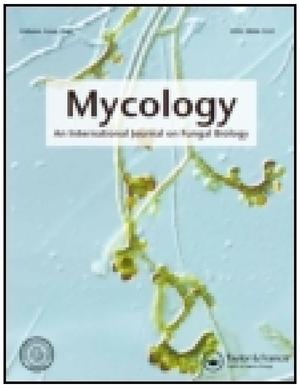

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Fungal hosts of mycetophilids (Diptera: Sciaroidea excluding Sciaridae): a review

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Fungal hosts of mycetophilids (Diptera: Sciaroidea excluding Sciaridae): a review

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The larvae of more than 1000 species representing more than 40 families of European Diptera feed on fungi. Of these, the mycetophilids (Diptera: Bolitophilidae, Ditomyiidae, Diadocidiidae, Keroplatidae and Mycetophilidae) represent the largest group. A total of 417 mycetophilid species (38% of the European fauna) are associated with ca. 650 species of macrofungi (from 196 genera and 18 orders) and with five genera of slime moulds. Host preferences of mycetophilids are generally based on the hyphal structure and consistency of fruiting bodies rather than on host phylogeny. A few mycetophilid species seem to be confined to particular genera and species of fungal hosts.

Keywords: Diptera; Bolitophilidae; Keroplatidae; Mycetophilidae; rearing records; host-fungal preferences

Introduction

Fungi provide a number of microhabitats for insects, supplying them with both food and shelter, and associations between insects and fungi are quite variable. The Diptera is one of the major groups of insects that use fungi for larval development. Fungivorous species are spread across the entire order of Diptera and include more than 40 families (Jakovlev 1994; Chandler 2010). Mycetophilids represent the largest and probably the best studied group of Diptera associated with fungi. They compose a rich assemblage of nematocerous flies (Diptera, Nematocera) in the infraorder Bibionomorpha and superfamily Sciaroidea. Five families (Bolitophilidae, Diadocidiidae, Ditomyiidae, Keroplatidae and Mycetophilidae) are informally classified as 'fungus gnats' or 'mycetophilids' by most European authors (Kjærandsen et al. 2007). Species in these families are morphologically similar and ecologically uniform. As larvae, they are associated either with fungal fruiting bodies or with mycelia in dead wood and soil litter. The superfamily Sciaroidea includes also families that are not entirely fungivorous, for example, the large family of black-winged fungus gnats (Sciaridae) which live as larvae primarily in soil litter feeding on plant roots (Binns 1981). A few species of Sciaridae are found as larvae either in decaying wood (Tuomikoski 1960) or in the beds of cultivated mushrooms, where they feed on both fungal mycelium and sporophores (Smith 1989). This may lead to confusion in applying the name 'fungus gnats' or 'fungus midges' to Sciaridae, as has been done in numerous publications concerning insect pests of commercial mushrooms. To avoid confusion, I shall henceforth use the term *mycetophilids* to indicate all European families of the superfamily Sciaroidea except Sciaridae.

Mycetophilids are distributed worldwide and are represented by about 4500 known species, of which more than 1450 are from the Palaearctic region (Søli et al. 2000). According to the Fauna Europaea (Chandler 2011), 1098 species of mycetophilids had at that time been recorded in Europe; of these, 36, 7, 4, 109 and 942 were species of Bolitophilidae, Diadocidiidae, Ditomyiidae, Keroplatidae and Mycetophilidae, respectively.

In Europe, mycetophilids are especially diverse in the boreal zone. In contrast to many other insects groups, they seem to display an increasing diversity towards the north. The most species-rich fauna of mycetophilids in Europe are found in Scandinavia, where 722 species have been recorded from Sweden (Kjærandsen et al. 2007) and 718 species from Finland (Jakovlev and Polevoi 2008).

Adult mycetophilids are thought to be sensitive to drought and are therefore associated with moist and shady forests, with preference for stable old-growth stands (Økland 1994). During the day, they hide under loose bark, under logs, in cavities of snags, in root pits of fallen trees etc. They are generally most active in the evenings and in the mornings (Jakovlev and Myttus 1989), though some species appear to be nocturnal (Hutson et al. 1980). They have reduced dispersal ability and therefore high vulnerability to environmental changes such as those that occur when open areas are created by forest management.

Studies focused on discovering fungal host species of mycetophilid larvae have a long history in Europe

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starting from the middle of the nineteenth century. The most comprehensive data covering about 400 species of mycetophilids have been obtained in Great Britain (Edwards 1925; Buxton 1960; Trifourkis 1977; Chandler 1978, 1993, 2010), Germany (Eisfelder 1955; Plassmann 1971), Hungary (Dely-Draskovits 1974), Finland (Hackman and Meinander 1979; Jakovlev 2011), Russian Karelia (Jakovlev 1995), Estonia (Kurina 1998) and Czech and Slovak Republics (Ševčík 2006).

Little is known about larval microhabitats in other parts of the world; only a few useful records are available from Siberia and far eastern Russia (Ostroverkhova 1979; Zaitzev 1994, 2003), Japan (Okada 1939; Sasakawa and Ishizaki 1999) and North America (Bruns 1984). The number of species descriptions of mycetophilids is increasing most quickly in tropical areas, especially in the Southern Hemisphere, but no data on the larval biology of these new species are currently available.

In this essay, I have summarised all rearing records from the literature and have categorised associations of mycetophilid species in Europe with their fungal hosts. Data on known fungal hosts are presented according to account by Jakovlev (1994) and subsequent records of rearing mycetophilids from fungi (Chandler 1993; Kurina 1998; Rimšaite 2000; Zaitzev 2003; Ševčík 2006; Jakovlev 2011).

Records of the rearing of mycetophilids on identified fungal hosts

Species identification of mycetophilids based on examination of larvae is currently impossible because the larvae lack unique morphological characteristics and because species-specific molecular markers have yet to be determined. Therefore, current knowledge of the host fungi of mycetophilid species is based only on records of rearing adult insects from larvae found within fungal fruiting bodies or on their surface. The rearing techniques used by most authors are very laborious: larvae required for rearing are transferred with part of the fungus to rearing boxes, which are carefully checked to remove decomposition products, moulds, etc. until the adults appear. There are also methods of rearing using coir fibre (Webb 2004) and emergence traps located over dead wood bearing wood-inhabiting fungi (for review, see Buxton 1960; Chandler 2010; Jakovlev 2011). Rearing records are only of value if the fungus is correctly identified; the fungi were not identified or were incorrectly identified in many reports (Chandler 2010).

At present, a total of 417 species of mycetophilids representing 38% of the European mycetophilid fauna have been reared from fungi at least once (Jakovlev 2011). Reliable identification of the fungi associated with these 417 mycetophilid species was provided for 398 species (in 3194 records); for the remaining 19 species, the larvae were found in decaying wood and the fungal host was either not identified or the identification seems doubtful.

Table 1. Numbers of rearing records of mycetophilids with reliable identification of the fungal host species in Europe.

