

Fungus associations known in Diptera (Nematocera) a review

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Outline

- Associations with rotten/fresh fungal tissues in nematoceros Diptera.
- Number of known species of mycetophilids (Diptera:Sciaroidea).
- Types of larval microhabitats of **mycetophilids/fungus gnats**.
- Fungi which are not attractive to Diptera.
- Polyphagy or monophagy? Species confined to particular fungal hosts.
- **Methods of collecting and rearing adults of nematoceros Diptera from fungi and decaying wood.**
- Further reading

Order DIPTERA (true flies)

Flies and mosquitoes are classified as order Diptera, which mean two wings. The insects in this order have only one pair of membranous flying wings. The second pair of wings are reduced to small knobs, called halteres, for the purpose of balancing. **6920 fly species in Finland**
Order Diptera is divided into two suborders, Nematocera and Brachycera.

Nematocera (gnats,
or lower Diptera)



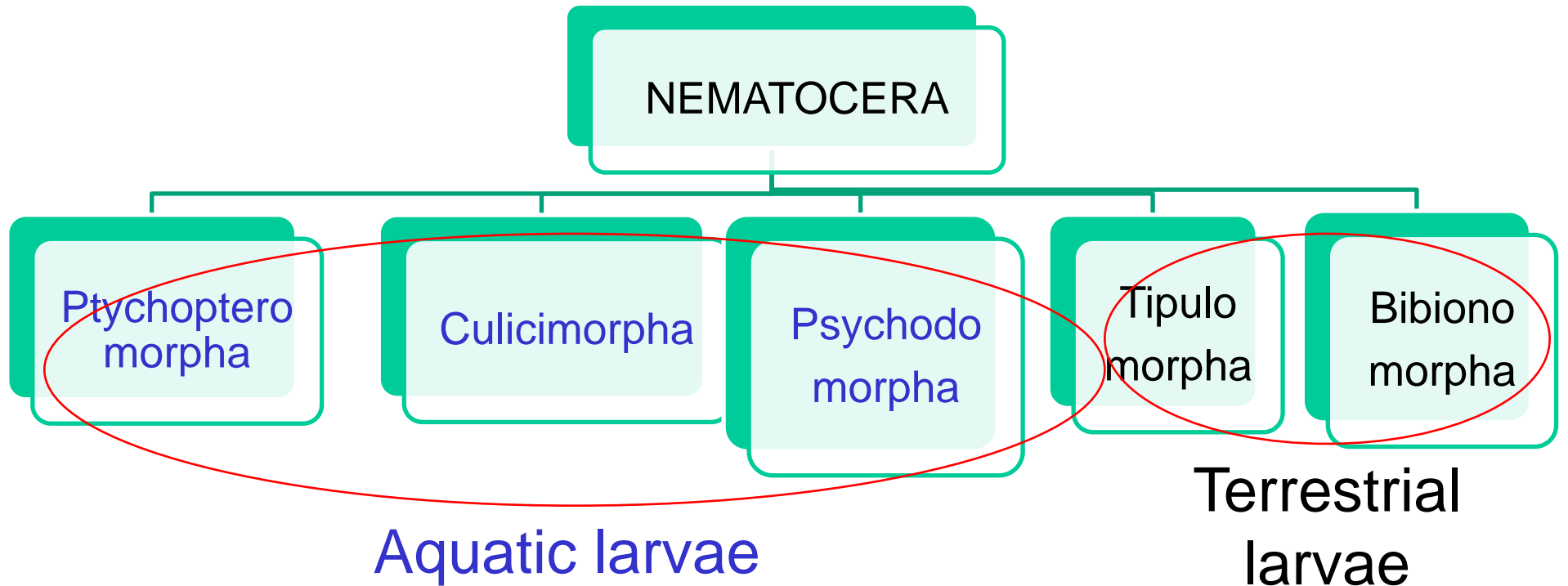
2932 species in Finland

Brachycera (flies)



3989 species in Finland

Infraorders in the suborder Diptera:Nematocera



Fungus associations known in Diptera (Nematocera)

