Fungus gnats (Diptera: Bolitophilidae, Diadocidiidae, Ditomyiidae, Keroplatidae & Mycetophilidae) from Tyresta National Park and Nature Reserve in Sweden

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Faunistic data on fungus gnats from the boreonemoral, old-growth, pine-dominated forests of Tyresta National Park and the surrounding Nature Reserve are presented. The material was collected with Malaise traps, window traps and coloured pan traps at 15 sites in the years 1997–2003. The Tyresta forest suffered from a 450 ha area wild-fire in 1999, and about half (55%) of the samples originates from newly, partly heavily burnt wild-fire sites. Altogether 248 species are recorded, including 22 species new to Sweden, viz. *Symmerus nobilis* Lackschewitz, 1937, *Orfelia unicolor* (Staeger, 1840), *Phthinia winnertzi* Mik, 1869, *Sciophila krysheni* Polevoi, 2001, *Sciophila modesta* Zaitzev, 1982, *Sciophila persubtilis* Polevoi, 2001, *Sciophila setosa* Garrett, 1925, *Boletina edwardsi* Chandler, 1992, *Gnoriste harcyniae* von Röder, 1887, *Allodia* (*Allodia*) *anglofennica* Edwards, 1921, *Allodia* (*Brachycampta*) *foliifera* (Strobl, 1910), *Anatella ankeli* Plassmann, 1977, *Exechiopsis (Xenexechia) perspicua* (Johannsen, 1912), *Synplasta pseudingeniosa* Zaitzev, 1993, *Mycetophila dziedzickii* Chandler, 1977, *Mycetophila gentilicia* Zaitzev, 1999, *Mycetophila lubomirskii* Dziedzicki, 1884, *Phronia distincta* Hackman, 1970, *Sceptonia regni* Chandler, 1991, *Sceptonia thaya* Sevcik, 2004, *Trichonta clavigera* Lundström, 1913, and *Trichonta subterminalis* Zaitzev & Menzel, 1996. Five species (1 *Diadocidia*, 1 *Docosia*, 2 *Cordyla* and 1 *Dynatosoma*) are regarded as new to science and will be described elsewhere. The species richness and composition fits well the general picture of increasing species diversity towards north when compared with other surveys in the Nordic region. The material shows no significant difference between fire-sites and intact forest with respect to number of specimens caught, but the species composition is quite different. As expected, the highest number of species (185) was found at the undisturbed sites, and 43 species are significantly found to be avoiding the fire sites. Still, attraction of many fungus gnats to wild-fire sites is strongly indicated by a high number of species (151) captured there, of which 37 species are significantly over-represented at such sites. For 201 species (81%) the known larval habitat is given, showing that fungus gnats from Tyresta are dependant upon a rich biota of both epigeal and wood-growing fungi, and on decaying wood, particularly of deciduous trees.

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1. INTRODUCTION

Although the fauna of fungus gnats in boreonemoral forests of Sweden has gained considerable attention lately (Økland et al. 2005, Kurina et al. 2005), the fauna is still far from well documented. We report here faunistic data from a study of fungus gnats in the forest of the Tyresta National Park (TNP) and the surrounding Nature Reserve (TNR), situated only 30 km outside Sweden's capital, Stockholm (Figure 1). While Økland et al. (2005) focused on oak-dominated boreonemoral forests the primary aim of this study is to complement the faunistic knowledge by studying an old-growth, pine-dominated forest situated in the same region. In addition the opportunity was given to compare the species composition inside and outside freshly burned wild-fire sites.

Tyresta National Park was established as late as in 1993. Considering the age, structure and general level of undisturbance, the forest of Tyresta is indeed one of very few old-growth forest still left on the mainland south of the river Dalälven in Sweden. Only Gotska Sandön National Park, a small island in the Baltic Sea, is comparable when the amount and age of Scots pine trees are considered. In contrast to most other parts of the country the Tyresta forest was secured from modern forestry already in the 1930's by its purchase by the City Council of Stockholm, and the proximity of the Tyresta forest to the capital of Sweden is paradoxally the most important reason why it is protected today. The area was reserved for future recreational use for the people of the capital, a foresight that left a unique national heritage of exciting nature. The core National Park has

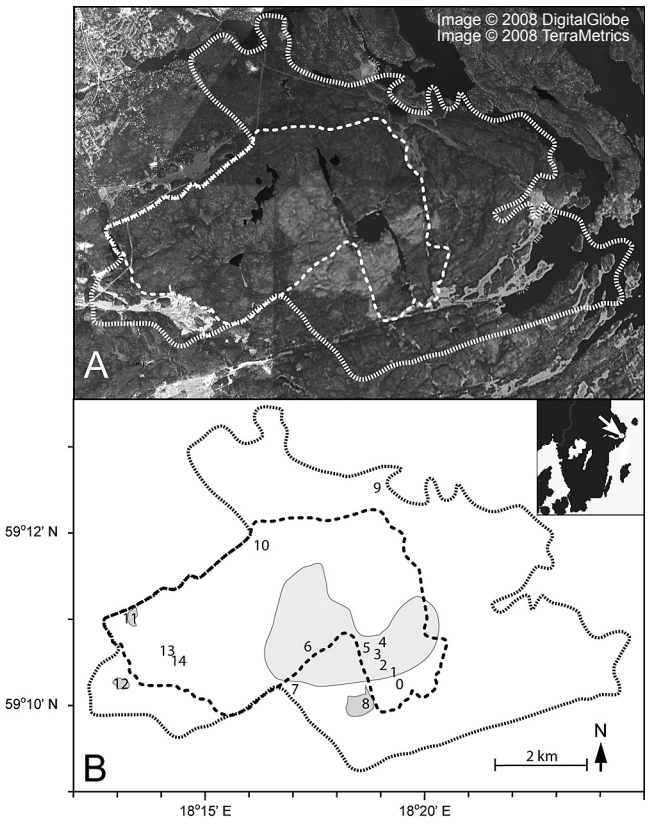

Figure 1. Map of Tyresta Nature Reserve and National Park.
— A. Satellite image downloaded from Google Earth ®mapping service, with border of the outer Nature Reserve and central National Park shown in dotted white. The 450 ha fire site from 1999 is clearly visible as a pale kidney shaped area centrally in the park.
— B. Simplified map of the area showing position of the 15 sampling sites. The numbers correspond to Table 1. The grey shaded areas are those affected by fires.

the surrounding Nature Reserve as a buffer zone, totalling some 4500 hectares. The Tyresta foundation now manages the protected area and the three City Councils (Tyresö, Stockholm and Haninge) as well as the Swedish Government through its Swedish Environmental Agency are represented in the foundation board of trustees.

2. MATERIAL AND METHODS

A documentation survey of saproxylic invertebrates of the Tyresta forest was started in 1996. Following a 450 hectares wild-fire in 1999 the focus of the survey was redirected towards the effects of the fire on the ecosystem and the post-fire insect re-colonization. Hence, suitable parts of the area, in and outside the newly burnt areas, were sampled with various insect traps during 2000-2002 within the frame of an ambitious post-fire documentation program called "The Ephemeral Fauna Project" (TEFP, Ahnlund et al. 2006), initiated and funded by the Swedish Environmental Agency. Documentation of the insect fauna in the area continued with the Swedish Malaise Trap Project (SMTP, Karlsson et al. 2005), where three Malaise traps were operating in Tyresta NP in 2003-2005.

2.1. Sampling sites and material

The data presented in this paper results from the examination of parts of the total material obtained by the projects mentioned above using various methods of collection, viz: Malaise traps, window traps and white, green and yellow pan-traps. List of sites, used traps and trapping periods from which the fungus gnat material has been identified is presented in Table 1. In total the examined material constitute 2479 trap-days. Malaise traps catches dominate with 1698 trap-days (68%), coloured pan-traps make up 416 trap-days (17%), and window traps make up 365 trap-days (15%). The examined catches from wild-fire sites make up 1354 trap-days (55%), while material from forest undisturbed with respect to fires make up 1125 trap-days (45%).

A series of Malaise-traps were deployed along a transect line into the wild-fire site in April 2000, one year after the fire, and one additional site was added in 2001 (Figure 1). Site 0 was outside the burnt area,while sites 1–5, were inside the burnt area. Sites 1–3 protruded with increasing distance from the margin of the burnt area into its core. All these sites were pine-dominated, dry forests on bedrock that had experienced rather similar impact from the fire relating to burn depth, whereas flame-height varied more. Site 4 differed by being spruce-dominated and experienced a weaker impact from the fire, especially affecting the burning depth in the soil. Site 5, where sampling not started until in 2001, was an area with very high fire intensity with crown-fires.

Figure 2. Malaise trap on the site 6 affected with strong wild-fire. Soil destruction is deep, only mineral soil left. Photo Bert Viklund

At site 6 two Malaise traps and two big white pan traps were put out as soon as access to the major August 1999 wild-fire site was considered safe for sampling (Figure 2). Site 7 is a mixed forest with old aspen trees, *Populus tremula*. The Malaise trap was deployed over a big fallen aspen trunk. The yellow pans were situated close by on standing aspens and also on the fallen one. The green pan trap was exposed

Table 1. List of sites, used traps and trapping periods at Tyresta NP and NR from which fungus gnat material have been identified.

* The Ephemeral Fauna Project, ** Swedish Malaise Trap Project.
Trapping method : Mt - Malaise trap, Wt - Window trap, GPT - green pan trap, YPT - yellow pan trap, WPT - white pan trap. The site numbers correspond to Figure 1.

