Seventy eight insect species reared from fungi in an ancient, semi-natural beech woodland in the Chilterns

R. Fortey (RF) and P. J. Chandler (PJC)

published online February 2021

Summary

Seventy eight species of non-coleopteran fungivorous insects were raised from fungi collected from an ancient, semi-natural beech wood in the southern Chiltern Hills near Henley. This allows matching the host fungus with the insect species that develop from them. Although many fungivorous insects are polyphagous, others are not, and we have identified food sources for a number of flies that have been known for many years as adults without determining the fungi from which they develop. These include: *Exechiopsis leptura*, raised from *Botryobasidium aureum*; *Mycetophila autumnalis* raised from the bracket *Postia*; *M. lamellata* from *Ceriporiopsis*; *M. unipunctata* from the resupinate *Physisporinus*; *Tarnania nemoralis* from *Clitocybe*, and *Lasiomma seminitidum* from rotting *Meripilus giganteus*. *M. unipunctat*a had been known for more than 200 years without a host being identified. A brief discussion is given of conservation issues around fungivorous insects, in recognition of their importance in the woodland ecosystem.

Introduction

Grim's Dyke Wood is a small part of Lambridge Wood, an extensive tract dominated by mature beech trees and lying about a mile northwest of Henley-on-Thames. It was the subject of a detailed human and natural history published as *The Wood for the Trees* (Fortey 2016). Like many similar Chiltern woods it is underlain by clay-with-flints that cap the high ground, in turn overlying chalk that makes the dry valleys at lower elevations. For centuries, Lambridge Wood was part of the Grey's Court estate (now National Trust) before being sold off in 1922. Documents in the Oxfordshire Records Office prove that the wood was already in existence in 1600 (Fortey 2017) – it is therefore correctly described as ancient. Extensive patches of native bluebells *Hyacinthoides non-scripta*, with Woodruff *Galium odoratum* and Wood Spurge *Euphorbia amygdaloides* are consistent with this. However, its recent history has been dominated by the need for beech for the furniture industry, and after that for tent pegs and brush backs. Regeneration followed the end of that industry in the middle of the last century. The woodland is dominated today by tall beech trees that are mostly about 80-100 years old. Intermixed with these, there is a quantity of ash - now suffering from die-back - with oak, cherry and regenerating wych elm. Holly and hazel are common understory trees.

Current research focuses on the biological diversity supported by this characteristic south Oxfordshire habitat. RF and colleagues collected beetles and published the results in a paper in *Fritillary* two years ago (Fortey et al. 2019), where more background locality information is also given. In that paper particular attention was directed towards beetles associated with fungi. RF is president of the Fungus Survey of Oxfordshire and has determined more than 300 species from Grim's Dyke Wood. The present project to identify the non-coleopteran Insecta with fungivorous habits was initiated five years ago. The insects are mostly flies raised from fungal fruitbodies collected, and then incubated by RF in his home laboratory, in order to establish an unequivocal link between the host fungus and insect species. Flies have been sampled

in flight since the time of the early entomologists, but details of the life cycle of many species has remained unknown. This paper records fungal associations established for the first 78 species raised by RF and identified by PJC. It is possible to continue such research indefinitely, since different fungus species (and new flies) continue to appear each year. This paper was arbitrarily prepared when the number of insect species raised had passed 75 and the research had run for five years.

Materials and methods

The main fungus "season" is late summer and autumn, but varies from year to year according to rainfall. A few species continue into the winter months. Most fungi are relatively ephemeral and it is important to collect and isolate them while they are still in good condition. Many insect larvae eat the fruit bodies of mushrooms and some pupate within the context (cap flesh) of the fungus; others pupate in leaf litter or soil when fully developed. Bracket fungi are usually tougher and have their own associated insect species, many of which develop within the fungus itself. Fungi were collected when they were relatively young and brought back quickly to the laboratory, where the species were determined. For agarics and boleti *Funga Nordica* 2 (Knudsen and Vesterholt 2018) was a standard reference, supplemented with nomenclatural and other updates from the online Checklist of British & Irish Basidiomycetes (based on Legon and Henrici 2005) and the appropriate volumes of *Fungi Europaei*. The Polyporaceae (Berniccia 2005) and Corticiaceae (Berniccia and Gordon 2010) volumes in this series were consulted in the determination of bracket and resupinate species, respectively. The latter grow on the undersides of lying wood and logs and have been less investigated than more showy mushroom species. It is often necessary to cut off resupinates with a sharp knife together with a sliver of the wood to which they are attached.