A. Associations with **rotten** fungal tissues:

1. TRICHOCERIDAE

2. ANISOPODIDAE

3. SCATOPSIDAE

4. CERATOPOGONIDAE

5. CHIRONOMIDAE

6. PSYCHODIDAE

7. CECIDOMYIIDAE

exception: Porricondylinae and Lestremiinae



Fungus associations known in Diptera (Nematocera)

B. Associations with fresh fungal tissues:

Tipulomorpha

- TIPULIDAE
- PEDICIIDAE
- LIMONIIDAE



Bibionomorpha

- BOLITOPHILIDAE
- DIADOCIDIIDAE
- DITOMYIIDAE
- KEROPLATIDAE
- MYCETOPHILIDAE
- SCIARIDAE



Tipulomorpha –Crane Flies

- Adults have long thin legs and slender body.
- Larvae feed on decomposed plant and fungal tissues (some can eat alive plants and fungi)

Tipulidae

Limoniidae

Pediciidae



Bibionomorpha- Fungus gnats or mycetophilids - Sciarioidea

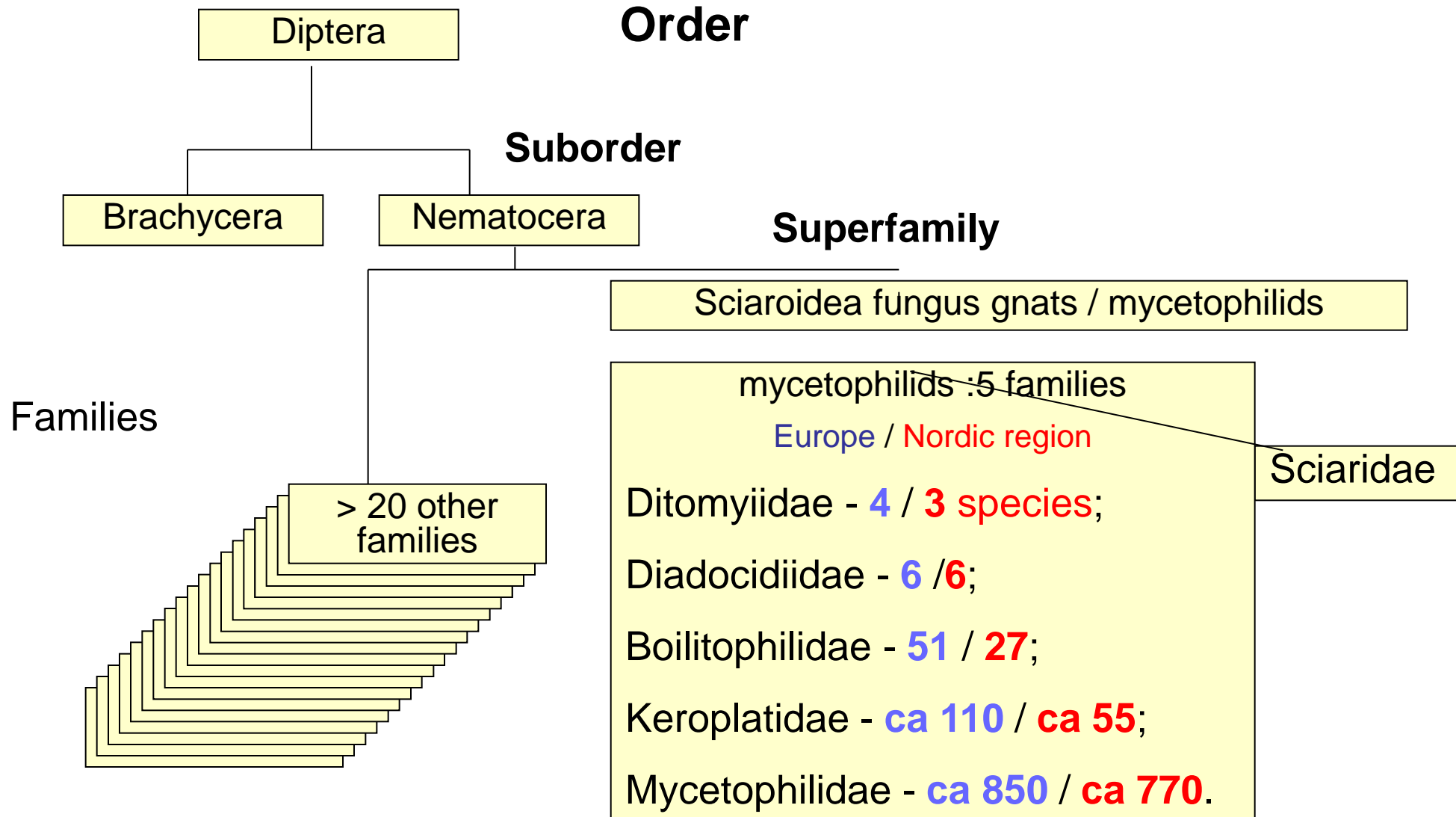
The superfamily Sciarioidea is the largest group of Diptera associated with fungi.

