of the type is unavailable [13,14], and this is the cause for several taxonomical rearrangements of this genus, of which none can still be considered final, because epitypification was never conducted. Hansford [15] first mentioned the possible synonymy of the *Wentiomyces* and *Dimeriella* Speg., but it was Müller and Arx [13], who finally concluded that these two genera are in fact synonymous, and have given the name *Wentiomyces* priority over *Dimeriella*, and eleven other generic names

considered synonymous. It has to be noted, that in their understanding of the genus, the shape of the setae was no longer considered specific, therefore *Wentiomyces* fide Müller and Arx [13] included also species with simple, acute or blunt setae; in addition some taxa included have sparse paraphysoids. Farr [16] however claimed *Wentiomyces* to be a doubtful genus, which should not be used in favor of *Dimeriella*. This was further applied and expanded by Barr [17], who rejected *Wentiomyces*, and transferred six species (including two subspecies) with dichotomously branched setae to *Neocoleroa* Petrak, and one lichenicolous species with straight, acute setae to *Raciborskiomyces* Siemaszko. To further complicate the situation, this rearrangement is not widely and uniformly accepted. In addition, Etayo and Sancho [18], transferred two lichenicolous taxa with straight setae to *Niesslia* Auersw. Because of this chaos, it is even difficult to estimate the correct number of the species included in *Wentiomyces*. After their treatment from 1962 [13], Arx and Müller [19] concluded that *Wentiomyces* contains "about 50 species", the large number being of course due to synonimization of *Dimeriella* with *Wentiomyces*, and this was later adopted by Kirk et al. [20].

Search in Index Fungorum database [21], however, brings only 21 records, with 20 species and two subspecies. Of these, *Wentiomyces fuliginosus* (Woron.) E. Müll. is treated as a synonym of *Antenulariella fuliginosa* Woron., *Wentiomyces hirtulus* (Speg.) E. Müll. as a synonym of *Dimeriella hirtula* Speg., and *Wentiomyces peltigericola* D. Hawksw. as a synonym of *Niesslia peltigericola* (D. Hawksw.) Etayo. Search in the MycoBank database [10] brings the same number of results, but without clear statements on the status of the abovementioned three species, suggesting 20 existing species for *Wentiomyces*. That is due to the fact, that no formal combinations were created for the vast majority of *Dimeriella* species to be included in *Wentiomyces*, even in the abovementioned studies by Müller and Arx [13], and Arx and Müller [19].

This situation clearly indicates that the genus *Wentiomyces* is in urgent need for revision, and the chaos here is corroborated by the fact, that there are no molecular sequences of any of the described species [22]. It is also worth noting, that the names *Wentiomyces* and *Dimeriella* are on the preliminary draft of the list of protected generic names for fungi [23], and therefore the taxonomic and phylogenetic relationships between and within them will have to be resolved.

If the MycoBank classification system is adopted, the genus *Wentiomyces* comprises species, which grow as saprotrophs and/or biotrophs on plants, and as specialized lichenicolous fungi (Tab. 1). Most plant-associated taxa grow hypophyllously, with only few recorded also from plant stems. Some authors label *Wentiomyces* spp. as pathogens, causing leaf spot diseases ([24] for *W. javanicus*). It appears, that some taxa can also penetrate leaf cuticle [e.g. *W. clavisetus* (Doidge) Arx] [15]; in case of lichenicolous taxa, Hansford [25] mentions that *W. lichenicola* (Hansf.) D. Hawksw. penetrates the thallus of a lichen. Lichenicolous species occur on terrestrial lichens (*W. peltigericola* on *Peltigera* spp.), but also on epiphyllous lichens (*W. lichenicola* on *Fellhanera* and *Bacidina*). According to the USDA fungus-host database [26], there are 38 published reports on 14 species of *Wentiomyces* from 16 countries; half of the reports are from tropical countries; these are however incomplete data, because many other reports, especially for lichenicolous species, exist (Tab. 1). There is a recent finding of *Wentiomyces* sp. from Poland [27] on dead leaves of *Rhododendron tomentosum* Harmaja from poor fen. We know also on the findings on other Ericaceae from raised bog in Siberia (N.V. Filippova, personal

Tab. 1 Summary of the distribution and substratum colonized by all known *Wentiomyces* spp.