No. of rearing records	1	2	3	4	5	6	7	8	9	≥10	Total 3194
No. of mycetophilid species	77	75	51	31	22	17	16	18	12	79	398

Seventy-seven mycetophilid species have only one rearing record, and 75 species have only two rearing records (Table 1). This is not sufficient to reveal the occurrence of host specialisation, that is, to indicate whether larvae of a species are specialised for living in and consuming a particular fungal species. The remaining mycetophilid species have three or more rearing records, which is sufficient for categorisation of their host-use patterns.

Five groups of mycetophilid larvae based on microhabitat

Almost all rearing records of mycetophilids are from fungi, either from fruiting bodies or from rotten wood or litter impregnated with fungal mycelia. Based on this, mycetophilid larvae are generally viewed as fungivorous although it is uncertain how many species are true fungal feeders and how many are predaceous or saprophagous. According to the current classification of larval diets of mycetophilid larvae by Matile (1997), mycetophilid species associated with sporophores most probably feed on spores and/or hyphae; those living under bark and in rotting wood perhaps consume only hyphae or consume non-fungal organisms that they encounter in decaying wood.

Mycetophilid larvae can be roughly divided into five groups based on microhabitat. These groups do not exactly coincide with mycetophilid systematics, which are currently based almost exclusively on the morphological characteristics of adults.

Group I. The first and the largest group includes the entire family Bolitophilidae and most members of the subfamily Mycetophilinae of the family Mycetophilidae, including the tribe *Exechiini* and most of the tribe *Mycetophilini* (*Dynatosoma, Mycetophila* and *Platurocypta*). All species belonging to this group live as larvae inside fruiting bodies of macrofungi that are mainly soft, epigeic (i.e. emerging from the soil surface) agarics and boleti. There are also several species of *Dynatosoma* and *Mycetophila* that colonise polypores and other wood-inhabiting Basidiomycetes. Some species of the genus *Allodia* (subgenus *Brachycampta*) are chiefly or exclusively associated with epigeic saprotrophic Ascomycota in the order Pezizales.

Group II. The second group includes the entire family Diadocidiidae and genus *Ditomyia* in the family Ditomyiidae; the tribe *Keroplatini* (genera *Keroplatus, Cerotelion* and *Rocetelion*) of the family Keroplatidae; the entire subfamilies Mycomyinae, Sciophilinae and Leiinae; and some Gnoristinae (genera *Ectrepeshoneura* and *Tetragoneura)* of the Mycetophilidae. Larvae of these insects live on the hymenial surface of fruiting bodies within slime or silky tubes that serve as a shelter and probably also as traps for spores. They are therefore considered to be spore feeders, as confirmed by studies of the larval mouthparts (Madwar 1937; Plachter 1979b; Zaitzev 1979, 1984b), digestive systems (Zaitzev 1983, 1984a) and gut contents (Parmenter 1953) of some species. These larvae are chiefly associated with dead wood and bark-encrusting fungi. Some (e.g. *Sciophila* species) can colonise soft epigeic macrofungi like agarics and Pezizales; in doing so, they retain their typical habit of living in slimy webs on the surface of fruiting bodies.

Group III. The third group includes the genus *Symmerus* (Ditomyiidae) and several genera of the subfamilies Gnoristinae, including the large genus *Boletina*, and Mycetophilinae (Mycetophilidae). Larvae of these species live without well-pronounced webs on the surface of fruiting bodies under patches of mucilage and excrement that they use as shelter (e.g. genera *Phronia*, *Trichonta* and *Epicypta* in the Mycetophilinae) or in softened wood (e.g. *Boletina*). They probably feed on fungal hyphae, as do most members of subfamily Gnoristinae and a few genera of Mycetophilinae (e.g. *Sceptonia* and *Zygomyia*) with poorly studied larval biology. According to Zaitzev (1979), *Boletina* and closely related *Aglaomyia* and *Saigusaia* might live in old galleries formed by other insects.

Group IV. The fourth group includes several members of the family Keroplatidae belonging to tribes *Orfeliini* (e.g. genera *Orfelia*, *Platyura* and *Xenoplatytura*) and *Macrocerini* (genus *Macrocera*) and some Mycomyinae (genus *Neoempheria*). These larvae also live in slimy webs on decaying wood or on soil litter but not necessarily on the surface of fungal fruiting bodies. According to chemical contents of larval webs, which act as a paralytic poison for other invertebrates (Mansbridge 1933; Plachter 1979a), these larvae are probably carnivorous. Relative to the first three groups, this group is rather small.

Group V. The fifth group of mycetophilids includes a few members of Mycetophilidae whose larvae live in the burrows of small mammals, in the nests of birds (e.g. some species of *Docosia* and *Leia*, subfamily Leiinae), on the walls of caves (*Speolepta leptogaster* Winnertz, Gnoristinae), or among mosses and liverworts (*Gnoriste* species and *Boletina dubia* Meigen, Gnoristinae). The larval diets of these species are totally unknown; they could be generalist feeders, phytophagous, or fungivorous. This group of mycetophilids is not discussed further in this paper.

Fungal orders and their mycetophilid assemblages

During a period of some 160 years from ca. 1850 to the present, entomologists in Europe intensively studied insect larvae that colonised sporophores of macrofungi and fungal-colonised wood. A substantial number of fungal species with sporophores large enough to provide food for larval development were used for rearing experiments in different geographical areas. The results show that mycetophilids can breed as larvae in various fungi with different types of sporophores.

It is evident, however, that fungi have been unevenly studied as larval microhabitats for mycetophilids. Most rearing records are from macrofungi chiefly belonging to Agaricomycotina. This may reflect the preference of mycetophilids for large fruiting bodies but may also reflect the lack of data on larval development in microscopic fungi in leaf litter and decaying wood, where mycetophilid larvae also occur and often in high densities (Binns 1981). That the fungal hosts are still unknown for more than half of the mycetophilid species in Europe suggests that they may be associated with fungi that have yet to be examined by entomologists. This has been demonstrated by the few attempts to rear mycetophilids from formerly unstudied wood-inhabiting corticioid fungi (Jakovlev 2011) and by emergence trapping from soil, litter and decaying wood (Irmler et al. 1996; Økland 1999).

A systematic list of the fungi covered in this account, that is, fungi from which mycetophilids were reared in Europe, is provided in the Appendix. The fungal classification is complete to the level of genus. Numbers of mycetophilid species reared from each fungal genus and numbers of rearing records (in parentheses) are indicated. Higher fungal taxonomy follows Hibbett et al. (2007); the nomenclature of fungal genera follows CABI, Bioscience databases (2008).

The list covers a variety of fungi (ca. 650 species) belonging to two phyla (Basidiomycota and Ascomycota), 18 orders and 196 genera. The number of species is very approximate, however, because different authors at different times and in different countries often used synonyms or indicated only fungal host genera.