Five families ([Bolitophilidae](#), [Diadocidiidae](#), [Ditomyiidae](#), [Keroplastidae](#) and [Mycetophilidae](#)) are informally classified as '*fungus gnats*' or '*mycetophilids*' by most European authors.

Species in these families are morphologically similar and ecologically uniform: as larvae associated either with fungal fruiting bodies or with mycelia

- in dead wood (most of the species)
- and soil litter (a few species).

Systematic position of fungus gnats / mycetophilids



Sciaridae – “fungus midges”

The superfamily Sciarioidea includes also families that are not entirely fungivorous, for example, the large family of black-winged fungus gnats (**Sciaridae**) which live as larvae primarily in soil litter feeding on plant roots



[Bradysia sp . Photo Nina Lurci](#)

Sciaridae and *mycetophilids*

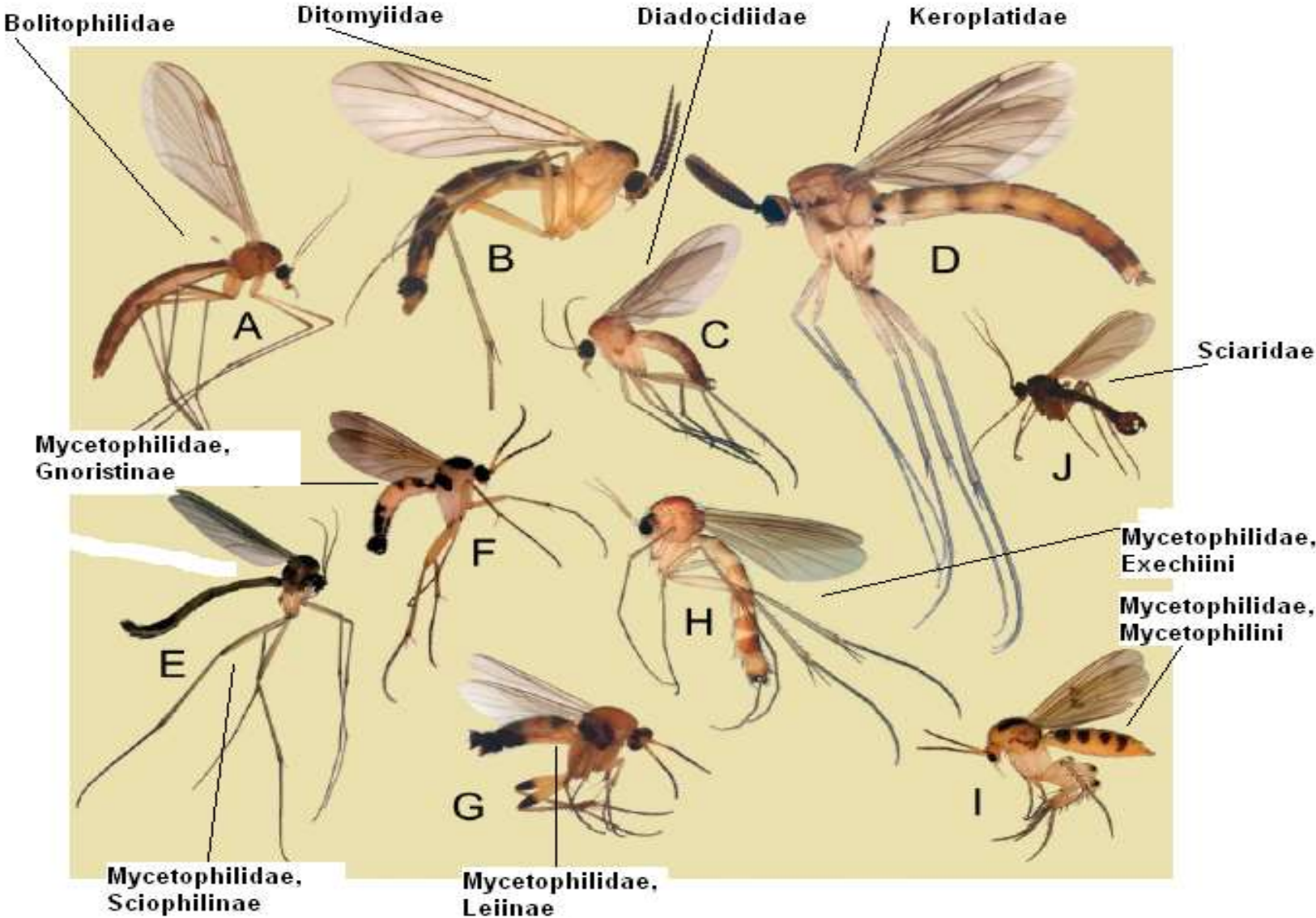
A few species of **Sciaridae** are found in the beds of cultivated mushrooms, where they feed on both fungal mycelium and sporophores. This may lead to confusion in applying the name 'fungus gnats' or 'fungus midges' → to **Sciaridae**, as has been done in numerous publications concerning insect pests of commercial mushrooms. To avoid confusion, I shall henceforth use the term