Species	Substratum	Locality	References
Wentiomyces alpivagus Nograsek Syn. *Neocoleroa alpivaga* (Nograsek) M.E. Barr	*Silene acaulis* (A); *Carex firma* (B); *Saxifraga caesia* (C); *Saxifraga paniculata* (D)	(A) Sweden; (B–D) Austria	(A–D) [32]
W. clavisetus (Doidge) Arx Syn. *Dimeriella claviseta* Doidge; *Coleroa claviseta* (Doidge) Hansf.	Asteraceae, e.g. *Vernonia anulifolia* (A); *Erlangea marginata* (B); *Cordia* sp. (C); *Varronia* sp. (D); *Mikania* sp. (E)	(A) Uganda; (B) Malawi; (C,D) West Indies, Costa Rica, northern South America; (E) East and South Africa, Ghana	(A) [13,15]; (B) [26]; (C–E) [33]
W. clusiae J.L. Bezerra & Poroca	Leaves of *Clusia melchiori*	Venezuela, Brazil	[26,34]
W. dryadis K. Holm & L. Holm Syn. *Neocoleroa dryadis* (K. Holm & L. Holm) M.E. Barr	Dead leaves of *Dryas octopetala* (A); *Cassiope tetragona* (B)	(A,B) Norway (Svalbard)	[35]
W. fimbriatus (Dearn. & House) M.E. Barr Syn. *Venturia fimbriata* Dearn. & House; *Lasiostemma fimbriatum* (Dearn. & House) M.E. Barr; *Neocoleroa fimbriata* (Dearn. & House) M.E. Barr	On languishing leaves of *Antennaria* sp. (A); *Achillea millefolium* (B); *Filipendula ulmaria* (C); *Saxifraga caespitosa* (D); *Silene acaulis* (E)	(A) USA; (B,D,E) Canada; (C) Sweden	(A) [36]; (C) [26]; (B,D,E) [37,38]
W. fuliginosus (Woron.) E. Müll. Syn. *Antennulariella fuliginosa* Woron.	Live leaves of *Ilex aquifolia* L.	Caucasus	[13]
W. hansfordii (Syd.) E. Müll. Syn. *Acarothallium hansfordii* Syd.	Leaves of Rubiaceae (cf. *Canthium* sp.)	Uganda	[39]
W. hirtulus (Speg.) E. Müll. Syn. *Dimeriella hirtula* Speg.; *Asteromyxa hirtula* (Speg.) Theiss. & Syd.	Live leaves of *Baccharis* spp.	Brazil, Ecuador	[13,33,40–42]
W. inconspicuus Spooner	Leaf litter of *Poa flabellata*	South Georgia (Antarctica)	[43]
W. indicus Tilak, S.B. Kale & S.V.S. Kale	Leaf litter of *Ixora parviflora*	India	[44]
W. javanicus Koord. Syn. *Dichaetis javanica* (Koord.) Clem. & Shear	Dead leaves of *Ficus elastica* (A); dead leaves of *Kentia forsteriana* (B); leaf spot on leaf of *Cynodon dactylon* (C); leaf spot on leaf of *Ficus elastica* (D); leaf spot on leaf of *Persea gratissima* (E); *Sorghum vulgare* (F)	(A) Indonesia (Java); (B) France (pot plant); (C–E) Burma; (F) Papua New Guinea	(A) [12,13]; (B) [29]; (C–E) [24]; (F) [26]