The numbers of mycetophilid species reared from different fungal orders are presented in Table 2. These values clearly indicate the key groups of large fungi used by mycetophilids for their larval development. They are the orders Agaricales, Boletales, Russulales, Polyporales and Hymenochaetales (Basidiomycota, Agaricomycotina). They include fungi with soft, fleshy fruiting bodies, both epigeic and lignicolous, and fungi with relatively hard sporophores chiefly growing on wood. Soft sporophores are usually ephemeral while hard sporophores have longer life spans and more predictable occurrences. These differences between soft and hard types of sporophores are reflected in their mycetophilid assemblages.

Table 2. Numbers of species of mycetophilids (by group) reared from different orders of fungi in Europe.

Orders of fungi	Mycetophilid groups and number of species reared				
	Group I	Group II	Group III	Group IV	Total
Phylum Basidiomycota					
Subphylum Agaricomycotina					
Class Tremellomycetes					
Tremellales	3	1	2	–	–
Dacrymycetales	3	1	3	–	–
Class Agaricomycetes					
Subclass Agaricomycetidae					
Agaricales	136	17	3	–	156
Boletales	70	14	9	–	88
Atheliales	–	1	1	–	2
Subclass Phallomycetidae					
Gomphales	–	5	–	–	11
Phallales	–	1	–	–	2
Class Agaricomycetes incertae sedis					
Polyporales	105	68	105	14	222
Russulales	84	31	37	–	118
Hymenochaetales	37	38	48	11	102
Cantharellales	3	12	2	–	15
Auriculariales	4	9	2	–	13
Thelephorales	3	6	1	–	9
Corticiales	3	3	3	–	6
Sebacinales	2	1	2	–	3
Trechisporales	2	0	2	–	2
Gloephyllales	–	1		–	1
Phylum Ascomycota					
Subphylum Pezizomycotina					
Class Leotiomycetes					
Helotiales	3	1	0	–	4
Class Sordariomycetes					
Subclass Hypocreomycetidae					
Hypocreales	1	0	1	–	1
Subclass Xylariomycetidae					
Xylariales	3	6	4	–	11
Class Pezizomycetes					
Pezizales	23	10	1	–	35
Myxomycetes	4	0	0	–	4

Note: Group I – larvae inside sporophores (Bolitophilidae, *Exechiini* and part of *Mycetophilini*); Group II – larvae in slimy webs on the hymenial surface, spore feeders (Diadocidiidae, Ditomyiidae, *Keroplatini*, Mycomyinae, Sciophilinae and Leiinae); Group III – larvae without webs on fungal sporophores and mycelia (most Gnoristinae and part of *Mycetophilini*); Group IV – larvae in slimy webs on sporophores or on decaying wood, predators (*Macrocerini* and *Orfeliini*, see explanations in the text).

Basidiomycota and Agaricomycotina

Agaricales, Boletales and Russulales

Most species of large fungi from which mycetophilids have been reared have soft, fleshy fruiting bodies [0]and belong to three large orders – the Agaricales, Boletales and Russulales. Most of these are gilled mushrooms (agarics, russulas and milk-caps) or pore mushrooms (boleti) that have a cap and stipe and were formerly united in the order Agaricales s. l. According to modern classifications and with reference to recent molecular phylogenetic analyses (Hibbett et al. 2007), the orders Boletales and Russulales also include some wood-encrusting fungi similar to polypores. Mycetophilids have been reared from ca. 460 species in these orders, including ca. 300 species of Agaricales (ca. 240 epigeic and ca. 60 lignicolous species), ca. 70 species of Boletales and ca. 120 species of Russulales; for the latter order, ca. 90 species are in the Russulaceae and ca. 30 species are corticioid fungi (Jakovlev 2011). Species assemblages of mycetophilids exploiting these groups of fungi are similar: the main mycetophilid groups are Bolitophilidae and Mycetophilidae, particularly *Mycetophilini* and *Exechiini*. In the Bolitophilidae, most species are associated with fungi in the orders Agaricales and Boletales, while *Mycetophilini* and *Exechiini* frequently colonise Russulaceae as well.

Hosts in the Agaricales, Boletales and Russulaceae for the most common mycetophilid species are presented in Table 3. Some mycetophilids (e.g. *Mycetophila fungorum* De Geer, *Exechia fusca* Meigen and *Allodia lugens* Wiedemann) do not show any preferences among these fungi but others seem to prefer Agaricales (*Allodiopsis domestica* Meigen and *Bolitophila cinerea* Meigen), Boletales (*Mycetophila signatoides* Dziedzicki, *Bolitophila rossica* Landrock and *Exechia separata* Lundström), or Russulaceae (*Mycetophila alea* Laffoon and *Cordyla fasciata* Meigen).

Agaricales

In total 156 mycetophilid species have been reared from Agaricales (119 species from epigeic agarics and 104 species from agarics growing on wood) (Jakovlev 2011). Mycetophilid larvae probably occur in almost all species of these fungi, regardless of fruiting body size or habitat. Indeed, mycetophilids were reared from 72 genera of agarics (see Appendix). From 25 to almost 50 mycetophilid species were obtained from *Cortinarius*, *Amanita* and several Tricholomataceae (like *Tricholoma*, *Clitocybe* and *Armillaria*) with relatively large and fleshy fruiting bodies. Many genera with small sporophores also support diverse mycetophilid assemblages. For example, 36, 30, 23 and 12 mycetophilid species have been reared from *Inocybe*, *Collybia, Mycena* and *Marasmius,* respectively. Even the smallest sporophores, like those of *Cantharellula*, *Cystoderma*, *Omphalina* and *Nolanea*, can be colonised by mycetophilid larvae. Each of these small sporophores usually harbours one or two larvae of the same mycetophilid species within the stipe.

Mycetophilid species associated with agarics are, not as a rule, host specific; that is, they are able to colonise phylogenetically unrelated fungal hosts. For instance, *Mycetophila fungorum* was recorded from more than 100 species of agarics, although most often from

Table 3. Examples of fungal families and numbers of rearing records of the most abundant species of mycetophilids living in their fruiting bodies.