mycetophilids →

to indicate all European families of the superfamily Sciaroidea except Sciaridae.



Fungus gnats (Diptera, Sciaroidea) of different families, subfamilies and tribes



Family Ditomyiidae
(chiefly in temperate forests)
4 species Europe/ 3 Nordic Region

Larvae live on the surface of polypore fungi feeding on fungal spores (genus *Ditomyia*)

Larvae live in decaying wood feeding on fungal mycelia (genus *Symmerus*)

Above:

Ditomyia fasciata (Meigen)

Adults in copula

Photo Philippe Moniotte (Belgium)

Below:

Ditomyia fasciata (Meigen)

Larvae on polypore fungus

Photo from Diptera.info (Poland)



Family Diadocidiidae (typical taiga insects)

6 species in Europe / 6 species in the Nordic Region

- Adults are tiny and very small (3-5 mm body length)
- Larvae live on the surface of decaying wood feeding on fungal mycelia, often in colonies



Family Keroplatidae - Petosienisääskiä

ca 110 species in Europe / ca 55 species in the Nordic Region

- Larvae live on the surface of polypore fungi feeding on fungal spores (genera *Keroplatus*, *Cerotelion*)
- Larvae live on the surface of decaying wood feeding on fungal mycelia or on other invertebrates which they encounter (genus *Macrocera*)



Pictures: Above:

Macrocera centralis (Meigen)

Adult, male (Lammi, Finland)

Below:

Macrocera stigma (Meigen)

Larvae on the surface of ***Ulmus*** fallen trunk Lammi, Finland)



Family Bolitophilidae – Henttosienisääskiä

ca 51 species in Europe / ca 27 species in the Nordic Region

- Larvae live inside soft fruiting bodies (sporophores) of macrofungi
- Many species seem confined to particular fungal hosts



*Bolitophila
cinerea.*

Upper – adult
fly;

Lower – larvae
in *Hypholoma
sublateritium*

(after Ševčík
2010)



Family Mycetophilidae - Aitosienisääskiä

ca 850 species in Europe / ca 770 species in the Nordic Region

Adults differ in size: body length from 2-3 mm (genera *Sceptonia*, *Zygomyia*, etc.)

to 10-12 mm (genus *Gnoriste*)