Tab. 1 *(continued)*

Species	Substratum	Locality	References
W. cfr. *javanicus*	Decomposing leaves of *Pistacia lentiscus*, *Phillyrea angustifolia* and *Cistus* spp.	Italy	[45]
W. lichenicola (Hansf.) D. Hawksw. Syn. *Dimeriella lichenicola* Hansf.; *Neocoleroa lichenicola* (Hansf.) M.E. Barr	*Asterothyrium leucophthalmum* on leaves of *Acalypha fruticosa* (A)	(A) Uganda; (B) United Kingdom	(A) [25,46]; B [47]
W. lichenicola subsp. *bouteillei* Bricaud, Cl. Roux & Sérus. Syn. *Neocoleroa lichenicola* subsp. *bouteillei* (Bricaud, Cl. Roux & Sérus.) M.E. Barr	*Fellhanera bouteillei* on leaves of *Buxus sempervirens* (A); *Bacidina* sp. on leaves of *Buxus sempervirens* (B); *Bacidina* cf. *vasakii* on leaves of *Buxus sempervirens* (C); *Woessia* sp. on trunk of *Sorbus* sp. (D)	(A–C) Spain; (A) France; (D) Luxembourg; (E) United Kingdom; (F) USA; (G) Austria	(A–C) [46]; (D) [48]; (E–G) [47]
W. cf. *lichenicola* subsp. *bouteillei*	*Lecania cuprea*	Lithuania	[49]
W. melioloides (Berk. & M.A. Curtis) E. Müll. Syn. *Asterina melioloides* Berk. & M.A. Curtis; *Dimerosporium melioloides* (Berk. & M.A. Curtis) G. Martin; *Parodiopsis melioloides* (G. Winter) Maubl.; *Chaetostigme melioloides* (Berk. & M.A. Curtis) Syd.	*Baccharis halimifolia* (A); leaves of *Lagenophora pumila* (B); *L. huegelii* (C); *L. stipitata* (D); *Baccharis* sp. (E); *Conyza* sp. (F); *Erigeron* sp. (G)	(A) USA; (B) New Zealand; (C,D) Australia; (E–G) North and South America, Bermuda; (H) Brazil	(A) [50]; (B) [51]; (C,D) [26]; (E–G) [33]; H [47]
W. molarifer Scheuer Syn. *Neocoleroa molarifera* (Scheuer) M.E. Barr	Dead leaves and stems of *Carex davalliana* (A); *Carex baldensis* (B)	(A) Austria; (B) Germany	[52]
W. oreophilus (Speg.) E. Müll. Syn. *Dimerosporium oreophilum* Speg.; *Venturia oreophila* (Speg.) Theiss.; *Dimeriella oreophila* (Speg.) E. Müll. & Arx	Dead leaves of *Rhododendron ferrugineum*	Austria, Germany	[53,54]
W. pandei S.K. Bose	Leaves of *Crataegus crenulata*	India	[21]
W. peltigericola D. Hawksw. Syn. *Raciborskiomyces peltigericola* (D. Hawksw.) M.E. Barr; *Niesslia peltigericola* (D. Hawksw.) Etayo	*Peltigera aphthosa* (A); on dead portions of thalli of *P. leucophlebia* (B); *P. rufescens* (C); *P. britannica* (D); *Peltigera* sp. (E); *P. praetextata* (F); *Stereocaulon depressum* (G); *S. rivularis* (H); *Peltigera scabrosa* (I); *P. didactyla* (J)	(A,C,D) Norway; (A,D,E) Greenland; (A) the Faroes; (A,C,H–J) Russia; (A) Austria; (A,D,G) Canada; (A,D,F) Spain; (A) Sweden; (B) Great Britain; (D) USA; (A) Iceland	(A) [55–71]; (B) [72]; (C) [57,63]; (D) [65,66,73–75]; (E) [73]; (F) [66]; (G) [64]; (H) [63,64]; (I,J) [63]