	Mycetophilid species									
Fungal families	*Myc fung*	*Myc sign*	*Mycalea*	*Bol cine*	*Bol ross*	*Exe fusc*	*Exe sepa*	*Allo luge*	*Allo dom*	*Cord fasc*
Agaricales:										
Tricholomataceae	30	–	4	6	1	18	2	20	36	1
Cortinariaceae	19	–	–	2	–	5	3	9	2	–
Strophariaceae	12	–	–	44	–	4	–	5	–	–
Amanitaceae	22	–	1	2	–	6	1	1	1	1
Other families	50	1	2	7	0	30	9	21	15	0
Boletales:										
Boletaceae	49	38	13	3	24	10	26	5	–	3
Paxillaceae	5	8	1	–	1	–	–	4	–	–
Other families	–	1	1	–	0	–	4	3	–	0
Russulales:										
Russulaceae	58	10	38	2	–	20	3	21	1	31
Other families	–	–	–	–	0	–	–	1	–	0

Note: *Myc fung – Mycetophila fungorum, Myc sign – Mycetophila signatoides, Myc alea – Mycetophila alea, Bol cine – Bolitophila cinerea, Bol ross – Bolitophila rossica, Exe fusc – Exechia fusca, Exe sepa – Exechia separata, Allo luge – Allodia lugens, Allo dom – Allodiopsis domestica, Tarn fene – Tarnania fenestralis, Cord fasc – Cordyla fasciata.*

Amanita, Armillaria, Cortinarius and the *Tricholoma flavovirens* group. There is some evidence that some mycetophilid species may be specialised for developing in particular agarics. *Bolitophila cinerea* more commonly colonises wood-inhabiting Strophariaceae (e.g. *Hypholoma, Kuehneromyces* and *Pholiota*) than other agarics. A group of specialised mycetophilid species in the genus *Brachypeza* are confined to *Pleurotus* (Jakovlev 2011). A few species (*Bolitophila melanoleuci* Polevoi, *Rymosia batava* Barendrecht and *Mycetophila finlandica* Edwards) have been reared only from fungi of one genus (Table 4).

Boletales

Fungi in the order Boletales have a rich mycetophilid fauna (88 species) that are mainly similar with those of the agarics. Most mycetophilids reared from boleti belong to group I (*Exechiini*, *Mycetophilini* and Bolitophilidae) and relatively few belong to the other groups. There are differences among the mycetophilid faunas associated with pore mushrooms, gilled mushrooms and some wood-encrusting fungi with resupinate fruiting bodies (*Coniophora, Serpula*, *Leucogyrophana* etc.) that formerly belonged to different orders.

The soft, pore fungi of the former family Boletaceae, with particularly genera *Boletus*, *Leccinum* and *Suillus* incorporate high species diversity of mycetophilid species. Studies focused on the mycetophilid assemblages associated with the family Boletaceae in Russian Karelia (Jakovlev 1980) and North America (Bruns 1984) have shown that *Boletus* and *Leccinum* support very similar mycetophilid fauna and commonly support species of *Mycetophila*: *M. fungorum* in Europe, *M. fisherae* Laffoon in North America and *M. signatoides* in both continents. *Suillus* species differ from other boleti in supporting large infestations of two specialised mycetophilid species, *Bolitophila rossica* Landrock and *Exechiopsis indecisa* Walker, which suggests a polyphyletic origin of the family Boletaceae (Jakovlev 1980). According to current knowledge, *Tylopilus felleus* (Bull.) P. Karst. is the only species of bolete that is not colonised by mycetophilid larvae.

The related families of gilled mushrooms (Gomphidiaceae, Hygrophoraceae and Paxillaceae) have mycetophilid assemblages similar to those of boleti and agarics. Members of the mycetophilid group I (*Exechiini, Mycetophilini* and Bolitophilidae) predominate. According to rearing records, the genera *Paxillus* and *Hygrophoropsis* have the richest mycetophilid fauna, even though each of these genera has only one species. Interestingly, sporophores of *Paxillus involutus* (Batsch) Fr. support high infestations of mycetophilids that include 24 species, none of which has ever been associated with the closely related *Tapinella atrotomentosa* (Batsch) Šutara. The mycetophilids that colonise *Paxillus involutus* include a range of generalised species and one specialised species, *Bolitophila hybrida* Meigen.

Other fungi currently included in the order Boletales differ markedly from ‘boleti’ in having gasteroid sporophores (e.g. *Scleroderma* and *Rhizopogon*) or corticioid-type sporophores growing on wood like the ‘cellar’ fungus *Coniophora puteana* (Schum. ex Fries) Karst. and members of the related genera *Leucogyrophana* and *Serpula*. These fungi have a very poor mycetophilid fauna. Every genus is colonised on average by only two to three non-host-specific species of mycetophilids, living either on the surface of sporophores (e.g. *Cerotelion striatum* Gmelin and *Keroplatus testaceus* Dalman [Keroplatidae])

Table 4. Examples of fungal genera with specialised mycetophilid species living in their fruiting bodies.

Fungal genus, species	Associated mycetophilid species	References[a]
Fomes fomentarius	*Keroplatus tipuloides, Sciophila rufa*	2, 7, 12, 16, 14
Fomitopsis pinicola	*Mycetophila attonsa*	7, 14
Laetiporus sulphureus	*Bolitophila rectangulata*	9, 11, 14, 16
Hyphodontia	*Tetragoneura sylvatica*	3, 7
Trichaptum	*Trichonta flavicauda*	7, 17
Lentinellus	*Trichonta brevicauda*	7, 17
Polyporus	*Mycetophila bialorussica, M. cingulum*	1, 3, 5, 7, 14, 15
Amylocystis, Leptoporus, Postia	*Bolitophila occlusa, Mycetophila laeta, Dynatosoma thoracicum*	2, 7, 8, 10, 13, 14
Bankera, Sarcodon, Ramaria, Clavariadelphus	*Mycetophila hetschkoi*	4, 6, 7
Calocera, Tremella	*Phronia siebeckii, Trichonta apicalis*	1, 7, 14, 15
Peniophora	*Diadocidia ferruginosa*	2, 3, 7, 16
Tricholomopsis	*Mycetophila finlandica*	1, 6, 9, 10, 14
Aleuria, Gyromitra, Discina, Peziza, Verpa	*Allodia sylvatica*	1, 2, 3, 4, 6, 7, 14
Inocybe	*Rymosia batava*	4, 6
Melanoleuca	*Bolitophila melanoleuci*	6
Arcyria, Lycogala, Mycilago, Reticularia, Tubifera	*Platurocypta punctum, P. testata, Mycetophila adumbrata, M. vittipes*	1, 2, 14, 15

[a]References: 1 – Buxton (1960), 2 – Chandler (1978), 3 – Chandler (1993), 4 – Dely-Draskovits (1974), 5 – Edwards (1925), 6 – Jakovlev (1995), 7 – Jakovlev (2011), 8 – Komonen (2003), 9 – Kurina (1998), 10 – Laštovka (1971), 11 – Okada (1939), 12 – Plassmann (1971), 13 – Schigel et al. (2006), 14 – Ševčík (2006), 15 – Trifourkis (1977), 16 – Zaitzev (1994), 17 – Zaitzev (2003).

or inside them (e.g. *Mycetophila bohemica* Lastovka, *M. brevitarsata* Lastovka, *M. lunata* Meigen and *M. ocellus* Walker [Mycetophilidae]).