Larval microhabitats cover all groups of fungi. Larvae can live:

- inside fruiting bodies
- on the surface of fruiting bodies
- within dead wood

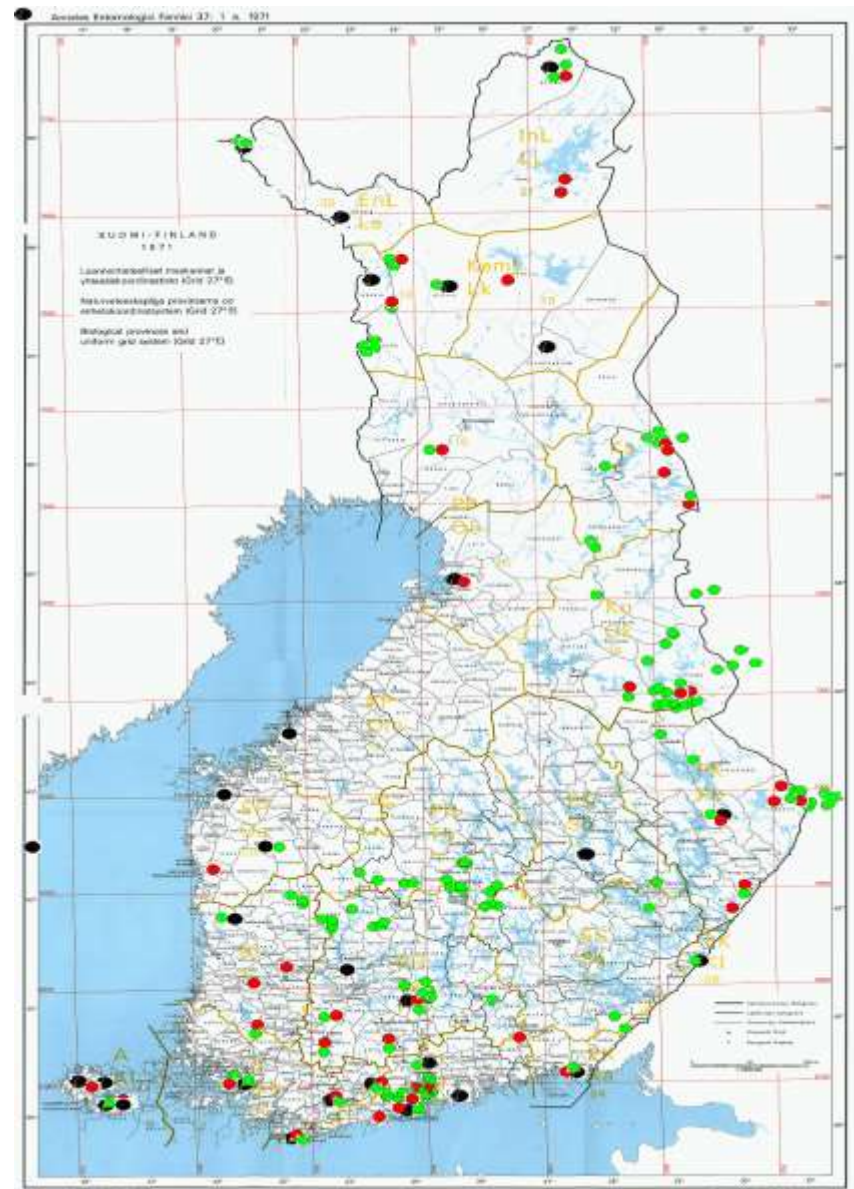


Sites of faunistic studies of fungus gnats in Finland and Russian Karelia

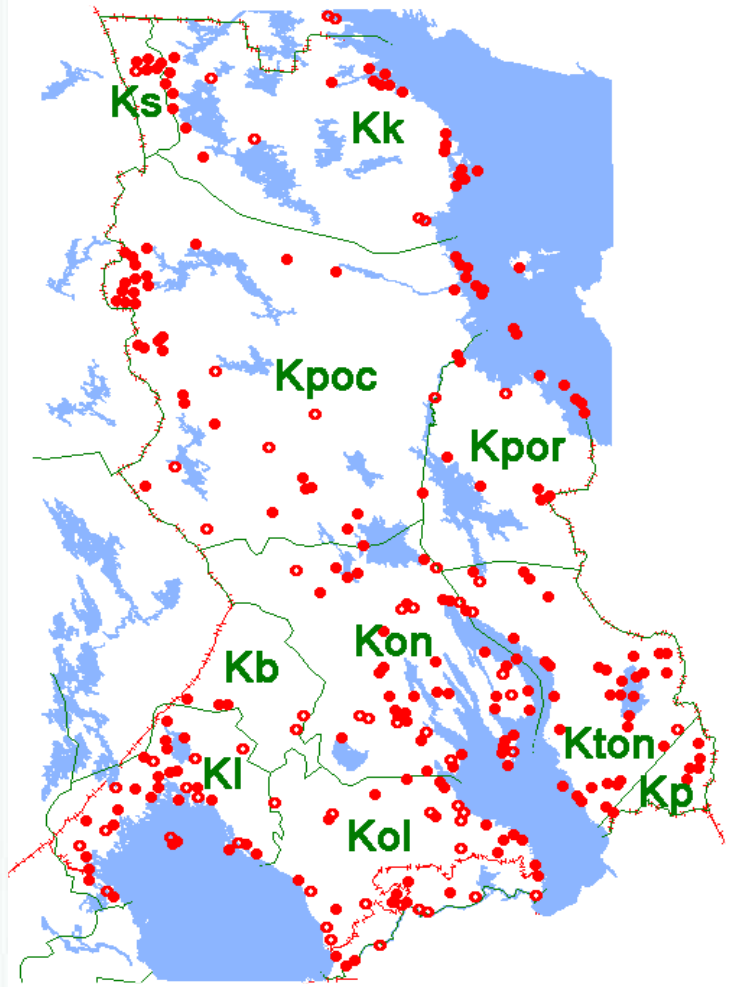
•1865-1940
ca 70
localities;

•1960-1970
ca 65
localities;

