Fungus gnats (Diptera: Sciaroidea) associated with dead wood and wood growing fungi: new rearing data from Finland and Russian Karelia and general analysis of known larval microhabitats in Europe

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In this contribution new rearing records of fungus gnats from poorly studied larval microhabitats are presented. From 61 species of wood growing Basidiomycete fungi, 6 species of Ascomycete fungi and slime moulds most of which had not previously been the subject of rearing studies, and from dead wood samples with fungal mycelia made over a period of 1994–2009 in Finland and Russian Karelia, 110 species of fungus gnats were obtained, 98 of them from identified fungi. Of these for 12 species fungal hosts were formerly unknown and for 30 species larval microhabitats have been discovered for the first time. Numbers of fungus gnat species with known larval microhabitats (a total of 498 species that comprises 45.4% of the European fauna) and numbers of known fungal hosts (some 650 species of macrofungi) are calculated and categorized based on this study and previous records from Europe and East Palaearctic.

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1. Introduction

Diptera are one of the major groups of saproxylic insects, but the ecology of most species is still poorly known. Many species are rare and threatened with extinction due to loss of woodlands and impoverishment of what remains. However, the conservation of them is hindered by lack of knowledge, particularly poor understanding of the larval habitat requirements (Rotheray *et al.* 2001). During recent years many studies of substrate associations among insects inhabiting dead wood and fungi growing on wood have been made, but with a few exceptions they do not concern Diptera. This is due in part to the technical difficulties of obtaining adult flies from larvae living in fungal fruiting bodies, and especially in decaying wood, which are most difficult to be cultured. Not least is the problem of identifying host fungi, especially if they are present in the samples only as sterile tissues (mycelia) that are often used by Diptera larvae.

Fungus gnats in the broad sense (Diptera: Sciaroidea without Sciaridae), including the families Bolitophilidae, Ditomyiidae, Diadocidiidae, Keroplatidae, and Mycetophilidae with more than 1,100 species that occur in Europe (Chandler 2004 and subsequent contributions by various authors) comprise the largest group of Diptera associated with fungi. All known rearing records of fungus gnats with a few exceptions are from fungi, either from fruiting bodies or from rotten wood or soil litter impregnated with fungal mycelia. Based on this fungus gnat larvae are generally viewed as mycetophagous although it is uncertain how many species are true fungal feeders and how many are predatory or saprophagous.

Studies focused on discovering fungal host species of the larvae of fungus gnats has a long history in Europe. Traditionally good knowledge of the larval microhabitats have been in Great Britain since a classic study by Edwards (1925) and subsequent investigations by Madwar (1937), Buxton (1960), Trifourkis (1977) and Chandler (1978, 1993a) covering about two hundred fungus gnat species. Comprehensive studies on Diptera living as larvae in fungi were conducted also in certain areas of Central Europe, e.g. German and Austrian Alps (Eisfelder 1955, Plassmann 1971), Hungary (Dely-Draskovits 1974), Czech & Slovak republics (Ševčik 2006) and in Northern Europe, including Finland (Hackman & Meinander 1979, Väisänen 1981), Russian Karelia (Jakovlev 1980, 1986, 1995) and Estonia (Kurina 1991, 1994, 1998).

Rearing records of fungus gnats were also obtained from France (Falcoz 1921, 1923, 1926, Bonnamour 1926, Matile 1962, 1963, 1964, 1990), the Netherlands (Barendrecht 1938), Italy (Canzanelli 1941), Bulgaria (Bechev 1989), Portugal (Ribeiro 1990), Lithuania (Rimšaite 2000) and some areas of Central Russia (Sakharova 1977, Zaitzev 1984c, Khalidov 1984, Krivosheina *et al*. 1986), Southern Russia and Transcaucasian republics (Krivosheina & Mamajev 1968, Zaitzev 1994, 2003), Siberia and Russian Far East (Ostroverkhova 1979, Zaitzev 1982, 1994, 2003) and Japan (Okada 1939, Sasakawa & Ishizaki 1999).

According to my compilation classifying the present knowledge of rearing records of Palaearctic Diptera from fungal fruiting bodies and from other media containing fungal hyphae (Jakovlev 1994), identified fungal hosts were known for some 300 species in the Palaearctic Region and some 280 species in Europe, of these some old rearing records which cannot be checked by studying the collected material need confirmation (Falk & Chandler 2005). In more recent years additional rearing records were obtained from Europe by Chandler (1993a), Rimšaite (2000), Zaitzev (2003), Ševčik (2006) and from Japan (Sasakawa & Ishitaki 1999), which raised the total number of fungus gnat species with known larval microhabitats to some 400 species in Palaearctic and some 380 species in Europe.

A further increase in sources of information on fungus gnat species with formerly unknown larval microhabitats appeared when researchers started to use emergence traps set up on dead wood (over fallen trunks, branches and stumps), soil, litter and moss carpets (Jakovlev *et al*. 1994, Irmler *et al*. 1996, Økland 1999, Ševčík & Roháček 2008; Jakovlev, J., Penttinen, J., Polevoi, A., Salmela, J. & Ståhls-Mäkelä, G., in prep.). This method does not alter the substrate or microclimatic conditions and certainly produces a considerable variety of fungus gnat species. However, records obtained by the emergence traps (with a few exceptions, e.g. Cardew & Carrières (2001) where the authors sampled only one fungal species) do not always provide the exact information on the fungal hosts because two or more species of fungi might inhabit the sample covered with the trap. This does not allow correlating hatched species of insects with their respective fungal hosts, and the records are not of the same value as those obtained with rearing from the sample of only one host fungus which is correctly identified.

Current knowledge of the host fungi of fungus gnat species relies mostly upon rearing records from soft fruiting bodies of agarics, russulas, boleti and some soft polypores, whereas associations with wood-encrusting fungi and with fungal mycelia in dead wood, soil and litter are still poorly investigated. What little is known of saproxylic mycetophilids has been summarized for the British Isles by Alexander (2002), chiefly on the basis of the accounts of Edwards (1925) and Chandler (1978, 1993a). For other areas of the Palaearctic region rearing records from wood-encrusting fungi and slime moulds are scattered in a few publications of which the most comprehensive are Krivosheina *et al*. (1986), Jakovlev (1994), Zaitzev (1994, 2003) and Ševčik (2006).

It is evident that a requirement is a study of the

Table 1. List of study sites with information on their location and forest type. The locality name is the closest name for each site on a 1:20 000 map. The following abbreviations are used for the site types: ogf = old growth forest, omf = old managed forest, city = urban forest patches in cities; bcc = clear-cut treated with prescribed burning. Coordinates: Finland = E27 grid; Russian Karelia = E33 grid.

Site No	Pro-vince	Municipality	Locality	Coordinates	Site type	Years
1	*Ab*	Karjalohja	Karkali SNR	66851:33221	ogf, lime	2004–2008
2	N	Espoo	Nuuksio SNR	66939:33621	ogf, spruce	2005
3	*Ta*	Lammi	Kotinen SNR	67944:33964	ogf, aspen	2004–2008
4	*Ta*	Lammi	Kotinen SNR	67946:33965	ogf, spruce	2003
5	*Ta*	Padasjoki	Vesijako SNR	68061:33988	ogf, spruce	2005, 2008
6	*Pp*	Tervola	Pisavaara SNR	73536:34154	ogf, spruce	2003
7	*Kon*	Kondopoga	Kivach SNR	69088:35503	ogf, spruce	1994, 1998, 2000
8a	*Ok*	Kuhmo	Ulvinsalo SNR	70998:36638	ogf, spruce	2004, 2005
8b	*Ok*	Kuhmo	Paljakka SNR	71834:35502	ogf, spruce	2004, 2005
8c	*Kpoc*	Kostomuksha	Kostamus SNR	71707:36590	ogf, spruce	2005
9	*N*	Sipoo	Rörstrånd	67068:34008	ogf, spruce	2005, 2009
10	*N*	Sipoo	Sipoonkorpi	66915:33983	ogf, spruce	2008, 2009
11	*N*	Kirkkonummi	Fagerö	66694:33661	omf, alder	2007
12	*Ta*	Lammi	Pappilanlehto	67731:33946	omf, aspen	2004, 2007, 2008
13	*Ta*	Luopioinen	Kuohijoki	68017:33813	omf, aspen	2007, 2008
14	*N*	Helsinki	Haltiala	66859:33855	city, spruce	2007, 2008
15	*N*	Helsinki	Herttoniemi	66801:33909	city, spruce	2007
16	*N*	Vantaa	Kuusijärvi	66909:33962	city, spruce	2001, 2003, 2004
17	*N*	Tuusula,	Ruotsinkylä	66971:33898	city, spruce	2005
18	*Kon*	Petrozavodsk	Lososinka	68519:35571	city, spruce	1996
19	*Li*	Kilpisjärvi	Saana mountain	76751:32533	mountain birch	2006
20	*Ta*	Lammi	Evo, Leipäsuonaho	67899:33959	bcc	2003, 2005, 2008
21	*Ta*	Lammi	Evo, Saarijärvi	67927:33959	bcc	2003, 2004, 2005

fungus gnat species which might be reared from a wide range of wood-growing fungi that have not been sufficiently examined by entomologists. Many species with unknown larval microhabitats could be restricted to species or to groups of fungi that have been little studied. The other option is that they do not colonize fruiting bodies but use decaying wood as a shelter and fungal mycelia as nutrition that make them difficult to find and rear.

For the past fifteen years I have worked to fill this gap in knowledge and this paper presents results of my rearing experiments from dead wood and wood-encrusting fungi in Finland and Russian Karelia that have not been published yet. Most of the fungi involved had not previously been the subject of rearing studies. I also tried to summarize all rearing records from the literature to categorise substrate associations of fungus gnat species occurring in Europe.

2. Study areas, material and methods

2.1. Sampling sites

The data presented in this paper result from materials collected in Russian Karelia during 1994–2000 and in Finland during 2001–2009. The study areas were located both in hemiboreal, southern-, mid- and northern boreal zones and according to Heikinheimo & Raatikainen (1971), include biogeographical provinces of *Regio aboensis* (*Ab*), *Nylandia* (*N*), *Tavastia australis*, (*Ta*), *Ostrobottnia kajanensis* (*Ok*), *Ostrobottnia borealis* (*Ob*), *Lapponia enontekiensis* (*Le*) in Finland, *Karelia onegensis* (*Kon*) and *Karelia pomorica occidentalis* (*Kpoc*) in Russian Karelia.

The sites from which fungi were sampled (Table 1) were selected to obtain a diversity of wood-growing fungi and were, therefore, generally situated in protected areas where fallen wood is left to decay on the ground. Altogether ten sites consisted of old-growth forest (ogf) in strict nature reserves (SNR) in Finland (sites 1–6, 8a, b) and in Russian Karelia (sites 7, 8c). Another ten sites (10–18) were in small reserves for old-growth (sites 9–10), old-managed forest (omf, sites 11–13) and urban forest patches (city) preserved within the cities of Helsinki (sites 14–15), Vantaa, Tuusula (sites 16–17) and Petrozavodsk (site 18). All these sites represent seminatural coniferous forest, whether spruce-dominated or mixed herb-rich forest on the limestone and fertile soils with a large proportion of deciduous trees, chiefly aspen, birch, alder, and in some sites also lime and hazel.

Additional rearing records were obtained from non-forested sites like oroarctic mountain birch meadows behind the timberline in Finnish Lapland (site 19) and, to allow fire-dependent fungi to be sampled, from clear cuts treated with prescribed burning (bcc) in 1997–2001 and with some trees retained, in southern Finland (sites 20–21).

2.2. Sampling methods

Adult fungus gnats were reared from fruiting bodies growing on dead wood or from pieces of dead wood impregnated with fungal mycelium. I aimed to cover a wide range of wood-decay fungi and therefore tried to check different tree species in different stages of decay (including strongly decayed logs overgrown by surrounding ground vegetation) and in different conditions. The study areas were walked through and dead wood appearing to be suitable habitat for fungus gnat larvae (fallen logs, logging residues and naturally broken branches, stumps and standing dead trees) were carefully examined. Mosses, lichens and liverworts growing on decaying wood were also examined for the presence of Diptera larvae. Samples containing larvae were taken for further rearing. The common species of fungi (e.g. *Fomes fomentarius*, *Fomitopsis pinicola*, etc.) were identified directly in the field, but of the more difficult species I collected specimens of fruiting bodies for further microscopical identification by the experts (see Acknowledgements).

A few specimens of Mycetophilidae collected during an investigation into the saproxylic insects in Kuhmo, Eastern Finland and Kostamus Strict Nature Reserve, Russian Karelia were passed to me by Gergely Várkonyi in 2004–2005 and those reared from fruiting bodies of polypores in Pisavaara, northern Finland that I obtained from Dmitry Schigel in 2004 are also included in this paper.

2.3. Rearing techniques

In 1994–2007 for rearing adult flies from fungal hosts I used the traditional method by placing the sample of fungal fruiting bodies or pieces of dead wood with mycetophilid larvae into rearing chambers on a layer of sterilized peat soil (turf). A peat (substrate) was covered with damp moss (*Sphagnum*, etc.) on which the samples were placed. To minimize disturbance of the larval webs I tried to sample relatively big pieces of decaying wood with fungi using 1.5–2 l plastic containers (sizes vary from 114 × 110 mm to 180 × 180 mm) as the rearing chambers. The containers were kept outdoors until the first frost in October – November, and then were removed to the laboratory where the rearing process was continued at room temperature. The containers were regularly checked to collect emerging adults, keeping moisture and removing moulds, predaceous beetles and mites.

In 2008–2009 to avoid high mortality of larvae the rearing techniques were slightly modified: a part of the rearing chambers were moved into the laboratory, while the other part was operated directly in the forest sites to provide the larvae with a more natural pupation habitat. Samples were sorted in two parts by the kinds of material: (1) larvae inside fungal fruiting bodies or (2) outside fruiting bodies, or in/on wood, under bark, etc. For the latter group of samples I removed the bottoms from the plastic containers and embedded them flush with the soil directly in the forest site, next to the log or stump where the larvae were found. Then I put the sample with larvae within the container on a layer of damp moss. Containers were covered with a perforated transparent cover and protected from rain with a kind of hip-roof made from laminated paper. I checked the containers one-two times a month during the season, opening the cover and placing inside a small piece of cotton with ether for a short time. Then I carefully searched emerging adults with a pocket lamp. Adult fungus gnats that emerged in the rearing chambers were identified to the species level (all males and also the females in some genera where it was possible) and preserved in 70% alcohol using 2 ml plastic tubes with screw caps. Male terminalia for detailed observation were separated from the abdomen and heated in a solution of KOH for maceration, then washed with acetic acid and distilled water for neutralization and inserted into glycerine. After examination, terminalia were stored in the glycerine medium in special plastic microvials. The material is deposited in the author's collection.

3. Results

The pooled material obtained during this study consists of more than 400 reared individuals and 110 species of mycetophilids, 98 of them from identified fungi, the others from rotten wood without fungal fruiting bodies. They were reared from 61 species of Basidiomycete fungi, including agarics, polypores and non-polypore species, 5 species of Ascomycete fungi and one species of slime moulds (see Appendix).

Among 110 fungus gnat species listed in this paper 68 species have previously been reared from fungi. For the other 12 species, viz.: *Diadocidia spinosula*, *Orfelia nigricornis*, *O. unicolor*, *Macrocera fasciata*, *M. pilosa*, *Mycomya bicolour*, *Boletina nigricans*, *Ectrepesthoneura colyeri*, *Dynatosoma reciprocum*, *Trichonta hamata*, *T. subfusca*, *T. subterminalis* fungal hosts were unknown and for 30 species, including *Orfelia nemoralis*, *Mycomya nitida*, *M. forestaria*, *M. ruficollis*, *Neoempheria pictipennis*, *Boletina edwardsi*, *B. populina*, *Acnemia falcata*, *Phthinia congenita*, *P. mira*, *Sciophila fenestella*, *S. jakutica*, *S. setosa*, *Syntemna daisetsuzana*, *S. penicilla*, *S. stylatoides*, *Leia picta*, *Epicypta fumigata*, *Mycetophila abiecta*, *M. bohemica*, *M. dziedzickii*, *M. lubomirskii*, *M. xanthopyga*, *Phronia unica*, *Zygomyia pictipennis*, *Z. vara*, *Z. zaitzevi*, *Brevicornu serenum*, *Exechiopsis pulchella* and *Pseudobrachypeza helvetica* larval microhabitats were discovered for the first time.