Tab. 1 *(continued)*

Species	Substratum	Locality	References
W. sibiricus (Petr.) E. Müll. Syn. *Neocoleroa sibirica* Petr.	Dry stems of *Vaccinium myrtillus* (A); dead stems of *Filipendula* sp. (B); leaves of *Larix decidua* (C); *Vaccinium* sp. (D)	(A) Russia (Siberia); (B–D) Great Britain	(A) [13,76]; (B,C) [14]; (D) [26]
W. tatjanae S.Y. Kondr. Syn. *Niesslia tatjanae* (S.Y. Kondr.) Etayo	Parasymbiotic on *Pseudocyphellaria coronata* (A); *Sticta* cf. *boschiana* (B); *Lobaria* sp. (C)	(A) Tasmania, New Zealand; (B) Papua New Guinea; (C) not indicated	[77]
W. vanensis Tilak & Talde	Dead leaves of *Ficus benghalensis*	India	[21]
Wentiomyces sp.	*Parmelia caperata* (A); dead leaves of *Rhododendron tomentosum* (B); *Croton antisyphiliticus* (C); *Dianella revoluta* (D); *Hevea brasiliensis* (E); *Hibiscus elatus* (F); *Lagenophora huegelii* (G); *Pandanus* sp. (H); dead leaf of *Eucalyptus coccifera* (I); dead stem of *Chamerion angustifolium* (J)	(A) Spain; (B) Poland; (C) Brazil; (D,G) Australia; (E) Brunei; (F) Venezuela; (H) Mauritius; (I,J) Great Britain	(A) [46]; (B) [27]; (C–G) [26]; (H) [78]; (I,J) [79]

communication, 2014). Distribution of *Wentiomyces* spp., together with substrata on which they were recorded, as compiled from the literature, is given in the Tab. 1. Strikingly, some species or specimens [e.g. *W. alpivagus* Nograsek and *W. fimbriatus* (Dearn. & House) M.E. Barr, or *W. fimbriatus* and *W. sibiricus* (Petr.) E. Müller] were recorded from identical plant host species, raising a question about their true taxonomic status.

There is an interesting suggestion about possible anamorph genus drawn by de Hoog et al. [28], who have examined a herbarium material of *W. javanicus* deposited by Joly [29]. Joly [29] depicted anamorphic fungus, which he had isolated in pure culture from ascospores of his specimen of *W. javanicus*; de Hoog et al. [28] noted the resemblance of this anamorph to *Rhinocladiella anceps* (Sacc. & Ellis) S. Hughes (recalled also by Arzanlou et al. [30]). Unequivocal link between these two morphs was however not demonstrated; moreover, according to molecular analyses species from the genus *Rhinocladiella* and similar *Ramichloridium* are placed predominantly within *Chaetothyriales* and *Capnodiales*, with possible teleomorphs for *Rhinocladiella* in *Capronia* spp. [30,31].

Our specimens could not be identified to the species level, because we have not observed asci and ascospores, and the sole gross morphology of pseudothecia and setae, or host species, do not provide firm characters. *Wentiomyces oreophilus* (Speg.) E. Müll. described from *Rhododendron ferrugineum* L. has straight setae, and therefore cannot be considered conspecific with our finding (as was incorrectly assumed by Wilk et al. [27] regarding another specimen from poor fen). *Wentiomyces sibiricus* (Petr.) E. Müll., described from *Vaccinium myrtillus* L. could be one possibility. Worth noting is the fact, that the specimens presented here differ greatly from the specimen presented by Wilk et al. [27], being in all respects smaller (42–50 µm versus 87.5–170 µm) and having less ramified setae. We cannot even state for sure, that both specimens reported here represent the same or different species, and therefore further research aimed specifically at habitat- and host- preferences of non-lichenicolous *Wentiomyces* spp. is certainly needed.

Acknowledgments

This work was partially financed by MNiSW grant No. N305 052 240. Funding from EU through the European Social Fund, contract number UDA-POKL.04.01.01-00-072/09-00 to first author is also acknowledged. First author would like to express sincere thanks to B. Pawlik (Cracow), A. Chlebicki (Cracow), Ch. Scheuer (Graz), N.V. Filippova (Khanty Mansiysk), A. Pierotti (AscoFrance), B. Wergen (AscoFrance), M. Bemmann (AscoFrance), D.P. Di Lonardo (Wageningen), M.M. Thaung (Los Angeles) for invaluable help with obtaining important publications. Two anonymous reviewers are acknowledged for invaluable comments greatly improving quality of the manuscript.