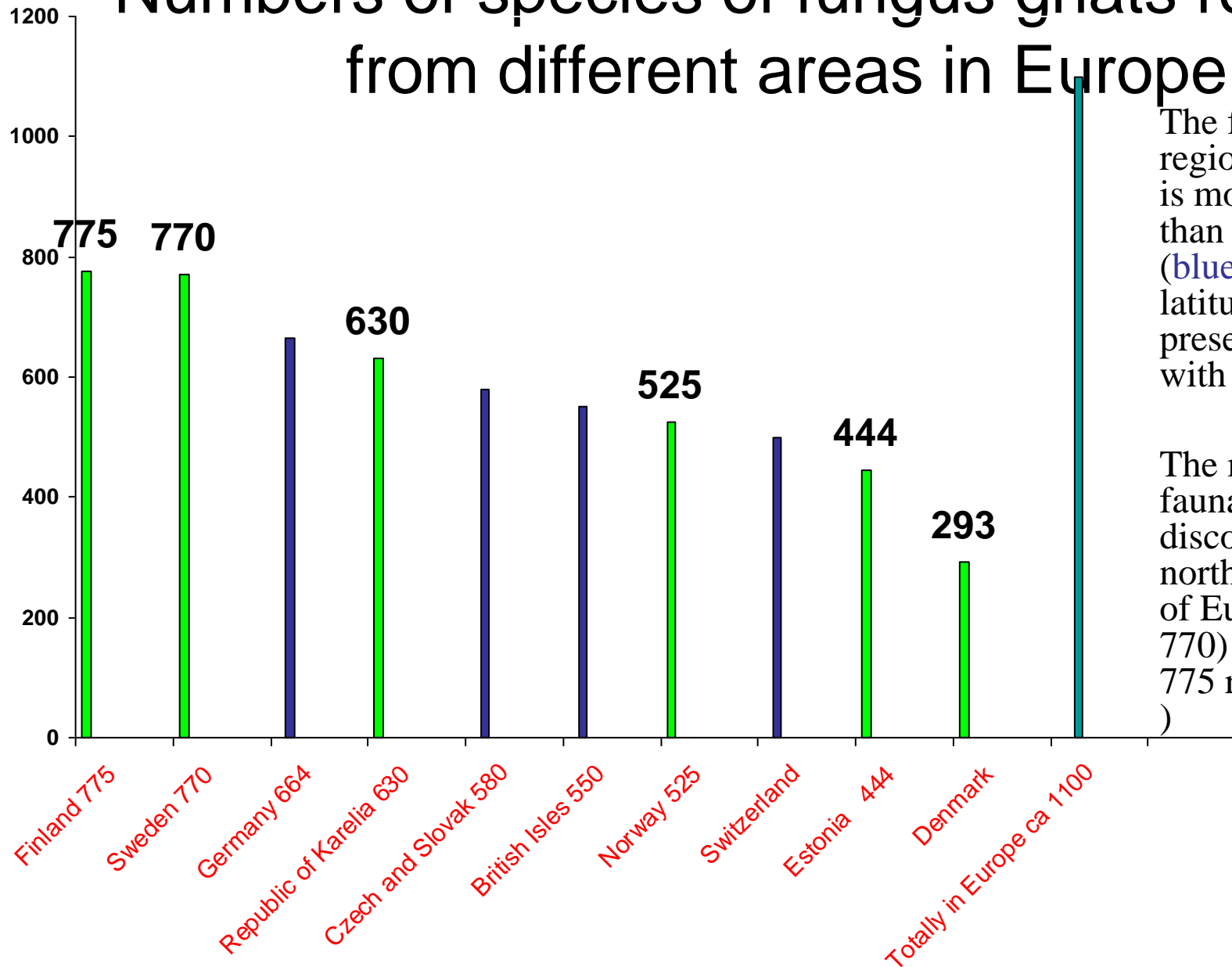
•1990 -2011
ca 170
localities



•1974-2010
ca 100 localities



Numbers of species of fungus gnats recorded from different areas in Europe



The fauna in the Nordic region (green columns) is more species rich than in Central Europe (blue columns). I.e. no latitudinal gradient presents, in contrast with most other taxa

The most species-rich fauna has been discovered so far in the northernmost countries of Europe: Sweden (ca 770) and Finland (ca 775 recognized species)

The threat status of Finnish fungus gnats has now, for the first time, been evaluated (the 2010 Finnish Red Data Book)

Category	Species number	%
RE	0	0
CR	0	0
EN	2	0,3
VU	32	4,4
NT	45	6,1
DD	23	3,1
NA	7	1,0
NE	74	10,1
LC	551	75,1
Total	734	100,0

Types of larval microhabitats of fungus gnats



(1) Larvae live merely under bark or in strongly decayed damp wood: *Boletina sciarina* Staeger, 1840 (Mycetophilidae)

Types of larval microhabitats of fungus gnats (continuing)

(2) Larvae live in webs on the inner surface of lignicolous fungi



Keroplatus testaceus Bosc
(Keroplattidae)



Types of larval microhabitats of fungus gnats (continuing)

(3) Larvae live in slimy webs
on the surface of dead wood.

They probably are predators
feeding on other invertebrates
which they encounter caught
by sticky slimy webs

Macrocera stigma Curtis
(Keroplastidae)



Types of larval microhabitats of fungus gnats (continuing)



(4) Larvae live inside fruiting bodies of lignicolous fungi or slime moulds:

Mycetophila adumbrata Mik
(Mycetophilidae)



(5) Larvae live in fruiting bodies of epigeal fungi:

Exechia contaminata Winn.
(Mycetophilidae)

Long legs of mycetophilids could work as a brush to transfer fungal spores



Mycetophila fungorum
De Geer



METLA

Fungal fruiting bodies attract both females and males of mycetophilids for mating

Upper – *Mycetophila ruficollis*, adults on *Armillaria gallica* ;

Lower –
Mating adults of *Leptomorphus forcipatus* (after Ševčík 2010)



Fungi which are not attractive to Diptera



- **Cantharellus and related species**
- *Cantharellus cibarius*
- *Cantharellus lutescens*
- *Cantharellus tubaeformis* (*suppilovahvero*)
- *Craterellus cornucopioides* (*mustatorvisieni*)