3.1. Survey of species

The list of fungus gnat species obtained during this study is constructed in the following order: species name, number of reared individuals (males, females), locality according to Table 1, species of fungus (if fungus fruiting body present in the sample), tree species and details (trunk, stump, branch), collecting date, emergence date. Larvae and cocoons, if not specified otherwise, were found in/on the fruiting body. Fruiting bodies collected from the same tree are considered as one sample

Species with formerly unknown named fungal hosts are marked with one asterisk (*) in front of the species name, those with totally unknown larval microhabitats (the first rearing records) are marked with two asterisks (**). Specimens obtained from D. Schigel and G. Várkonyi are denoted with the collector's name within brackets, otherwise all material was collected by the author.

Higher taxonomy of mycetophilids follows Bechev (2000), hierarchy and numbers of species occurring in Europe are given, if not specified otherwise, according to the Fauna Europaea online database (Chandler 2004). The nomenclature of fungi generally follows CABI, Bioscience databases (2008) and Kotiranta *et al*. (2009) for polypores and other aphyllophoroid fungi.

Data on known larval microhabitats is presented (if the original record is not otherwise specified) according to Jakovlev (1994) and further rearing records from fungal fruiting bodies by Chandler (1993a), Kurina (1998), Rimšaite (2000), Zaitzev (2003) and Ševčík (2006). Records obtained with emergence traps over decaying wood, soil and leaf litter (Jakovlev *et al*. 1994, Irmler *et al*. 1996, Økland 1999, Ševčík & Roháček 2008; Jakovlev, J., Penttinen, J., Polevoi, A., Salmela, J. & Ståhls-Mäkelä, G., in prep.) are indicated separately.

3.1.1. Family Bolitophilidae

Genus *Bolitophila* Meigen

Bolitophila is a genus comprising 36 species In Europe, of these there are rearing records for twenty one species, all from fungal fruiting bodies. Most species are associated with Agaricales (both lignicolous and terrestrial) and Boletales. Of these there are some polyphagous species (e.g. *B. cinerea* Meigen, 1818, *B. tenella* Winnertz, 1863, *B. hybrida* Meigen, 1804, *B. pseudohybrida*, Landrock 1912) that were reared from a number of fungal hosts and, vice versa, species that are probably confined to particular group of fungal hosts, e.g. *B. basicornis* Mayer, 1871 – fungi of the family Cortinariaceae, *B. aperta* – Strophariaceae, *B. bimaculata* Zetterstedt, 1838, *B. glabrata* Loew, 1869 and *B. maculipennis* Walker, 1836 – Tricholomataceae, *B. nigrolineata* Landrock, 1912 – Paxillaceae, *B. rossica* Landrock, 1912 – Boletaceae. Among wood-growing fungi *Bolitophila* species usually colonize agarics like *Armillaria*, *Flammulina*, *Hypholoma* and *Pholiota*. Only three species: *B. occlusa* Edwards, 1913, *B. obscurior* Stackelberg, 1969 and *B. rectangulata* Lundström, 1913 are chiefly or exclusively associated with soft polypores, of these *B. rectangulata* is restricted to the only fungal hosts, *Laetiporus sulphureus*.

Bolitophila (Bolitophila) tenella Winnertz, 1863. 4 ♂♂, Site 5, ex. *Armillaria mellea*-group on aspen, 18.VIII.–4.IX.2003. Formerly reared from many species of agarics, mostly wood-growing *Armillaria*, *Hypholoma* and *Pholiota*.

Bolitophila (Cliopisa) aperta Lundström, 1915. 7 ♂♂, 3 ♀♀, Site 12, ex. *Pholiota squarrosa* on birch, 24.IX.–1.XI.2007; 2 ♂♂, Site 15, ex. *Hypholoma capnoides* on spruce stump, 2.IX.–13.X.2008. Formerly has been reared from *Hypholoma capnoides* (Hackman & Meinander 1979), *H. fasciculare*, *Cortinarius trivialis* and *Tricholoma focale* (Jakovlev 1995), all rearing records were obtained from Finland and Russian Karelia.

Bolitophila (Cliopisa) occlusa Edwards, 1913. 5 ♂♂, 4 ♀♀, Site 10, ex. *Postia alni* on aspen stump on clear-cut, 4.–18.IX. and 22.IX. 2008; 2 ♂♂, 1 ♀, Site 5, ex *Postia caesia* on spruce log, 24.VIII.–25.IX.2008; 5 ♂♂, 4 ♀♀, Site 9, ex. *Postia stiptica* on spruce log, 19.X.–5.XI. 2009; 5 ♂♂, 3 ♀♀, Site 6, ex. *Postia alni* on aspen log (D. Schigel leg); 2 ♂♂, same place ex. *Leptoporus mollis* on spruce log (D.Schigel leg.). Formerly has been reared from *Hypholoma fasciculare* (Bogatyreva 1979), *Pleurotus* (Zaitzev 1984c) and from small soft polypores as *Polyporus* (Ostroverkhova 1979), *Amylocystis* (Komonen 2001), *Postia* and *Leptoporus* (Chandler 1978, Ševčík 2006, Schigel *et al*. 2006).

3.1.2. Family Diadocidiidae

Genus *Diadocidia* Ruthe

Five species in Europe; collecting records obtained using emergence traps over rotting wood exist for the three most common ones: *D. ferruginosa* Meigen, 1830, *D. valida* Mik, 1874, *D. spinosula* Tollet, 1948 (Irmler *et al*. 1996, Økland 1999) and for the recently described species *D. trispinosa* Polevoi, 1995 (Jakovlev, J., Penttinen, J., Polevoi, A., Salmela, J. & Ståhls-Mäkelä, G., in prep.). Preimaginal stages are described only for *D. ferruginosa* that live as larvae in long dry silken tubes under bark or in rotten wood (Edwards 1925) and probably feed on fungal mycelia (Zaitzev 1994) or spores (Matile 1997).

Diadocidia ferruginosa Meigen, 1830. 1 ♂, Site 18, ex. *Peniophora laurentii* on fallen pine branch, 12.–29.VI.1996. Chandler (1993a) reported the rearing of this species from the fungus *Peniophora* sp.

* *Diadocidia spinosula* Tollet, 1948. 3 ♂♂, Site 18. Reared from decaying wood of burnt spruce stump bearing *Antrodia xantha*, 12.–29.VI.1996.

3.1.3. Family Keroplatidae

Subfamily Keroplatinae

Genus *Keroplatus* Bosc

All five species occuring in Europe are web spinners on bracket fungi and probably spore feeders (Matile 1990). Larvae of the most widespread species, *K. testaceus* Dalman, 1818 and *K. tipuloides* Bosc, 1792 have been repeatedly recorded living in webs, which they construct under the brackets and on adjacent bark (Chandler 1993b, Jakovlev 1994). *K. reaumurii* Dufour, 1839 was reared by Chandler (1993b) from larvae found on undetermined encrusting fungi on fallen branches. Ševčík (2006) reared *K. tuvensis* Zaitzev, 1991 from *Polyporus varius*. Accociations with *Thelephora terrestris* for *K. dispar* Dufour, 1839 cited in Jakovlev (1994) actually related to *K. testaceus*.

Keroplatus testaceus Dalman, 1818. 1 ♂, Site 17, ex. *Trametes hirsuta* on birch log, 10.VI.–5.VII.2002; 1 ♂, 2 ♀♀, Site 2, ex *Bjerkandera adusta* on dead standing grey alder, 10.VIII.–9.X.2005; 2 ♂♂, 1 ♀, Site 2, ex *Fomitopsis pinicola* on fallen grey alder log, 16.VI.–24.VII.2005; 1 ♂, Site 10, ex. *Pycnoporus cinnabarinus* on birch log, 14.V.–12.VII.2008. This species develops in webs on the underside of logs bearing encrusting fungi or beneath the brackets of polypores. There are records from *Fomes*, *Fomitopsis*, *Hapalopilus*, *Phellinus*, *Polyporus*, *Pycnoporus*, *Stereum*, *Serpula* and *Trametes* species (Falk & Chandler 2005).

Keroplatus tipuloides Bosc, 1792. 1 ♂, 2 ♀♀, Site 4, ex. *Fomes fomentarius* on birch, 9.VI.–12.VII.2003. Formerly was reared repeatedly from *F. fomentarius* and was, therefore, classified as monophagous on this fungal host (Jakovlev 1994, Cardew & Carrières 2001).

Genus *Orfelia* Costa

Fifteen species in Europe, all are web spinners chiefly associated with dead wood but, according to Hutson *et al*. (1980) and Smith (1989) could be also found in turf, grass tussocks, under logs and boulders, in worm tunnels, among mosses and liverworts. Rearing records do not indicate named fungal hosts with the exception of Chandler (1993a) who has reported *Orfelia unicolor* for the first time from the pupa suspended in threads on *Trametes versicolor*.

* *Orfelia fasciata* (Meigen, 1804). 1 ♂, Site 13, reared from damp aspen stump; the larva in webs under the loose bark bearing dead sporophores of *Trametes ochracea*, 29.V.–18.VII. 2008. Formerly was reared by Edwards (1925, p.530) from "larvae found feeding on moulds under loose but wet bark (poplar)" and obtained in emergence traps over beech stumps, logs and on litter (Irmler *et al.* 1996).

** *Orfelia nemoralis* (Meigen, 1818). 1 ♂, Site 13, reared from slash residues in aspen-dominated forest. Larvae in webs on the underside of fallen damp aspen branches bearing fungal mycelium and resupinate fruiting bodies of *Byssomerulius corium*, 29.V.–18.VII.2008. No former rearing records.

**Orfelia nigricornis* Fabricius 1805. 2 ♂♂, Site 13, reared from slash residues in aspen-dominated forest. Larvae in webs on the underside of fallen damp aspen branches bearing fungal mycelium and resupinate fruiting bodies of *Byssomerulius corium*, 29.V.–18.VII.2008; 1 ♂, Site 8a, reared from a piece of decaying aspen log, 9.–16.VII.2004 (G.Várkonyi *et al*. leg). Formerly larvae were found in rotting wood (Chandler 1978), under bark of dead trunk of *Juglans regia* (Zaitzev 1994) and imago obtained with emergence traps over beech logs (Irmler *et al*. 1996).

Orfelia unicolor (Staeger, 1840). 2 ♂♂, Site 1, reared from fallen moist and moss-covered trunk of willow, *Salix caprea*. Larvae in webs on lower side, on the surface of rotten wood without fungal fruiting bodies. 26.V.–30.VII.2006. Formerly reared from fallen spruce trunk, larvae under bark, on the surface of dead wood covered with fungal mycelia (Zaitzev 1994) and obtained in emergence traps over beech and alder logs (Irmler *et al*. 1996).

Genus *Neoplatyura* Malloch

Four species in Europe, rearing records exist for only one species, *N. flava*, larval habits are similar to those of *Orfelia* – the larvae live in webs under bark, under fallen wood and in soil.

Neoplatyura flava (Macquart, 1826). 1 ♂, Site 10, reared from damp moist birch branches stored in heaps at the edge of clear-cut area. 29.V.–18.VI.2007. The larva in webs on the underside of branches bearing dead fruiting bodies of *Fomes fomentarius*. Formerly was obtained with emergence traps over decaying pine wood (Jakovlev *et al*. 1994) on soil, ground vegetation and moss carpets (Økland 1999) and has been reared in West Siberia from *Daldinia concentrica* and *Chalciporus piperatus* (Bogatyreva 1979).

Subfamily Macrocerinae

Genus *Macrocera* Meigen.

This genus contains 46 species in Europe. In contrast with Keroplatinae, larvae of *Macrocera* are quite difficult to find and that seems to be the reason of the total absence of rearing records from named fungal hosts. Edwards (1925) mentioned that the early stages of *Macrocera* are practically unknown, in spite of the fact that many of the species are quite common. According to Falk &

Chandler (2005) larvae of this genus have been reared from a range of situations including clumps of turf, rotting wood and cave walls and are considered predaceous.

The oldest rearing records exist for two common species: *M. fasciata* Meigen, 1804 from larvae feeding on fungus growing in a cellar (Enslin 1906) and *M. stigma* Curtis, 1837 from a decaying trunk of *Carpinus betulus* (Winnertz 1863). Further collections using emergence traps (Jakovlev *et al*. 1994, Irmler *et al.* 1996, Økland 1999, Ševčík & Roháček 2008; Jakovlev, J., Penttinen, J., Polevoi, A., Salmela, J. & Ståhls-Mäkelä, G., in prep.) has revealed *M. anglica* Edwards, 1925, *M. angulata* Meigen, 1818, *M. aterrima* Stackelberg, 1945, *M. centralis* Meigen, 1818, *M. parva* Lundström, 1914, *M. pilosa* Landrock, 1917, *M. stigma* Curtis, 1837 and *M. stigmoides* Edwards, 1925 from rotten wood, *M. crassicornis* Winnertz, 1863, *M. stigma*, *M. vittata* Meigen, 1830 – from soil and litter and *M. fascipennis* Staeger, 1840 from tussocks of the grass *Scirpus sylvaticus*.

* *Macrocera fasciata* Meigen, 1804. 2 ♂♂, Site 3, reared from damp moist log of aspen bearing *Datronia mollis*, 27.VI.–24.VII.2006. Larval webs were under the loose bark on the underside of the log. Formerly it was reared from some fungus growing in a cellar (Enslin 1906) and from larvae found in hollows of an aspen tree (Plassmann 1971).

* *Macrocera pilosa* Landrock, 1917. 1 ♂, Site 1, reared from rotten fallen trunk of *Corylus avellana*. Larval webs were on decaying sapwood covered with resupinate fruiting bodies of *Antrodiella romellii*, 16.V.–25.VI.2007. Formerly obtained in emergence traps over beech logs and spruce stumps (Økland 1999).

3.1.4. Family Mycetophilidae

Subfamily Mycomyiinae

Genus *Mycomya* Rondani

Among the 89 species of *Mycomya* recorded in Europe rearing records exist for about one-third of them. The larvae of this genus spin delicate slimy webs usually on the under surface of bark-growing fungi, or on fungal mycelium under bark. There are, however, some species that could develop also in soil and litter, e.g. *M. annulata* (Meigen, 1818), *M. britteni* Kidd, 1955, *M. levis* Dziedzicki, 1885, *M. marginata* (Meigen, 1818) and *M. shermani* Garrett, 1924, that have been reared from soil and ground vegetation using emergence traps (Jakovlev *et al*. 1994, Økland 1999, Ševčík & Roháček 2008) and *M. nitida* (Zetterstedt, 1852) found in burrows of rodents (Hackman 1963). Although larval habits of *Mycomya* are similar to those of *Orfelia* and *Macrocera* their larval diet is unknown. According to Laštovka (1972) *Mycomya* larvae are viewed as zoophagous, although the study of gut contents of *M. marginata* has verified their mycophagy (Parmenter 1953).

Known fungal hosts have been listed by Väisänen (1984) and Jakovlev (1994) but according to Falk & Chandler (2005) accuracy the old rearing records, e.g. for *M. griseovittata* (Zetterstedt, 1852), *M. ornata* (Meigen, 1818) and *M. punctata* (Meigen, 1818) is doubtful. Additional fungal hosts have been reported by Chandler (1993a) and by this investigation. The list of known fungal hosts incorporates mostly bark-encrusting fungi, bracket polypores, and wood-growing agarics but also some terrestrial fungi, e.g. Väisänen (1981) has reared *M. circumdata* (Staeger, 1840), *M. permixta* Väisänen, 1984, *M. tenuis* (Walker, 1856) and *M. trilineata* (Zetterstedt, 1838) from decaying fruiting bodies of *Leccinum*.

Mycomya (Mycomya) annulata (Meigen, 1818). 2 ♂♂, Site 7, reared from strongly decayed pine trunks and branches retained in heaps lying on the ground after thinning in pine forest. Larvae in webs on the fungal mycelia, 24.V.–14.VI.1994; 2 ♂♂, Site 3, reared from decaying pine log partly bearing loose bark and covered with resupinate fungus *Skeletocutis biguttulata*, 14.IX.–14.XI.2007. Formerly reared from *Polyporus* sp. (Ostroverkhova 1979) and from *Gyromitra gigas* (Jakovlev 1995).

* *Mycomya (Mycomya) bicolor* (Dziedzicki, 1885). 1 ♂, Site 21, ex. *Gloeophyllum sepiarium* on burned spruce stump, larvae in webs on the lower surface of fruiting bodies, 27.VII.–12.VIII. 2003. Formerly reported as "larvae on polypores" (Plassmann 1971, Sakharova 1977, Väisänen 1984) and "Fagus, under bark" (Plassmann 1971).