Once identified, the fungi were placed in closed containers for larvae to develop, if any are present. The laboratory is unheated, but kept frost free. Most specimens were placed on a bed of slightly dampened coir, which is sterile, serves to absorb fluids produced as the fungi decay, and provides a medium in which pupation can occur. Quite frequently, all visible traces of the original fungus will have vanished by then. It is essential to label the fungus species involved. A favoured receptacle for smaller fruitbodies was a Kilner jar in which the lid-disc had been removed and replaced with gauze, which was then tightened with the screw cap. This allows air to penetrate while effectively sealing in any insects that develop. The time taken for flies to appear varies according to species, but is often several weeks, and may be much longer. Unfortunately, the original collection dates of all the fungi were not recorded, so accurate gestation times cannot be presented here. A few examples have been kept over winter and flies appear the following year. Insects of a particular species usually mature at the same time, which helps with spotting when small flies are on the wing. A few days can be allowed for later hatchings, and then the container placed in the freezer to kill the flies. They were then picked out with a fine brush, placed in small tubes of alcohol, and sent to PJC for determination.

As far as the flies are concerned Jakovlev (1994) provided a compilation of previous published records of fungivorous Diptera, to which he added many of his own records. Earlier significant studies had been done by Buxton (1954, 1960) and Hackman & Meinander (1979). Since then, the principal contributions have been by Ševčík (2006, 2010) and Jakovlev (2011). However, this is the first study based on intensive collection from a small area of woodland habitat.

Fungivorous flies in the woodland ecosystem

Fungivorous flies can be very abundant. From one small example of the common ochre brittlegill *Russula ochroleuca* with a cap diameter of about 4 cm more than ninety fungus gnats of a single *Mycetophila* species were raised. From oyster mushrooms *Pleurotus ostreatus*, small *Drosophila* species abound in their hundreds. These small flies provide a significant food source for insectivores. Many of the fungi studied are mycorrhizal associates of *Fagus* and in peak season twenty or so specimens of brittlegills *Russula* or milkcaps *Lactarius* can be found around a single tree. If they are assumed to all yield gnats the numbers of flies generated through the woodland as a whole must be prodigious. The flies themselves support specialist parasitoids. Not all fungi seem to be equally attractive to flies. Several attempts to raise gnats from the large magpie inkcap *Coprinopsis picaceus* met with no success, possibly because this species becomes deliquescent very rapidly. Non-auto-digesting fungi in the same family Psathyrellaceae do support fungus gnats. Very tough bracket fungi, such as *Ganoderma*, are mostly decomposed by beetles (e.g. *Cis* spp. Coleoptera: Ciidae). However, less woody brackets such as *Trametes* and *Polyporus* play host to a variety of flies, and are more persistent than agarics, serving to extend new hatchings into the winter months.

Fly larvae frequently infest the fleshier parts of fungal fruitbodies but do not seem to affect their ability to shed spores from the gills or tubes. Species that get riddled with fly larvae can be as abundant as those that do not. For example, the cep *Boletus edulis* is liable to become flyblown whereas other boletes such as the dotted stem bolete *Neoboletus luridiformis* do not; the blackening brittlegill *Russula nigricans* is corkier than many other brittlegills and persists on the forest floor long after its softer relatives have been eaten away. The reproductive success of most fungi does not seem to be diminished by the insects that they nurture. However, the larvae of a number of flies are probably spore eaters (Jakovlev 2011) and this will directly impact the fecundity of the fungus concerned. Jakovlev (2011) also notes that these species tend to be those that are confined to one, or a few hosts, in contrast to a larger number of much more polyphagous species. There are several examples listed below, including some newly recognised associations. Some species prefer one host although they are recorded from other species: *Mycetophila alea* is common on the blackening brittlegill although it can be found occasionally on other hosts. One fungus, the stinkhorn *Phallus impudicus* is best known for distributing its spores by means of flies consuming its fetid gleba (spore mass). It was not recovered from the study area during the conduct of this survey. Nor is it fungivory in the sense used in this paper.