Russulales

Like Boletales, Russulales includes genera with mushroom-shaped fruiting bodies divided into cap and stipe and also lignicolous fungi with resupinate wood-encrusting sporophores. Mycetophilids have been reared from 11 genera of Russulales (Appendix). Gilled mushrooms of Russulales have very rich mycetophilid assemblages; 64 species of mycetophilids have been reared from *Russula*, and 61 species have been reared from *Lactarius*. Most of these species belong to *Exechiini* and *Mycetophilini*, and the proportion of specialised species is higher for these Russulales genera than for genera of Agaricales and Boletales. The following species of the mycetophilid genera *Cordyla, Exechia* and *Mycetophila* are chiefly or exclusively associated with *Russula* and *Lactarius*: *Cordyla crassicornis* Meigen, *C. fasciata* Meigen, *C. flaviceps* Staeger, *C. fusca* Meigen, *C. murina* Winnertz, *C. nitens* Winnertz, *C. nitidula* Edwards, *Exechia contaminata* Winnertz, *E. nigroscutellata* Landrock, *E. pseudocincta* Strobl, *Mycetophila blanda* Winnertz and *M. estonica* Kurina. Some species clearly prefer particular groups of milk-caps; for example, Exechia *pseudocincta, Mycetophila blanda* and *M. estonica* are associated with the *Lactarius deliciosus* group, and *Exechia contaminata* is associated with *Lactarius necator* (Chandler 1978; Jakovlev 1994).

In contrast with these mushroom-forming Russulales, wood-inhabiting Russulales are usually colonised by only a few mycetophilid species. The only exception is the genus *Stereum*, which seems to be very attractive to mycetophilids. A total of 17 mycetophilid species have been reared from *Stereum*. They belong to group I (*Mycetophila luctuosa* Meigen, *M. marginata* Meigen, *M. ocellus* Meigen, *M. ornata* Meigen and *M. trinotata* Lundström), group II (*Keroplatini*, Mycomyiinae, Sciophilinae and Leiinae) and group III (*Trichonta*).

Cantharellales, Gomphales and Thelephorales

Here, I have united several groups of fungi that in some cases are not closely related. These include some club fungi (e.g. *Clavariadelphus*), some coral fungi (*Ramaria*) and some fungi with sporophores similar to those of the agarics but with folds (the Cantharellales) or tooth-like or spine-like projections (the hydnoid or tooth fungi) rather than gills. These groups are colonised by only a few species of mycetophilids that usually develop on the hymenium surface in slime tubes. This feeding location can be explained by the textures of the sporophores, which are generally denser than in agarics. One species, *Mycetophila hetschkoi* Landrock, is the most typical inhabitant of four genera of these fungi, *Bankera*, *Sarcodon* (Thelephorales), *Clavariadelphus* and *Ramaria* (Gomphales). This mycetophilid species, which is very abundant in the boreal taiga zone, has never been recorded from any other fungal genus and is probably restricted to these four.

Wood-inhabiting polypores (Polyporales, Hymenochaetales and Gloephyllales) and non-polyporous fungi (Corticiales and some Russulales)

Fungi with generally tougher fruiting bodies growing on wood provide a very important microhabitat for mycetophilid larvae. In contrast to the sporocarps of agarics, boleti and russulas, these tougher sporocarps seem the most attractive for mycetophilids in group III. These include species in the Gnoristinae, which are mycelium feeders living under loose bark or within decaying wood, and species in the genera *Phronia, Sceptonia, Trichonta, Zygomya* and some *Mycetophila*, which feed on both sporophores and fungal mycelia in fungal-colonised wood. Decaying trunks, stumps and other wood that is colonised with these fungi constitute a very reliable and long-lived habitat to which group III mycetophilids are evidently adapted.

Wood-inhabiting polypores vary in life strategies and, as a consequence, in fruiting body architecture, consistency and duration. Schigel (2009) proposed the concept of "basidiocarp consistency classes" for polypores in Finland. The consistency classes range along a hardness gradient from fometoid (hard, robust, perennial or long-lasting annual), trametoid (corky or leathery), trichaptoid (thin, leathery), xanthochoroic and piptoporoid (soft, hardening when dead), to tyromycetoid, armillarioid and agaricoid (ephemeral, quickly turning slimy and disintegrating when dead) (Schigel et al. 2006; Schigel 2007).

The distinction between consistency classes is not always clear, and this classification also does not always coincide with modern fungal systematics (e.g. the genera *Fomes, Phellinus* and *Heterobasidion* are united in the fomitoid class but belong to different orders). The consistency classes are useful, however, for describing associations of insects with different kinds of wood-inhabiting fungi (Orledge and Reynolds 2005).

The mycetophilid fauna clearly differ between the first three classes (fometoid, trametoid and trichaptoid) versus all other classes. Hard, leathery, long-lasting fruiting bodies are colonised chiefly by mycetophilid species of group II (larvae living in webs on the surface of sporophores) and group III (larvae protected by individual shelters on the surface of sporophores and larvae feeding on mycelia beneath the bark). Mycetophilid species with predatory larvae living in slime webs (tribes *Macrocerini* and *Orfeliini*, Keroplatidae) are associated only with these fungi. Among the fometoid, trametoid and trichaptoid wood-inhabiting fungi, the genera *Trametes* and *Bjerkandera* harbour the most species-rich mycetophilid assemblages (see Appendix). Polypores with sporophores that are soft when young (xanthochoroic and piptoporoid classes) and with ephemeral sporophores (tyromycetoid and armillarioid classes) harbour mycetophilid species that belong to group I, II and III.

Fungi in the Polyporales, which is the largest order in this group of polypores, harbour the richest mycetophilid fauna. Altogether, 222 mycetophilid species have been reared from them, which is more than from any other order of macrofungi, including Agaricales. Some genera of Polyporales (e.g. *Amylocystis*, *Oligoporus* and *Postia*) have soft and short-lasting sporophores, which may appear only in suitable years. The sporophores of other genera (e.g. *Laetiporus*, *Piptoporus* and *Polyporus*) are tougher and have longer life spans, and some (e.g. *Bjerkandera, Fomes, Trametes* and *Trichaptum*) are perennial. This diversity of conditions provided by Polyporales, ranging from soft and ephemeral to tough and long-lasting sporophores, explains the great diversity in mycetophilid species that colonise them.

Fungi in the order Hymenochaetales apparently support a less diverse assemblage of mycetophilid species than those in the Polyporales but this may be a consequence of insufficient data. Rearing records of mycetophilids from Hymenochaetales come chiefly from the British Isles and include the genera *Hyphodontia* (as *Poria*), *Inonotus* and *Phellinus* (Chandler 1978, 2010). In addition to listing the same mycetophilids that are known from Polyporales, these records also list several species, for example *Monoclona rufilatera* (Walker) and *Tetragoneura sylvatica* (Curtis), that have never been recorded from other fungi. Jakovlev (2011) reared the mycetophilid species *Phthinia congenita* (Plassmann), *Phthinia mira* (Ostroverkhova), *Exechiopsis pulchella* (Winnertz) and *Pseudobrachypeza helvetica* (Walker) from formerly unknown hosts (*Asterodon* and *Resinicium* spp.) in the order Hymenochaetales.