Mycomya (Mycomya) cinerascens (Macquart, 1826). 1 ♂, Site 17, ex. *Trametes hirsuta* on birch log, 13.VIII.–6.X.2002. Formerly reared from larvae found on fruiting bodies of *Stereum* (Edwards 1925, Chandler 1978), *Thelephora terrestris* (Jakovlev 1995) and *Cortinarius* sp. (Kurina 1994). Besides fruiting bodies the species has been collected with emergence traps over beech logs and stumps, alder and spruce stumps (Irmler *et al*. 1996).

** *Mycomya (Mycomya) nitida* (Zetterstedt, 1852). 1 ♂, Site 20, ex. *Cylindrobasidium laeve* on spruce stump under loose bark, larvae in webs, 29.V.–21.VI.2004. No former rearing records. Adults have been found in burrows of rodents (Hackman 1963).

** *Mycomya (Mycomya) forestaria* Plassmann, 1978. 1 ♂, Site 18, reared from decaying spruce stump in moist spruce-dominated forest along the river. Larvae in webs under bark, 25.V.–4.VI.1996. No former rearing records.

Mycomya (Mycomya) marginata (Meigen, 1818). 1 ♂, 2 ♀♀, Site 5, ex *Sparassis crispa*, 24.IX.–24.X.2008. Formerly reared from various wood-growing fungi, mostly bracket polypores, corticoid and jelly fungi (cf. Jakovlev 1994), also from *Pleurotus* (Hutson *et al*. 1980), *Naucoria* (Chandler (1993a), *Simocybe* (Alexander 2002) and from fungoid wood (Zaitzev 1994). Collected by emergence traps over dead wood (Irmler *et al*. 1996) and on tussocks of the grass *Calamogrostis epigejos* (Ševčík & Roháček 2008).

Mycomya (Mycomya) occultans (Winnertz, 1863). 1 ♂, Site 4, ex. *Laxitextum bicolor* on rotting birch log, 18.VIII.–5.IX.2003. Formerly reared from bracket fungi growing on broad-leaved trees, viz: *Daedalea*, *Piptoporus* (Winnertz 1863, Landrock 1927), *Lenzites betulina*, *Plicaturopsis crispa* (Eisfelder 1955), *Inonotus radiatus* (Väisänen 1984, record with question mark) and obtained with emergence traps over beech limbs (Schiegg 1999).

** *Mycomya (Mycomya) ruficollis* (Zetterstedt, 1852). 1 ♂, Site 7, ex. *Trichaptum pargamenum* on fallen birch trunk, larvae in webs on the lower surface of fruiting bodies, 19.V.–14.VI.2000. No former rearing records.

Mycomya (Mycomyopsis) trilineata (Zetterstedt, 1838). 1 ♂, Site 4, ex *Laxitextum bicolor* on rotting birch log, larvae in webs on the surface of fruiting bodies, 14.–30.VIII.2003; 1 ♂, Site 5, ex. *Phlebia tremellosa* on birch trunk bearing loose bark, larvae in webs on fruiting body, 27.VII.–4.IX.2005. Formerly reared from rotting *Leccinum scabrum* (Väisänen 1984).

Mycomya (Mycomya) wankowiczii (Dziedzicki, 1885). 1 ♂, Site 8b, reared from a piece of decaying silver birch log, 27.VII.–2.VIII.2005 (G.Várkonyi *et al*. leg.). Formerly reared from *Stereum* on fallen birch branches (Edwards 1925), *Phallus impudicus* (Plassmann 1971, Hutson *et al.* 1980) and *Hypholoma lateritium* (Eisfelder 1955).

Genus *Neoempheria* Osten Sacken

Larvae are web spinners on fungi or rotting wood (Falk & Chandler 2005). Fungal hosts are recorded for two of eight European species; *N. proxima* (Winnertz, 1863) which has been reared from *Bjerkandera adusta* (Eisfelder 1955) and *N. striata* (see below).

** *Neoempheria pictipennis* (Haliday, 1833). 1 ♂, 1 ♀, Site 1, reared from larvae in webs on moist damp wood of fallen trunk of *Corylus avellana*, 23.VII.2007–8.VIII.2007. No former rearing records.

Neoempheria striata (Meigen, 1818). 3 ♂♂, 2 ♀♀, Site 4, ex. *Laxitextum bicolor* on fallen birch trunk, 18.VIII.–2.IX.2003; 2 ♂♂, Site 10, ex. *Trichaptum pargamenun* on birch stump, 14.–29.VII.2003; 1 ♂, Site 16, reared from larvae on the surface of fruiting bodies of *Trametes hirsuta* on birch stump, 30.VI.–24.VII.2009. Formerly was reared from larvae on fruiting bodies of wood-growing fungi: *Trametes suaveolens* (Dufour 1842), *T. versicolor* (Zaitzev 1994), *Auricularia auricula-judae* (Falcoz 1923), *Thelephora terrestris* (Jakovlev 1995). Khalidov (1984) published a rearing record of this species from *Tapinella atrotomentosa* which is very rarely infested with insect larvae. Matile (1963) found larvae of *N. striata* in webs on pine branches lying on the ground and considered them to be carnivorous on nematodes which became immobilised (probably with oxalic acid) on contact with the web.

Subfamily Gnoristinae

Genus *Apolephthisa* Grzegorzek
This genus includes only one known species, *A. subincana*, which lives as larvae in mucilaginous tubes on the bark of deciduous trees encrusting with fungi (Madwar 1937).

Apolephthisa subincana (Curtis, 1837). 1 ♂, Site 5, reared from larvae in webs under loose bark on soft decaying birch log (white rot) bearing resupinate fungus *Hyphodontia barba-jovis*, 24.VIII.–19.IX.2008; 1 ♂, Site 8b, reared from a piece of decaying aspen log, 31.VIII.–6.IX.2005 (G.Várkonyi *et al*. leg.). Formerly reared from *Hyphodontia paradoxa* (Edwards 1925) and *Phlebia radiata* (Trifourkis 1977).

Genus *Boletina* Staeger
This big genus comprises about 90 members in the Palaearctic and more than 70 species in Europe (Chandler 2004, 2009, Jakovlev & Penttinen 2007). Rearing records exist only for seven of them viz: *B. basalis* (Meigen, 1818), *B. dubia* (Meigen, 1804), *B. gripha* Dziedzicki, 1885, *B. nigricans* Dziedzicki, 1885, *B. nigricoxa* Staeger, 1840, *B. trivittata* (Meigen, 1818) and *B. trispinosa* Edwards, 1913. Of these the commonest four species – *B. basalis*, *B. gripha*, *B. nigricans* and *B. trivittata* were obtained in emergence traps in a range of situations including rotting wood and soil litter (Jakovlev *et al.* 1994, Irmler *et al.* 1996, Økland 1999). Rotting wood is indicated as larval microhabitat for *B. trispinosa* by Schiegg (1999) and soil litter for *B. nigricoxa* by Plassmann (1971). The species of closely related genera, *Saigusaia flaviventris* (Staeger, 1840) and *Aglaomyia ingrica* (Stackelberg, 1948) develop in rotten wood as well (Chandler 1978, Zaitzev 1994).

There are two cases of rearing records of *Boletina* from other substrates. *B. gripha* has been reared from fruiting bodies of *Suillus bovinus* by Kurina (1998) and *B. dubia* has been reared from liverworts by Cheetham (1920). Edwards (1925), based on the latter record and his own observations that the adults of many of the larger *Boletina* species are most frequently found along banks of mountain streams, supposed that they might develop amongst bryophytes and it seemed quite likely that they are liverwort feeders. Falk & Chandler (2005) mentioned that *Boletina* and related genera develop in or on fungi, decaying wood or bryophytes. I have, however, never succeeded in finding *Boletina* larvae in liverworts or other bryophytes and also failed to rear any *Boletina* species from fungal fruiting bodies.

** *Boletina edwardsi* Chandler, 1992. 1 ♂, Site 3, reared from decaying pine log, partly bearing loose bark and fruiting bodies of polypores. The larvae were found within soft damp rotten wood bearing the resupinate fungus *Skeletocutis biguttulata*, 22.V.–14.VII.2007. No former rearing records.

Boletina gripha Dziedzicki, 1885. 4 ♂♂, Site 18, reared from damp decaying wood (brown rot) of spruce stump, 9.V.–1.VI.1996; 2 ♂♂, 1 ♀, Site 5, reared from huge spruce log bearing loose bark; larvae on the surface of decaying wood (white rot) covered with *Resinicium bicolor*, 28.V.–21.VI.2008. Formerly reared from decaying wood of pine where larvae live in large colonies (Jakovlev *et al*. 1994), spruce (Jakovlev 1995), from soil in pine forest (Jakovlev *et al*. 1994) and from fruiting bodies of *Suillus bovinus* Kurina (1998).

* *Boletina nigricans* Dziedzicki, 1885. 1 ♂, Site 3, reared from fallen birch trunk, larvae in white sapwood under bark bearing *Hyphodontia barba-jovis*, 22.IV.–11.VI.2006. Formerly was obtained in emergence traps on soil, the ground vegetation, moss carpets (Jakovlev *et al*. 1994, Økland 1999) and over rotten wood (Jakovlev, J., Penttinen, J., Polevoi, A., Salmela, J. & Ståhls-Mäkelä, G., in prep.).

Boletina nigricoxa Staeger, 1840. 1 ♂, Site 11, reared from larvae found in thick litter of fallen leaves of *Alnus glutinosa* woodland. Larvae collected on 27.IX.2007 overwintered; adults emerged next spring, 25.IV.2008. Plassmann (1971) cited the old record of Beling (1875) who found larvae of this species between decayed leaves in soil litter in deciduous forest. My finding suggests a possible association of larvae with rotting plant material.

** *Boletina populina* Polevoi 1995. 1 ♂, Site 3, reared from larvae collected in rotten wood of damp spruce log covered with *Antrodia serialis*, 22.V.–14.VI.2007. No former rearing records.

Genus *Ectrepesthoneura* Enderlein

Larvae of this genus, which includes ten species in Europe, are generally known to develop on rotten wood bearing fungal growth. Two species, *E. colyeri* Chandler, 1980 and *E. hirta* (Winnertz 1863) were repeatedly hatched from decaying wood, chiefly ash and oak, but rearing records with named fungal hosts exist only for the commonest species *E. hirta* (Chandler 1978).

* *Ectrepesthoneura colyeri* Chandler, 1980. 1 ♂. Site 5, reared from decaying spruce log lying on moist swampy soil partly covered with moss. The larvae were found within soft whitish rotten wood under loose bark bearing several small fruiting bodies of *Skeletocutis amorpha*, 24.VII.–21.VIII.2008. Formerly collected with emergence traps over rotten logs of ash and oak (Økland 1999, Martinsen & Søli 2000).

Ectrepesthoneura hirta (Winnertz 1863). 1 ♂, Site 5, reared from larvae collected in decaying spruce log on whitish sterile fungal tissue (? *Resinicium bicolor*) encrusting inner layer of bark, 28.V.–12.VII.2008; 1 ♂, Site 17, larvae on very rotting, barkless, thin pine log covered with *Skeletocutis biguttulata*, 21.VIII.–22.IX.2008. Formerly reared from *Trametes versicolor* (Winnertz 1863), from rotten pine wood (Matile 1964) and obtained in emergence traps over rotten logs of ash, oak and pine (Økland 1999, Martinsen & Søli 2000).

Genus *Tetragoneura* Winnertz

This genus includes three species in Europe, of which rearing records exist only for *T. sylvatica*.

Tetragoneura sylvatica (Curtis, 1837). 4 ♂♂, 3 ♀♀, Site 1, reared from strongly decayed fallen trunk of hazel (*Corylus avellana*) bearing resupinate fruiting bodies of *Hyphodontia paradoxa* and *H. radula*, 27.VII.–4.IX.2006. The larvae in slime tubes on the edges of fruiting bodies where they are attached to bark and beneath loose bark. Formerly recorded as larvae in slight slimy web on mouldy branches (Edwards 1925) and on fruiting bodies of *Hyphodontia paradoxa* (Madwar 1937, Chandler 1978).

Subfamily Sciophilinae

Genus *Acnemia* Winnertz

Six species in Europe, all are believed to be associated with dead wood and lignicolous fungi (Falk & Chandler 2005), but rearing records exist only for *A. nitidicollis* (Meigen, 1818). A record of *A. amoena* Winnertz, 1863 in the list of saproxylic insects in Britain (Alexander 2002) as a relict ancient woodland species that has been reared in Europe from *Thelephora* and *Paxillus* is in error and these details actually related to *Neoempheria striata* (Peter Chandler, pers. comm).

***Acnemia falcata* Zaitzev, 1982a. 1 ♂, Site 21, reared from larvae in webs beneath fruiting body of *Rhodonia placenta* growing on burned spruce stump, 24.VII.–28.VIII.2003. No former rearing records.

Acnemia nitidicollis (Meigen, 1818). 1 ♂, Site 3, reared from larvae under the bark of decaying spruce log bearing resupinate fruiting bodies of *Antrodia serialis*, 29.IV.–2.VI.2005; 3 ♂♂, 2 ♀♀, Site1, reared from strongly decaying fallen trunk of grey alder, larvae in webs under bark covered with moss and bearing fruiting bodies of *Fomitopsis pinicola*, 16.V.–18.VI.2007. This was formerly reared from fruiting bodies of *Leccinum* (Hackman & Meinander 1979, Jakovlev 1995) from rotten wood (Edwards 1925, Landrock 1940) and collected with emergence traps over logs (Irmler *et al*. 1996, Økland 1999), soil (Irmler *et al.* 1996) and tussocks of the grass *Calamagrostis epigejos* (Ševčík & Roháček 2008).

Genus *Leptomorphus* Curtis

Larvae of the three species distributed in Europe, *L. forcipatus* Landrock, 1918, *L. subforcipatus* Zaitzev & Ševčík, 2002 and *L. walkeri* Curtis, 1831, are found in webs on bark-growing fungi (Chandler 1978, 1993a, Zaitzev & Ševčík 2002). Two other species: *L. panorpiformis* Matsumura, 1916 and *L. quadrimaculatus* Matsumura, 1915, found only in the East Palaearctic, develop on the surface of decaying wood covered with fungal mycelium (Zaitzev 1994, Zaitzev & Ševčík 2002).

Leptomorphus (Leptomorphus) forcipatus Landrock, 1918. 4 ♂, Site 7, ex *Trichaptum abietinum* on spruce log, 11.VI.–24.VII.2000; 2 ♂♂, 1 ♀, Site 10, ex *Trichaptum abietinum* on spruce log, 4.VI.–17.VII.2008; 1 ♂, Site 5, ex. *Stereum subtomentosum* on grey alder log, larvae in webs on fruiting bodies, 17.VIII.–2.IX.2003. My new records confirm formerly recorded fungus hosts from *Trichaptum* (Jakovlev 1995) and *Stereum* (Zaitzev & Ševčík 2002). Økland (1999) has obtained this species in an emergence trap over a dead spruce log.

Genus *Phthinia* Winnertz

Eight species are currently known from Europe. Rearing records existing for one European species, *P. humilis* Winnertz, 1863 (Edwards 1925) and two species from East Palaearctic, *P. lenae* Zaitzev, 1984 and *P. hyrcanica* Zaitzev, 1984 (Zaitzev 1994) indicate that larvae develop in webs on the surface of fungal mycelium and moulds on rotten wood. *P. humilis* and *P. winnertzi* Mik, 1869 have been obtained in emergence traps on soil, moss carpets and ground vegetation (Økland 1999) and over decaying logs (Jakovlev, J., Penttinen, J., Polevoi, A., Salmela, J. & Ståhls-Mäkelä, G., in prep.). For *P. winnertzi* unlike other *Phthinia* species there are rearing records from fruiting bodies of agarics (Kurina 1994, Alexander 2002).

** *Phthinia congenita* Plassmann, 1984. 1 ♂, Site 5, reared from strongly decayed, moss-covered spruce log lying on moist swampy ground, larvae in webs within cavities in softened, moist wood bearing thick resupinate *Asterodon ferruginosus* (both fertile and sterile tissues), 24.VI.–24.VII.2008. No former rearing records.

** *Phthinia mira* (Ostroverkhova, 1977). 4 ♂♂, 1 ♀, Site 5, reared from decaying spruce log, cocoons and larvae in webs on whitish resupinate fungus *Resinicium bicolor* (both fertile and sterile tissues) encrusting inner layer of loosened bark, 29.V.–24.VI.2008. No former rearing records.