Site	Trapping method	Trap days	Date interval	Forest type	Fire	Soil destruction
0*	Mt	52	4.8-24.9.2000	*Pinus-Betula*	no	no
0*	Wt	52	4.8-24.9.2000	*Pinus-Betula*	no	no
0*	Mt	66	26.5.-30.7.2001	*Pinus-Betula*	no	no
0*	Mt	222	30.10.2001-6.6.2002	*Pinus-Betula*	no	no
1*	Mt	221	14.4.-26.8.2000	*Pinus-Betula*	moderate	deep
2*	Mt	50	14.4.-2.6.2000	*Pinus-Betula*	intermediate	moderate
3*	Mt	85	14.4.-2.6.2000	*Pinus-Betula*	intermediate	moderate
4*	Mt	94	14.4.-15.7.2000	*Picea-Pinus*	weak	weak
4*	Mt	17	10.5.-26.5.2001	*Picea-Pinus*	weak	weak
4*	Mt	161	30.10.2001-7.4.2002	*Picea-Pinus*	weak	weak
4*	Wt	70	1.5.-14.7.2000	*Picea-Pinus*	weak	weak
5*	Wt	83	6.7.-26.9.2000	*Pinus-Betula*	intense	moderate
5*	Mt	200	26.5.2001- 3.1.2002	*Pinus-Betula*	intense	moderate
6*	Mt	140	13.8-20.10.1999	*Pinus-Betula*	strong	deep
6*	WPT	42	9.9.-20.10.1999	*Pinus-Betula*	strong	deep
7*	Wt	49	3.6. -21.7.1997	*Picea-Populus*	no	no
7*	GPT	52	21.7.-10.9.1997	*Picea-Populus*	no	no
7*	YPT	220	28.7.-20.9.2000	*Picea-Populus*	no	no
7*	Mt	95	19.6.-20.9.2000	*Picea-Populus*	no	no
8*	Mt	92	5.5.-15.7.1999	*Pinus-Betula*	intermediate	intermediate
9*	Wt	111	28.5.-14.9.1999	Deciduous, with *Quercus*	no	no
10*	GPT	58	28.5.-24.7. 1999	*Picea-Pinus*	no	no
11*	Mt	37	11.6.-17.7.1999	*Pinus-Picea*	intermediate	moderate
11*	WPT	44	17.7.-29.8.1999	*Pinus-Picea*	intermediate	moderate
12*	Mt	18	31.5.-17.6.2002	*Pinus-Picea*	moderate	weak
13**	Mt	68	8.6.-26.8.2003	*Pinus-Betula*	no	no
14**	Mt	80	2.7.-16.10.2003	*Picea-Pinus*	no	no

already in 1997 under an unusually big sporocarp of *Fomitopsis pinicola* on a spruce log.

The burned sites 8, 11 and 12 below were affected by fire earlier in the season than the major wild-fire site and are also of much smaller size. Site 8 is a 20 hectares wild-fire site from 1997, and thus the material represents part of a fauna on a two year old fire site (as the Malaise trap in Site 5). Site 9 is a coastal deciduous forest and the sampling was done on a big dead oak with almost all bark felled. Site 10 is a rather moist forest site and the green pan trap was put under a sporocarp of *Fomitopsis pinicola* growing on spruce. Site 11 is an exposed wild-fire site with an area of a few hectares that burned in the beginning of June 1999. Site 12 is of the same size as site 11 but in a more closed forest and the wild-fire here started already in late May 1999. Sites 13 and 14 have not been affected by fire for many decades, the former is a pine dominated bedrock forest and the latter is a forest site mainly with spruce.

On the sites 1–12 a 50/50 proportion of glycol and water, with some detergent added, were used to collect the insects. On the sites 13–14 the material was collected in 80% alcohol. The sorted material was then transferred to 80% alcohol for subsequent identification and storage.

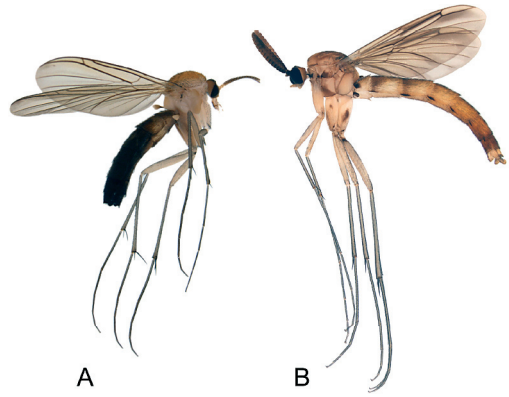

Figure 3. Two of the more conspicuous and interesting fungus gnats recorded from the Tyresta forest. — A. *Macrorrhyncha rostrata* (Zetterstedt, 1851). This poorly known and rare species was described from Östergötland, and it is included in the 2005 Swedish Red List. It is known to have larvae living inside rotting wood of standing beech and oak trunks. — B. *Keroplatus testaceus* Dalman, 1818. The larva of this species requires large bodies of damp rotten wood with bracket fungi and inhabits mainly old-growth forests. Photo Jostein Kjærandsen

2.2. Species identification and digitalization

Careful examination of terminalia is usually needed for identification of fungus gnats. The material was identified in alcohol under stereo microscope by the two first authors (JJ and JK). For parts of the material maceration of the terminalia in KOH was needed for secure identification. A few specimens were slide-mounted in Canada balsam as described by Kjærandsen (2006), the rest are stored dark in 80 % alcohol. All specimens were recorded with unique identification codes using the Biota 2 database software (Colwell 2007), and the list of examined material was extracted from this database. Genera and species are listed alphabetically within a classification basically following Bechev (2000). Nomenclature follows the database of Fauna Europaea (Chandler 2005). All examined material will be deposited at the Swedish Museum of Natural History, Stockholm, Sweden (NHRS).

2.3. Species distribution and larval microhabitats

We use the following categories to classify distribution types of the species: Holarctic (found in Europe and North America), Palaearctic (extending to the eastern part), Western Palaearctic (west of the Ural Mountains and extending outside Europe), European (widely distributed in Europe), and Nordic. The Nordic biogeographical region defined widely as to include three northwestern provinces of Russia (*Lapponia rossica, Karelica rossica* and *Regio Viburgensis*), Finland, Sweden, Norway, Denmark, The Faroes and Iceland. For species new to Sweden and other species considered

noteworthy we present more detailed data on their known distribution.

Data on known larval microhabitats is presented (if not otherwise specified) according to Jakovlev (1994) and further rearing records from fungal fruiting bodies: sporocarps in basidial and ascocarps in ascomycetous fungi (Chandler 1993, Kurina 1998, Papp 2002, Rimšaite 2003, Sevčik 2006, J. Jakovlev, in prep.), decaying wood, soil and leaf litter (Jakovlev et al. 1994, Irmler et al. 1996, Økland 1999, Alexander 2002, Falk & Chandler 2005, J. Jakovlev et al., in prep.). In Table 2 we use the following abbreviations to classify known rearing records of the species:

- Fb (Epi) − fruiting bodies of epigeal fungi of different trophic (both saprotrophic and mycorrhizal species) and systematic groups;
- Fb (Wgr) − fruiting bodies of wood-growing fungi of different systematic groups and slime moulds;
- (DC/CF) − decaying wood of deciduous (DC) or coniferous (CF) trees without any special references to wood-growing fungi;
- mineral soil and leaf litter with and without groung vegetation.

3. RESULTS

The examined material yielded altogether 4 954 specimens, and resulted in the identification of 248 species belonging to the families Bolitophilidae (3), Diadocidiidae (3), Ditomyiidae (1), Keroplatidae (15) and Mycetophilidae (226) (Table 2). Five of the species are considered to be new to science, and 22 species (marked with a *) are recorded for the first time from Sweden. If we look at the wider distribution of the species found at the Tyresta forest we find that 37 % are Holarctic and another 37 % are Palaearctic, while 4 % are restricted to the Western Palaearctic Region, 20 % are only known from Europe, and 3 % are only known from the Nordic Region (Table 3).

The material show no significant difference between fire-sites and intact forest with respect to number of specimens caught, but the species composition is quite different (Table 2). As expected, the highest number of species (185) was found at the undisturbed sites, and 43 species are found ($p < 0.05$, chi-test) to be significantly avoiding the fire sites. Still, attraction of many fungus gnats to wild-fire sites is strongly indicated by a high number of species captured there, of which 37 species are significantly over-represented at such sites ($p < 0.05$, chi-test). Altogether 2879 specimens (54 %) belonging to 151 species (61 %) were caught at the wild-fire sites. Species found to be strongly associated ($p < 0.001$, chi-test) to the fire-sites include: *Bolitophila tenella* Winnertz, 1863, *Orfelia nemoralis* (Meigen, 1818), *Mycomya ruficollis* (Zetterstedt, 1852), *Sciophila hirta* Meigen, 1818, *S. lutea* Macquart, 1826, *S. setosa* Garrett, 1925, *Apolephthisa subincana* (Curtis, 1837), *Boletina basalis* (Meigen, 1818), *Coelosia tenella* (Zetterstedt, 1852), *Exechia fusca* (Meigen, 1804), *Exechiopsis perspicua* (Johannsen, 1912), *Pseudorymosia fovea* (Dziedzicki, 1910), *Dynatosoma cochleare* Strobl, 1895, *Phronia biarcuata* (Becker, 1908), *P. forcipata* Winnertz, 1863, *P. forcipula* Winnertz, 1863, and *P. obtusa* Winnertz, 1863.

For 201 (81 %) of the species found at Tyresta one or several larval microhabitats are known (Table 2). Of these for 188 species (76 %) there are rearing records from fruiting bodies of fungi, for 164 species (66 %) – from decaying wood, and for 33 species (13 %) – from the soil or leaf litter.

Among the fruiting bodies-dependent species there is a dominance of wood-growing fungi hosts (100 species or 40 %) over epigeal fungi hosts (88 species or 36 %). Among the saproxylic species there is a dominance of relationship to deciduous trees (107 species or 43 %) over relationship to coniferous trees (57 species or 23 %). For all groups there is a considerable overlap with many generalists known to live in multiple categories.

Table 2. List of fungus gnats collected at Tyresta Nature Reserve and National Park.

For each species is given the classified world distribution, the sites where the species was caught, the number of specimens caught at undisturbed sites with respect to fire and at fire sites, and the known larval microhabitats.

The Chi-square statistics tests for bias between non-fire and fire sites, where the expected values are adjusted to fit the number of trap-days, i.e. 45% and 55%, respectively. Significance levels: * p<0.05, ** p<0.01, *** P<0.001.

The known larval microhabitats are classified into three major categories, viz. fruiting bodies of fungi (Fb), decaying wood (Wood) and soil and litter (Soil), with further denotation of Wood growing (Wgr) vs. epigeal (Epi) fungi, and deciduous (DC) vs. coniferous (CF) tree species.