Insects and hosts

Below is the list of non-coleopteran insects and the host fungi from which they were reared. There was only one lepidopteran (moth), which is listed first. The rest are Diptera. They are listed in alphabetical order of their families (and genera and species within each family) without regard to their higher classification. The commonest and most diverse flies belong to the Family Mycetophilidae fungus gnats, with Drosophilidae dominating in some other samples. Crane flies *sensu lato* belong to the families Pediciidae, Limoniidae, and Trichoceridae. The date given after the fly name is the month/year when the first collection of the insect emerged. The numbers of insects in that collection is after the fungus name. Determinations are by PJC except for the moth (Ian Sims), phorid (Henry Disney) and cecidomyiid (Jan Ševčík). In a few cases precise species identification could not be made in the absence of the

diagnostic male fly. Abbreviations for mushroom genera: C. (*Clitocybe*) H. (*Hypholoma*) P. (*Pleurotus*) Ps. (*Psathyrella*) R. (*Russula*). * Polyphagous species

Table 1. Non-coleopteran insects and the host fungi from which they were reared

INSECT (date)	FUNGUS (First)	OTHER FUNGI (if any) See also Table 2
Lepidoptera		
Tineidae		
*Morophaga choragella** (10/17)	*Megacollybia platyphylla* (1)	
Diptera		
Anthomyiidae		
Lasiomma seminitidum (11/20)	*Meripilus giganteus* (4)	
*Pegomya geniculata** (4/17)	*Trametes versicolor* (1)	
*Pegomya winthemi** (10/18)	*Russula olivacea* (9)	
Bolitophilidae		
Bolitophila occlusa (11/15)	*Postia tephroleuca* agg. (5)	
Bolitophila saundersii (1/16)	*Hypholoma capnoides* (20)	*H. fasciculare*
Cecidomyiidae		
Lestodiplosis polypori (7/17)	*Trametes versicolor* (4)	
Ceratopogonidae		
Forcipomyia sp. (10/17)	*Russula nigricans* (1)	
Ditomyiidae		
Ditomyia fasciata (9/15)	*Trametes versicolor* (15)	
Dolichopodiidae		
Medetera sp. (3/17)	Under fungal bark	
Drosophilidae		
*Drosophila kuntzei**(9/18)	*Boletus edulis* (6)	*M. platyphylla*
*Drosophila obscura** (6/18)	*Laetiporus sulphureus* (5)	
*Drosophila phalerata** (9/16)	*Megacollybia platyphylla* (10)	*P. ostreatus, R. subfoetens*
*Hirtodrosophila cameraria** (12/16)	*Xerocomus pruinatus* (8)	*R. subfoetens*
*Hirtodrosophila confusa** (6/18)	*Laetiporus sulphureus* (3)	
Hirtodrosophila trivittata (9/18)	*Pleurotus ostreatus* (16)	
Leucophenga maculata (7/17)	*Pleurotus ostreatus* (3)	
Fanniidae		
*Fannia canicularis** (3/19)	*Boletus edulis* (3)	
*Fannia monilis** (9/17)	*Polyporus ciliatus* (1)	
Heleomyzidae		
*Suillia atricornis** (9/17)	*Russula foetens* (1)	
*Suillia bicolor** (10/17)	*Hypholoma fasciculare* (1)	*Clitocybe nebularis*
*Suillia variegata** (9/17)	*R. cyanoxantha* (5)	*P. ostreatus, C. nebularis*
Hybotidae		
Drapetis assimilis (9/20)	*Megacollybia platyphylla (1)*	
Limoniidae		
*Achyrolimonia decemmaculata** (3/15)	*Datronia mollis* (2)	4 other brackets
Mycetophilidae		
*Allodia grata** (9/17)	*Megacollybia platyphylla* (3)	
*Allodia lugens** (1/19)	*Laccaria laccata* (3)	
*Allodia ornaticollis** (9/17)	*Inocybe cookei* (4)	*Ps. piluliformis*
*Allodiopsis rustica** (11/17)	*Clitocybe nebularis* (2)	
Brachypeza armata (9/18)	*Pleurotus ostreatus* (3)	