Phthinia winnertzi Mik, 1869. 1 ♂, Site 5, ex. *Asterodon ferruginosus* on spruce log (in company with *Phthinia congenita*), 24.VI.–24.VII. 2008. Formerly obtained in emergence traps over decaying log of *Alnus glutinosa* (Jakovlev *et al*. 2006) and reared from wood-growing *Pholiota* (Alexander 2002) and terrestrial *Russula flava* (Kurina 1994).

Genus *Polylepta* Winnertz

Three species in Europe (Chandler 2004), of these two common ones, *P. guttiventris* Zetterstedt, 1852 and *P. borealis* Lundström, 1912, have been obtained with emergence traps over dead wood (Jakovlev *et al*. 1994, Irmler *et al*. 1996) soil and ground vegetation (Økland 1999).

Polylepta borealis Lundström, 1912. 1 ♂, Site 3, reared from soft, moist, brownish wood of spruce log covered with moss and bearing *Antrodia serialis*, 19.V.–16.VI.2005. Formerly was obtained with emergence traps from decaying pine wood (Jakovlev *et al*. 1994) and reared from *Gyromitra esculenta* (Jakovlev 1995).

Genus *Sciophila* Meigen

Larvae develop in webs on the surface of fungal fruiting bodies, especially the tougher lignicolous species where they probably feed on fungal spores (Falk & Chandler 2005). Rearing records exist for about 30 species, e.g. about half of the known European fauna of *Sciophila*. Most of them are associated with wood-growing polypores, but some species are able to develop in folds of the apothecia of *Pezizales*, e.g. *S. karelica* Zaitzev, 1982 and *S. modesta* Zaitzev, 1982, or on soft fruiting bodies of terrestrial agarics, most often on *Hydnum repandum* and *Lactarius* species. Two *Sciophila* species: *S. hirta* Meigen, 1818 and *S. lutea* Macquart, 1826 are generalists known to live on a wide range of fungal hosts including both soft terrestrial fungi and hard polypores. Larvae of *S. baltica* Zaitzev, 1982 and *S. nonnisilva* Hutson, 1979 have been found on fungal mycelium on the surface of rotten wood (Zaitzev 1994).

Sciophila buxtoni Freeman, 1956. 1 ♂, Site 4, ex. *Phellinus tremulae* on aspen log, larvae in webs on fruiting bodies, 23.VI.–8.VII.2003; 1 ♂, same place ex. *Steccherinum nitidum* on aspen twig, 23.VI.–8.VII.2003; 1 ♂, Site 6, ex. *Steccherinum luteoalbum* on decaying spruce log, 1.IX.–8.X.2003 (D. Schigel leg.); 1 ♂ same place, ex *Antrodiella pallescens* growing on dead brackets of *Fomes fomentarius* on birch log, 1.IX.–8.X.2003 (D. Schigel leg.); 1 ♂, 2 ♀♀, Site 5, ex. *Antrodiella pallescens* growing on dead brackets of *Fomes fomentarius* on birch log, 4.IX.–3.XI.2008; 1 ♂, Site 8c. Reared from a piece of decaying aspen log, 13.–19.VII.2005 (G.Várkonyi *et al*. leg.). This species has been formerly reared from a wide range of polypores: *Daedaleopsis*, *Fomes*, *Fomitopsis*, *Laetiporus* and *Trametes*.

** *Sciophila fenestella* Curtis, 1837. 1 ♂, Site 21, ex. *Rhodonia placenta* on burned spruce stump, 24.VII.–16.VIII.2003. No former rearing records.

Sciophila hirta Meigen, 1818. 1 ♂, 2 ♀♀, Site 12, ex *Rigidoporus populinus* on maple tree (*Acer platanoides*), 17.VIII.–2.IX.2003 ; 1 ♂, Site 21, ex. *Rhodonia placenta* on burned spruce log, larvae in webs on the surface of the resupinate fruiting body, 18.VIII.–24.IX.2003; 2 ♂♂, Site 4, ex. *Phlebia gigantea* on spruce log, 18.VIII.–2.IX. 2003; 1 ♂, 1 ♀, same place, ex. *Pholiota squarrosa* on standing dead birch, 10.IX.–4.X.2003; 1♂, Site2, ex. *Bjerkandera adusta*, young white sporophores on standing dead grey alder. 17.VII.–28.VIII.2005, 1 ♂, same place, ex *Inonotus radiatus* on standing dead grey alder, 17.VIII.–2.IX.2005; 1 ♂,1 ♀, Site 15, ex. *Polyporus melanopus* on the ground along roots of dead birch, 2.IX.–13.10.2008; 1 ♂, 3 ♀♀, Site 5, ex *Sparassis crispa* on roots of dead pine, 24.IX.–2.XI.2008. Formerly reared from a range of polypores and epigeic soft fungi.

** *Sciophila jakutica* Blagoderov, 1992. 1 ♂, Site 21, ex. *Rhodonia placenta* on burned spruce stump, 18.VIII.–24.IX.2003 (in company with *S. hirta*). No former rearing records.

Sciophila lutea (Macquart, 1826. 1 ♂, 2 ♀♀, Site 1, ex. *Verpa bohemica*, 16.V.–25.VI.2007; 1 ♂, Site 5, ex *Bjerkandera adusta* on grey alder, 18.VIII.–24.IX.2008; 1 ♂, 4 ♀♀, same place, ex *Lentinellus vulpinus* on fallen birch trunk, 24.IX.–24.X.2008. Formerly reared from fruiting bodies of a wide range of fungi, including lignicolous and terrestrial species.

Sciophila pseudoflexuosa Kurina, 1991. 1 ♂, Site 15, ex. *Polyporus melanopus* growing on the ground along roots of dead birch, 24.IX.–27.X.2008. Formerly reared from *Gyrodon lividus*, *Russula* sp. (Rimšaite 2000), *Albatrellus ovinus* (Ševčík 2006) and *Lactarius* species: *L. helvus* (Kurina 1991), *L. necator* (Rimšaite 2000), *L. acerrimus*, *L. vellereus* (Ševčík 2006) and *L. deliciosus* (Jakovlev *et al*. 2006). The closely related species *Sciophila flexuosa* Zaitzev, 1982 has been reared from *Pleurotus citrinopileatus*.

** *Sciophila setosa* Garrett, 1925. 1 ♂, Site 21, ex. *Stereum subtomentosum* growing on burned grey alder log, larvae in webs between sporophores, 31.V.–29.VI.2003. No former rearing records.

Sciophila varia (Winnertz, 1863) 1 ♂, Site 16, ex. *Hydnum repandum*, 23.VIII.–12.IX.2003. Formerly reared from *Daedalea quercina*, *Leccinum scabrum* (Landrock 1940), *Cantharellus cibarius* (Zaitzev 1982b), *Hydnum repandum* (Landrock 1940, Kurina 1994, Chandler 1987), *Suillus bovinus*, *Paxillus involutus* (Hackman & Meinander 1979, Khalidov 1984).

Genus *Syntemna* Winnertz

Eleven species in Europe. According to a few rearing records existing only for *S. hungarica* Lundström, 1912 (Hutson *et al*. 1980) and *S. nitidula* Edwards, 1925 (Irmler *et al*. 1996) larvae develop in rotting beech wood on which they construct webs. No named fungal hosts are known.

** *Syntemna daisetsuzana* Okada, 1938. 1 ♂, Site 3, ex. *Tomentella crinalis* growing on the bark on the underside of decayed aspen log, 22.V.–22.VI.2006. No former rearing records.

** *Syntemna penicilla* Hutson, 1979. 2 ♂♂, Site 8b, reared from a piece of decaying pine log, 4.–14.VIII.2004 (G.Várkonyi *et al*. leg.). No former rearing records.

** *Syntemna stylatoides* Zaitzev, 1994. 2 ♂♂, 1 ♀, Site 3, reared from damp moist fallen aspen trunk, larval webs under the loose bark on the underside of the log covered with *Datronia mollis*, 22.V.–27.VI.2006. No former rearing records.

Subfamily Leiinae

Genus *Leia* Meigen

Nineteen species in Europe; rearing records exist for eight of them. Generally the larvae live in a slimy web on the under surface of fungi, or on the surface or under bark of rotting wood. *L. cylindrica* Winnertz, 1863 and *L. picta* Meigen, 1818 were obtained with emergence traps over decaying logs (Jakovlev, J., Penttinen, J., Polevoi, A., Salmela, J. & Ståhls-Mäkelä, G., in prep.), *L. bilineata* Winnertz, 1863 is chiefly associated with wood growing polypores (Eisfelder 1955, Dely-Draskovits 1974), *L. winthemii* Lehmann, 1822 and *L. bimaculata* Meigen, 1808 – with terrestrial agarics (Jakovlev 1994, Chandler 1993a, Ševčík 2006). *L. crucigera*

Zetterstedt, 1838 was reared from wood-growing *Neolentinus tigrinus* (Ševčík 2006). Some species show a tendency to saprophagous feeding, e.g. *L. bilineata* Winnertz, 1863 and *L. piffardi* Edwards, 1925 have been reared from the nests of birds and mammals (Hutson *et al*. 1980), *L. arsona* Hutson, 1978 – from various rotting plant material (Chandler & Pijnakker, 2009) and obtained in emergence traps on tussocks of *Glyceria maxima* (Ševčík & Roháček 2008).

Leia bilineata Winnertz, 1863. 1 ♂, 1 ♀, Site 5. Reared from larvae in fine webs on underside of damp strongly decaying wood of spruce log, partly moss-covered, fungal mycelium within the wood, no fruiting bodies outside, 24.VIII.–1.XI.2008. Formerly reared from *Piptoporus betulinus*, *Phellinus igniarius* (Kurina 1994), *Phellinus* sp (Rimšaite 2000), also from larvae found under the bark of oak, and in nests of the squirrel *Sciurus vulgaris* (Hutson *et al*. 1980), obtained in emergence traps over decaying ash and beech logs (Økland 1999).

** *Leia picta* Meigen, 1818. 1 ♂, Site 1, reared from rotten trunk of *Tilia cordata* lying on the ground. Larval webs were on the fungal mycelia under loose bark, 16.V.–25.VI.2008.

Leia winthemii Lehmann, 1822. 1 ♂, Site 8a, reared from a piece of decaying pine log, 31.VIII.–6.IX.2004, G.Várkonyi *et al*. leg. 1 ♂, 4 ♀♀, Site 5, ex *Lentinellus vulpinus* on fallen birch trunk, larvae in webs on the under surface of sporophores, 24.IX.–24.X. 2008. Formerly reared from various fungi like *Pleurotus*, *Paxillus*, *Lactarius* and *Peziza* (Jakovlev 1994).

Subfamily Mycetophilinae

Tribe Mycetophilini

Genus *Dynatosoma* Winnertz

Thirteen species in Europe, all known larval microhabitats are bracket fungi, larvae live inside fruiting bodies. Rearing records exist for most of European species except the rarest ones, *D. abdominale* Staeger, 1840, *D. majus* Landrock, 1912, *D. nobile* Loew, 1873 and two recently described species, *D. dichaeta* Polevoi, 1995 and *D. silesiacum* Ševčík, 2001.

Dynatosoma fuscicorne (Meigen, 1818). 3 ♂♂, Site 5, ex *Fomitopsis pinicola* on pine, 24.VII.–6.VIII.2008; 3 ♂♂; 4 ♀♀, Site 12, ex *Fomitopsis pinicola* on grey alder, 19.VI.–7.VII.2004 and 25.V.–16.VI.2007;1 ♂, Site 5, ex *Postia caesia* on spruce log, 24.VII.–5.IX.2008; 1 ♂, same place, ex *Climacocystis borealis* on spruce log, 24.IX.–7.X.2008; 1 ♂, Site 20, ex. *Trametes hirsuta* on birch stump, 29.VII.–18.VIII.2005. Formerly reared from a wide range of polypores (Chandler 1993a, Jakovlev 1994, Ševčík 2006).

* *Dynatosoma reciprocum* (Walker, 1848). 3 ♂♂, 1 ♀, Site 5, ex *Resinicium bicolor* on the surface of decaying sapwood (white rot) on the underside of the huge spruce trunk bearing loose bark, 28.V.–24.VII.2008; 2 ♂, Site 3, reared from larvae under bark of spruce log bearing *Trichaptum abietinum*, 12.VI.–24.VII.2008. Formerly reared from larvae on fungal mycelium in decaying wood (Zaitzev 1984c).

Dynatosoma thoracicum Zetterstedt, 1838. 2 ♂♂, Site 5, ex *Postia caesia* on spruce log, 18.VIII.–22.IX.2008. Formerly reared from *Postia caesia* only (Jakovlev 1994, Ševčík 2006). This species was identified according figures given in Zaitzev (2003, figs 56–1, 57–1, 57–2) which do not agree with the Zetterstedt's type material for *D. thoracicum* but belong to another, most likely undescribed species (Kjaerandsen *et al.* 2007).

Genus *Epicypta* Winnertz

Seven species in Europe, preimaginal stages are described only for *E. aterrima* (Zetterstedt, 1938) as the case bearing larvae develop in damp rotten wood (Brocher 1931, Steenberg 1938, Chandler 1981). According to Zaitzev (2003) *E. scatophora* (Perris, 1849) has similar larval habits.

** *Epicypta fumigata* (Dziedzicki, 1923). 1 ♂, Site 1, ex *Hyphodontia paradoxa*/*radula* on underside of a strongly decayed log of *Corylus avellana*, 24.V.–27.VI.2006. No former rearing records.

Genus *Mycetophila* (Meigen)

This is the biggest genus of fungus gnats with 131 species occurring in Europe. Edwards (1925, p. 631) wrote that the larvae of *Mycetophila* "live in the interior of fungi, some species attacking many different kinds, others being restricted to a single fungus-host. They may be found either in terrestrial or lignicolous fungi, though the same species will usually occur only in one of these classes of host". This has been confirmed by further studies; at present rearing records from fruiting bodies of identified fungi exist for ca 60 *Mycetophila* species, of these about half were reared chiefly from soft terrestrial agarics, another half – from wood-growing fungi. The number of species of *Mycetophila* associated with dead wood and wood-encrusting fungi could be certainly increased during further studies. This study has added five species, and another five species, *M. caudata* Staeger, 1840, *M. lapponica* Lundström, 1906, *M. nigrofusca* Dziedzicki, 1884, *M. stolida* Walker, 1856 and *M. sumavica* Laštovka, 1963, for which fungal hosts were so far unknown have been obtained with emergence traps over dead wood (Jakovlev, J., Penttinen, J., Polevoi, A., Salmela, J. & Ståhls-Mäkelä, G., in prep.).

Generally, *Mycetophila* species, particularly those associated with lignicolous fungi, tend to colonize a few related fungal hosts, e.g. *M. adumbrata* and *M. vittipes* Zetterstedt, 1852 – slime moulds; *M. laeta* Walker, 1848, *M. tridentata* Lundström, 1913 and *M. trinotata* Staeger, 1840 – polypores; *M. attonsa* Laffoon, 1957 – *Fomitopsis pinicola*; *M. cingulum* Meigen, 1830 – *Polyporus squamosus* and *Grifola frondosa*; *M. forcipata* Lundström, 1911 – *Piptoporus betulinus*. There are, however several generalists like *M. alea* Laffoon, 1965, *M. fungorum* De Geer, 1776, *M. ichneumonea* Say, 1823, *M. luctuosa* Meigen, 1830, *M. marginata* Winnertz, 1863, *M. ocellus* Walker, 1848 able to colonize tens of fungal species from different orders and ecological groups.

** *Mycetophila abiecta* (Laštovka, 1963). 2 ♂♂, Site 1, reared from moist fallen, moss-covered trunk of willow (*Salix caprea*) without fungal fruiting bodies, 4.–31.VIII.2007. No former rearing records.

Mycetophila adumbrata Mik, 1884. 1 ♂, Site 20, ex *Lycogala epidendrum* on burned birch stump 27.VII.–24.VIII. 2008. Formerly reared from slime moulds (Zaitzev 2003, Ševčík 2006).

Mycetophila attonsa (Laffoon, 1957). 2 ♂♂, Site 20, ex. *Fomitopsis pinicola* on burned pine stump, 19.V.–9.VI. 2003; 1 ♂, Site2, ex *Fomitopsis pinicola* on grey alder, 12.–28.VIII. 2005. Formerly reared only from *Fomitopsis pinicola* (Ševčík 2006).