No. Species	World distribution	Sites	Specimens	Non-fire/ fire sites	Chi-test	Known larval microhabitats
Family Bolitophilidae						
Genus *Bolitophila* Meigen						
Subgenus *Bolitophila* Meigen						
1 *cinerea* Meigen, 1818	Pal.	4	0/1			Fb
2 *tenella* Winnertz, 1863	Pal.	0•1•4•5	2/156	Fire	***	Fb (Epi&Wgr)
Subgenus *Cliopisa* Enderlein						
3 *modesta* Lackschewitz, 1937	Pal.	4	0/1			Fb (Epi&Wgr)
Family Diadocidiidae						
Genus *Diadocidia* Ruthe						
Subgenus *Diadocidia* Ruthe						
4 *ferruginosa* (Meigen, 1830)	Hol.	0	1/0			Wood (DC)
5 *spinosula* Tollet, 1948	Pal.	0•8•14	6/3			Soil + Wood (CF&DC)
6N *Diadocidia* sp. A	Nordic	14	1/0			-
Family Ditomyiidae						
Genus *Symmerus* Walker						
7* *nobilis* Lackschewitz, 1937	European	7	1/0			Wood (DC)
Family Keroplatidae						
Subfamily Keroplatinae						
Tribe Keroplatini						
Genus *Keroplatus* Bosc						
8 *testaceus* Dalman, 1818	Pal.	7	3/0			Fb (Wgr)
Tribe Orfeliini						
Genus *Isoneuromyia* Brunetti						
9 *semirufa* (Meigen, 1818)	Pal.	1	0/3			-
Genus *Macrorrhyncha* Winnertz						
10 *rostrata* (Zetterstedt, 1851)	European	0	2/0			Wood (DC)
Genus *Neoplatyura* Malloch						
11 *flava* (Macquart, 1826)	Pal.	0•7•14	11/0	Non-fire	***	Soil + Wood (CF&DC)
Genus *Orfelia* Costa						
12 *fasciata* (Meigen, 1804)	European	4•14	1/2			Soil + Wood (DC)
13 *nemoralis* (Meigen, 1818)	European	8•12	0/23	Fire	***	Wood (DC)
14* *unicolor* (Staeger, 1840)	W. Pal.	0•7•13•14	5/0	Non-fire	*	Wood (CF&DC)
Genus *Pyratula* Edwards						
15 *zonata* (Zetterstedt, 1855)	W. Pal.	0•4•5•7•9•14	28/6	Non-fire	***	Soil + Wood (DC)
Genus *Urytalpa* Edwards						
16 *ochracea* (Meigen, 1818)	European	0	2/0			-
Subfamily Macrocerinae						
Genus *Macrocera* Meigen						
17 cf. *maculata* Meigen, 1818	European	14	7/0	Non-fire	**	-
18 *parva* Lundström, 1914	Pal.	0	1/0			Soil + Wood (DC)
19 cf. *phalerata* Meigen, 1818	Pal.	7	1/0			Wood (DC)
20 cf. *pumilio* Loew, 1869	European	0	1/0			Soil + Wood (DC)
21 *stigmoides* Edwards, 1925	Pal.	0	1/0			Soil + Wood (DC)
22 *zetterstedti* Lundström, 1914	W. Pal.	0•5•8	5/4			-

Table 2.

No.	Species	World distribution	Sites	Specimens	Non-fire/ fire sites	Chi-test	Known larval microhabitats
Family Mycetophilidae							
Subfamily Mycomyinae							
Genus *Mycomya* Rondani							
Subgenus *Mycomya* Rondani							
23	*annulata* (Meigen, 1818)	Pal.	0•7	52/0	Non-fire	***	Soil + Wood (CF&DC) + Fb(Wgr)
24	*bicolor* (Dziedzicki, 1885)	Hol.	7	1/0			Wood(CF&DC)+Fb(Wgr)
25	*cinerascens* (Macquart, 1826)	Hol.	0•5	2/1			Wood (CF&DC) + Fb (Epi&Wgr)
26	*denmax* Väisänen, 1979	Hol.	2	0/1			Wood (DC)
27	*festivalis* Väisänen, 1984	Nordic	0	2/0			Soil
28	*flavicollis* (Zetterstedt, 1852)	W. Pal.	0	1/0			Wood (DC)
29	*maculata* (Meigen, 1804)	Hol.	14	2/0			Wood (CF) + Fb (Epi)
30	*marginata* (Meigen, 1818)	Pal.	0	1/0			Wood (DC) + Fb (Wgr)
31	*nigricornis* (Zetterstedt, 1852)	Hol.	4	0/1			Wood (CF)
32	*nitida* (Zetterstedt, 1852)	Hol.	0•4	2/6			Wood (CF) + Fb (Wgr)
33	*prominens* (Lundström, 1913)	Pal.	2•10	1/2			Wood(DC)+Fb(Epi&Wgr)
34	*ruficollis* (Zetterstedt, 1852)	Hol.	0•4•8•14	2/82	Fire	***	Soil + Wood (CF&DC)
35	*shermani* Garret, 1924	Hol.	0•7	2/0			Soil + Wood (CF)
36	*tenuis* (Walker, 1856)	Pal.	0	1/0			Wood (DC) + Fb (Epi)
37	*vittiventris* (Zetterstedt, 1852)	European	0	1/0			-
Subgenus *Mycomyopsis* Väisänen							
38	*affinis* (Staeger, 1840)	Pal.	7	1/0			Wood (CF&DC)
39	*maura* (Walker, 1856)	European	7	1/0			-
40	*trilineata* (Zetterstedt, 1838)	Pal.	7	15/0	Non-fire	***	Soil + Wood (CF&DC) + Fb (Epi&Wgr)
Subfamily Sciophilinae							
Genus *Acnemia* Winnertz							
41	*angusta* Zaitzev, 1982	European	0•14	8/0	Non-fire	**	Wood (DC) + Fb (Wgr)
42	*longipes* Winnertz, 1863	Pal.	0•7	3/0			-
43	*nitidicollis* (Meigen, 1818)	Pal.	0–9•14	161/222			Wood(DC)+Fb(Epi&Wgr)
Genus *Allocotocera* Mik							
44	*pulchella* (Curtis, 1837)	Hol.	1•7•8•14	121/6	Non-fire	***	Soil + Wood (CF&DC) + Fb (Wgr)
Genus *Azana* Walker							
45	*anomala* (Staeger, 1840)	European	0•1•4•7•8•12	4/14			-
Genus *Coelophthinia* Edwards							
46	*thoracica* (Winnertz, 1863)	European	4•7•14	11/1	Non-fire	**	Soil + Wood (CF&DC) + Fb (Epi)
Genus *Megalopelma* Enderlein							
47	*nigroclavatum* (Strobl, 1910)	Hol.	12	0/5	Fire	*	Wood (CF) + Fb (Wgr)
Genus *Monoclona* Mik							
48	*rufilatera* (Walker, 1837)	Hol.	0•2•4•8•9•12	3/12			Wood (DC) + Fb (Wgr)
Genus *Neuratelia* Rondani							
49	*nemoralis* (Meigen, 1818)	Hol.	14	2/0			Wood (CF&DC)
Genus *Phthinia* Winnertz							
50	*mira* (Ostroverkhova, 1977)	Pal.	0•14	2/0			Wood(CF&DC)+Fb(Wgr)
51*	*Phthinia* cf. winnertzi Mik, 1869	European	14	1/0			Wood(DC)+Fb(Epi&Wgr)
Genus *Polylepta* Winnertz							
52	*borealis* Lundström, 1912	Hol.	14	1/0			Wood (CF&DC) + Fb (Epi&Wgr)
53	*guttiventris* (Zetterstedt, 1852)	Hol.	11	0/1			Soil + Wood (CF&DC)
Genus *Sciophila* Meigen							
54	*fenestella* Curtis, 1837	Hol.	0	1/0			Wood (DC) + Fb (Wgr)
55	*geniculata* Zetterstedt, 1838	European	13•14	25/0	Non-fire	***	Fb (Wgr)
56	*hirta* Meigen, 1818	Hol.	0–5•8	3/105	Fire	***	Fb (Epi&Wgr)
57	*karelica* Zaitzev, 1982	Hol.	1•4	0/5	Fire	*	Fb (Epi)
58*	*krysheni* Polevoi, 2001	European	4	0/1			-
59	*lutea* Macquart, 1826	Hol.	0–7	6/229	Fire	***	Fb (Epi&Wgr)
60*	*modesta* Zaitzev, 1982	Hol.	1•4•5	0/10	Fire	**	Fb (Epi)
61	*nonnisilva* Hutson, 1979	Hol.	4•14	1/1			Wood (DC) + Fb (Wgr)
62*	*persubtilis* Polevoi, 2001	Nordic	3•4•11•13	1/3			-

Table 2.

No.	Species	World distribution	Sites	Specimens	Non-fire/ fire sites	Chi-test	Known larval microhabitats
63	*plurisetosa* Edwards, 1921	Hol.	4	0/1			Fb (Epi&Wgr)
64	*rufa* Meigen, 1830	Pal.	14	8/0	Non-fire	**	Fb (Wgr)
65*	*setosa* Garrett, 1925	Hol.	0•4	1/48	Fire	***	Fb (Wgr)
66	*varia* (Winnertz, 1863)	Pal.	14	1/0			Fb (Epi&Wgr)
Subfamily Gnoristinae							
Genus *Apolephthisa* Grzegorzek							
67	*subincana* (Curtis, 1837)	W. Pal.	0•3–5•7•8	7/142	Fire	***	Wood(CF&DC)+Fb(Wgr)
Genus *Boletina* Staeger							
68	*basalis* (Meigen, 1818)	Pal.	3•4•8•12	0/40	Fire	***	Soil + Wood (DC)
69*	*edwardsi* Chandler, 1992	European	0	1/0			Soil + Wood (CF)
70	*erythropyga* Holmgren, 1883	Pal.	7	1/0			-
71	*gripha* Dziedzicki, 1885	Pal.	0•3•4•5	126/27	Non-fire	***	Soil + Wood (CF&DC) + Fb (Epi)
72	*lundstroemi* Landrock, 1912	Pal.	8	0/2			Wood (DC)
73	*nigricans* Dziedzicki, 1885	Pal.	0•1•4•6•7•11	62/14	Non-fire	***	Soil + Wood (CF&DC)
74	*plana* (Walker, 1856)	Pal.	8	0/5	Fire	*	Wood (CF)
75	*populina* Polevoi, 1995	European	8	0/1			Wood (CF)
76	*sciarina* Staeger, 1840	Hol.	8	0/1			Wood (CF)
77	*trivittata* (Meigen, 1818)	Pal.	4	0/1			Soil + Wood (DC)
Genus *Coelosia* Winnertz							
78	*fusca* Bezzi, 1892 W.	Pal.	3•4•5•6	0/11	Fire	**	Wood (DC) + Fb (Epi)
79	*tenella* (Zetterstedt, 1852)	Hol.	0–6•8•11	7/147	Fire	***	Soil + Wood (CF) + Fb (Epi&Wgr)
Genus *Dziedzickia* Johannsen							
80	*marginata* (Dziedzicki, 1885)	European	0	1/0			-
Genus *Ectrepesthoneura* Enderlein							
81	*colyeri* Chandler, 1980	European	0•1•2•4•5•7•8	7/27	Fire	**	Wood (CF&DC)
82	*hirta* (Winnertz, 1846)	European	0•1•3–8•11•12	83/147	Fire	**	Wood (CF&DC)
83	*pubescens* (Zetterstedt, 1860)	European	0•4•5•8	6/10			Wood (CF&DC)
84	*tori* Zaitzev & Økland, 1994	European	7	6/0	Non-fire	**	-
Genus *Gnoriste* Meigen							
85	*bilineata* Zetterstedt, 1852	European	14	2/0			Wood (DC)
86*	*harcyniae* von Röder, 1887	European	3	0/3			-
Genus *Grzegorzekia* Edwards							
87	*collaris* (Meigen, 1818)	Pal.	14	1/0			Wood (CF&DC)
Genus *Palaeodocosia* Meunier							
88	*vittata* (Coquillett, 1901)	Hol.	4•7•14	8/1	Non-fire	**	Soil + Wood (CF&DC)
Genus *Saigusaia* Vockeroth							
89	*flaviventris* (Strobl, 1894)	Pal.	7	2/0			Wood (DC)
Genus *Synapha* Meigen							
90	*vitripennis* (Meigen, 1818)	Hol.	0•5–8•12•14	135/52	Non-fire	***	Soil + Wood (CF&DC)
Genus *Syntemna* Winnertz							
91	*hungarica* (Lundström, 1912)	Hol.	7	1/0			Wood (CF&DC)
92	*stylata* Hutson, 1979	European	7•14	18/0	Non-fire	***	Wood (CF)
Genus *Tetragoneura* Winnertz							
93	*sylvatica* (Curtis, 1837)	Pal.	4	0/2			Soil + Wood (DC) + Fb (Wgr)
Subfamily Leiinae							
Genus *Docosia* Winnertz							
94	*fumosa* Edwards, 1925	European	2•4•6	0/13	Fire	**	Soil
95	*gilvipes* (Haliday in Walker, 1856)	Hol.	0•1•4•5•6	2/6			Soil + Wood (DC) + Fb (Epi&Wgr)
96N	*Docosia* sp. A	Nordic	4	0/1			-
Genus *Leia* Meigen							
97	*cylindrica* (Winnertz, 1863)	W. Pal.	0•5•7•14	46/4	Non-fire	***	Wood (CF&DC)
98	*picta* Meigen, 1830	European	0•7	4/0	Non-fire	*	Wood (CF&DC)
99	*subfasciata* (Meigen, 1818)	Pal.	4•8•12	0/4			Wood (DC)
100	*winthemi* Lehmann, 1822	Hol.	0•1•4–8•11•12	29/61	Fire	*	Wood (CF&DC) + Fb (Epi&Wgr)
Genus *Rondaniella* Johannsen							
101	*dimidiata* (Meigen, 1804)	Hol.	0•5•7•8•12•14	43/4	Non-fire	***	Fb (Epi&Wgr)