Cordyla fusca (11/20)	*Russula fellea* (6)	
*Docosia gilvipes** (9/17)	*Amanita rubescens* (2)	*Clavulina cinerea*
*Exechia bicincta** (9/18)	*Amanita rubescens* (12)	*Mucidula mucida*
Exechia dizona (11/18)	*Hygrophorus eberneus* (1)	
*Exechia dorsalis** (10/17)	*Amanita citrina* (4)	4 other agarics/boleti
*Exechia fusca** (11/16)	*Xerocomus pruinatus* (4)	many other agarics
Exechia seriata (9/20)	*Russula risigalina* (8)	
*Exechia spinuligera** (11/20)	*Pluteus cervinus* (1)	
Exechiopsis leptura (12/18)	*Botryobasidium aureum* (9)	
Mycetophila alea (10/20)	*Russula nigricans* (29)	
Mycetophila autumnalis (10/20)	*Postia tephroleuca* agg. (2)	
*Mycetophila britannica** (11/15)	*Russula fellea* (6)	several other agarics
Mycetophila dentata (6/18)	*Polyporus squamosus* (4)	[new host sp.]
Mycetophila formosa (10/20)	*Phlebia radiata* (2)	*Byssomerulius corium*
*Mycetophila fungorum** (11/15)	*Amanita citrina* (16)	many other agarics/boleti
Mycetophila lamellata (11/20)	*Ceriporiopsis gilvescens* (15)	
Mycetophila luctuosa (10/20)	*Clitocybe phaeopthalma* (2)	
*Mycetophila ocellus** (1/21)	*Phlebia tremellosa* (3)	[new host sp.]
Mycetophila ornata (3/17)	*Trametes versicolor* (1)	
*Mycetophila perpallida** (11/16)	*Xerocomus pruinatus* (3)	several agarics
*Mycetophila ruficollis** (11/16)	*Collybia butyracea* (1)	*Hypholoma fasciculare*
Mycetophila unipunctata (11/20)	*Physisporinus sanguinolentus* (6)	
*Mycomya marginata** (2/16)	*Trametes versicolor*	
Platurocypta testata (10/17)	*Tubifera ferruginosa* (6)	
Pseudexechia trivittata (11/20)	*Parasola conopila* (3)	
Pseudexechia tuomikoskii (11/20)	*Psathyrella piluliformis* (1)	*Ps conopila*
Sciophila baltica (10/17)	*Hydnum repandum* (2)	
*Tarnania fenestralis** (12/20)	*Clitocybe nebularis* (7)	
Tarnania nemoralis (10/20)	*Clitocybe phaeophthalma* (2)	
Trichonta foeda (4/16)	*Stereum hirsutum* (2)	
Trichonta vitta (12/15)	*Schizopora paradoxa* (3)	
Pediciidae		
*Ula mollissima** (1/16)	*Spongipellis delectans* (1)	*Phlebia radiata*
*Ula sylvatica** (10/17)	*Schizopora paradoxa* (1)	*R. nigricans*
Phoridae		
Megasella flavicans (7/17)	*Pleurotus ostreatus* (2)	
Platypezidae		
Polyporivora ornata (9/15)	*Trametes versicolor* (6)	
Polyporivora picta (1/17)	*Trametes versicolor* (3)	
Psychodidae		
*Psychoda lobata** (9/16)	*Megacollybia platyphylla* (3)	
Sciaridae		
Bradysia sp. (9/17)	*Agaricus sylvicola* (3)	
*Lycoriella ingenua** (1/16)	*Spongipellis delectans* (8)	*P. ostreatus*
Scatopsciara sp. (1/21)	*Gloeocystidiellum porosum*	
Trichosia caudata (6/18)	*Laetiporus sulphureus* (1)	
Sphaeroceridae		
*Apteromyia claviventris** (9/20)	*Megacollybia platyphylla* (1)	
*Crumomyia fimetaria** (1/17)	Fungoid muntjac pellet	
Crumomyia roserii (1/17)	*Mycena pura* (2)	
*Gigalimosina flaviceps** (2/16)	Fungoid roe deer pellet (1)	
*Spelobia clunipes** (4/16)	Fungoid roe deer pellet (1)	

Spelobia parapusio (11/17)	*Bjerkandera adusta* (2)
Syrphidae	
Cheilosia scutellata (10/18)	*Boletus edulis*(1)
Trichoceridae	
*Trichocera rufescens** (1/21)	*Clitocybe nebularis* (2)
*Trichocera saltator** (12/16)	*Armillaria gallica* (1)

Note: two taxa – *Drapetis* and *Forcipomyia* - listed above, may not belong with fungivorous species, and are not counted, but since they were recovered from the appropriate samples they are included for the sake of completeness.