Mycetophila autumnalis Lundström, 1909. 1 ♂, Site 5, reared from larvae under loose bark of spruce log on thick sterile fungal tissue on the surface of decayed wood, 29.V.–4.VII.2008. Formerly reared from larvae found on fungal mycelium under bark of rotting spruce log (Zaitzev 2003).

Mycetophila bialorussica Dziedzicki, 1884. 3 ♂♂, Site 15, ex. *Polyporus melanopus* on the ground along roots of dead birch, 2.IX.–13.X.2008. Probably confined to *Polyporus* as confirmed by recent observations (Zaitzev 2003, Ševčík 2006).

***Mycetophila bohemica* (Laštovka, 1963). 1 ♂, Site 5, reared from thin top piece of strongly decayed spruce log bearing resupinate fruiting bodies of *Leucogyrophana romellii*, larvae under bark, 29.V.–4.VII.2008. No former rearing records.

** *Mycetophila dziedzickii* Chandler, 1977. 1 ♂ Site 21, reared from fallen birch trunk; larvae under loose bark bearing fruiting bodies of *Scytinostroma galactinum*, 19.V.–19.VI.2003. No former rearing records. The related species *M. lunata* Meigen, 1804 has been reared from *Coniophora puteana* (Chandler 1993a) and *Hygrophoropsis aurantiaca* (Kurina 1994).

Mycetophila flava Winnertz, 1863. 1 ♂, Site 21, ex *Neolentinus lepideus* on burned pine stump, 9.–28.VI.2003. Formerly reared from the same fungus species, also from *Leccinum*, *Amanita*, *Kuehneromyces*, *Inocybe* (Jakovlev 1994) and *Pleurotus* (Rimšaite 2000).

Mycetophila formosa Lundström, 1911. 2 ♂♂, Site 20, ex. *Phlebia radiata* on burned birch trunk, 6.VII.–13.VIII.2005; 1 ♂ Site 5, reared from moist, whitish, strongly decayed wood of spruce log bearing *Trechispora hymenocystis*, 16.VIII.– 11.IX.2008. Formerly reared from *Phlebia radiata* (Edwards 1925, Buxton 1960).

Mycetophila fungorum De Geer, 1776. 1 ♂, 3 ♀♀, Site 5, ex. *Armillaria mellea*-group, 18.VIII.–6.IX.2003. Formerly reared from tens of species of agarics (Jakovlev 1994) and obtained with emergence traps over dead wood (Jakovlev *et al*. 1994), soil and ground vegetation (Økland 1999).

Mycetophila hetschkoi Landrock, 1912. 4 ♂♂, 3 ♀♀, Site 7, ex. *Bankera fuligineoalba*, 7.–

29.IX.1998. Formerly reared from *Clavariadelphus*, *Ramaria*, *Bankera* and *Sarcodon* (Dely-Draskovits 1974, Jakovlev 1994) and probably confined to this fungal host group.

Mycetophila ichneumonea Say, 1823. 1 ♂, Site 5, ex. *Armillaria mellea*-group, 18.VIII.–6.IX.2003. Formerly reared from various agarics.

Mycetophila laeta Walker, 1848. 1 ♂, Site 14, ex *Fomitopsis pinicola* on grey alder, 4.V.–13.VI.2008. Formerly reared from the same fungus species (Zaitzev 1984c, Jakovlev 1995, Ševčík 2006), *Phellinus igniarius* (Kurina 1994), and *Ph. tremulae* (Rimšaite 2000).

** *Mycetophila lubomirskii* Dziedzicki, 1884. 1 ♂, Site 5, reared from larvae in rotting wood of spruce log with *Steccherinum luteoalbum* on the surface, 24.VII.–6.VIII.2007; 3 ♂♂ Site 5, ex. *Asterodon ferruginosus* (both fertile and sterile tissues) on strongly decayed, moss-covered spruce log lying on moist swampy ground, 25.VIII.–19.IX.2008. No former rearing records.

Mycetophila luctuosa Meigen, 1830. 1 ♂, Site 21, ex *Neolentinus lepideus* on burned pine stump, 9.–28.VI.2003 (in company with *Mycetophila flava*). Formerly reared from wood-growing *Kretzchmaria deusta*, *Chondrostereum purpureum* (Buxton 1960), *Sebacina incrustans* (Chandler 1993a), *Neolentinus tigrinus* and *Pleurotus* spp (Ševčík 2006), *Trametes versicolor* (Plassmann 1971) and a wide range of epigeic fungi, mostly Russulaceae.

Mycetophila marginata Winnertz, 1863. 2 ♂♂, 3 ♀♀, Site 4, ex *Bjerkandera adusta* on spruce stump, 2.–18.IX.2003; 4 ♂♂, 2 ♀♀, Site2, ex *Bjerkandera adusta* on grey alder, 12.VIII.–1.IX.2005; 2 ♂♂, Site 10, ex. *Trametes velutina* on birch stump in clear-cut, 31.VIII.–16.IX.2008. This species is polyphagous in wood-growing fungi, but was also reared from the epigeic *Paxillus involutus* (Madwar 1937), *Hebeloma crustuliniforme* and *Russula vesca* (Chandler 1993a).

Mycetophila ocellus Walker, 1848. 1 ♂, Site 4, ex *Bjerkandera adusta* on spruce stump, 2.–18.IX. 2003; 1 ♂, same place, ex *Phlebia radiata* on decaying birch log, 24.V.–12.VI.2006; 1 ♂, Site 4, ex *Stereum rugosum* on grey alder lying on the ground, 12.V.–29.V.2007. This species is polyphagous in many wood-growing fungi (Jakovlev 1994), but was also reared from terrestrial agarics like *Chroogomphus*, *Amanita* and *Psathyrella* (Chandler 1993a).

Mycetophila strigatoides Landrock, 1927. 1 ♂, Site 15, ex. *Polyporus melanopus*, on roots of dead birch, 27.VIII.–29.IX.2008. Formerly reared from *Trametes* (Zaitzev 1984c), *Polyporus*, *Neolentinus* (Jakovlev 1995, Ševčík 2006), *Lyophyllum* (Rimšaite 2000) and *Russula* (Jakovlev 1995).

Mycetophila subsigillata Zaitzev, 1999. 1 ♂, Site 10, ex. *Hohenbuehelia petaloides* on decayed slash-residues on clear-cut, 23.VI.–20.VII.2002. Formerly reared from *Clitocybe* sp. (Zaitzev 2003). This species has recently been segregated from the closely related *M. sigillata* Dziedzicki, 1884 and, therefore, records for *M. sigillata* cited in Jakovlev (1994) may apply to this species as well.

** *Mycetophila xanthopyga* Winnertz, 1863. 1 ♂, Site 20, ex. *Phlebia radiata* on birch trunk, 6.VII.–18.VIII.2005. No former rearing records.

Genus *Phronia* Winnertz.

At present 68 species are known from Europe, of these 62 species are found in the Nordic region (Jakovlev & Polevoi 2009). Larval microhabitats are recorded only for twelve of them. Generally, *Phronia* larvae are protected with a kind of slime case and, therefore, able to live on the surface of wood encrusting fungi, on moulds growing on fallen wet branches, logging residues, etc. Since *Phronia* larvae are not common inhabitants of fungal fruiting bodies, fungal hosts have been recorded only for two species, *P. siebeckii* Dziedzicki, 1889 that has been reared from fruiting bodies of *Calocera viscosa* (Buxton 1960, Ševčík 2006) and *P. braueri* Dziedzicki, 1889 – from *Pluteus salicinus* (Chandler 1993a). *P. braueri*, and seven more *Phronia* species: *P. basalis* Winnertz, 1863, *P. biarcuata* Becker, 1908, *P. caliginosa* Dziedzicki, 1889, *P. forcipula* Winnertz, 1863, *P. humeralis* Winnertz, 1863, *P. nitidiventris* van der Wulp, 1859, *P. strenua* Winnertz, 1863 and *P. tenuis* Winnertz, 1863 have been reared from dead wood encrusting with fungi (Steenberg 1924, Edwards 1925, Buxton 1960) and obtained with emergence traps over decaying logs (Jakovlev *et al*. 1994, Irmler *et al*. 1996). *P. taczanowskyi* Dziedzicki, 1889 has been collected by emergence traps on tussocks of the grass

Calamagrostis epigejos (Ševčík & Roháček 2008).

Phronia humeralis Winnertz, 1863. 3 ♂♂, 1 ♀, Site 10, ex. *Chondrostereum purpureum* on the fallen birch twigs retained in heaps in managed spruce forest, 29.V.–4.VII.2008. Formerly reared from *Corticium* (Buxton 1960).

Phronia siebeckii Dziedzicki, 1889. 2 ♂♂, Site 9, ex. *Tremella foliacea* on fallen birch trunk, 18.VIII.–2.X.2005. Formerly reared from *Calocera viscosa* (Buxton 1960, Ševčík 2006).

Phronia strenua Winnertz, 1863. 3 ♂♂, Site 21, reared from larvae on moulds on heavily decayed slash residues (fallen birch branches), 10.IX.–22.X.2003. Formerly has been reared from larvae bearing regular and fairly hard conical black cases, feeding on moulds on sodden fallen and barkless branches (Edwards 1925).

** *Phronia unica* Dziedzicki, 1889. 1 ♂, Site 3, ex. *Physisporinus sanguinolentus* on fallen spruce trunk, strongly decayed, wet and partly covered with moss, 11.VI.–24.VII.2007. No former rearing records.

Genus *Trichonta* Winnertz.
A big genus with 51 species in Europe, rearing records exist for 19 species, of these 18 are from bark-growing fungi. Larvae usually feed internally like those of *Dynatosoma* and *Mycetophila*, but some species have the larval habits similar to those of *Phronia* developing upon the surface of the fungus covered by a sheet of dry mucilage. According to Edwards (1925) *T. foeda* Loew, 1869 develops under patches of mucilage and excrement on the under surface of the fungus *Stereum hirsutum*; in most cases in association with *T. falcata* Lundström, 1911. Occurrence of larvae of *T. hamata* Mik, 1880 and *T. perspicua* van der Wulp, 1892 on fungal mycelium growing on rotting wood recorded by Zaitzev (2003) allows the suggestion that they are feeding on fungal mycelium, but may also indicate the pupation place. One species, *T. venosa* (Staeger, 1840) has been reared by Edwards (1925) from larvae living in puff-balls, *Lycoperdon* sp., thus differing markedly in habits from those of the other species members of *Trichonta*.

Trichonta brevicauda Lundstrom, 1909. 4 ♂♂, 4 ♀♀, Site 5, ex. *Lentinellus vulpinus* on birch log, 24.IX.–7.X.2008. According to Gagné (1981) in Vermont, (USA) was reared from the same fungal species.

Trichonta flavicauda Lundström, 1914. 1 ♂, Site 5, ex. *Trichaptum abietinum* on spruce log, 29.V.–14.VI.2008. Formerly reared from *Trichaptum laricinum* (Zaitzev 2003).

* *Trichonta hamata* Mik, 1880. 1 ♂, Site 13, ex. *Peniophora laurentii* on strongly decaying birch log lying on the ground, 24.IX.–13.X.2007. Formerly reared from fungal mycelium on the surface of rotting wood (Zaitzev 1984c).

Trichonta girschneri Landrock, 1912. 3 ♂♂, 2 ♀♀, Site 3, ex. *Datronia mollis* on decaying aspen log hanging 0,5 m above the ground, 22.V.–17.VI.2006. Formerly reared from a resupinate polypore on spruce in Central Russia (Zaitzev 1984c) and from *Oxyporus* sp. on *Maackia amurensis* in Russian Far East (Zaitzev 2003).

* *Trichonta subfusca* Lundström, 1909. 1 ♂, Site 19, ex. *Exidia repanda* on decaying trunk of mountain birch (*Betula nana*) lying on the ground, 20.VI.–9.VII.2006. Formerly reared from larvae on fungal mycelium in rotten wood (Zaitzev 1984c).

**Trichonta subterminalis* Zaitzev & Menzel, 1996. 1 ♂, Site 4, ex. *Laxitextum bicolor* on aspen log, 18.VIII.–4.IX.2003. Rearing records from the encrusting fungus *Peniophora incarnata* (Chandler 1993a) exist for closely related species *T. terminalis* Walker, 1856.

Trichonta vitta (Meigen, 1830). 2 ♂♂, Site 1, ex. *Hyphodontia paradoxa* on decaying hazel log (*Corylus avellana*), 12.V.–25.VI.2006; 1 ♂, Site 12, ex. *Gloeoporus dichrous* on decaying elm log, 17.VIII.–14.IX.2008. Formerly reared from *Hyphodontia paradoxa* (Edwards 1925, Chandler 1993a).

Genus *Zygomyia* Winnertz.
Nothing is known on the life-history of this genus with thirteen species occurring in Europe, as well as in closely related genus *Sceptonia* Winnertz in spite of the abundance of some species. Edwards (1925, p. 643) suspected that larvae may be saprophagous in their habits since "The reduction in size and general black colouring of the adults are very frequent accompaniments of the adoption of a saprophagous mode of life by the larvae in other groups of Diptera". Indeed, fungal hosts have not hitherto been reported for any members of these

genera. However, six species of *Zygomyia*, viz.: *Z. kiddi* Chandler, 1991, *Z. pseudohumeralis* Caspers, 1980, *Z. semifusca* Meigen, 1818, *Z. pictipennis* (Staeger, 1840), *Z. vara* (Staeger, 1840) and *Z. zaitzevi* Chandler, 1991 have been obtained with emergence traps over dead wood (Jakovlev, J., Penttinen, J., Polevoi, A., Salmela, J. & Ståhls-Mäkelä, G., in prep.) that together with new rearing records listed below prove associations with wood-growing fungi.

** *Zygomyia pictipennis* (Staeger, 1840). 1 ♂, Site 20, ex. *Cylindrobasidium laeve* on spruce stump, 14.VI.–18.VII.2005. No former rearing records.

** *Zygomyia vara* (Staeger, 1840). 1 ♂, 2 ♀♀, Site 12, reared from larvae under bark of decaying fallen branch of mountain ash (*Sorbus aucuparia*) bearing numerous fruiting bodies of *Encoelia fascicularis* 18.VIII.–17.IX.2004. No former rearing records.

** *Zygomyia zaitzevi* Chandler, 1991. 1 ♂, Site 3, reared from fallen birch trunk, the larvae under loose bark bearing *Phlebia tremellosa*, 23.VII.–13.VIII.2008. No former rearing records.

Tribe Exechiini

Genus *Allodia* Winnertz

A big genus with more than 40 species currently recorded in Europe. The larvae of those species for which rearing records exist (22 European species and two species from the Russian Far East) are associated with fruiting bodies of macrofungi, mainly soft terrestrial acarics and boleti. There is also a group of species within subgenus *Brachycampta*, viz.: *A.(B.) barbata* Lundström, 1909, *A.(B.) elevata* Zaitzev, 1984, *A.(B.) foliifera* (Strobl, 1910), *A.(B.) neglecta* Edwards, 1925, *A.(B.) silvatica* Landrock, 1912, *A.(B.) triangularis* (Strobl, 1895) and *A.(B.) westerholti* Caspers, 1980 (Chandler 1993a, Jakovlev 1994, Zaitzev 2003, Ševčík 2006), which are chiefly or exclusively associated with terrestrial saprotrophic *Ascomycota* belonging to the order Pezizales.

Allodia (Allodia) lugens Wiedemann, 1817. 4 ♂♂, Site 3, ex *Armillaria borealis* 18.VIII.–12.IX.2004 (in company with *M. strobli*). Formerly reared from many species of macrofungi, chiefly agarics.

Allodia (Allodia) zaitzevi Kurina, 1998. 1 ♂, Site 18, ex. *Pluteus cervinus*, 2.–23.VIII.1991 (erroneously reported in Jakovlev (1993) as *Allodia ornaticollis*). This species has recently been segregated from *A. ornaticollis* Meigen, 1818 and some former rearing records for *A. ornaticollis* in Jakovlev (1994) may apply to this species. Twelve species of macrofungi, *Boletus edulis*, *Suillus bovinus*, *Gomphiduis glutinosus*, *Amanita muscaria*, *A. citrina*, *A. porphyria*, *Tricholoma terreum*, *Russula vinosa*, *R. flava*, *R.fragilis*, *R. paludosa* and *R. velenovskyi* reported by Kurina (1998). Ševčík (2006) reared it from *Collybia butyracea*, *Conocybe aporos*, *Cortinarius cumatilis* and *Russula* sp. and it has been reared in Britain from *Russula ochroleuca* by J. Webb (Peter Chandler pers. comm.).