Table 2.

No.	Species	World distribution	Sites	Specimens	Non-fire/ fire sites	Chi-test	Known larval microhabitats
Subfamily Mycetophilinae							
Tribe Exechiini							
	Genus *Allodia* Winnertz						
	Subgenus *Allodia* Winnertz						
102*	*anglofennica* Edwards, 1921	Hol.	4•7	2/1			Fb (Epi)
103	cf. *embla* Hackman, 1971	Hol.	4	0/1			Fb (Epi)
104	*lugens* (Wiedemann, 1817)	Hol.	4•7	11/0	Non-fire	***	Fb (Epi&Wgr)
105	*lundstroemi* Edwards, 1921	Pal.	7	1/0			Fb (Epi&Wgr)
106	*ornaticollis* (Meigen, 1818)	Hol.	7	2/0			Fb (Epi&Wgr)
107	*truncata* Edwards, 1921	Hol.	4•7	9/1	Non-fire	**	Fb (Epi)
108	*zaitzevi* Kurina, 1998	Hol.	1•7	13/3	Non-fire	**	Fb (Epi)
	Subgenus *Brachycampta* Winnertz						
109	*barbata* (Lundström, 1909)	Hol.	4•7	2/3			Fb (Epi&Wgr)
110	*czernyi* (Landrock, 1912)	Hol.	7	1/0			Fb (Epi&Wgr)
111*	*foliifera* (Strobl, 1910)	Hol.	7	1/0			Fb (Epi&Wgr)
112	*grata* (Meigen, 1830)	Pal.	5•7•9	31/1	Non-fire	***	Fb (Epi&Wgr)
113	*pistillata* (Lundström, 1911)	Hol.	1	0/1			Fb (Epi)
114	*silvatica* (Landrock, 1912)	Pal.	4	0/2			Fb (Epi&Wgr)
	Genus *Allodiopsis* Tuomikoski						
115	*domestica* (Meigen, 1830)	Hol.	1•4•5•7	2/4			Fb (Epi)
116	*rustica* (Edwards, 1941)	Pal.	4	0/1			Fb (Epi)
	Genus *Anatella* Winnertz						
117*	*ankeli* Plassmann, 1977	European	7	9/0	Non-fire	***	-
118	*ciliata* Winnertz, 1863	Hol.	0•4	2/1			-
119	*setigera* Edwards, 1921	Hol.	14	1/0			Soil
120	*simpatica* Dziedzicki, 1923	Hol.	4•5	0/5	Fire	*	Fb (Wgr)
121	*turi* Dziedzicki, 1923	Pal.	4•7	1/1			-
	Genus *Brevicornu* Marshall						
122	*fuscipenne* (Staeger, 1840)	Hol.	4	0/1			Wood (DC)
123	*improvisum* Zaitzev, 1992	Hol.	8	0/1			Wood (DC)
124	*sericoma* (Meigen, 1830)	Hol.	0•4•5•6	4/7			Wood (DC) + Fb (Epi)
	Genus *Cordyla* Meigen						
125	*brevicornis* (Staeger, 1840)	Pal.	0•1•3•7•9	12/6			Soil + Wood (CF&DC) + Fb (Epi)
126	*crassicornis* Meigen, 1818	Pal.	5•6•7	1/2			Soil+Wood(DC)+Fb(Epi)
127	*fasciata* Meigen, 1830	Pal.	0•1•7•14	12/1	Non-fire	***	Soil + Wood (CF&DC) + Fb (Epi)
128	*fissa* Edwards, 1925	Pal.	0	1/0			Wood (DC) + Fb (Epi)
129	*flaviceps* (Staeger, 1840)	Pal.	14	4/0	Non-fire	*	Soil+Wood(DC)+Fb(Epi)
130	*fusca* Meigen, 1804	Pal.	14	4/0	Non-fire	*	Fb (Epi&Wgr)
131	*nitens* Winnertz, 1863	Pal.	0•7	19/0	Non-fire	***	Wood (DC) + Fb (Epi)
132	*nitidula* Edwards, 1925	Pal.	14	2/0			Fb (Epi)
133	*parvipalpis* Edwards, 1925	Pal.	0•3•6•8	30/23			Wood(CF&DC)+ Fb(Epi)
134	*semiflava* (Staeger, 1840)	Pal.	0•3•8•14	4/14			Wood (DC)
135N	*Cordyla* sp. A	Nordic	3	0/3			-
136N	*Cordyla* sp. B	Nordic	1•4	0/1			-
	Genus *Exechia* Winnertz						
137	*bicincta* (Staeger, 1840)	Hol.	7•9	11/0	Non-fire	***	Fb (Epi&Wgr)
138	*borealis* Lundström, 1912	Nordic	4	0/1			-
139	*contaminata* Winnertz, 1863	Hol.	0•5•7	5/3			Fb (Epi)
140	*dizona* Edwards, 1924	Pal.	7•11	1/1			Fb (Epi&Wgr)
141	*dorsalis* (Staeger, 1840)	Pal.	14	1/0			Wood (DC) + Fb (Epi&Wgr)
142	*festiva* Winnertz, 1863	Pal.	7	10/0	Non-fire	***	-
143	*fusca* (Meigen, 1804)	Hol.	0•2•4•5•6•7•8	39/89	Fire	***	Soil + Wood (DC) + Fb (Epi&Wgr)
144	*lucidula* (Zetterstedt, 1838)	Pal.	4•6	0/2			Fb (Epi&Wgr)
145	*lundstroemi* Landrock, 1923	Pal.	4	0/1			Fb (Epi&Wgr)
146	*nigroscutellata* Landrock, 1912	Pal.	4	0/2			Fb (Epi)
147	*parva* Lundström, 1909	Pal.	0	1/0			Wood (CF&DC) + Fb (Epi&Wgr)
148	*parvula* (Zetterstedt, 1852)	Pal.	7	2/0			Fb (Epi)
149	*pseudocincta* Strobl, 1910	Pal.	4•7	1/1			Fb (Epi)

Table 2.