Figure 1 *Exechiopsis leptura.* Photo by Janet Graham

Figure 2 *Mycetophila unipunctata.* Photo by Janet Graham

Polyphagous species

A large number of the insect species listed are polyphagous, that is, they are able to mature as larvae in many different fungi. This is particularly the case with those many agarics and boleti with soft and ephemeral fruit bodies: it may be a case of 'first come, first served' as a given fungus usually yields numbers of a few species of fly, rather than a wide range of species with few individuals. Some flies are recorded above from a single fungus species, but are actually known from many more, as summarized on a database compiled by PJC. To give one example *Allodia lugens* was only raised from the common deceiver *Laccaria laccata* in the present study, but has been well associated with more than a dozen families of agarics and even one ascomycete. *Mycetophila fungorum* (and its close relative *M. perpallida*) can be raised from most agarics, and discovery of another one is not surprising. Nor are polyphagous species

confined to the Mycetophilidae; species of *Suillia* (Heleomyzidae) and drosophilids can be equally unfussy. Species that are likely to have a broad range of fungal food are marked with asterisks in the list. However, even flies with a wide range of host preferences rarely grow up in both agarics and bracket fungi, which have their own specialists. Within this latter group there seem to be preferences for one particular host.

One polyphagous species that matures within several saproxylic fungi is a small crane fly with densely spotted wings *Achyrolimonia decemmaculata* which has been raised from a variety of brackets in our study, originally from *Datronia mollis* (new host), but subsequently from *Trametes gibbosa*, *Schizopora paradoxa*, *Radulomyces confluens* and *Postia* species. *Datronia* and *T. gibbosa* are particularly hard textured even when young and the latter is mostly consumed by small, specialist beetles of the genus *Cis*, and minute staphylinids, which can be found in great numbers. It seems likely that this crane fly is able to utilize these more intransigent fruit bodies, although *Schizopora* and *Postia* play host to additional species.

New fly-host relationships

A number of flies have been raised from a fungal host for the first time during this study. These flies are not necessarily rare – some of them have been recognized from those captured on the wing for many years - but they have not previously been associated with a host fungus. The most striking example below is *Mycetophila unipunctata*, whose host has not been identified in 200 years of study.

Exechiopsis leptura – this fungus gnat was raised from the yellow anamorph stage of the resupinate *Botryobasidium aureum* growing on rotten beech wood. This is the first time any member of the subgenus *Exechiopsis* (*Xenexechia*) has been identified with a host. *E. leptura* has been collected since its original description by Meigen (1830) and is not uncommon. *Botryobasidium* is a wood decaying fungus, usually marked by white patches on the underside of rotting logs.

Mycetophila autumnalis – associated with *Postia tephroleuca* agg., a soft bracket on fallen beech wood, from which it was raised; the gnat species was first described in Lundstrōm (1909). This is the first rearing from a named fungus: it had previously been reared from mycelium under bark of a rotting spruce log (Zaitzev 2003) and from sterile fungal tissue under loose bark of a spruce log (Jakovlev 2011).

Mycetophila lamellata – associated with *Ceriporiopsis gilvescens*, a resupinate poroid common under somewhat decayed fallen broad-leaved branches. Named over a century ago from mature flies (Lundstrōm 1911), it has not been reared previously.

Mycetophila unipunctata – first described by Meigen (1818) and frequently collected, this fungus gnat was reared for the first time from the red-bruising resupinate poroid *Physisporinus sanguinolentus*, a relatively common species on softening, lying beech wood.

Tarnania nemoralis – this species was reared for the first time from the frequent agaric *Clitocybe phaeophthalma*. Its common and polyphagous relative *T. fenestralis* was found on *C. nebularis*.