Allodia (Brachycampta) foliifera (Strobl, 1910). 2 ♂♂, Site 1, ex. *Exidia cartilaginea* on rotting birch lying on the ground, 1.VI.–2.VII.2004; 3 ♂♂, same place, ex. *Peziza badia* 1.–27.VI.2004. Formerly reared from *Peziza* sp. (Jakovlev 1995, under the name of *Allodia triangularis* Strobl, 1895), *Peziza repanda* (Falk & Chandler 2005) and *Peziza micropus* (Ševčík 2006).

Allodia (Brachycampta) neglecta Edwards, 1925. 1 ♂, Site 1, ex. *Verpa bohemica*, 20.V.–12.VI.2004. Formerly reared from Pezizales of the genera *Verpa*, *Gyromitra* and also from the lignicolous agaric *Kuehneromyces mutabilis* (Jakovlev 1994).

Allodia (Brachycampta) silvatica Landrock, 1912. 2 ♂♂, Site 16, ex. *Peziza succosa*, 22.VII.–14.VIII.2001; 1 ♂, Site 10, ex *Peziza* sp., 14.VI.–7.VII.2008. This species has never been reared from fungal species other than Pezizales.

Genus *Anatella* Winnertz

The genus comprises twenty-nine species in Europe, mostly of unknown biology. The larvae probably develop in such microhabitats that make them difficult to find. Reliable rearing records exist only for two species and suggest associations with small lignicolous ascomycetes and jelly fungi. *A. flavomaculata* Edwards, 1925 has been reared from *Cydoniella acicularis* (Chandler 1993a), the other species, *Anatella lenis* Dziedzicki, 1923 has been reared from *Ascocoryne sarcoides* (Ševčík 2006) and from *Exidia glandulosa*

(Plassmann 1971). There are also records for *A. flavomaculata* and *A. minuta* Staeger, 1840 from agarics *Amanita*, *Pholiota* and *Lactarius* (Khalidov 1984) that need confirmation. *A. ciliata* Winnertz, 1863 was collected with emergence trap over dead wood (Jakovlev *et al*. in prep.). I have never succeeded in rearing *Anatella* from fungi with the exception of one female that is not possible to identify.

Anatella sp. 1 ♀, Site 5, ex. *Asterodon ferruginosus* (both fertile and sterile tissues) on strongly decayed, moss-covered spruce log lying on moist swampy ground, 25.VIII.–24.IX.2008.

Genus *Brevicornu* Marshall

The 38 species of this genus occurring in Europe do not resemble closely related species of *Allodia* as well as most other Exechiini in their habits. Associations with fungal hosts are recorded only from southern Europe and due to confused taxonomy of *Brevicornu* need confirmation in most cases. *B. sericoma* (Meigen, 1930) has been reared from *Amanita* (Falcoz 1926) and *B. griseicolle* (Staeger, 1840) – from several Cortinariaceae species: *Hebeloma*, *Inocybe* (Canzanelli 1941, Eisfelder 1955) and *Cortinarius* (Plassmann 1971). One unidentified *Brevicornu* female has been reared from *Russula paludosa* in Finland (Hackman & Meinander 1979).

New records listed below as well as data obtained with emergence traps (Jakovlev, J., Penttinen, J., Polevoi, A., Salmela, J. & Ståhls-Mäkelä, G., in prep.) for *B. fennicum* (Landrock, 1927), *B. fuscipenne* (Staeger, 1840), *B. improvisum* Zaitzev, 1992, *B. ruficorne* (Meigen, 1838), and *B. sericoma* (Meigen, 1830) show that at least part of the *Brevicornu* species develop in dead wood and in soil litter, feeding probably on microfungi.

Brevicornu sericoma (Meigen, 1830). 1 ♂, Site 20, ex. *Chondrostereum purpureum* on fallen birch trunk on burnt clear-cut, 31.VII.–12.IX.2005. The old rearing record from *Amanita rubescens* (Falcoz 1926) needs confirmation.

** *Brevicornu serenum* (Meigen, 1830) 2 ♂♂, Site 1, reared from rotting fallen trunk of willow (*Salix caprea*), larvae under bark covered with moss and bearing resupinate fruiting bodies of *Phellinus conchatus*, 12. –29.V.2006. No former rearing records.

Genus *Cordyla* Meigen

Rearing records exist for eleven of the fifteen species of European fauna, all from fruiting bodies of soft macrofungi; chiefly but not exclusively relate to *Russula* and *Lactarius* (Jakovlev 1994). Almost all of them were also collected with emergence traps from decaying wood (Økland 1999; Jakovlev, J., Penttinen, J., Polevoi, A., Salmela, J. & Ståhls-Mäkelä, G., in prep.).

Cordyla murina Winnertz, 1863. 1 ♂, Site 5, ex. *Asterodon ferruginosus* (both fertile and sterile tissues) on strongly decayed, moss-covered spruce log, 25.VII.–24.VIII.2008. Formerly reared from various soft agarics (Jakovlev 1994) and *Scleroderma verrucosum* (Falcoz 1926).

Cordyla parvipalpis Edwards, 1925. 4 ♂♂, Site 7, reared from strongly decayed wood of pine log bearing *Antrodia* sp., 19.V.–24.VII.1998. Formerly reared from *Russula* (Sakharova 1977) and obtained in emergence traps over decaying pine twigs covered wood with fungal mycelium (Jakovlev *et al*. 1994).

Genus *Exechia* Winnertz

This genus incorporates 44 species in Europe; of these fungal hosts are known for 28 species. The larvae develop within soft fruiting bodies on various agarics, both terrestrial and wood growing, boletes and Russulales. Rearing records from other fungal hosts are known for a few species: *E. cornuta* Lundström, 1914 and *E. lundstroemi* Landrock, 1923 were reared from *Neolentinus lepideus* and from Hydnaceae, *E. lucidula* Zetterstedt, 1938, *E. parva* Lundström, 1909, *E. separata* Lundström, 1913 and *E. spinuligera* Lundström, 1913 – from Pezizales (Jakovlev 1994). Rearing records from bracket fungi exist only for *Exechia fusca*.

Exechia fusca Winnertz, 1863. 4 ♂♂, Site 7, reared from strongly decayed wood of pine log bearing *Antrodia* sp., 19.V.–24.VII.1998 (in company with *Cordyla parvipalpis*); 3 ♂♂, Site 5, ex. *Armillaria mellea*-group, 18.VIII.–6.IX. 2003. Formerly reared from tens of species of agarics (Jakovlev 1994), but there are also a few rearing records from bracket fungi: *Trametes versicolor* (Edwards 1925), *T. gibbosa* (Buxton 1960), soft polypores: *Polyporus squamosus* (Winnertz 1863) and records obtained with emergence traps over soil, litter (Irmler *et al*. 1996) and dead wood (Jakovlev, J., Penttinen, J., Polevoi, A., Salmela, J. & Ståhls-Mäkelä, G., in prep.).

Genus *Exechiopsis* Tuomikoski

This big genus with more than 40 species in Europe was separated from *Exechia* by Tuomikoski (1966), based on morphological differences of the imago. The larval habits of these two genera are also not identical; *Exechia* incorporates species chiefly confined to soft fungi whereas the host range of the *Exechiopsis* is wider and include wood-encrusting fungi, at least for a few species.

Soft agarics are recorded as fungal hosts for seven *Exechiopsis* species of the European fauna. *E. indecisa* (Walker, 1856), *E. clypeata* (Lundström, 1911), *E. intersecta* (Meigen, 1918), *E. fimbriata* (Lundström, 1909), *E. subulata* (Winnertz, 1863), were reared from boletes and Tricholomataceae (Jakovlev 1994, Ševčík 2006), *E. januarii* (Lundström, 1913) – from *Paxillus involutus* (Khalidov 1984) and *E. dumitrescae* Burghele-Balacesco, 1972 – from unidentified wood-growing agarics (Zaitzev 2003). There are also rearing records obtained in Japan by Sasakawa & Ishizaki (1999) for *E. indecisa* from *Russula*, for *E. unguiculata* (Lundström, 1909) from *Mycena* and for five Eastern species from agarics, chiefly wood-growing Mycenaceae.

Wood-growing fungi other than agarics could be the possible hosts for *E. sagittata* Laštovka & Matile, 1974, *E. pseudopulchella* (Lundström, 1912), *E. (Xenexechia) leptura* (Meigen, 1830), which were obtained with emergence traps over dead wood (Jakovlev, J., Penttinen, J., Polevoi, A., Salmela, J. & Ståhls-Mäkelä, G., in prep.) and for three species listed below.

Exechiopsis (Exechiopsis) subulata (Winnertz, 1863). 4 ♂♂, Site 5, ex. *Asterodon ferruginosus* (both fertile and sterile tissues) on strongly decayed, moss-covered spruce log lying on moist swampy ground 16.VIII.–11.IX.2008. Formerly reared from *Suillus variegatus* (Khalidov 1984). In Jakovlev (1994) this record was erroneously given as from *Xerocomus subtomentosus*.

Exechiopsis (Exechiopsis) clypeata (Lundström, 1911). 1 ♂ Site 5, ex. *Asterodon ferruginosus* (in company with *E. subulata*), 16.VIII.–11.IX.2008. Formerly reared from *Suillus bovinus* (Khalidov 1984) and *Mycena galericulata* (Kurina 1998).

** *Exechiopsis (Exechiopsis) pulchella* (Winnertz, 1863). 1 ♂, 1 ♀, Site 3, ex. *Scytinostroma galactinum*, thick sterile tissue on the surface of decayed soft, fibrous and moist birch wood 31.VIII.–27.IX. 2006; 2 ♂♂, 1 ♀, Site 5, ex. *Asterodon ferruginosus*, thick sterile tissue on moist, moss-covered decaying spruce log, 22.VIII.–24.IX.2008. No former rearing records.

Three very small genera: *Pseudobrachypeza* Tuomikoski, 1966, *Pseudorymosia* Tuomikoski, 1966 each comprises in Europe only one species and *Stigmatomeria* Tuomikoski, 1966 (two species), with hitherto poorly known larval microhabitats.

** *Pseudobrachypeza helvetica* (Walker, 1856). 1 ♂ Site 5, reared from larvae on the wet layer of the inner side of bark covered with *Resinicium bicolor* (both fertile and sterile tissues), 15.VII.–22.VIII.2008. No former rearing records.

Pseudorymosia fovea (Dziedzicki, 1910). 3 ♂♂, Site 5, ex. *Asterodon ferruginosus* (in company with *E. clypeata* and *E. subulata*), 16.VIII.–11.IX.2008. Formerly reared from a terrestrial agaric, *Tricholoma fulvum* (Eisfelder 1955).

Stigmatomeria crassicornis (Stannius, 1831). 2 ♂♂, Site 1, ex *Ascocoryne sarcoides* on birch log, 16.V.–25.VI. 2008. Larvae in basal parts of conidia and apothecia growing in the crack of decaying wood. Formerly reared from truffles (Tuberaceae) (Edwards 1925, Chandler 1978, 2010).

4. Discussion

4.1. Methodological conclusions

The traditional rearing method by placing the sample with larvae into a rearing chamber has the value of providing exact information of the fungal hosts and has been successfully used by many researchers. However, although very effective for species developing internally in soft fruiting bodies, this method leads to high mortality of larvae living outside, in delicate webs on the hymenial surface on wood-growing polypores, which are more demanding to moisture conditions and need longer time for larval development that lasts, as a minimum, three to four weeks.

Table. 2. Number and proportion of successful and unsuccessful cultures among different groups of fungi and samples without fruiting bodies. For polypores, corticeous fungi and dead wood: A operated in lab / B operated directly in the forest.

No. of cultures A/B:	Soft fungi	Polypores	Corticoid fungi	Jelly fungi	Ascomycota	Myxomycota	Dead wood	Total
Successful	31	93/6	34/6	6	16	1	1/7	201
Unsuccessful	–	72/4	66/4	6	9	2	78/33	242
Total cultures	31	165	110	12	25	3	119	465
Successful cultures A/B (%)	100	56.4/60	30.9/60	50.0	64.0	33.3	1.3/17.5	43.2
No. of fungal species cultured	12	33	19	5	7	1	–	77
Of these successful	12	31	16	4	6	1	–	71
No. of fungus gnat species obtained	17	60	51	–	7	2	5	110

This could be a reason why most rearing records of fungus gnats relate to macrofungi with well pronounced fruiting bodies, soft at least when young. This does not give a true impression of the entire range of their fungal hosts and I, therefore, tried to sample other fungal groups, such us polypores with resupinate fruiting bodies, corticeous fungi and jelly fungi that have seldom or never been examined by entomologists.

As verified by my experience, both decaying wood and wood growing fungi are exploited by a range of fungus gnat species; they may be found within fruiting bodies or on their surface, on rotting sapwood and inner layer of loosened bark of fallen trunks, branches and well decayed stumps impregnated with fungal mycelia. Wet decaying heartwood is also a suitable place to find larvae of certain fungus gnat species. These breeding sites favourable to saproxylic fungus gnats are especially common in old-growth forest sites where fallen wood is left to decay on the ground but occur also in city forests and parks harbouring old deciduous trees with holes and moribund parts.

On the other hand, to find full-fed fungus gnat larvae and manage successful rearing of adults is a matter of luck. Larval webs could be easily found outwardly because of their glistening, but the procedure of detaching them together with resupinate fruiting bodies to place into a rearing chamber very often leads to the forthcoming death of the larvae. The reasons could be deterioration of the substrate, destruction of larval webs and altering microclimatic conditions, first of all moisture. Not least is the problem of food supply; larvae of many keroplatids and some mycetophilids, like *Neoempheria*, could be predatory feeding on the other wood-decay associates which they encounter, and simply die because of starvation.

A range of fungus gnat larvae including some Gnoristinae and Mycetophilinae live in softened wood without well-pronounced webs and in some species are aggregated in large colonies. Generally, they are easier to culture but only in those cases when the wood becomes soft enough to allow detaching carefully a piece containing larvae from the trunk or stump. Another option is to find larvae on relatively small pieces of wood, e.g. on fallen branches, that make them easier to transfer into rearing chambers.

In this study a wide range of wood-growing fungi with different characters of fruiting bodies were used for rearing fungus gnat larvae. The pooled sample comprises a total of 465 cultures, including both fruiting bodies and pieces of decaying wood with fungal mycelia (Table 2). Of these only 43.2%, i.e. 193 cultures of 71 fungal species and eight cultures with fungal mycelia (altogether 201 cultures) were successful, i.e. reared imagoes occurred in the containers.

Comparing the percentages of successful and unsuccessful cultures that were transferred to the laboratory (A) and those operated directly in the forest (B), one with another, indicates for which group of fungi the methods of rearings implemented in this investigation are applicable and for which they are in need of further modification.

As expected, culturing soft and ephemeral fruiting bodies of wood-growing agarics like *Armillaria*, *Hypholoma*, *Pholiota*, as well as *Neolentinus*, *Lentinellus* and some relatively soft polypores like *Polyporus*, *Postia*, *Sparassis* (totally 31 cultures), were always successful.

Difficulties occurred with species associated with bark-encrusting fungi and decaying wood on which my study was chiefly focused. Samples of polypores with fungus gnat larvae and cocoons have produced adult flies in 56.4% of cultures, those with corticeous fungi – in 30.9%. Among Ascomycotina cultures with large fruiting bodies of saprotrophic *Pezizales* were usually successful while those with wood-growing species failed in most cases. Number of cultures of jelly fungi and slime moulds (that were successful in 50% and 33% respectively) were too small to make any conclusions based on this investigation. Finally, the lowest proportions of successful cultures were obtained using samples with larvae that develop in decaying wood without fruiting bodies. These fungus gnat species seem almost uncultivable under laboratory conditions and most of my rearing experiments failed.

This leads to a conclusion that the results obtained with the emergence traps for rearing species from pieces of dead wood or sections of entire logs in their original locality, thus keeping the substrate and microclimatic conditions almost unchanged, should form the basis of the rearing records. However, although very practical for revealing larval microhabitats, the majority of records refers only to a tree species and stage of decay and, therefore, is not valuable to specify the exact fungal host species.

Väisänen (1981) pioneered the rearing method surrounding the sporophore with an open metal cylinder to prevent pupating larvae from leaving, and then used the soil samples for rearing adults during the winter. The results obtaining four species of *Mycomya* that had never been reared from soft fungi before have indicated high effectiveness of this method that could be used for further rearing of larvae of the fungus gnat species that develop in soil and litter.