Authors' contributions

The following declarations about authors' contributions to the research have been made: collected material, performed final identification, conducted literature study, prepared drawings and wrote the manuscript: MW; helped writing the manuscript: JP; designed the methods, performed initial identification, and helped writing the manuscript: MWr.

References

1. Thormann MN, Rice AV. Fungi from peatlands. Fungal Divers. 2007;24:241–299.
2. Gorham E, Lehman C, Dyke A, Clymo D, Janssens J. Long-term carbon sequestration in North American peatlands. Quat Sci Rev. 2012;58:77–82. http://dx.doi.org/10.1016/j.quascirev.2012.09.018
3. Peltoniemi K, Fritze H, Laiho R. Response of fungal and actinobacterial communities to water-level

drawdown in boreal peatland sites. Soil Biol Biochem. 2009;41(9):1902–1914. http://dx.doi.org/10.1016/j.soilbio.2009.06.018

4. Thormann MN. Diversity and function of fungi in peatlands: a carbon cycling perspective. Can J Soil Sci. 2006;86:281–293. http://dx.doi.org/10.4141/S05-082
5. Thormann MN. The role of fungi in decomposition dynamics in peatlands. In: Wieder RK, Vitt DH, editors. Boreal peatland ecosystems. Berlin: Springer; 2006. p. 101–123. (Ecological studies; vol 188).
6. Myers B, Webster KL, Mclaughlin JW, Basiliko N. Microbial activity across a boreal peatland nutrient gradient: the role of fungi and bacteria. Wetl Ecol Manag. 2012;20(2):77–88. http://dx.doi.org/10.1007/s11273-011-9242-2
7. Golovchenko AV, Kurakov AV, Semenova TA, Zvyagintsev DG. Abundance, diversity, viability, and factorial ecology of fungi in peatbogs. Eurasian Soil Sci. 2013;46(1):74–90. http://dx.doi.org/10.1134/S1064229313010031
8. Peltoniemi K, Straková P, Fritze H, Iráizoz PA, Pennanen T, Laiho R. How water-level drawdown modifies litter-decomposing fungal and actinobacterial communities in boreal peatlands. Soil Biol Biochem. 2012;51:20–34. http://dx.doi.org/10.1016/j.soilbio.2012.04.013
9. Krug J. Moist chambers for the development of fungi. In: Foster MS, Bills GF, Mueller GM, editors. Biodiversity of fungi. New York, NY: Academic Press; 2004. p. 589–593. http://dx.doi.org/10.1016/B978-012509551-8/50030-1
10. MycoBank fungal databases [Internet]. 2014 [cited 2014 Apr 15]; Available from: http://www.mycobank.org
11. Integrated Taxonomic Information System [Internet]. 2014 [cited 2014 Apr 15]; Available from: http://www.itis.gov