No.	Species	World distribution	Sites	Specimens	Non-fire/ fire sites	Chi-test	Known larval microhabitats
150	*repanda* Johannsen, 1912	Hol.	1•3•8	0/3			Fb (Epi&Wgr)
151	*separata* Lundström, 1912	Hol.	4	0/4			Fb (Epi&Wgr)
152	*seriata* (Meigen, 1830)	Pal.	0•1•4	2/3			Fb (Epi&Wgr)
153	*spinuligera* Lundström, 1912	Pal.	4•6	0/4			Fb (Epi&Wgr)
Genus *Exechiopsis* Tuomikoski							
Subgenus *Exechiopsis* Tuomikoski							
154	*aemula* Plassmann, 1984	European	0•4•6•7	2/6			-
155	*clypeata* (Lundström, 1911)	European	7	1/0			Fb (Epi&Wgr)
156	*forcipata* (Lackschewitz, 1937)	Pal.	1	0/1			-
157	*indecisa* (Walker, 1856)	Pal.	6•7•14	2/1			Fb (Epi)
158	*januarii* (Lundström, 1913)	European	4	0/1			Fb (Epi)
159	*pseudopulchella* (Lundström, 1912)	Pal.	7	2/0			-
160	*pulchella* (Winnertz, 1863)	European	1•4	0/12	Fire	**	Wood (CF&DC)
161	*subulata* (Winnertz, 1863)	Pal.	7	1/0			Fb (Epi&Wgr)
Subgenus *Xenexechia* Tuomikoski							
162	*crucigera* (Lundström, 1909)	European	7	1/0			-
163*	*perspicua* (Johannsen, 1912)	Hol.	4	0/32	Fire	***	-
164	*seducta* (Plassmann, 1976)	European	7	1/0			-
Genus *Myrosia* Tuomikoski							
165	*maculosa* (Meigen, 1818)	European	7	1/0			Fb (Epi)
Genus *Pseudexechia* Tuomikoski							
166	*trivittata* (Staeger, 1840)	Pal.	4	0/1			Fb (Epi)
Genus *Pseudorymosia* Tuomikoski							
167	*fovea* (Dziedzicki, 1910)	Pal.	1•2•3•4•5	0/71	Fire	***	Wood (DC) + Fb (Epi)
Genus *Rymosia* Winnertz							
168	*fasciata* (Meigen, 1804)	European	0•1•4–7	14/18			Wood (DC) + Fb (Epi&Wgr)
169	*signatipes* (van der Wulp, 1859)	Pal.	5•7	1/1			Fb (Wgr)
Genus *Synplasta* Skuse							
170*	*pseudingeniosa* Zaitzev, 1993	European	7	1/0			-
171	*sintenisi* (Lackschewitz, 1937)	European	7	6/0	Non-fire	**	Wood (DC)
Genus *Tarnania* Tuomikoski							
172	*fenestralis* (Meigen, 1818)	Pal.	0	1/0			Fb (Epi&Wgr)
Tribe Mycetophilini							
Genus *Dynatosoma* Winnertz							
173	*cochleare* Strobl, 1895	Pal.	4•14	2/26	Fire	***	Wood (DC) + Fb (Wgr)
174	*dihaeta* Polevoi in Zaitzev&Polevoi,1995	European	4•9	1/16	Fire	**	-
175	*fuscicorne* (Meigen, 1818)	Hol.	0–2•4•5•8•9•14	18/25			Wood (DC) + Fb (Wgr)
176	*majus* Landrock, 1912	Pal.	0	1/0			-
177	*nigromaculatum* Lundström, 1913	Pal.	7•9	6/0	Non-fire	**	Wood (DC) + Fb (Wgr)
178	*norwegiense* Zaitzev & Økland, 1994	European	14	1/0			Fb (Wgr)
179	*reciprocum* (Walker, 1848)	Pal.	7	1/0			Wood (DC) + Fb (Wgr)
180	*rufescens* (Zetterstedt, 1838)	European	9•14	13/0	Non-fire	***	Fb (Wgr)
181N	*Dynatosoma* sp. A	European	0•7	2/0			Fb (Wgr)
Genus *Epicypta* Winnertz							
182	*aterrima* (Zetterstedt, 1852)	Hol.	4•8	0/5	Fire	*	Wood (DC) + Fb (Wgr)
Genus *Mycetophila* (Meigen)							
183	*abiecta* (Laštovka, 1963)	Pal.	7•11	2/1			Wood (DC)+ Fb (Wgr)
184	*alea* Laffoon, 1965	Hol.	3–5•7•8•14	3/8			Fb (Epi)
185	*attonsa* (Laffoon, 1957)	Hol.	7•14	2/0			Wood (CF&DC) + Fb (Wgr)
186	*biusta* Meigen, 1818	European	4	0/7	Fire	*	-
187	*blanda* Winnertz, 1863	Pal.	4	0/2			Fb (Epi)
188	*bohemica* (Laštovka, 1963)	Pal.	0•7	5/0	Non-fire	*	Wood (DC)+ Fb (Wgr)
189	*caudata* Staeger, 1840	Hol.	5	0/2			-
190	*confluens* Dziedzicki, 1884	Hol.	0	1/0			Fb (Epi)
191*	*dziedzickii* Chandler, 1977	Pal.	6	0/1			Fb (Wgr)
192	*flava* Winnertz, 1863	Pal.	4	0/1			Fb (Epi&Wgr)
193	*fungorum* (De Geer, 1776)	Hol.	0–9•12•14	273/61	Non-fire	***	Soil + Wood (CF&DC) + Fb (Epi&Wgr)
194*	*gentilicia* Zaitzev, 1999	Pal.	0	1/0			-

Table 2.

No.	Species	World distribution	Sites	Specimens	Non-fire/ fire sites	Chi-test	Known larval microhabitats
195	*ichneumonea* Say, 1823	Hol.	0•4•5•7•8•14	3/5			Wood (DC) + Fb (Epi&Wgr)
196	*laeta* Walker, 1848	Hol.	4•14	2/2			Wood (DC) + Fb (Wgr)
197*	*lubomirskii* Dziedzicki, 1884	European	0•6	5/4			Wood(CF&DC)+Fb(Wgr)
198	*luctuosa* Meigen, 1830	Hol.	0•4•5•7•8	5/14			Wood (CF&DC) + Fb (Epi&Wgr)
199	*marginata* Winnertz, 1863	European	4•5	0/12	Fire	**	Fb (Epi&Wgr)
200	*ocellus* Walker, 1848	Hol.	4•7	2/5			Wood (CF&DC) + Fb (Epi&Wgr)
201	*perpallida* Chandler, 1993	W. Pal.	6•7	14/3	Non-fire	**	Fb (Epi)
202	*signatoides* Dziedzicki, 1884	W. Pal.	7	1/0			Fb (Epi)
203	*sordida* van der Wulp, 1874	Hol.	7	1/0			Fb (Wgr)
204	*strigatoides* (Landrock, 1927)	Pal.	14	1/0			Fb (Epi&Wgr)
205	*strobli* Laštovka, 1972	Pal.	0•1•4•5•7	8/4			Fb (Epi&Wgr)
206	*stylata* (Dziedzicki, 1884)	Pal.	0•14	2/0			Fb (Epi)
207	*subsigillata* Zaitzev, 1999	Pal.	5	0/1			Fb (Epi)
208	*sumavica* (Laštovka, 1963)	Pal.	2•3•4•7•14	7/12			Wood (DC) + Fb (Wgr)
209	*vittipes* Zetterstedt, 1852	Pal.	7	1/0			Fb (Wgr)
210	*xanthopyga* Winnertz, 1863	European	14	1/0			Wood (DC) + Fb (Wgr)
211	*zetterstedtii* Lundström, 1906	Pal.	7•8	2/2			-
Genus *Phronia* Winnertz							
212	*biarcuata* (Becker, 1908)	Hol.	1•2•3•4•5	0/28	Fire	***	Wood (CF&DC)
213	*braueri* Dziedzicki, 1889	Hol.	0•2•3	3/6			Wood(CF&DC)+Fb(Wgr)
214	*cinerascens* Winnertz, 1863	Hol.	1•4•5	0/9	Fire	**	Wood (CF)
215	*disgrega* Dziedzicki, 1889	Hol.	14	2/0			Wood (DC)
216*	*distincta* Hackman, 1970	Hol.	14	1/0			-
217	*elegantula* Hackman, 1970	Pal.	0	1/0			-
218	*exigua* (Zetterstedt, 1852)	Hol.	0•8	1/1			Wood (DC)
219	*flavipes* Winnertz, 1863	Hol.	0	1/0			-
220	*forcipata* Winnertz, 1863	Pal.	0•1•5•8	10/82	Fire	***	Wood (DC)
221	*forcipula* Winnertz, 1863	Hol.	0•4•5	15/61	Fire	***	Fb (Wgr)
222	*nigricornis* (Zetterstedt, 1852)	Hol.	0•4	1/1			Wood (DC)
223	*nigripalpis* Lundström, 1909	Hol.	0•1•2•3•5•8•14	24/48	Fire	*	Wood (DC)
224	*nitidiventris* (van der Wulp, 1858)	Pal.	0•5	4/2			Wood (DC)
225	*obtusa* Winnertz, 1863	Hol.	1•3•4•6•8•9	1/18	Fire	***	Wood (DC) + Fb (Wgr)
226	*portschinskyi* Dziedzicki, 1889	Hol.	1•3	0/6	Fire	*	-
227	*strenua* Winnertz, 1863	Hol.	0•3•8	3/3			Wood(CF&DC)+Fb(Wgr)
228	*tiefii* Dziedzicki, 1889	Hol.	0•1	2/3			Fb (Wgr)
229	*willistoni* Dziedzicki, 1889	Hol.	1•3•4	0/12	Fire	**	-
Genus *Platurocypta* Enderlein							
230	*punctum* (Stannius, 1831)	Hol.	1•4•7•8•13	3/10			Fb (Wgr)
231	*testata* (Edwards, 1925)	Hol.	0•3•5	1/2			Fb (Wgr)
Genus *Sceptonia* Winnertz							
232	*fumipes* Edwards, 1925	European	7•13•14	13/0	Non-fire	***	-
233	*longisetosa* Ševčik, 2004	European	0•4•13•14	20/1	Non-fire	***	-
234*	*regni* Chandler, 1991	Pal.	13•14	25/0	Non-fire	***	-
235*	*thaya* Sevcik, 2004	European	7	1/0			-
Genus *Trichonta* Winnertz							
236*	*clavigera* Lundström, 1913	Pal.	4	0/1			-
237	*girschneri* Landrock, 1912	Hol.	5•7	17/2	Non-fire	***	Wood (DC) + Fb (Wgr)
238	*hamata* Mik, 1880	Hol.	4•8	0/2			Wood (DC) + Fb (Wgr)
239	*melanura* (Staeger, 1840)	Hol.	0•1	11/1	Non-fire	**	Fb (Wgr)
240	*submaculata* (Staeger, 1840)	Pal.	3•4•5•9	1/6			-
241*	*subterminalis* Zaitzev & Menzel, 1996	Pal.	8	0/3			Fb (Wgr)
242	*venosa* (Staeger, 1840)	Hol.	8	0/1			Fb (Epi)
243	*vitta* (Meigen, 1830)	Hol.	4•5•8	0/6	Fire	*	Wood (DC) + Fb (Wgr)
244	*vulcani* (Dziedzicki, 1889)	Hol.	14	1/0			Wood (CF)
Genus *Zygomyia* Winnertz							
245	*notata* (Stannius, 1831)	Pal.	0	1/0			Wood (DC)
246	*pseudohumeralis* Caspers, 1980	Pal.	0•7•8•14	4/1			Wood (CF) + Fb (Wgr)
247	*semifusca* (Meigen, 1818)	Hol.	0•7•14	18/0	Non-fire	***	Soil + Wood (CF&DC)
248	*zaitzevi* Chandler, 1991	European	7	1/0			Wood(CF&DC)+Fb(Wgr)

Table 3. The known distribution of species of fungus gnats found at Tyresta NP and NR.

	# species	Proportion
Holarctic	91	37%
Palaearctic	92	37%
Western Palaearctic	9	4%
European	49	20%
Nordic	7	3%
Total	**248**	**100%**

3.1. Species new to Sweden and other noteworthy findings

Family Diadocidiidae

Genus *Diadocidia* Ruthe

Subgenus *Diadocidia* Ruthe

Diadocidia (*Diadocidia*) sp. A

Material: Site 14, 4–26 Aug 2003 – 1 female, 2 males.

Distribution type: Nordic, reported from Norway by Kjærandsen & Jordal (2007).

Larval microhabitats: Unknown.

Remarks: This species is close to *Diadocidia fissa* Zaitzev, 1994 and *D. furnacea* Chandler, 1994, but seems to be new to science and will be described elsewhere.

Family Ditomyiidae

Genus *Symmerus* Walker

* *Symmerus nobilis* Lackschewitz, 1937

Material: Site 7, 19 Jun–28 Jul 2000 – 1 male.