Lasiomma seminitidum – a relatively large anthomyiid fly that was collected from decaying *Meripilus giganteus*, a huge, soft-textured bracket at the base of beech stumps. This is the first time it has been reared from a fungal host, but it is known

from bird's nests as a saprophage, and presumably decaying fungi offer a similar habitat.

Flies with host preference

A number of insects raised were from fungi that they appear to favour, although there may be additional records from other hosts. Working through the list given above alphabetically, these include:

Bolitophilidae.

Bolitophila saundersii has repeatedly been found associated with sulphur tuft, *Hypholoma* (Edwards 1925, Buxton 1960). *B. occlusa* only from the soft bracket *Postia* (Ševčík 2010).

Ditomyiidae.

Ditomyia fasciata is regularly reared from the common Turkey tail *Trametes versicolor*, a well-known association (Ševčík 2010).

Drosophilidae.

Hirtodrosophila trivittata can be abundant on oyster mushrooms (*Pleurotus ostreatus*) (Ševčík 2010). The species was recorded first from Britain in 2005 but is now widespread in the south.

Mycetophilidae.

Cordyla fusca favours brittlegills (Russulaceae) (Edwards 1925, Ševčík 2010).

Mycetophila alea has been raised from other species but is particularly abundant in *Russula nigricans* (Edwards 1925, Jakovlev 1994). This fungus is a member of the section Compactae with much tougher and more persistent fruit bodies than most brittlegills, which allow *M. alea* to pupate within the flesh. In their blackened state *R. nigricans* can persist for several months, but we have not recovered flies from specimens in this condition.

Mycetophila formosa had only been recovered from resupinate *Phlebia* spp. (Buxton 1960, Edwards 1925; Jakovlev 2011) but was also obtained from *Byssomerulius corium* in the present study.

Pleurocypta testata is a specialist in the striking red slime mould *Tubifera* and had been reared previously from several other slime moulds (Buxton 1954, Chandler 1993, Ševčík 2010).

Pseudexechia was revised by Kjærandsen (2009), who remarks of *P. trivittata* that it "has been raised from fruiting bodies of coprophilous agarics like *Coprinus*, *Psathyrella* and *Panaeolus* ". The present evidence suggests this may not be entirely accurate. *P. trivittata* was raised from *Parasola* (formerly *Psathyrella) conopila*, which is not coprophilous but a saprobe in beech litter. The recently described *P. tuomikoskii* was raised from *Psathyrella piluliformis*, a species clustering on dead beech wood, and subsequently from *Parasola conopila*. Coprophilous '*Coprinus*' species would now be referred to *Coprinopsis*, *Coprinellus* or *Parasola* in the family Psathyrellaceae, while *Coprinus sensu stricto* is now placed in Agaricaceae and not related to the other 'ink caps' Hence it appears that *Pseudexechia* favours members of

the family Psathyrellaceae rather than being adapted to coprophilous hosts *per se*, although Edwards (1925) did report males of *P. trivittata* hovering over mature horse dung. The family status of *Panaeolus* has not yet been resolved; although the dark spores are like those of some *Psathyrella* spp. not all are coprophilous, and the genus has been considered as related to Psathyrellaceae in the past.

Sciophila baltica was raised from *Hydnum repandum* for the first time in the UK, and is known from the same host elsewhere in Europe (Ševčík 2010).

Trichonta vitta has been associated with *Schizopora paradoxa* since the studies of Edwards (1925) and it has been raised three times during this study (also recorded elsewhere from *Gloeoporus* by Jakovlev (2011). *T. foeda* is regularly associated with *Stereum hirsutum* (Edwards 1925).

Platypezidae.

Polyporivora picta and *P. ornata* are associated with *Trametes versicolor* (Chandler 2001).

Fungi hosting several fly species

To amplify Table 1 a list is given of fungi from which more than one fly species has been raised (Table 2), which identifies the more prolific hosts in this study. The fungi are given in alphabetical order by genus, without regard to classification.

Table 2. Alphabetical list of fungi from which more than one fly species has been raised, a supplement to Table 1.