In this study focused on wood-growing fungi, Väisänen's method with soil samples is not applicable. However, as it was mentioned in the methods section, sixty containers (ten with polypores, ten with corticeous fungi and forty with larvae in/on decaying wood without fungal fruiting bodies) were operated directly in forest that allowed them to pupate in more natural conditions. Although these numbers are disproportionally small in comparison with ca 400 containers transferred into the laboratory, I have found that this method has some advantages in the case of fungoid wood samples, where the percentage of successful cultures was 17.5 versus 1.3% using standard breeding techniques. In case of fruiting bodies the effectiveness of both methods was about the same.

4.2. Associations with different fungal hosts

Current knowledge on the larval diet of fungus gnats is almost exclusively based on the fact that they are associated with fungi growing on different substrates and are, therefore, mycetophagous. Studies containing primary data that could verify mycophagy, predation or saprophagy as a type of larval nutrition are very scanty. Matile (1997) analysed all suitable literature based on the studies of the larval mouthparts (Madwar 1937, Plachter 1979b, Zaitzev 1979, 1984b), digestive system (Zaitzev 1983, 1984a), types and chemical contents of larval webs (Mansbridge 1934, Plachter 1979a) and proposed predation only for a few genera of Keroplatidae (e.g. *Orfelia*, *Platyura*, *Xenoplatytura*, *Macrocera*) and some Mycomyinae, e.g. *Neoempheria*, that live in webs on decaying wood or on soil litter. Other fungus gnat species associated with sporophores most probably feed on spores or/and hyphae, those living under bark and in rotting wood perhaps consumes hyphae only. There are also a few species found as larvae in nests of birds and mammals (some *Docosia* and *Leia* species), on the walls of caves (*Speolepta leptogaster* Winnertz, 1863) or amongst bryophytes (*Gnoriste* species – mosses, *Boletina dubia* – liverworts), that could be saprophagous or phytophagous, but this needs confirmation.

As regard to associations with different species of fungal hosts, fungus gnats as well as other Diptera associated with macrofungi are generally viewed as polyphagous and able to colonise fungi

Table 3. Numbers and percentage of fungus gnat species with known and unknown larval microhabitats (Mhb) in Europe. Abbreviations of fungus gnat groups: Bol, Bolitophilidae; Dia, Diadocidiidae (including *Sciarosoma*); Dit, Ditomyiidae; Ker, Keroplatinae; Mac, Macrocerinae; Myc, Mycomyinae; Sci, Sciophilinae; Gno, Gnoristinae; Lei, Leiinae; Exe, Exechiini; Myce; Mycetophilini; Man, Manotinae.

	Bol	Dia	Dit	Keroplatidae		Mycetophilidae							Total
				Ker	Mac	Myc	Sci	Gno	Lei	Exe	Myce	Man	
Mhb known*	21	4	4	17	10	33	52	25	14	113	123	1	417
%	58.3	57.1	100	27.0	21.7	34.0	56.5	20.8	27.5	40.5	40.9	100	38.0
Mhb known**	21	5	4	20	14	44	55	47	19	132	136	1	498
% **	58.3	71.4	100	31.7	30.4	45.4	59.8	39.2	37.3	47.8	45.2	100	45.4
Total in Europe	36	7	4	63	46	97	92	120	51	279	301	1	1,097

* Data obtained with emergence traps not included.
** Data obtained with emergence traps included.

belonging to different taxonomic and ecological groups. This is well confirmed by the existence of many generalist Diptera species which have been reared by various authors from tens species of mushrooms (Chandler 1978, Jakovlev 1994) and explained by the fact that soft and ephemeral fruiting bodies constitute an unpredictable food source (Hanski 1989).

Wood-growing fungi having relatively long lifespan of the fruiting bodies differ from epigeic fungi in that their occurrence is more predictable. This is consistent with many examples of monophagous species among fungivorous Coleoptera and allows one to assume that certain groups of these fungi might contain specialized species of Diptera as well (Jonsell & Nordlander 2004). With regard to the species covered earlier, my records have confirmed host preferences to certain species of hard polypores (*Keroplatus tipuloides*, *Mycetophila attonsa* and *M. laeta*), soft polypores (*Bolitophila aperta*, *Mycetophila bialorussica*, *Trichonta brevicauda* and *Dynatosoma thoracicum*) and slime moulds (*Mycetophila adumbrata*). A more detailed study focused on tough lignicolous fungi may also throw light on the host preferences of the fungus gnat species that were reared for the first time during this investigation.

To estimate for how many fungus gnat species of the European fauna fungal hosts are actually known (i.e. reliable rearing records exist) at the moment of writing and how many species of fungi were ever recorded as fungal hosts, I tried to summarize all of the available rearing records of fungus gnats. For this I used data obtained both from this investigation and from the literature, including those cited in my summary (Jakovlev 1994, from where I have deleted doubtful records and species that have been further synonymised) and subsequent original rearing records (e.g. Chandler 1993a, Rimšaite 2000, Zaitzev 2003, Ševčík 2006).

The total numbers of fungus gnat species of the European fauna with known and unknown larval microhabitats and their percentage in different taxonomic groups of fungus gnats are presented in Table 3. Data obtained with traditional rearing methods (i.e. hand picking of the larvae with forthcoming rearing of adults in the rearing chambers) and the percentage of the species with known larval microhabitats within different families, subfamilies and tribes of fungus gnats are presented in the two first rows and marked with one asterisk. In the two following rows I calculated those values including data obtained with emergence traps (two asterisks).

A total of 417 species that comprises 38% of the European fungus gnat fauna have been at least once recorded as reared from larvae with indication of the fungal host or some microhabitat other than fungal fruiting bodies. If we add the records obtained with emergence traps, the total amount of the fungus gnat species with known larval microhabitats will equal 498. It means that the average percentage of the fungus gnat species with known larval microhabitats occuring in Europe is now 45.4%, whereas for the remaining 599 species or 54.6%, rearing records are absent so far.

Table 4. Numbers of known fungal hosts from which rearing records of fungus gnats exist. Abbreviations of fungus gnat groups as in Table 3.

Fungal group (no. of fungal host spp.)	Fungus gnat groups and no. of species reared from different fungal hosts											
	Bol	Dia	Dit	Keroplatidae		Mycetophilidae						Total
				Ker	Mac	Myc	Sci	Gno	Lei	Exe	Myce	
Agaricales:												
Epigeic (~240)	17	–	–	–	–	2	4	2	3	72	19	119
Wood-growing (~60)	15	–	–	1	–	2	6	1	5	51	23	104
Boletales (~70)	10	–	–	3	–	5	8	3	4	46	18	97
Russulaceae (~90)	3	–	–	1	–	1	7	1	5	44	21	83
Hydnums, ramarioid & clavarioid spp. (~20)	–	–	1	1	–	5	9	–	3	11	4	34
Lycoperdales (5)	–	–	–	–	–	–	–	1	1	6	1	9
Polypores:												
Soft (~30)	9	–	6	3	–	1	9	1	4	5	20	72
Hard (~60)	1	1	5	10	2	14	23	6	7	4	36	121
Corticeous spp. (~30)	–	1	1	5	–	10	8	5	1	5	32	68
Jelly fungi (~10)	–	–	–	2	–	3	3	–	2	7	8	25
Pezizales (~20)	–	–	–	1	–	1	6	1	3	21	1	34
Wood-growing Ascomycota (~10)	–	–	1	1	–	–	3	–	2	4	3	14
Myxomycota (5)	–	–	–	–	–	–	–	–	–	–	6	4
Decaying wood without fungal fruiting bodies	2	3	4	14	4	17	15	14	6	4	18	102
Soil and litter	–	–	–	–	–	1	–	2	5	3	3	16
Emergence traps:												
Over dead wood (–)	6	3	1	10	11	32	27	39	11	53	66	260
Without dead wood (–)	1	3	–	3	9	6	6	12	2	4	4	50

At the moment of writing, taking into account about fifty species that have been added to the European fungus gnat fauna after 2004, a real percentage of the species with known larval microhabitats is a bit lower. Nevertheless, these values show a considerable increase in the level of knowledge in comparison to calculations in Jakovlev (1994) where numbers of fungus gnat species with known larval microhabitats (after deleting doubtful records and species that were later synomized) are ca 300 species in the Palaearctic region and ca 270 species in Europe (ca 230 species for Mycetophilidae, 21 for Bolitophilidae, 16 for Keroplatidae, 3 for Diadocidiidae and 2 for Ditomyiidae).

The percentage of species with known larval microhabitats varies from 30–40% for groups chiefly associated with dead wood and bark-encrusting fungi (family Keroplatidae, subfamilies Gnoristinae and Leiinae) to 45–58% for groups chiefly reared in/on fruiting bodies (family Bolitophilidae, subfamilies Mycomyinae, Sciophilinae, tribes Exechiini and Mycetophilini). This reflects the better knowledge of the species inhabiting fungal fruiting bodies in comparison with those that do not necessarily live in fruiting bodies. The smallest groups, families Diadocidiidae (including Sciarosoma), Ditomyiidae and subfamily Manotinae that include only a few species in Europe comprise, most likely, only species associated with dead wood and wood-growing fungi.

Numbers of species of different groups of macrofungi and other media from which fungus gnats have ever been reared in Europe are presented in Table 4. A list of recorded fungal hosts cover a total of ca 650 species of macrofungi including a wide range of systematic and ecological groups, like epigeic and wood-growing agarics, boletes, russulas, puffballs, hydnums, ramarioid, clavarioid species, polypores, corticeous, tremelloid species, saprotrophic and lignicolous Ascomycotina and slime moulds. The accumulated numbers of known fungal host species presented in Table 4 are calculated very approximately because different authors in different times and countries often used synonyms or indicated only fungal host genera.

There are also numerous rearing records from larvae collected under bark, in decaying wood, soil and litter without indication of fungal host species. Finally, rearing records obtained with emergence traps placed over dead wood or on soil, litter and ground vegetation, usually without indication of fungal hosts (Jakovlev *et al*. 1994, Irmler *et al.* 1996, Økland 1999, Ševčík & Roháček 2008, Jakovlev *et al*. in prep.) are summarized in separate rows. This summary classifying the present knowledge of the larval microhabitats of fungus gnats allows several conclusions and speculations.

4.2.1. Basidiomycete fungi with soft large fruiting bodies, mainly terrestrial

As it was expected, most of the known fungal hosts belong to macrofungi with soft fleshy fruiting bodies with a cap and stipe, including members of Agaricales, Boletales and Russulaceae in Russulales that formerly were united in the order Agaricales *s.l.* but are now divided into different orders. They comprise, altogether ca 460 species, of these about 300 species of Agaricales (ca 240 epigeic and ca 60 lignicolous species), ca 70 species of Boletales and ca 90 species of Russulaceae. These fungi possess a considerable fungus gnat fauna and the main groups exploiting them are Bolitophilidae and Mycetophilidae, particularly Mycetophilini and Exechiini. In the Bolitophilidae most of the species are associated with fungi of the orders Agaricales and Boletales, while Mycetophilini and Exechiini frequently colonize Russulaceae as well.

In contrast, other subfamilies of Mycetophilidae generally avoid colonizing soft macrofungi. There are only a few exceptions like *Coelophthinia thoracica* (Winnertz, 1863), several species of *Sciophila*, (Sciophilinae), *Coelosia tenella* Zetterstedt, 1852 (Gnoristinae), *Leia bimaculata* Meigen, 1804, *L. winthemii* (Lehmann, 1822) and *Rondaniella dimidiata* (Meigen, 1804) (Leiinae), that have been repeatedly reared from agarics and Pezizales. Some of them, e.g. *Sciophila* species, retain their typical habit to live on the surface of fruiting bodies in slimy webs. Keroplatidae, Diadocidiidae, Ditomyiidae, and Manotinae are chiefly or exclusively absent in soft macrofungi.

Fungi of the order Agaricales (agarics) are exploited by the greatest variety of fungus gnats. In total 119 fungus gnat species have been reared from epigeic agarics and 104 species from agarics growing on wood. It can be supposed that fungus gnat larvae occur in almost all species of these fungi, regardless of size and place of occurrence of the fruiting bodies. In accordance with the hypothesis of the prevalence of polyphagy, fungus gnat species associated with agarics are, as a rule, polyphagous associated with several phylogenetically unrelated fungal hosts whereas specialized species could be exemplified with singletons like *Bolitophila melanoleuci* Polevoi, 1996 which has been reared only from fungi of the genus *Melanoleuca*, *Rymosia batava* Barendrecht, 1938 – from *Inocybe*, and *Mycetophila finlandica* Edwards, 1913 – from *Tricholomopsis*. A group of specialized species of the genus *Brachypeza* are confined to *Pleurotus* that has unclear systematic position but is similar to wood-growing agarics in texture of fruiting bodies.

Boletales, including the soft pore fungi of families Boletaceae (*Boletus*, *Leccinum*), Suillaceae (*Suillus*), Gyroporaceae (*Gyroporus*) and related families (Gomphidiaceae, Hygrophoraceae, Paxillaceae) that have gills under their caps but belong to the same order, have a rich fungus gnat fauna mainly similar with those of the agarics. Altogether 97 species of fungus gnats were reared from these fungi and the most specialized fauna are characterized for the genus *Suillus*. This differs clearly from other boletes by very high infestation of fruiting bodies by *Bolitophila rossica* and *Exechiopsis indecisa* that was a reason to suspect polyphyletic origin of the family Boletaceae (Jakovlev 1980).

Fungi of the family Russulaceae serve as hosts for 83 species of fungus gnats reared from ca 90 species of russulas (genus *Russula*) and milk-caps (*Lactarius*). The majority of them belong to subfamily Mycetophilinae and the proportion of specialized species is higher than among members of Agaricales and Boletales. Several species of *Cordyla*: *C. crassicornis* Meigen, 1818, *C. fasciata* Meigen, 1830, *C. flaviceps* Staeger, 1840, *C. fusca* Meigen, 1804, *C. murina* Winnertz, 1863, *C. nitens* Winnertz, 1863, *C. nitidula* Edwards, 1925, *Exechia*: *E. contaminata* Winnertz, 1863, *E. nigroscutellata* Landrock, 1912, *E. pseudocincta* Strobl, 1910 and *Mycetophila*: *M. blanda* Winnertz, 1863, *M. estonica* Kurina, 1992, are chiefly or exclusively associated with *Russula* and *Lactarius*. Some species clearly prefer particular groups of milk-caps, e.g. *Exechia pseudocincta*, *Mycetophila blanda*, *M. estonica* – *Lactarius-deliciosus* group, while *Exechia contaminata* – *Lactarius necator*.

About twenty species of hydnums, ramarioid and clavarioid fungi (orders Cantharellales, Gomphales and Thelephorales) together are known as hosts of 34 fungus gnat species, with a few exceptions belonging to the family Mycetophilidae. Of these at least one species, *Mycetophila hetschkoi* is strictly confined to this group of fungi.

From puffballs (Lycoperdales) only nine species: *Coelosia tenella*, *Docosia gilvipes* Haliday, 1856, *Allodiopsis gracai* Ševčík & Papp, 2003, *A. pseudodomestica* Lackschewitz, 1937, *Brachypeza bisignata* Winnertz, 1863, *Cordyla murina*, *C. styliforceps* (Bukowski, 1934), *Rymosia pseudocretensis* Burghele-Balacesco, 1972 and *Trichonta venosa* Staeger, 1840 were reared so far.

4.2.2. Wood-growing basidiomycete fungi with tougher fruiting bodies

Wood-growing fungi other than agarics harbour about the same large number of fungus gnats. To use the terms that are in general use among mycologists, wood-growing fungi could be roughly divided into polypores, corticeous fungi that are separated from polypores by non-poroid hymenial surface of fruiting bodies, jelly fungi with jelly-like fruiting bodies, and a group of wood-growing Ascomycota.

Polypores comprise a polyphyletic group of basidiomycetous fungi, the spores of which develop in pores (excluding boleti, but including some lamellate species with hard fruiting bodies). As a substrate for development of fungus gnat larvae, all polypores from which fungus gnats have ever been reared could be categorised either as hard polypores (i.e. species with bark-encrusting fruiting bodies having a hard, woody texture) or soft polypores with relatively soft fruiting bodies, similar to wood-growing agarics in terms of consistency and duration.