12. Koorders SH. Botanische Untersuchungen über einige in Java vorkommende Pilze, besonders über Blätter bewohnende, parasitisch auftretende Arten. Amsterdam: J. Müller; 1907. [Verhandelingen der Koninklijke Akademie van Wetenschappen; vol 13(4)].
13. Müller E, von Arx JA. Die Gattungen der didymosporen Pyrenomyceten. Wabern-Bern: Kommissionsverlag Buchdr. Büchler; 1962. (Beiträge zur Kryptogamenfiora der Schweiz, Bd. 11, Heft 2).
14. Hawksworth DL, Sivanesan A. New and interesting microfungi from Slapton, South Devonshire: Ascomycotina III. Mycol Res. 1976;67(3):477–483. http://dx.doi.org/10.1016/S0007-1536(76)80175-1
15. Hansford CG. The foliicolous Ascomycetes, their parasites and associated fungi: especially as illustrated by Uganda specimens. Kew: Imperial Mycological Institute; 1946. (Mycological papers; vol 15).
16. Farr ML. *Dimeriella*, *Wentiomyces*, *Episphaerella*, and *Epipolaeum* (fungi: Pyrenomycetes). Taxon. 1965;14(1):18. http://dx.doi.org/10.2307/1216705
17. Barr ME. Notes on some "dimeriaceous" fungi. Mycotaxon. 1997;64:149–172.
18. Etayo J, Sancho LG. Hongos liquenícolas del sur de Sudamérica, especialmente de Isla Navarino (Chile). Bibl Lichenol. 2008;98:1–302.
19. von Arx JA, Müller E. A re-evaluation of the bitunicate ascomycetes with keys to families and genera. Stud Mycol. 1975;9:1–159.
20. Kirk PM, Cannon PF, Minter DW, Stalpers JA, editors. Dictionary of the fungi. 10th ed. Wallingford: CABI; 2008.
21. Index Fungorum database [Internet]. 2014 [cited 2014 Apr 15]; Available from: http://www.indexfungorum.org
22. NCBI database [Internet]. 2014 [cited 2014 Apr 15]; Available from: http://www.ncbi.nlm.nih.gov/genbank/
23. Kirk PM, Stalpers JA, Braun U, Crous PW, Hansen K, Hawksworth DL, et al. A without-prejudice list of generic names of fungi for protection under the "International code of nomenclature for algae, fungi, and plants." IMA Fungus. 2013;4(2):381–443. http://dx.doi.org/10.5598/imafungus.2013.04.02.17
24. Thaung MM. Pathologic and taxonomic analysis of leaf spot and tar spot diseases in a tropical dry to wet monsoon ecosystem of lowland Burma. Australas. Plant Pathol. 2008;37(2):180–197. http://dx.doi.org/10.1071/AP08007
25. Hansford CG. Contributions towards the fungus flora of uganda. VIII. New records (continued). Linnean. 1946;157(3):138–212. http://dx.doi.org/10.1111/j.1095-8312.1946.tb00424.x