Fungus	Fly species
Amanita citrina	*Mycetophila fungorum* *Exechia dorsalis*
Amanita rubescens	*Exechia bicincta* *E. fusca* *Suillia variegata* *Docosia gilvipes*
Armillaria spp.	*Mycetophila fungorum* *M. perpallida* *Hirtodrosophila cameraria* *Trichocera saltator*
Bjerkandera adusta	*Ditomyia fasciata* *Spelobia parapusio*
Boletus edulis.	*Drosophila kuntzei* *Cheilosia scutellata* *Fannia canicularis* *Mycetophila fungorum* *M. perpallida*
Clitocybe nebularis	*Allodiopsis rustica* *Suillia bicolor* *S. variegata* *Tarnania fenestralis* *Trichocera rufescens*
Gymnopus erythropus	*Exechia dorsalis* *E. fusca*
Hygrophorus eberneus	*Exechia dizona* *E. fusca* *Drosophila phalerata*
Hypholoma fasciculare	*Suillia bicolor* *Ula mollissima* *Mycetophila ruficollis* *Bolitophila saundersii*
Laccaria laccata	*Allodia lugens*

	Exechia dorsalis
Megacollybia platyphylla	*Allodia grata* *Apteromyia claviventris* *Drosophila kuntzei* *Mycetophila britannica* *M. fungorum* *Psychoda lobata,*
Mucidula mucida	*Hirtodrosophila cameraria* *Drosophila phalerata* *Mycetophila perpallida* *Exechia bicincta*
Mycena haematopus	*Exechia bicincta* *E. fusca*
Pleurotus ostreatus	*Brachypeza armata* *Hirtodrosophila trivittata* *Drosophila phalerata* *Leucophenga maculata* *Lycoriella ingenua* *Fannia monilis* *Megasella flavicans*
Polyporus squamosus	*Exechia bicincta* *Mycetophila britannica* *M. dentata*
Postia sp. *'tephroleuca'*	*Bolitophila occlusal* *Mycetophila autumnalis*
Psathyrella piluliformis	*Allodia ornaticollis* *Pseudexechia trivittata* *P. tuomikoskii*
Russula spp. *(*excl. *R. nigricans)*	*Mycetophila perpallida* *M. britannica* *Exechia seriata* *E. fusca* *Hirtodrosophila cameraria* *Suillia variegata* *Pegomya winthemi* *Cordyla fusca*
Schizopora paradoxa	*Ula sylvatica* *Achyrolimonia decemmaculata* *Trichonta vitta*
Spongipellis delectans	*Ula mollissima* *Lycoriella ingenua*
Trametes versicolor	*Ditomyia fasciata* *Mycetophila ornata* *Polyporivora ornata* *P. picta* *Mycomya marginata* *Pegomya geniculata* *Lestodiplosis polypori*
Xerocomus sp.	*Mycetophila perpallida* *M. fungorum* *Exechia fusca* *E. dorsalis*

The taxonomy of the bolete *Xerocomus* is still in a state of flux. Early records were of the widely reported *X. chrysenteron*, but more recent determinations favour *X. pruinatus* for the common beech wood species.

Figure 3 *Mucidula mucida* Beech tuft or Porcelain fungus, one host for the polyphagous fungus gnat *Exechia bicincta.*

Figure 4 *Trametes versicolor* Turkey tail, a small bracket fungus with several flies specifically associated with it.

Conservation issues

This study shows a wealth of fungivorous insects flourishing within the compass of one relatively small Chiltern beech wood. Many of the species raised were capable of maturing from a variety of mushrooms, and these present few problems for the conservation of their biodiversity. Numbers of fungi vary from year to year, but all seasons produce at least some Russulas and other mycorrhizal genera that provide continuity for fungus gnats and other insects. A different set of species require saproxylic fungi, which need decaying logs as a substrate. Some of these fungi are inconspicuous resupinates growing on the underside of lying branches and other debris, and links between these species and particular mycetophilid species are still being demonstrated. It is clearly important to maintain a good supply of woody material to encourage as wide a variety of these associated fungi/insects as possible, and to leave logs to decay over a considerable time. More specialized fungus gnats like *Exechiopsis leptura* reported here may depend on a single fungal species for successful reproduction, and if the fungus is not common it requires a relatively large stretch of woodland to increase the likelihood of host and gnat meeting up. These relationships are not, perhaps, the most obvious in considering management of woodland habitats to benefit total biodiversity, but a healthy population of fungivorous insects is an important factor in maintaining populations of insectivores higher in the food chain.