The simplest calculations presented in Table 4 demonstrate that only a relatively small portion of the spectrum of species of polypores and ecologically similar fungal groups has been studied for their fungus gnat fauna so far. In total, fungus gnats were reared from ca 60 species of hard polypores, ca 30 species of soft polypores, ca 30 species of corticoid fungi, ca 10 species of jelly fungi, ca 10 species of wood-growing Ascomycota and six species of slime moulds. However, the species pool of fungus gnats associated with these fungi is very diverse. All families and subfamilies are present there, with especially high numbers of Mycomyinae, Sciophilinae and Mycetophilini while the Bolitophilidae and Exechiini are represented by only a few species associated with soft polypores.

Hard polypores present a range of genera, viz.: *Abortiporus*, *Antrodia*, *Antrodiella*, *Bjerkandera*, *Ceriporia*, *Ceriporiopsis*, *Daedalea*, *Daedaleopsis*, *Datronia*, *Fomes*, *Fomitopsis*, *Ganoderma*, *Gloeophyllum*, *Gloeoporus*, *Hapalopilus*, *Heterobasidion*, *Hypodonthia*, *Inonotus*, *Lenzites*, *Oxyporus*, *Phellinus*, *Piptoporus*, *Pycnoporus*, *Rigidoporus*, *Skeletocutis*, *Steccherinum*, *Trametes*, *Trichaptum* from which fungus gnats have been recorded. In total, 121 fungus gnat species were reared from ca 60 species of these fungi. The web spinners of the genera *Mycomya* and *Sciophila* and the free living as larvae *Dynatosoma* and *Mycetophila* are the most diverse. Species with the restricted choice of their fungus hosts are recorded for the most common bracket fungi as *Fomes fomentarius* (*Keroplatus tipuloides*, *Sciophila rufa*), *Fomitopsis pinicola* (*Mycetophila attonsa*), *Hyphodontia* (*Tetragoneura sylvatica*) and *Trichaptum* (*Trichonta flavicauda*).

The category “Soft polypores” in the Table 4 includes both true polypores, including the genera *Amylocystis*, *Climacocystis*, *Fistulina*, *Grifola*, *Laetiporus*, *Meripilus*, *Neolentinus*, *Physisporinus*, *Polyporus*, *Postia*, *Rhodonia*, *Sparassis*, *Trechispora*, *Tyromyces* and also some members of the order Russulales (genera *Albatrellus*, *Hericium* and *Lentinellus*) that are not phylogeneticaly related to polypores but similar in texture of fruiting bodies. Currently 72 fungus gnat species have been reared from ca 30 species of these fungi. Some are restricted to certain hosts, e.g. *Bolitophila rectangulata* – to *Laetiporus sulphureus*, *B. aperta* – to *Amylocystis*, *Leptoporus* and *Postia*; *Mycetophila bialorussica* and *M. cingulum* – to *Polyporus*; *Trichonta brevicauda* – to *Lentinellus*; *Trichonta flavicauda* – to *Trichaptum*; *Dynatosoma thoracicum* – to *Postia caesia*.

Wood-growing non-polyporous fungi with a few exceptions had not previously been the subject of rearing studies. However, they comprise a good place to find larvae of certain fungus gnat species. At the moment rearing records of fungus gnats have been recorded from the genera *Asterodon*, *Bondarzewia*, *Byssomerulius*, *Chondrostereum*, *Coniophora*, *Corticium*, *Cylindrobasidium*, *Laxitextum*, *Leucogyrophana*, *Merulius*, *Mycoacia*, *Peniophora*, *Phlebia*, *Plicaturopsis*, *Resinicium*, *Scytinostroma*, *Serpula* and *Tulasnella*. These fungi are analogous to bark-encrusting polypores in their environmental requirements, consistency of fruiting bodies and in associated fungus gnat fauna as well. They are chiefly colonized by web-spinners, both Keroplatidae (genera *Cerotelion*, *Rocetelion*, *Keroplatus* and *Orfelia*) and Mycetophilidae (*Mycomya*, *Neoempheria*, *Leptomorphus*, *Phthinia*, *Sciophila*, *Syntemna*, *Apolephthisa*, *Ectrepesthoneura*). Besides them there are rearing records for several species of Leiinae (*Rondaniella*) and Mycetophilinae (some *Dynatosoma*, *Mycetophila*, *Phronia*, *Trichonta*, *Pseudorymosia* and *Synplasta*) with free-living larvae. The existing data are generally not sufficient to reveal specialised fungus gnat species, but *Diadocidia ferruginosa* and *Trichonta subterminalis* were repeatedly reared only from these fungi.

Jelly fungi incorporate the five genera: *Auricularia*, *Calocera*, *Exidia*, *Sebacina* and *Tremella*, from which in total 25 species of fungus gnats have been reared. Of these eight species with larvae developing in webs, *Cerotelion striatum* (Gmelin 1790), *Keroplatus testaceus*, *Mycomya marginata*, *M. sigma* Johannsen, 1910, *Neoempheria striata*, *Sciophila hirta*, *S. nonnisilva* and, *S. plurisetosa* Edwards, 1921 were reared from *Auricularia auricula-judae* and one species, *Leia bimaculata* (Meigen, 1804) – from *Calocera viscosa*. Species that develop without webs like *Docosia*, *Allodia*, *Anatella*, *Rymosia*, *Mycetophila*, *Phronia* and *Trichonta* were reared from *Tremella*, *Sebacina*, *Calocera* and *Exidia*. None of the species have been reared with sufficient frequency to be certain that they are restricted to certain hosts though the first rearing records of *Trichonta apicalis* Strobl, 1898 and *Phronia siebeckii* Dziedzicki, 1889 from *Calocera* by Buxton (1960) were subsequently confirmed by Trifourkis (1977), Chandler (1978) and Sevcik (2006).

4.2.3. Ascomycete fungi and slime moulds

Among Ascomycotina fungus gnats use a relatively small number of species for development that might reflect the fact that they have not been enough investigated. From tough lignicolous Ascomycotina only 14 species of fungus gnats have been reared; *Symmerus annulatus* (Meigen, 1830) (*Hypoxylon*), *Neoplatyura flava* (*Daldinia*), *Docosia gilvipes* (*Ustulina*), *Rondaniella dimidiata* (*Hypoxylon*), *Allocotocera pulchella* (Curtis, 1837) (*Daldinia*), *Sciophila hirta* (*Bulgaria*), *Sciophila lutea* (*Kretzchmaria*), *Mycetophila luctuosa* (*Kretzchmaria, Ustulina*), *M. marginata* (*Bulgaria*), *M. ocellus* (*Hypocrea, Kretzchmaria*), *Zygomyia vara* (*Encoenia*), *Anatella flavomaculata* (*Cydoniella*), *Anatella lenis* and *Stigmatomeria crassicornis* (*Ascocoryne*).

Ascomycotina of the order Pezizales with big soft fruiting bodies growing on soil or on well-decayed wood remains (genera *Aleuria*, *Gyromitra*, *Discina*, *Peziza*, *Verpa*) support, in total, 34 fungus gnat species chiefly belonging to Exechiini, Sciophilinae and Leiinae. Several species of *Allodia* (*Brachycampta*) and *Sciophila* clearly prefer to colonise these fungi.

Slime moulds or myxomycetes have a very limited but strictly specialised fungus gnat fauna. Two species of the genus *Platurocypta*: *P. punctum* Stannius, 1831, *P. testata* Edwards, 1925 and two species of *Mycetophila*: *M. adumbrata* and *M. vittipes* were repeatedly reared from slime moulds of the genera *Arcyria*, *Lycogala*, *Mycilago*, *Reticularia* and *Tubifera* but never occurred in fungi. *Manota unifurcata* Lundström, 1913, the unique species of the subfamily Manotinae in Europe has been reared from rotten wood bearing an undetermined myxomycete (Chandler 1978) but there are three additional records from Russia and Finland, one from the surface of very moist, rotten birch wood covered with a grayish coat of an unidentified fungus (Zaitzev 1990), another from decaying alder bearing dead fruiting bodies of *Fomitopsis pinicola* (Jakovlev *et al*. 2006) and the third obtained with emergence trap over fallen aspen trunk bearing *Trametes ochracea*, *Ganoderma lipsiense* and *Tomentella crinalis* (Jakovlev, J., Penttinen, J., Polevoi, A., Salmela, J. & Ståhls-Mäkelä, G., in prep.) where slime moulds were either unrecorded or absent.

4.2.4. Dead wood impregnated with fungal mycelia

This is a very important development site for certain fungus gnat species that are not necessarily associated with fruiting bodies. Currently a total of 102 species have been reared from larvae found in decaying wood impregnated with fungal mycelia or under bark without indication of fruiting bodies. It may be expected that many more species of fungus gnats with unknown larval microhabitats are associated with these substrates, still overlooked in comparison with soft macrofungi. Fungal mycelia in dead wood could serve as larval nutrition for a longer period after fruiting bodies dry out.

A pool of species reared from decaying wood covered with fungal mycelia incorporates all groups of fungus gnats (though records for Bolitophilidae and Exechiini most probably reflect pupation place) and the ratio between different taxa is relatively similar with those found in wood-growing fungi. The number of Keroplatidae, especially Macrocerinae species, obtained from dead wood is higher than those obtained from wood-growing fungi that could reflect the carnivorous diet of some keroplatids. Among Mycetophilidae only Gnoristinae that, according to Zaitzev (1979), could live in old galleries burrowed by other insects, are more diverse in dead wood than in fungal sporophores.

Finally, the very large total of 260 fungus gnat species that have been obtained with emergence traps over dead wood may indicate that at least part of them use it as a development site. This may concern all records of the species that live as larvae in webs (Diadocidiidae, Keroplatidae, Mycomyinae, Sciophilinae, some Gnoristinae and Leiinae) or within decaying wood (some Gnoristinae) and species with larvae protected with a shelter (*Epicypta*, some *Phronia* and *Trichonta*). For instance, using emergence traps has obtained eleven species of *Macrocera* whereas only four species have been reared using traditional methods. I also believe that some Mycetophilinae, e.g. members of the genera *Anatella*, *Brevicornu*, *Zygomyia*, *Sceptonia* and some species of *Exechiopsis* and *Mycetophila*, that have never been reared from fungal fruiting bodies but were obtained with emergence traps, develop in dead wood where they feed on wood-decaying fungi.

On the other hand, emergence traps could produce many species that do not actually breed in decaying wood but may use it as a cover during pupation stage. This may concern records obtained from dead wood samples of members of the Bolitophilidae and those species of the Exechiini and Mycetophilini that are well known as inhabitants of soft fruiting bodies of agarics. Even traditional rearing methods based on handpicking of the larvae found under bark could produce such species as *Bolitophila cinerea*, *Exechia separata*, *Mycetophila fungorum* and *M. luctuosa* (Wallace 1953) that develop within fruiting bodies and usually leave when fully fed.

4.2.5. Soil, litter, moss carpets and other debris containing fungal mycelia

At least 16 fungus gnat species have been recorded from these media. Again, among species that were found by Hackman (1963) in the burrows of voles, some Mycetophilinae, viz.: *Cordyla fasciata*, *Exechiopsis fimbriata*, *Mycetophila fungorum*, *M. luctuosa* are, most probably irrelevant to this development site, but migrated there for pupation. Other species like *Mycomya nitida* and *Docosia gilvipes* also recorded by Hackman (1963) may develop there, as well as *Docosia fumosa* Edwards, 1925, *Leia bilineata* and *L. piffardi* found in bird nests (Edwards 1925, Hutson *et al.* 1980, Rulik & Kallweit 2006). *Speolepta leptogaster* larvae live in silky webs on the walls of caves and feed mainly on algae and other organisms there (Matile 1962).

Specialization to develop in media other than dead wood and wood-growing fungi may be also supposed for some keroplatids like *Neoplatyura flava*, *Pyratula zonata* and several species of *Macrocera* that have repeatedly been obtained in emergence traps on soil and ground vegetation.

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Appendix

Names of fungi from which insects were reared in this investigation.

Basidiomycota. Agaricomycetes
Agaricales
– *Armillaria mellea*-complex.
– *Hohenbuehelia petaloides* (Bull.) Schulzer
– *Hypholoma fasciculare* (Huds.) P. Kumm.
– *Pholiota squarrosa* (Vahl) P. Kumm.
– *Chondrostereum purpureum* (Pers.: Fr.) Pouzar
– *Cylindrobasidium laeve* (Fr.) D.A. Reid
Boletales
– *Leucogyrophana romellii* (Fr.) Ginns
Gloeophyllales
– *Gloeophyllum sepiarium* (Wulfen : Fr.) P. Karst.
Polyporales
– *Antrodia serialis* (Fr.) Donk
– *Antrodia xantha* (Fr.: Fr) Ryvarden
– *Antrodiella pallescens* (=*semisulpina*) (Pilát) Niemelä & Miettinen
– *Antrodiella romellii* (Donk) Niemelä
– *Bjerkandera adusta* (Willd.: Fr.) P. Karst.
– *Byssomerulius corium* (Pers.) Parmasto
– *Datronia mollis* (Sommerf.) Donk
– *Fomes fomentarius* (L.: Fr.) Fr.
– *Fomitopsis pinicola* (Sw.: Fr.) P. Karst.
– *Ganoderma applanatum* (G. lipsiense) (Pers.) Pat.
– *Gloeoporus dichrous* (Fr.: Fr.) Bres.
– *Leptoporus mollis* (Pers. Fr.) Quel.
– *Merulius tremellosus* Schrad.
– *Neolentinus lepideus* (Fr.) Redhead & Ginns
– *Phlebia radiata* Fr.
– *Phlebiopsis gigantea* (Fr.) Jülich
– *Physisporinus sanguinolentus* (Alb. & Schwein.) Donk 1966
– *Polyporus melanopus* (Pers.: Fr.) Fr.
– *Postia alni* Niemelä & Vampola
– *Postia caesia* (Schrad.: Fr.) P. Karst.
– *Postia stiptica* (Pers.: Fr.) Julich.
– *Pycnoporus cinnabarinus* (Jacq.: Fr.) P. Karst.
– *Rhodonia placenta* (Fr.) Niemelä. K.H. Larsson & Schigel
– *Rigidoporus populinus* (Schumach.: Fr.) Pouzar
– *Skeletocutis amorpha* (Fr.) Kotl. & Pouzar
– *Skeletocutis biguttulata* (Romell.) Niemelä
– *Sparassis crispa* (Wulfen) Fr.
– *Steccherinum luteoalbum* (P. Karst.) Vesterh.
– *Steccherinum nitidum* (Pers.: Fr.) Vesterh.
– *Trametes hirsuta* (Wulfen) Lloyd
– *Trametes ochracea* (Pers.) Gilb. & Ryvarden
– *Trametes pubescens* (Schumach.: Fr.) Pilát
– *Trametes velutina* (Pers.) G. Cunn.
– *Trichaptum abietinum* (Pers.: Fr.) Ryvarden
– *Trichaptum pargamenum* (Fr.) G. Cunn.

Basidiomycota. Incertae sedis
Auriculariales
– *Exidia cartilaginea* S. Lundell & Neuhoff
– *Exidia repanda* Fr.
Cantharellales
– *Hydnum repandum* L.: Fr.
Hymenochaetales
– *Asterodon ferruginosus* Pat.
– *Hyphodontia paradoxa* (Schrad.) Langer & Vesterh.
– *Hyphodontia radula* (Pers.) Langer & Vesterh.
– *Hyphodontia barba-jovis* (Bull.: Fr.) J. Erikss.
– *Inonotus radiatus* (Sw.: Fr.) P. Karst.
– *Phellinus conchatus* (Pers.: Fr.) Quel.
– *Phellinus tremulae* (Bondartsev) Bondartsev & Borisov
Russulales
– *Laxitextum bicolor* (Pers.: Fr.) Lentz
– *Lentinellus vulpinus* (Sowerby) Kühner & Maire
– *Peniophora laurentii* S. Lundell
– *Stereum subtomentosum* Pouzar
– *Stereum rugosum* Pers.: Fr.
Trechisporales
– *Trechispora hymenocystis* (Berk. & Broome) K.H. Larss.
Tremellales
– *Tremella foliacea* Pers.: Fr.
Incertae sedis
– *Resinicium bicolor* (Alb. & Schwein.) Parmasto

Ascomycota
Helotiales
– *Ascocoryne cylichnium* (Tul.) Korf
– *Encoelia fascicularis* (Alb. & Schwein.) P. Karst.
Pezizales
– *Peziza badia* Pers.
– *Peziza succosa* Berk
– *Verpa bohemica* (Krombh.) J. Schröt.
Slime moulds
– *Lycogala epidendrum* (J.C. Buxb. ex L.) Fr.