Only a few records of mycetophilids are known from polypores in the orders Gloephyllales and Trechisporales. Two species, *Kerpolatus* sp. and *Mycomya bicolor* Dziedzicki, were reared from larvae developing in slimy webs on the hymenium surface of *Gloeophyllum abietinum* (Bull.) P. Karst. (Rimšaite 2000) and *Gloeophyllum sepiarium* (Wulfen) P. Karst. (Jakovlev 2011), and one species, *Mycetophila formosa* Lundström, was reared from hyphae and sporophores of *Trechispora hymenocystis* (Berk. & Broome) K.H. Larss. on a decaying spruce log (Jakovlev 2011).

Non-polypore fungi in the orders Corticiales and Russulales have fruiting bodies that are similar in consistency and texture to bark-encrusting polypores and that therefore support mycetophilids similar to those supported by polypores (Jakovlev 2011). Most rearing records are from *Stereum* and *Corticium* (Edwards 1925; Chandler 1978, 2011). Jakovlev (2011) added several species from the genera *Laxitextum, Scytinostroma* and *Lentinellus*. The latter genus belongs to the agaricoid consistency class [0]according to the classification by Schigel (2009).

Jelly fungi: Tremellales, Auriculariales and Sebacinales

Fungi with somewhat rubbery and gelatinous fruiting bodies that were formerly united into a paraphyletic group of jelly fungi (class Heterobasidiomycetes) now belong in the unrelated fungal orders of Tremellomycetes (Dacrymycetales and Tremellales) and Agaricomycetes (Auriculariales and Sebacinales). In total, 25 species of mycetophilids have been reared from five genera of jelly fungi: *Auricularia, Exidia* (Auriculariales)*, Sebacina* (Sebacinales), *Calocera* and *Tremella* (Tremellales). Of these, 13 species live as larvae within sporophores (group I), 8 species have larvae that form and develop in webs (group II) and 4 species have larvae that live without webs on the surface of sporophores (group III). Species composition and ratios between members of different groups of mycetophilids are similar to those associated with soft polypores. Two species, *Trichonta apicalis* Strobl and *Phronia siebeckii* Dziedzicki, seem to be specialised to develop only in jelly fungi. *Trichonta apicalis* was reared from *Calocera carnea* Wallr. in Britain (Buxton 1960; Trifourkis 1977*). Phronia siebeckii* was reared from *Calocera viscosa* (Pers.) Fr. in Britain (Buxton 1960) and in the Czech Republic (Ševčík 2006), and from *Tremella foliacea* Pers. in Finland (Jakovlev 2011).

Ascomycota: Pezizales, Xylariales, Hypocreales and Helotiales

The Ascomycota is the largest division of fungi and is very diverse. Rearing records of mycetophilids on ascomycetes exist only from those species that produce ascocarps (fruiting bodies) belonging to the largest subphylum, Pezizomycotina. The list of ascomycete fungi from which mycetophilids have been reared includes only 18 genera (see Appendix).

The type and seasonality of ascocarp influence the associated mycetophilid fauna. Ascocarps of the order Pezizales are among the largest ascomycete fructifications. They are soft and short-lived, and their mycetophilid assemblages are similar to those associated with agarics. In total, 34 mycetophilid species have been reared from the genera *Aleuria, Gyromitra*, *Discina*, *Peziza* and *Verpa*. All but one, *Orfelia discoloria* Meigen (Keroplatidae), belong to the family Mycetophilidae. Most belong to tribe *Exechiini.* The most diverse and abundant are species of the genus *Allodia*, for which there are 11 species and 28 rearing records. By seasonal trapping of adult flies in boreal forests, Jakovlev (1988) showed that *Allodia* species have distinct peaks of flight activity in spring that coincide with ascocarp production by Pezizales. The following *Allodia* species within the subgenus *Brachycampta* are chiefly or exclusively associated with Pezizales: *A. barbata* Lundstrom, *A. elevata* Zaitzev, *A. foliifera* (Strobl), *A. neglecta* Edwards, *A. silvatica* Landrock, *A. triangularis* (Strobl) and *A. westerholti* Caspers (Chandler 1993; Jakovlev 1994; Zaitzev 2003; Ševčík 2006). There are also several web-spinners, mostly belonging to the subfamily Sciophilinae, that develop in the folds of the apothecia of Pezizales; these are *Sciophila hirta* Meigen, *S. karelica* Zaitzev, *S. lutea* Macquart, *S. modesta* Zaitzev, *Leptomorphus walkeri* Curtis and *Polylepta borealis* Lundström.

Wood-inhabiting ascomycetes often have many small and relatively tough apothecia that are similar in consistency to the sporocarps of polypores. Only 14 species of mycetophilids have been reared from the following 10 genera of wood-inhabiting ascomytes: *Ascocoryne, Cudoniella, Bulgaria, Encoelia* (Helotiales), *Hypocrea* (Hypocreales), *Kretzschmaria*, *Daldinia, Hypoxylon, Ustulina* and *Xylaria* (Xylariales).

More mycetophilid species have been reared on Xylariales than on any other group of ascomycete fungi. Of the 11 records from Xylariales, *Symmerus annulatus* Meigen (Ditomyiidae) was reared by Chandler (1993) for the first time from *Hypoxylon rubiginosum*. All records from *Kretzchmaria, Hypoxylon, Ustulina* and *Xylaria* originated from Britain (Buxton 1960; Trifourkis 1977; Chandler 1993). Bogatyreva (1979) reported the rearing of two web-spinners, *Neoplatyura flava* Macquart (Keroplatidae) and *Allocotocera pulchella* (Curtis), from the *Daldinia concentrica*-complex in Siberia. Chandler (2011) noted that although ascocarps of *Daldinia* are not much favoured by Diptera because of their gelatinous contents, at least one species of Drosophilidae, *Amiota alboguttata* Wahlberg, is able to develop in them.

Helotiales host five species of mycetophilids which have never been reared from other fungi. *Anatella flavomaculata* Edwards has been recorded from *Cydoniella acicularis* (Bull.) J. Schröt. (Chandler 1978, 1993); *Anatella lenis* Dziedzicki and *Stigmatomeria crassicornis* (Stannius) have been recorded from *Ascocoryne sarcoides* (Jacq.) J.W. Groves & D.E. Wilson (Ševčík 2006) and *Zygomyia vara* Staeger has been recorded from *Encoelia fascicularis* (Alb. & Schwein.) P. Karst. (Jakovlev 2011).

Slime moulds or myxomycetes

Slime moulds, which are no longer considered to be fungi but traditionally studied by mycologists, host a very limited and specialised mycetophilid fauna. Two species of the genus *Platurocypta* (*P. punctum* Stannius and *P. testata* Edwards) and two species of *Mycetophila* (*M. adumbrata* Mik and *M. vittipes* Zetterstedt) were repeatedly reared from slime moulds of the genera *Arcyria, Lycogala, Mycilago, Reticularia* and *Tubifera* but have never been reared from fungi.