Distribution type: European. A little known species recorded from several localities in Central and Southern Europe. In the Nordic region so far recorded only from Russian Karelia (Polevoi 2000) and Norway (Gammelmo & Rindal 2006, Kjærandsen & Jordal 2007). Recorded also from the neighbouring Baltic countries Latvia (Lackschewitz 1937, type material) and Estonia (Kurina 1998). First record from Sweden.

Larval microhabitats: Rotting wood of deciduous trees (Zaitzev 1994). For the closely related species, *Symmerus annulatus* Meigen a host fungus *Hypoxylon rubiginosum* (Pers.) Fr. (Xylariales, Ascomycotina) is indicated (Chandler 1993).

Family Keroplatidae

Subfamily Keroplatinae

Tribe Keroplatini

Genus *Keroplatus* Bosc

Keroplatus testaceus Dalman, 1818, Figure 2B

Material: Site 7, 21 Jul–10 Sep 1997 –1 female; Site 7, 3 Jun–21 Jul 1997 –1 female, 1 male.

Distribution type: Palaearctic, widely distributed.

Larval microhabitats: In webs on the underside of logs bearing encrusting fungi or beneath the brackets of different polypore fungi. Requires large bodies of damp rotten wood with bracket fungi and utilizes mainly old-growth forests, but is also able to inhabit anthropogenic environments such as less established parklands and gardens (Falk & Chandler 2005).

Tribe Orfeliini

Genus *Macrorrhyncha* Winnertz

Macrorrhyncha rostrata (Zetterstedt, 1851), Figure 2A

Material: Site 0, 26 May-30 Jul 2001 – 2 males.

Distribution type: European. This poorly known and rare species was described from Östergötland, Sweden (Zetterstedt 1851) and is included as data deficient in the 2005 Red List of Swedish Species (Gärdenfors 2005). Also known from southern Finland (*Ab*: Kaarina and Karjalohja, J. Jakovlev *unpublished*) and Russian Karelia, Petrozavodsk (Lundström 1906). In Great Britain considered as vulnerable species with a genuinely restricted distribution confined to broad-leaved woodlands with old trees and dead wood (Falk & Chandler 2005). Other European *Macrorrhyncha* species are distributed mainly in the Mediterranean region (Chandler, Bechev & Caspers 2006).

Larval microhabitats: Larva is spinning webs in rotting wood, and the species has been recorded from standing, dead beech trunks (Alexander 2002) and hollow oak trunks (J. Kjærandsen *unpublished*).

Genus *Neoplatyura* Malloch

Neoplatyura flava (Macquart, 1826)

Material: Site 0, 26 May–30 Jul 2001 – 2 females, 2 males; Site 7, 28 Jul–20 Sep 2000 – 1 male; Site 14, 21 Jul-4 Aug 2003 – 2 females, 4 males.

Distribution type: Palaearctic, widely distributed (Evenhuis 2006).

Larval microhabitats: soil and ground vegetation impregnated with fungal mycelium (Jakovlev et al. 1994, Økland 1999), decaying wood of aspen, birch, pine and spruce (J. Jakovlev et al. *in prep*), perithecia of *Daldinia concentrica* (Jakovlev 1994).

Genus *Orfelia* Costa

* *Orfelia unicolor* (Staeger, 1840)

Material: Site 0, 4 Aug–24 Sep 2000 – 1 male; 26 May–30 Jul 2001 – 1 male; Site 7, 19 Jun–28 Jul 2000 – 1 male; Site 13, 4-26 Aug 2003 – 1 male; Site 14, 21 Jul–4 Aug 2003 – 1 male.

Distribution type: Western Palaearctic. In the Nordic region a few records are known, from Denmark (Petersen & Meier 2001), Finland (J. Jakovlev *unpublished*) and Russian Karelia (Polevoi 2000).

Larval microhabitats: Decaying wood of alder, beech (Irmler et al. 1996) and willow, *Salix caprea* (J. Jakovlev et al. *in prep*.), pupa was found suspensed in threads on *Trametes versicolor* (Chandler 1993).

Genus *Urytalpa* Edwards

Urytalpa ochracea (Meigen, 1818)

Material: Site 0, 26 May–30 Jul 2001 –2 males.

Distribution type: European, widely distributed. In Sweden probably underscored and included as data deficient in the 2005 Red List of Swedish Species (Gärdenfors 2005).

Larval microhabitats: Unknown, but probably suffering from the streamlining of the forest landscape structures by modern forestry.

Family Mycetophilidae

Subfamily Mycomyinae

Genus *Mycomya* Rondani

Mycomya (Mycomya) festivalis Väisänen, 1984

Material: Site 0, 4 Aug–24 Sep 2000 – 2 males.

Distribution type: Nordic. A little known species, recorded only from the Nordic Region.

Larval microhabitats: Soil litter in pine-dominated forest (J. Jakovlev et al. *in prep*).

Subfamily Sciophilinae

Genus *Phthinia* Winnertz

* *Phthinia* cf. *winnertzi* Mik, 1869

Material: Site 14, 2-21 Jul 2003 – 1 female.

Distribution type: European. A widely distributed but scarcely reported species, new to Sweden.

Larval microhabitats: Fruiting bodies of *Russula flava* (Kurina 1998), *Pholiota* (Alexander, 2002) rotting logs of aspen and common alder (J. Jakovlev et al. *in prep*).

Remarks: Determination of female based on comparison with other samples containing both sexes where coloration and terminalia differs from other Nordic species.

Genus *Sciophila* Meigen

Sciophila karelica Zaitzev, 1982

Material: Site 1, 15 Jul-26 Aug 2000 – 2 males; Site 4, 5 Jun-15 Jul 2000 – 1 male; 10-26 May 2001 – 2 males.

Distribution type: Holarctic. A poorly known species described from Russian Karelia and Canada (Zaitzev 1982). Subsequently reported from Sweden (Hedmark 1998) and Finland (Jakovlev et al. 2006).

Larval microhabitats: The type material was reared from larvae living in webs within folders of the apothecia of *Gyromitra esculenta* (Zaitzev 1982).

* *Sciophila krysheni* Polevoi, 2001
Material: Site 4, 10-26 May 2001 – 1 male.

Distribution type: European. A little known species described from Finland and subsequently reported from Scotland (Chandler 2005) and the Czech Republic (Ševčík 2005). New to Sweden.

Larval microhabitats: Unknown.

* *Sciophila modesta* Zaitzev, 1982
Material: Site 1, 15 Jul-26 Aug 2000 – 2 males; Site 4, 5 Jun-15 Jul 2000 – 5 males; Site 5, 26 May-21 Jul 2001 – 1 male; 21 Jul-15 Sep 2001 – 1 male.

Distribution type: Holarctic, widely distributed in Nearctic region (Zaitzev 1982). In the Palaearctic region found in the Northern Russia ranging from Russian Karelia to Vrangel island, Estonia, Slovakia and Switzerland (Chandler 2005, Ševčík 2005). New to Sweden.

Larval microhabitats: The type material was reared from larvae living in webs within folders of the apothecia of *Gyromitra esculenta* and *Ptychoverpa bohemica* (Zaitzev 1982), further reared from *Lactarius helvus* (Kurina 1994).

* *Sciophila persubtilis* Polevoi, 2001
Material: Site 3, 10-26 May 2001 – 1 male; Site 4, 5 Jun-15 Jul 2000 – 1 male; Site 11, 11 Jun-17 Jul 1999 – 1 male; Site 13, 8 Jun-2 Jul 2003 – 1 male.

Distribution type: Nordic. A little known species described from Russian Karelia and subsequntly reported from Finland (Jakovlev et al. 2006). New to Sweden.

Larval microhabitats: Unknown.

Remarks: Confusingly similar to *Sciophila cordata* Zaitzev, 1982 described from Alaska.

* *Sciophila setosa* Garrett, 1925
Material: Site 0, 7 Apr-6 Jun 2002 – 1 male; Site 4, 5 Jun-14 Jul 2000 – 2 males; 5 Jun-15 Jul 2000 – 35 males; 10-26 May 2001 – 11 males.

Distribution type: Holarctic, known from Canada and USA (Zaitzev 1982), in Europe previously reported from Finland only (Jakovlev et al. 2006). New to Sweden.

Larval microhabitats: Larvae in webs between sporophores of *Stereum subtomentosum* on grey alder (J.Jakovlev, in prep.).

Subfamily Gnoristinae

Genus *Boletina* Staeger

**Boletina edwardsi* Chandler, 1992
Material: Site 0, 7 Apr-6 Jun 2002 – 1 male.

Distribution type: European, widely distributed but new to Sweden.

Larval microhabitats: Pine wood decaying with *Skeletocutis biguttata* (Jakovlev et al. in prep.), soil impregnated with fungal mycelium in pine forest (Jakovlev et al. 1994).

Boletina erythropyga Holmgren, 1883
Material: Site 7, 19 Jun-28 Jul 2000 – 1 male.

Distribution type: Palaearctic, previously recorded only from northern localities. Tyresta represent the southernmost record in Europe. Zaitzev & Polevoi (2001) confirmed records from Scandinavia, Finland, Russian Karelia and from Vaigach Island in the Eastern Palaearctic Region.

Larval microhabitats: Unknown.

Genus *Gnoriste* Meigen

* *Gnoriste harcyniae* von Röder, 1887
Material: Site 3, 10-26 May 2001 – 1 female, 2 males.

Distribution type: European. A little known species described from the Harz mountains in Germany and later recorded from France, Switzerland, Austria, Norway and Finland (Chandler 2005). The Finnish record is doubtful and needs confirmation. New to Sweden.

Larval microhabitats: Unknown.

Subfamily Leiinae

Genus *Docosia* Winnertz

Docosia fumosa Edwards, 1925
Material: Site 2, 14 Apr-2 Jun 2000 – 1 female, 1 male; Site 4, 10-26 May 2001 – 10 males;

Site 6, 9 Sep-20 Oct 1999 – 1 male.

Distribution type: European. In the Nordic region recorded only from Denmark, Norway and Sweden (Chandler 2005).

Larval microhabitats: The only known rearing record is from dust in a blackbird`s nest (Rulik & Kallweit 2006).

[N] *Docosia* sp. A

Material: Site 4, 10-26 May 2001 – 1 male.

Distribution type: Nordic.

Larval microhabitats: Unknown.

Remarks: This undescribed species is close to *D. gilvipes* and will be further presented and described elsewhere.

Subfamily Mycetophilinae

Tribe Exechiini

Genus *Allodia* Winnertz

**Allodia (Allodia) anglofennica* Edwards, 1921

Material: Site 4, 29 May 2000 – 1 male; Site 7, 28 Jul-20 Sep 2000 – 2 males.

Distribution type: Holarctic. A common species previously overlooked in Sweden.

Larval microhabitats: Fruiting bodies of various epigeal fungi.