Richard Fortey
48 St Andrews Road, Henley-on-Thames, Oxfordshire, RG9 1JD
rafortey@gmail.com
Peter J. Chandler
606B Berryfield Lane, Melksham, Wiltshire, SN12 6EL
chandgnats@aol.com

References

Berniccia, A. 2005. Polyporaceae. Fungi Europaei 10. 806 pp.

Berniccia, A. and Gorjon, S. P. 2010. Corticiaceae s.l. Fungi Europaei 12. 1007 pp.

Buxton, P.A. 1954. British Diptera associated with fungi. II. Diptera bred from Myxomycetes. Proceedings of the Royal Entomological Society of London (A) 29: 163-171.

Buxton, P.A. 1960. British Diptera associated with fungi. III. Flies of all families reared from about 150 species of fungi. Entomologist's monthly Magazine 96: 61-94.

Chandler, P.J. 1993. New rearing records of fungus gnats (Diptera: Mycetophilidae and allied families). Dipterists Digest (First Series) 13: 29-35.

Chandler, P.J. 2001. The Flat-footed Flies (Diptera: Opetiidae and Playpezidae) of Europe. *Fauna Entomologica Scandinavica* 36: 1-276.

Edwards, F. W. 1925. British Fungus-Gnats (Diptera, Mycetophilidae), with a revised Generic Classification of the Family. Transactions of the Entomological Society of London 73: 505-670.

Fortey, J. 2017. The Lambridge Charity estate. Journal of the Henley-on-Thames Archaeological and Historical Group 30: 5-32.

Fortey, R.A. 2016. The wood for the trees. Harpercollins, London, 305 pp.

Fortey, R.A., Booth, R, Barclay, M. and Geiser M. 2019. Beetles from a typical ancient Chiltern beechwood. Fritillary 8, 48-67.

Hackman, W. & Meinander, M. 1979. Diptera feeding as larvae on macrofungi in Finland. Annales Zoologici Fennici 16: 50-83.

Jakovlev, J.B. 1994. Palaearctic Diptera associated with fungi and myxomycetes. Forest Research Institute, Petrozavodsk, 1-127 pp.

Jakovlev, J. 2011. 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. Entomologica Fennica 22: 157–189.

Kjærandsen, J. 2009. The genus *Pseudexechia* Tuomikoski re-characterized, with a revision of European species (Diptera, Mycetophilidae). Zootaxa 2056: 1-45.

Knudsen, H. and Versterholt, J. 2018. Funga Nordica 1965 pp. Nordsvamp, Copenhagen.

Legon, N. W. and Henrici, A. 2005. Checklist of the British and Irish Basidiomycota., 517 pp. R B G Kew.

Lundström, C. 1909. Beiträge zur Kenntnis der Dipteren Finlands. IV. Supplement Mycetophilidae. Acta Societatis pro Fauna et Flora Fennica 32: 1-63.

Lundström, C. 1911. Neue oder wenig bekannte europäische Mycetophiliden. Annales Musei Nationalis Hungarici 9: 390-419.

Meigen, J.W. 1818. Systematische Beschreibung der bekannten europäischen zweiflügeligen Insekten. Erster Theil. xxxvi + 332 + [1] pp. F.W. Forstmann, Aachen.

Meigen, J.W. 1830. Systematische Beschreibung der bekannten europäischen zweiflügeligen Insekten. Sechster Theil. xi + 401 + [3] pp. Schulz, Hamm.

Ševčík, J. 2006. Diptera associated with fungi in the Czech and Slovak Republics. Časopis Slezského Zemského Muzeum Opava (A), suppl. 2, 55: 1-84.

Ševčík, J. 2010. Czech and Slovak Diptera associated with fungi. 112 pp. Slezské Zemské Muzeum Opava.

Zaitzev, A.I. 2003. Fungus Gnats (Diptera: Sciaroidea) of the fauna of Russia and adjacent regions. Part II. International Journal of Dipterological Research 14: 77-386.

Acknowledgements

We thank Jan Ševčík, Henry Disney and Ian Sims for their identifications, and Janet Graham for her photographs of *Exechiopsis* and *Mycetophila* species used in the text.