Host selection of mycetophilids

Generally, dipteran larvae develop rapidly in ephemeral but very nourishing substrates. Mycetophilids are no exception, with those species that develop internally in soft fruiting bodies reaching maturity within 1 to 2 weeks, whereas larvae living outside in delicate webs on the hymenial surface or on wood-inhabiting fungi require at least 3 to 4 weeks to mature (Edwards 1925; Buxton 1960; Russell-Smith 1979). Generally, species adapted to rapid larval development (e.g. members of the family Bolitophilidae and subfamily Mycetophilinae in the Mycetophilidae) are chiefly confined to the soft, fleshy sporophores of agarics, boleti and russulas in the Basidiomycota and of the Pezizales in the Ascomycota.

Wood-inhabiting polypores and ecologically allied fungi generally have tough sporophores and therefore could be expected to be less attractive than fungi with softer sporocarps to dipteran larvae in general and to mycetophilid larvae in particular. These wood-inhabiting polypores, however, harbour a more diverse mycetophilid fauna than fungi with softer sporocarps because of the many species whose larvae live on the surfaces of their sporophores. These species include members of the families Diadociidae, Ditomyiidae and Keroplatidae; members of the Mycomiinae, Sciophilinae, Gnoristinae and Leiinae (which are subfamilies of Mycetophilidae) and members of some genera of Mycetophilinae. The occurrence of wood-inhabiting fungi is more predictable than that of epigeic fungi, and their mycelia in dead wood could serve as a larval food source for a relatively long period after the fruiting bodies dry. This is especially important for those mycetophilid species that are not necessarily associated with fruiting bodies.

The simplest overview of host preferences of mycetophilids shows that fungal orders that are unrelated phylogenetically host similar mycetophilid fauna if their fruiting bodies have a similar texture and consistency and if the fruiting bodies are produced under similar ecological conditions. This is illustrated by the orders of jelly fungi (Cantharellales, Gomphales and Thelephorales) and orders of hard polypores (Polyporales, Hymenochaetales and Gloephyllales), which host similar mycetophilid fauna – similarly orders Agaricales, Boletales and Russulales in their former limits (Agaricales s.l.). There seems to be a general pattern that host preference of mycetophilids is based on host hyphal structure and consistency of fruiting bodies rather than on host phylogeny.

The chemical composition of fruiting bodies with respect to both nutritional value and the presence of some unique chemical compounds undoubtedly plays an important role in determining host selection by mycetophilids, but these remain poorly investigated. As a place for mating, fungal sporophores attract not only egg-laying females but also males (Jakovlev and Myttus 1989) and, therefore, olfactory orientation seems important in host selection. Although many components of fungal odour (e.g. 1-octen-3-ol) are produced by a variety of unrelated fungi, experimental studies on the attraction of fungivorous Diptera (Jakovlev and Myttus 1989; Jakovlev and Polevoi 1991) and Coleoptera (Jonsson et al. 2007) have shown that artificial 1-octen-3-ol alone is considerably less attractive than a mixture of volatile compounds extracted from fresh fungal fruiting bodies.

At present, mycetophilids and the other groups of Diptera associated with fungi are generally considered to be non-host specific, that is, able to colonise fungal species belonging to different genera, orders, classes and even phyla. Lack of host specificity was hypothesised to be prevalent among fungivorous Diptera by Hanski (1989) based on rather extensive data. This hypothesis has been subsequently supported by rearing records of mycetophilids (Chandler 1993; Jakovlev 1994; Kurina 1998; Jakovlev 2011; Ševčík 2006).

On the other hand, the repeated rearing of particular mycetophilid species from the same fungal species (Eisfelder 1955; Buxton 1960; Hackman and Meinander 1979; Jakovlev 1980, 1995) has indicated that several mycetophilid species among the Bolitophilidae, Keroplatidae and Mycetophilidae seem to be chiefly or exclusively confined to particular fungal hosts. Examples of the most strictly specialised mycetophilid species are listed in Table 4. Table 4 includes only those mycetophilid species that have been repeatedly reared from a single fungal genus or species by at least two authors and that have not been reared from any other fungus. Besides these, there are many other species that are thought to be host specific, but the number of rearing records is insufficient to make definitive assessments.

Most of the specialised species listed in Table 4 are associated with wood-inhabiting polypores that produce abundant and stable sporophores in various forest habitats. These mycetophilid species include *Bolitophila rectangulata* Lundström, *B. occlusa* Edwards (Bolitophilidae), *Keroplatus tipuloides* Bosc (Keroplatidae), *Mycetophila attonsa* Laffon, *M. bialorussica* Dziedzicki, *M. cingulum* Meigen, *M. laeta* Walker, *Sciophila rufa* Meigen, *Tetragoneura sylvatica* (Curtis), *Trichonta brevicauda* Lundström and *T. flavicauda* Lundström (Mycetophilidae). In addition to wood-inhabiting mycetophilids, these fungi also harbour a set of specialised species of Coleoptera (Jonsell and Nordlander 2004).

Some mycetophilid species are apparently confined to fungi other than polypores, for example, *Mycetophila hetchkoi* (Mycetophilidae) – to hydnoid, ramarioid and clavarioid fungi – and *Phronia siebeckii* and *Trichonta apicalis* (Mycetophilidae) – to jelly fungi. A few mycetophilid species seem to be specialised to develop into particular genera of fungi with especially soft and ephemeroid fruiting bodies. A common forest species, *Allodia sylvatica* Landrock (Mycetophilidae), has never been reared from Basidiomycota but only from Pezizales. Large apothecia of these fungi can be abundant in suitable habitats in spring. Another common forest species, *Mycetophila finlandica* Edwards (Mycetophilidae), often colonises sporophores only of *Tricholomopsis rutilans* (Schaeff.) Singer and *T. decora* (Fr.) Singer, which though common, are usually not very abundant and have rather strict ecological requirements. *Rymosia batava* has never been reared from any fungi other than several species of *Inocybe*, including *I. aeruginascens* Babos, *I. agardhii* (N. Lund) P. D. Orton, *I. dulcamara* (Pers.) P. Kumm., *I. godeyi* Gillet, *I. heimii* Bon in Hungary (Dely-Draskovits 1974) and *I. lacera* (Fr.) P. Kumm. in Russian Karelia (Jakovlev 1995). Relative to many common forest agarics, *Inocybe* has tiny fruiting bodies, providing enough nutrition and space for the development of only one or perhaps two larvae. However, *Inocybe* is usually very abundant in a wide set of habitats, including secondary forests and even clear-cuts.