26. Farr DF, Rossman AY. Fungal databases, systematic mycology and microbiology laboratory, ARS, USDA [Internet]. 2014 [cited 2014 Nov 4]; Available from: http://nt.ars-grin.gov/fungaldatabases/
27. Wilk M, Banach A, Pawłowska J, Wrzosek M. Leaf-litter microfungal community on poor fen plant debris in Torfy Lake area (Central Poland). Acta Mycol. 2014;49(1):31–45. http://dx.doi.org/10.5586/am.2014.003
28. de Hoog GS, Rahman MA, Boekhout T. *Ramichloridium*, *Veronaea* and *Stenella*: generic delimitation, new combinations and two new species. Trans Br Mycol Soc. 1983;81(3):485–490. http://dx.doi.org/10.1016/S0007-1536(83)80116-8
29. Joly P. Sur quelques champignons foliicoles du Kentia forsteriana. Rev. Mycol. 1965;30:42–51.
30. Arzanlou M, Groenewald JZ, Gams W, Braun U, Shin H-D, Crous PW. Phylogenetic and morphotaxonomic revision of *Ramichloridium* and allied genera. Stud Mycol. 2007;58:57–93. http://dx.doi.org/10.3114/sim.2007.58.03
31. Untereiner WA. Taxonomy of selected members of the ascomycete genus *Capronia* with notes on anamorph-teleomorph connections. Mycologia. 1997;89(1):120. http://dx.doi.org/10.2307/3761181
32. Nograsek A. Ascomyceten auf Gefässpflanzen der Polsterseggenrasen in den Ostalpen. Bibl Mycol. 1990;133:271.
33. Farr ML. The didymosporous dimeriaceous fungi described on Asteraceae. Mycologia. 1979;71(2):243. http://dx.doi.org/10.2307/3759151
34. Bezerra JL, Poroca DJM, Leal FB. Algumas novas espécies de Ascomycotina. Publicações Inst Micol Universidade Fed Pernamb. 1972;640:1–15.
35. Holm K, Holm L. Dryadicolous ascomycetes from Svalbard. Bibl Mycol. 1993;15:53–62.
36. Dearness J, House HD. New or noteworthy species of fungi. II. Bull NY State Mus. 1921;233–234:32–43.
37. Barr ME. The Venturiaceae in North America. Can J Bot. 1968;46(6):799–864. http://dx.doi.org/10.1139/b68-111
38. Ginns JH. Compendium of plant disease and decay fungi in Canada, 1960–1980. Ottawa: Research Branch, Agriculture Canada; 1986.
39. Sydow H. Novae fungorum species. XXV. Ann Mycol. 1937;35(3–4):244–286.
40. Spegazzini C. Fungi aliquot paulistani. Rev Mus Plata. 1908;15(2):7–48.
41. Theissen F, Sydow H. Synoptische Tafeln. Ann Mycol. 1917;15(6):389–491.
42. Petrak F. Beiträge zur Pilzflora von Ekuador. Sydowia. 1950;4(1–6):450–587.
43. Pegler DN, Spooner BM, Smith RIL. Higher fungi of Antarctica, the subantarctic zone and Falkland Islands. Kew Bull. 1980;35(3):499. http://dx.doi.org/10.2307/4110020
44. Tilak ST. Contribution to our knowledge of Ascomycetes of India. XXVI. Sydowia. 1970;24(1–6):97–102.
45. Lunghini D, Granito VM, Di Lonardo DP, Maggi O, Persiani AM. Fungal diversity of saprotrophic litter fungi in a Mediterranean maquis environment. Mycologia. 2013;105(6):1499–1515. http://dx.doi.org/10.3852/13-103
46. Roux C, Bricaud O, Sérusiaux E, Coste C. *Wentiomyces lichenicola* subsp. nov. *bouteillei*. Champignon lichénicole non lichénisé (Dothideales, Dimeriaceae). Mycotaxon. 1994;50:459–474.
47. Global Biodiversity Information Facility (GBIF) [Internet]. 2014 [cited 2014 Mar 21]; Available from: http://www.gbif.org
48. Boom van den P, Diederich P, Serusiaux E. Lichens et champignons lichenicoles nouveaux ou interessants pour la flore de la Belgique et des regions voisines. VII. Bull Soc Nat Luxemb. 1996;97:81–92.
49. Motjejūnaitė J, Brackel von W, Stončius D, Preikša Z. Contribution to the Lithuanian flora of lichens and allied fungi. III. Bot Lith. 2011;17(1):39–46.
50. Berkeley MJ. Notices of North American fungi [cont.]. Grevillea. 1875;4(29):1–16.
51. Sydow H. Beiträge zur Kenntniss der Pilzflora Neu-Seelands – 1. Ann Mycol. 1924;22:293–317.
52. Scheuer C. Ascomyceten auf Cyperaceen und Juncaceen im Ostalpenraum. Bibl Mycol. 1988;123:1–274.
53. Remler P. Ascomyceten auf Ericaceen in den Ostalpen. Bibl Mycol. 1979;68:1–321.
54. Schmid-Heckel H. Pilze in den Berchtesgadener Alpen. Forschungsberichte Natl Berchtesgad. 1988;15:1–136.