Allodia (Allodia) cf. *embla* Hackman, 1971

Material: Site 4, 29 May 2000 – 1 male.

Distribution type: Holarctic. In Europe besides the Nordic region found only in Estonia, Great Britain and Germany (Chandler 2005).

Larval microhabitats: Fruiting bodies of epigeal agarics.

Remarks: The single male is slightly different from type material from Iceland, but the segregation of a separate species is pending further material.

Allodia (Brachycampta) barbata (Lundström, 1909)

Material: Site 4, 5 Jun-14 Jul 2000 – 3 males; Site 7, 28 Jul-20 Sep 2000 – 2 males.

Distribution type: Holarctic.

Larval microhabitats: Mostly fruiting bodies of Pezizales (Chandler 1993, Jakovlev 1994, Ševčík 2006).

**Allodia (Brachycampta) foliifera* (Strobl, 1910)

Material: Site 7, 28 Jul-20 Sep 2000 – 1 male.

Distribution type: Holarctic. A common species previously overlooked in Sweden.

Larval microhabitats: Fruiting bodies of Pezizales (Jakovlev 1994, Ševčík 2006),

and Auriculariales (J.Jakovlev in prep.).

Allodia (Brachycampta) pistillata (Lundström, 1911)

Material: Site 1, 2 Jun-15 Jul 2000 – 1 male.

Distribution type: Holarctic.

Larval microhabitats: Fruiting bodies of Pezizales.

Allodia (Brachycampta) silvatica (Landrock, 1912)

Material: Site 4, 5 Jun-14 Jul 2000 – 2 males.

Distribution type: Palaearctic.

Larval microhabitats: Fruiting bodies of Pezizales (Chandler 1993, Jakovlev 1994, Ševčík 2006).

Genus *Anatella* Winnertz

**Anatella ankeli* Plassmann, 1977

Material: Site 7, 28 Jul-20 Sep 2000 – 1 male; – 1 female, 3 males; – 4 males.

Distribution type: European, in the Nordic region reported from Norway (Kjærandsen 1993, Kjærandsen & Jordal 2007), Finland (Chandler 2005), and Russian Karelia (Polevoi 2000). New to Sweden.

Larval microhabitats: Unknown.

Genus *Cordyla* Meigen

[N] *Cordyla* sp. A

Material: Site 3, 10-26 May 2001 – 1 male.

Distribution type: Nordic.

Larval microhabitats: Unknown.

Remarks: This undescribed species will be treated in a forthcoming revision of *Cordyla* by O. Kurina (*in prep*.).

[N] *Cordyla* sp. B

= *Cordyla* spec. 1; Kurina et al 2005: 479

Material: Site 1, 15 Jul-26 Aug 2000 – 1 male; Site 4, 5 Jun-15 Jul 2000 – 2 males.

Distribution type: Nordic.

Larval microhabitats: Unknown.

Remarks: This undescribed species will be treated in a forthcoming revision of *Cordyla* by O. Kurina (*in prep*.).

Genus *Exechiopsis* Tuomikoski

* *Exechiopsis (Xenexechia) perspicua* (Johannsen, 1912)

Material: Site 4, 5 Jun-14 Jul 2000 – 18 females, 14 males.

Distribution type: Holarctic. A little known species, in the Palaearctic region previously reported from Finland only (Jakovlev et al. 2006). New to Sweden.

Larval microhabitats: Unknown.

Genus *Synplasta* Skuse

* *Synplasta pseudingeniosa* Zaitzev, 1993

Material: Site 7, 28 Jul-20 Sep 2000 – 1 male.

Distribution type: European. The species was described from Russian Karelia and has subsequently been recorded from Estonia (Chandler 2005). New to Sweden.

Larval microhabitats: Unknown.

Tribe Mycetophilini

Genus *Dynatosoma* Winnertz

Dynatosoma majus Landrock, 1912

Material: Site 0, 4 Aug-24 Sep 2000 – 1 male.

Distribution type: Palaearctic. A little known species distributed in central Europe, Siberia and Russian Far East. In the Nordic region recorded from Finland (Hackman 1980) and southern Sweden (Kurina et al. 2005).

Larval microhabitats: Presumed to be associated with wood-growing polypores as all *Dynatosoma* species of known biology. The only rearing record from 'rotten fungi' (Papp 2002) exists so far.

Dynatosoma norwegiense Zaitzev & Økland, 1994

Material: Site 14, 2-21 Jul 2003 – 1 male.

Distribution type: European.

Larval microhabitats: Fruiting bodies of *Tyromyces chioneus* (Ševčík 2006).

Remarks: The taxonomic status of this species should be clarified in relation to *D. thoracicum* (Zetterstedt, 1838).

[N] *Dynatosoma* sp. A

Material: Site 0, 4 Aug-24 Sep 2000 – 1 male; Site 7, 19 Jun-28 Jul 2000 – 1 male.

Distribution type: European. Infrequent but widely distributed species in Europe including the Nordic region.

Larval microhabitats: Fruiting bodies of *Postia caesia* (Lastovka 1972a).

Remarks: This species is *Dynatosoma thoracicum* (Zetterstedt, 1838) according to Zaitzev (2003), but the taxonomic status of this species needs to be clarified.

Genus *Mycetophila* (Meigen)

* *Mycetophila dziedzickii* Chandler, 1977

Material: Site 6, 13 Aug-9 Sep 1999 – 1 male.

Distribution type: Palaearctic, widely distributed but new to Sweden.

Larval microhabitats: under bark of birch log bearing rezupinate fruiting bodies of *Scytinostroma galactinum* (J. Jakovlev in prep.).

* *Mycetophila gentilicia* Zaitzev, 1999

Material: Site 0, 4 Aug-24 Sep 2000 – 1 male.

Distribution type: Palaearctic. In Europe so far known only from Central Russia (Chandler 2005) and Norway (Kjærandsen & Jordal 2007). New to Sweden.

Larval microhabitats: Unknown.

* *Mycetophila lubomirskii* Dziedzicki, 1884
Material: Site 0, 4 Aug-24 Sep 2000 – 2 males; 7 Apr-6 Jun 2002 – 3 males; Sites 6, 9 Sep-20 Oct 1999 – 3 males; – 1 male.

Distribution type: European, mainly northwestern parts but new to Sweden.

Larval microhabitats: under bark of rotting logs of aspen and spruce (J. Jakovlev et al. *in prep*.).

Mycetophila subsigillata Zaitzev, 1999
Material: Site 5, 26 May-21 Jul 2001 – 1 male.

Distribution type: Palaearctic, so far scattered records in Europe. Recently found in southern Sweden (Kurina et al. 2005).

Larval microhabitats: The only fungal host reported so far is *Clitocybe sp*. (Zaitzev 2003), but for the closely related *M. sigillata* Dziedzicki, 1884 there are numerous rearing records from various agarics and boleti (Jakovlev 1994).

Genus *Phronia* Winnertz

* *Phronia distincta* Hackman, 1970
Material: Site 14, 21 Jul-4 Aug 2003 – 1 male.

Distribution type: Holarctic, in Europe previously known only from Russian Karelia, Finland and Estonia (Chandler 2005). New to Sweden.

Larval microhabitats: Unknown.

Genus *Sceptonia* Winnertz

* *Sceptonia regni* Chandler, 1991
Material: Site 13, 4-26 Aug 2003 – 15 males. Site 14, 21 Jul-4 Aug 2003 – 10 males. Distribution type: Palaearctic , in Europe previously known from Russian Karelia, Finland (Jakovlev et al. 2006), Norway, Great Britain, and the Czech Republic (Chandler 2005). New to Sweden.

Larval microhabitats: Unknown.

* *Sceptonia thaya* Sevcik, 2004
Material: Site 7, 28 Jul-20 Sep 2000 – 1 male.

Distribution type: European. Recently described from the Czech Republic (Ševčík 2004), and subsequently reported from Finland (Jakovlev et al. 2006). New to Sweden.

Larval microhabitats: Unknown.

Genus *Trichonta* Winnertz

* *Trichonta clavigera* Lundström, 1913
Material: Site 4, 5 Jun-14 Jul 2000 – 1 male.

Distribution type: Palaearctic, mainly southern in Europe and new to Sweden.

Larval microhabitats: Unknown.

* *Trichonta subterminalis* Zaitzev & Menzel, 1996
Material: Site 8, 5-28 May 1999 – 3 males.

Distribution type: Palaearctic, in Europe previously reported from Ukraine, Central Russia, Estonia (Chandler 2005), Finland (Polevoi et al. 2006) and Norway (Kjærandsen & Jordal 2007).

Larval microhabitats: larvae were found in fruiting bodies of *Laxitextum bicolor* on decaying aspen log (J.Jakovlev in prep.).

Trichonta vulcani (Dziedzicki, 1889)
Material: Site 14, 21 Jul-4 Aug 2003 – 1 male.

Distribution type: Holarctic, widely distributed.

Larval microhabitats: the same species recorded as *Trichonta tristis* (Strobl, 1898) has been reared from a decaying spruce stump bearing resupinate fruiting bodies of the polypore *Antrodia xantha.* (Jakovlev & Penttinen 2007).

Remarks: The taxonomic status of this species should be clarified in relation to *Trichonta tristis* (Strobl, 1898).

Genus *Zygomyia* Winnertz

Zygomyia notata (Stannius, 1831)
Material: Site 0, 4 Aug-24 Sep 2000 – 1 male.

Distribution type: Palaearctic, widely distributed in Europe.

Larval microhabitats: Unknown.

4. DISCUSSION

The increased activity to document the insect fauna of the Tyresta NP and NR over the last decade, through the Saproxylic, the TEFP and the SMTP projects, has resulted in a couple of hundreds of Diptera species being reported from Sweden for the first time (see Ahnlund et al. 2006, Weber et al. 2007), and several discovered as new to science (e.g. Jashhof 2001). The insect fauna at the Tyresta forest has shown to be outstandingly high for certain groups, e.g. scuttle flies (Bonet et al. 2006), and the finding of 248 species of fungus gnats is thus not unexpected.

4.1. Species diversity and distribution

Kurina et al. (2005) reported 250 species from 17 localities in boreonemoral, oak-dominated forests throughout southern Sweden. Although the magnitude of the species diversity is similar to our result, only 136 species (55%) are common between the two surveys. This may result mainly from the different forest types, broad-leaved deciduous vs. coniferous to mixed, from the fact that the undisturbed parts of the Tyresta forest consists of old-growth forest, or simply from the fact that we used a greater variety of sampling methods.