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Appendix: List of fungal genera from which mycetophilids have been reared in Europe, numbers of mycetophilid species reared from each fungal genus, and numbers of rearing records (in parentheses)

Subphylum Agaricomycotina
Class Agaricomycetes
Subclass Agaricomycetidae
Agaricales
Tricholoma 46 (93)
Cortinarius 46 (136)
Amanita 39 (95)
Inocybe 36 (74)
Armillaria 34 (73)
Collybia 30 (53)
Pleurotus 29 (53)
Clitocybe 26 (75)
Pholiota 24 (57)
Mycena 23 (33)
Laccaria 23 (34)
Hebeloma 23 (42)
Hypholoma 22 (65)
Kuehneromyces 20 (24)
Hygrophorus 20 (39)
Lepista 19 (42)
Entoloma 16 (24)
Megacollybia 15 (20)
Psathyrella 14 (24)
Lepiota 14 (25)
Flammulina 13 (16)
Melanoleuca 13 (17)
Leucocortinarius 12 (12)
Lyophyllum 12 (13)
Marasmius 12 (17)
Agaricus 11 (14)
Macrolepiota 11 (14)
Gomphidius 10 (16)
Stropharia 10 (20)
Panellus 9 (8)
Hygrocybe 9 (10)
Pluteus 9 (19)
Tricholomopsis 8 (17)
Omphalotus 7 (6)
Lycoperdon 7 (7)
Panaeolus 7 (8)
Gymnopilus 6 (5)
Rhodophyllus 6 (5)
Tubaria 6 (5)
Calocybe 6 (6)
Conocybe 5 (4)
Crepidotus 5 (4)
Coprinus 5 (6)
Agrocybe 5 (7)
Ampulloclitocybe 5 (7)
Galerina 4 (3)
Mucidula 4 (3)
Naucoria 4 (3)
Phaeolepiota 4 (3)
Coprinopsis 4 (5)
Agrocybe 3 (2)
Cylindrobasidium 3 (2)
Cystoderma 3 (2)
Pleurocybella 3 (2)
Amanitopsis 3 (5)
Arrhenia 2 (1)
Bolbitius 2 (1)
Camarophyllus 2 (1)
Chlorophyllum 2 (1)
Clavaria 2 (1)
Clavulinopsis 2 (1)
Fayodia 2 (1)
Hygrophoropsis 2 (1)
Infundibulicybe 2 (1)
Lacrymaria 2 (1)
Limacella 2 (1)
Locellina 2 (1)
Nolanea 2 (1)
Omphalina 2 (1)
Ripartites 2 (1)
Simocybe 2 (1)
Xeromphalina 2 (1)

Atheliales
Plicaturopsis 2 (2)

Boletales
Suillus 42 (136)
Boletus 32 (94)
Leccinum 33 (65)
Paxillus 24 (60)
Xerocomus 19 (59)
Hygrophoropsis 11 (15)
Chroogomphus 3 (6)
Tapinella 4 (4)
Coniophora 2 (3)
Gyrodon 3 (3)
Boletinus 1 (2)
Gyroporus 2 (2)
Scleroderma 2 (2)
Serpula 2 (2)
Boletellus 1 (1)
Leucogyrophana 1 (1)
Rhizopogon 1 (1)

Subclass Phallomycetidae
Gomphales
Ramaria 10 (13)
Clavariadelphus 1 (1)
Gomphus 1 (1)

Phallales
Phallus 2 (2)

Class Agaricomycetes, incertae sedis
Auriculariales
Auricularia 9 (10)
Exidia 4 (4)

Cantharellales
Hydnum 12 (16)
Cantharellus 5 (8)
Craterellus 2 (2)
Clavulina 1 (1)
Tulasnella 1 (1)

Corticiales
Corticium 5 (7)

Gloephyllales
Gloeophyllum 1 (1)

Hymenochaetales
Hyphodontia 13 (22)
Phellinus 10 (13)
Inonotus 8 (11)

Resinicium 6 (6)
Asterodon 4 (4)

Polyporales
Polyporus 26 (46)
Trametes 25 (58)
Bjerkandera 14 (24)
Lentinus 14 (18)
Piptoporus 9 (17)
Fomes 8 (21)
Fomitopsis 8 (17)
Phlebia 8 (12)
Junghuhnia 7 (10)
Postia 6 (16)
Daedalea 6 (9)
Chondrostereum 6 (8)
Laetiporus 5 (6)
Merulius 5 (5)
Meripilus 4 (9)
Sparassis 4 (7)
Trichaptum 4 (7)
Daedaleopsis 4 (5)
Ganoderma 4 (4)
Tyromyces 4 (4)
Amylocystis 3 (3)
Datronia 3 (3)
Rigidoporus 3 (3)
Antrodiella 2 (4)
Grifola 2 (3)
Lenzites 2 (3)
Leptoporus 2 (3)
Antrodia 2 (2)
Climacocystis 2 (2)
Mycoacia 2 (2)
Skeletocutis 2 (2)
Abortiporus 1 (2)
Pycnoporus 1 (2)
Byssomerulius 1 (1)
Ceriporia 1 (1)
Ceriporiosis 1 (1)
Coriolus 1 (1)
Gloeoporus 1 (1)
Hapalopilus 1 (1)
Hydnellum 1 (1)
Oxyporus 1 (1)
Panus 1 (1)
Phellinus 1 (1)
Phlebiopsis 1 (1)
Physisporinus 1 (1)
Rhodonia 1 (1)

Russulales
Russula 64 (411)
Lactarius 61 (277)
Stereum 17 (33)
Laxitextum 4 (4)
Albatrellus 3 (3)
Peniophora 2 (6)
Lentinellus 2 (3)
Bondarzewia 2 (2)
Scytinostroma 2 (2)
Hericium 1 (1)
Heterobasidion 1 (1)

Sebacinales
Sebacina 2 (3)

Thelephorales
Thelephora 5 (5)
Sarcodon 3 (3)
Bankera 1 (1)
Hydnellum 1 (1)

Trechisporales
Trechispora 2 (2)

Class Tremellomycetes
Tremellales
Tremella 3 (5)

Dacrymycetales
Calocera 4 (7)

Phylum Ascomycota
Subphylum Pezizomycotina
Class Leotiomycetes
Helotiales
Ascocoryne 2 (2)
Cydoniella 1 (1)
Bulgaria 1 (1)
Encoelia 1 (1)

Class Sordariomycetes
Subclass Hypocreomycetidae
Hypocreales
Hypocrea 1 (1)

Subclass Xylariomycetidae
Xylariales
Kretzschmaria 4 (5)
Daldinia 2 (2)
Hypoxylon 2 (2)
Ustulina 1 (1)
Xylaria 1 (1)

Class Pezizomycetes
Pezizales
Gyromitra 19 (20)
Peziza 14 (29)
Ptychoverpa 8 (10)
Morchella 4 (6)
Discina 3 (3)
Neogyromitra 3 (3)
Aleuria 1 (1)
Mylitta 1 (1)

Myxomycetes
Lycogala 3 (6)
Arcyria 1 (2)
Reticularia 1 (2)
Tubifera 1 (2)
Mycilago 1 (1)
Unidentified Myxomycetes 2 (2)