55. Alstrup V, Olech M. Lichenicolous fungi from Spitsbergen. Pol Polar Res. 1993;14(1):33–42.
56. Alstrup V, Elvebakk A. Part 5. Fungi III. Lichenicolous fungi. In: Elvebakk A, Prestrud P, editors. A catalogue of Svalbard plants, fungi, algae, and cyanobacteria. Oslo: Norsk polarinstitutt; 1996. p. 261–270. (Norsk Polarintitutt Skrifter; vol 198).
57. Øvstedal DO. Nordisk lichenologisk forenings ekskursjon til Norge 1985. Graph Scr. 1992;1:14–25.
58. Kummerling H, Alstrup V. Some peltigericolous fungi, mainly from Scandinavia. Graph Scr. 1992;3:120–121.
59. Alstrup V, Hawksworth DL. The lichenicolous fungi of Greenland. Copenhagen: Kommissionen for Videnskabelige Undersøgelseri Grønland; 1990.
60. Alstrup V, Hansen ES, Daniels FJA. Lichenized, lichenicolous and other fungi from North and North-East Greenland. Folia Cryptogam. Est. 2000;37:1–20.
61. Zhurbenko M. Lichens and lichenicolous fungi of the northern Krasnoyarsk Territory, Central Siberia. Mycotaxon. 1996;58:185–232.
62. Zhurbenko M. Lichenicolous and some interesting lichenized fungi from the Northern Ural, Komi Republic of Russia. Herzogia. 2004;17:77–86.
63. Zhurbenko M. The lichenicolous fungi of Russia: geographical overview and a first checklist. Mycol Balc. 2007;4:105–124.
64. Zhurbenko M. Lichenicolous fungi and lichens growing on Stereocaulon from the Holarctic, with a key to the known species. Opusc Philolichenum. 2010;8:9–39.
65. Alstrup V, Cole MS. Lichenicolous fungi of British Columbia. Bryologist. 1998;101(2):221. http://dx.doi.org/10.2307/3244200
66. Moreno MIM. Taxonomia del genero *Peltigera* Willd. (Ascomycetes liquenizados) en la Peninsula Iberica y studio de sus hongos liquenicolas. Ruizia Monogr Real Jardín Botánico. 1999;15:1–200.
67. Santesson R. Fungi Lichenicoli Exsiccati. Fasc. 5–6. Thunbergia. 1988;6:1–18.
68. Thor G. The 9-th meeting of the Nordic Lichen Society, Sweden 1991. Graph Scr. 1992;4:19–29.
69. Hafellner J, Türk R. Über Funde lichenicoler Pilze und Flechten im Nationalpark Hohe Tauern (Kärntner Anteil, Österreich). Carinth. II. 1995;185(105):599–635.
70. Berger F. Beitrag zur Kenntnis der Flechten und lichenicolen Pilze Islands. Acta Bot Isl. 2000;13:69–82.
71. Ihlen PG, Wedin M. An annotated key to the lichenicolous Ascomycota (including mitosporic morphs) of Sweden. Nova Hedw. 2008;86(3):275–365. http://dx.doi.org/10.1127/0029-5035/2008/0086-0275
72. Hawksworth DL. Notes on some fungi occurring on Peltigera, with a key to accepted species. Trans Br Mycol Soc. 1980;74(2):363–386. http://dx.doi.org/10.1016/S0007-1536(80)80167-7
73. Alstrup V. New records in distribution of lichens and lichenicolous fungi. Graph Scr. 2004;16:46–57.
74. Diederich P. New species and new records of American lichenicolous fungi. Herzogia. 2003;16:41–90.
75. Holien H, Tonsberg T. The 10th meeting of the Nordic Lichen Society in Nord-Trondelag, Norway, 1993. Graph Scr. 1994;6:67–75.
76. Petrak F. Mykologische Beiträge zur Flora von Sibirien. II. Hedwigia. 1934;74:30–78.
77. Kondratyuk SY. New species of *Pronectria*, *Vouauxiomyces*, *Wentiomyces* and *Zwackiomyces* from Australasia. Muelleria. 1996;9:93–104.
78. Dulymamode R, Cannon PF, Peerally A. Fungi on endemic plants of Mauritius. Mycol Res. 2001;105(12):1472–1479.
79. The fungal records database of Britain and Ireland (FRDBI) [Internet]. 2014 [cited 2014 Mar 21]; Available from: http://www.gbif.orgwww.fieldmycology.net/FRDBI/FRDBI.asp