When compared with other surveys the Tyresta forest show an increasing affinity towards north in terms of number of shared species of fungus gnats. We find 150 species (60%) in common with the boreal and boreonemoral forests of southeastern Norway (Økland & Zaitzev 1997), 174 species (70%) in common with boreal-oceanic localities of northwestern Norway (Kjærandsen & Jordal 2007), and 185 species (75%) in common with Lule Lappmark in Northern Sweden (Kjærandsen et al. 2007). Despite being situated in the boreonemoral zone, the Tyresta forest shows significant boreal faunal element, including species like *Sciophila karelica* Zaitzev, 1992, *Boletina erythropyga* Holmgren, 1883, *Docosia* sp. A, *Synplasta pseudingeniosa* Zaitzev, 1993, and *Mycetophila flava* Winnertz, 1863. The species list from Tyresta fits well the general picture of increasing species diversity towards north (Økland et al. 2005, Kjærandsen & Jordal 2007). Only twelve species from the Tyresta forest were not reported in any of the areas mentioned above, viz.: *Macrorrhyncha rostrata* (Zetterstedt, 1851), *Orfelia fasciata* (Meigen, 1804), *Macrocera* cf. *maculata* Meigen, 1818, *Sciophila krysheni* Polevoi, 2001, *S. modesta* Zaitzev, 1982, *S. persubtilis* Polevoi, 2001, *S. setosa* Garret, 1925 , *Gnoriste harcyniae* vön Röder, 1887, *Exechia bicincta* (Staeger, 1840), *Exechiopsis* (*Xenexechia*) *perspicua* (Johannsen, 1912), *Phronia distincta* Hackman, 1970, and *Trichonta clavigera* Lundström, 1913.

4.2. Fire site association

The attraction to and occurrence of Diptera at fire-sites is still poorly investigated, but there are indications that true fire specialists among Diptera may outnumber the known specialist among Coleoptera (Ahnlund et al. 2006). Fire specialists are known among Cecidomyiidae, Empididae, Platypezidae and Drosophilidae but have to our knowledge never been reported among fungus gnats. Since adult fungus gnats are known to be especially common and diverse in damp forest environments (e.g. Kjærandsen & Jordal 2007) while less species rich in disturbed habitats like recent clearcuts (Økland 1994) and young regrowths (Økland 2000), we were surprised to find that the traps at fire-sites in the Tyresta forest did not collect less material compared to those from the undisturbed sites. As fresh wild-fire sites in old-growth forests are a rare habitat in the Nordic Region (Wikars 2006), we doubt that many fungus gnat species are exclusively dependent upon such a habitat. Still, a number of species showed a significant over-representation at the fire sites, indicating that they are attracted to and/or can take ad-

vantage of the special environment created by wild-fires. Proximate factors for their occurrence may be found in the special fungal flora at fire-sites, for instance dominated by a number of polypores, corticoid fungi and Ascomycetes (Penttilä & Kotiranta 1996, Wikars 2006), in the creation of dead wood and, thus, over time saproxylic microhabitats, or simply by the fact that a number of fungus gnat species prefer exposed/disturbed forest environments. Preliminary results from Finland (Jakovlev & Siitonen 2005, Jakovlev et al. 2006) demonstrate that clear-cuts with retention trees treated with prescribed burning inhabit a number of fungus gnats generally overlooked by traditional collecting in forest environments.

Unfortunately, due to heterogeneous sampling, the TEFP program was not designed to allow for a quantitative statistical analysis along the transect into the big fire area, and we have no data here to indicate that ultimate factors like attraction to smoke are involved among fungus gnats. However, some trends could be mentioned.

Altogether 37 species of fungus gnats have demonstrated a significant over-representation at the fire sites. Of these only for six species larval microhabitats are unknown. All but two (*Sciophila karelica* Zaitzev, 1982 and *S. modesta* Zaitzev, 1982 which are so far found as larvae only in epigeal Ascomycetes) species with known larval microhabitats appeared to be saproxylic, i.e. bred in dead wood or wood-growing fungi. These results shows that fungi growing on burned dead wood can probably host many species of fungus gnats even in relatively fresh fire sites.

It is noteworthy that the fire sites were the richest ones for *Sciophila* − a genus of relatively poor known ecology. Larvae develop in webs on the surface of fungi, especially the tougher lignicolous species (Falk & Chandler 2005) or in folders of the apothecia of Pezizales (Jakovlev 1994) where they probably feed on fungal spores. All species of the genus *Sciophila, viz: S. hirta* Meigen, 1818*, S. karelica* Zaitzev, 1982*, S. krysheni* Polevoi, 2001*, S. lutea* Macquart, 1826*, S. modesta* Zaitzev, 1982*, S. plurisetosa* Edwards, 1921 and *S. setosa* Garrett, 1925 that were relatively abundant in our study, were either strongly over-represented or found only at the fire sites. Of these *Sciophila setosa* in Europe previously has been reported only from Finnish clear-cut areas with retention trees treated with prescribed burning (Jakovlev et al. 2006). The same accounts for *Exechiopsis (Xenexechia) perspicua* (Johannsen, 1912), that at Tyresta was found only at one weakly burned area (site 4). Only one species, *Sciophila geniculata* Zetterstedt, 1838, found to be significantly avoiding the fire sites.

Most of the other species strongly associated with the fire sites are believed to be more of generalists living in exposed/disturbed forest environments. It is further interesting to note the fire associations in several genera of the subfamily Mycetophilinae, like *Phronia, Zygomyia, Sceptonia, Anatella, Brevicornu* and *Exechiopsis*, most of them with poorly known larval biology. Since fungal hosts have been recorded only for few species of these genera (unlike most other Mycetophilinae) it might indicate that in other species larvae are not inhabitants of fungal fruiting bodies, but rather feed on fungal mycelia in dead wood or in soil. Most of the species of *Phronia (P. biarcuata* (Becker, 1908), *P. cinerascens* Winnertz, 1863*, P. forcipata* Winnertz, 1863, *P. forcipula* Winnertz, 1863*, P. nigripalpis* Lundström, 1909*, P. obtusa* Winnertz, 1863, *P. portschinskyi* Dziedzicki, 1889, *P. willistoni* Dziedzicki, 1889 and *Exechiopsis (E. aemula* Plassmann, 1984 and *E. perspicua*) that were relatively abundant in our study have demonstrated positive correlation to fire sites. Of these only for one species, *Phronia obtusa*, there are also rearing records from a burnt spruce stump bearing the fire-opportunistic polypore *Rhodonia placenta* (J. Jakovlev, in prep).

Species of *Sceptonia* and *Zygomyia*, on the

other hand, seem to be more common at sites with intact forest. This was also typical for the most abundant species of *Trichonta*, associated chiefly with wood-growing fungi and *Cordyla* which prefer epigeal fungi. Species of *Anatella* and *Brevicornu* were presented with too small fractions. Only two species have shown clear preference to either intact forest (*Anatella ankeli* Plassmann, 1977) or to fire sites (*A. simpatica* Dziedzicki, 1923).

Several little known species found for the first time in Sweden, viz. *Gnoryste harcyniae* von Röder, 1887, *Docosia* sp. A, *Mycetophila dziedzickii* Chandler, 1977, *Trichonta clavigera* and *T. subterminalis* Zaitzev & Menzel, 1996 were collected only at sites affected by fire. Further studies on fungus gnats in burned areas, especially rearing from larvae living in decaying wood and litter colonised by fire-opportunistic fungi might reveal more species so far overlooked in the Swedish fauna.

4.3. Larval microhabitats

The larval stage of the greater majority of fungus gnats are believed to be associated with fungi, either in fruiting bodies or in mycelia in the soil, decaying wood and litter. The figures on known larval associations among fungus gnats found at the Tyresta forest (Table 2) suggests that 171 species (69 % of species found in Tyresta) are saproxylic and require dead wood of both coniferous and deciduous trees and/or fruiting bodies of wood-growing fungi. The fractions of the species which, according to current knowledge, are not inhabitants as larvae of dead wood, but of fruiting bodies of epigeal fungi only (26 species or 11%), or soil and ground vegetation only (3 species or 1 %) are much smaller.

The similar ratio of dominance of saproxylic over non-saproxylic species has been also revealed by Jakovlev (1995) in boreal forests of southern Karelia and probably is generally typical for fungus gnat communities. Økland et al (2005) suggested that the presence of both coniferous and deciduous forest elements in mixed forest probably promotes high species richness by combining habitats from both forest types. Kjærandsen & Jordal (2007) showed that deciduous and mixed boreal forests may have a higher species diversity of fungus gnats than pure coniferous boreal forests.

Herb-rich forest patches with dead wood of deciduous trees in mixed forests probably play a key role to create a high diversity of fungi, and thus microhabitats suitable for fungus gnats. About half of the species found in Tyresta (43 %) are known as inhabitants as larvae of dead wood of deciduous trees and it should be the main reason of the highest species diversity found in sites 0 and 7 that were especially rich in coarse dead wood of birch and aspen. Only from these sites three little known species: *Symmerus nobilis* Lackschewitz, 1937, *Macrorrhyncha rostrata* (Zetterstedt, 1851) and *Urytalpa ochracea* (Meigen, 1818), which probably indicate a high conservational value of the area, were collected. Of these the two latter species are included in the Swedish Red List (Gärdenfors 2005) while *Symmerus nobilis* that have not been formerly found in Sweden is redlisted in Norway (Gammelmo et al. 2006) and Great Britain (Falk & Chandler 2005). On the other hand, the number of species known to be inhabitants of dead wood of coniferous trees is about two times less counting only 23 % of the species found in Tyresta. Of these only one species, *Boletina edwardsi* Chandler, 1992 was found in Sweden for the first time.

Among the fungus gnats known from fruiting bodies of epigeal fungi there is a notable group of species that breed mostly or exclusively in the apothecia of ascomycetous fungi of the order Pezizales. Two species of *Allodia* belonging to subgenus *Brachycampta*: *A. (B) barbata* (Lundström, 1909) and *A. (B) silvatica* (Landrock, 1912) are known to be associated with *Ptychoverpa bohemica*, a fungus strongly confined to herb-rich forests on fertile soils (Jakov-

lev 1994). Two other species of *Brachycampta: A. (B) foliifera* (Strobl, 1910)*, A. (B) pistillata* (Lundström, 1911) and two species of *Sciophila: S. modesta* Zaitzev, 1982 and *S. karelica* Zaitzev, 1982, are associated with *Gyromitra esculenta,* and several species of *Peziza* present at the major fire-sites at Tyresta (K. Jaederfeldt pers. comm.).

In conclusion the rich fauna of fungus gnats at the Tyresta forest may be explained by two main factors; (1) that the unmanaged, old-growth, herb-rich, mixed forest patches on fertile soil promote a high diversity of larval micro-habitats suitable for fungus gnats, and (2) that half of the material were obtained from fresh wild-fire sites, a hitherto poorly studied habitat shown to attract and inhabit a rich and different fauna of fungus gnats.

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