Fungi which are not attractive to Diptera

- *Tapinella atrotomentosa*
(*Paxillus atrotomentosus*)



- *Tylopilus felleus*



Rearing record means that one **has reared** the adult fly from fungal fruiting body with fly larvae and **indicated** both (1) the species of host fungus and (2) the species of fly emerged from larvae



Е.Б. ЯКОВЛЕВ

ДВУКРЫЛЫЕ ПАЛЕАРКТИКИ,
СВЯЗАННЫЕ С ГРИБАМИ
И МИКСОМИЦЕТАМИ



All records of Diptera reared from fungi in Palaearctic region known to the time of writing (1993)

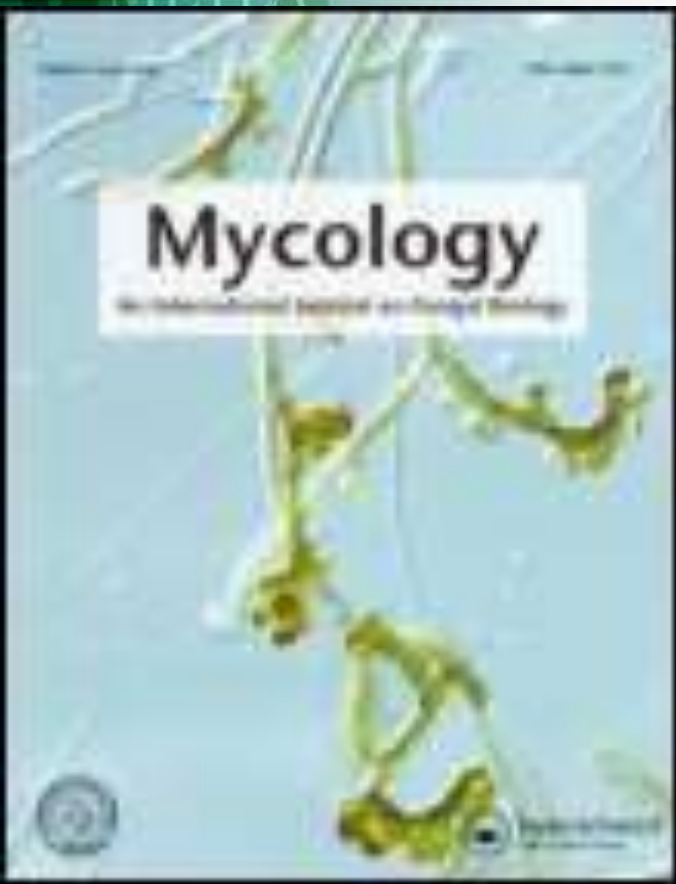
700 species of all families of Diptera reared from ca. 500 of macrofungi.

After 1993 a lot of new rearing records appeared, now these figures are → ca 1000 species of all families of Diptera reared from ca. 800 of macrofungi

Petrozavodsk 1994 (in Russian)

Jakovlev, J. 2011: Fungus gnats (Diptera: Sciarioidea) 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.**

Numbers of fungus gnat species with known larval microhabitats (a total of **498 species** that comprises **45.4% of the European fauna**) and numbers of known fungal hosts (some 650 species of macrofungi) are calculated and categorized based on this study and previous records from Europe and East Palaearctic.



To cite this article: Jevgeni Jakovlev (2012): Fungal hosts of mycetophilids (Diptera: Sciaroidea excluding Sciaridae): a review, *Mycology: An International Journal on Fungal Biology*, 3:1, 11-23

To link to this article:
<http://dx.doi.org/10.1080/21501203.2012.662533>

Numbers of rearing records (RR)

Agaricales - ca 300 host species; 1134 RR;

Russulaceae – ca 90 host species; 626 RR;

Boletales - ca 70 host species; 490 RR;

Hydnoids & ramaroids – ca 20 host species; 43 RR;

Ascomycota, Pezizales - ca 20 host species; 71 RR;

Polypores soft – ca 90 host species; 538 RR;

Polypores hard - ca 60 host species; 438 RR;

Corticoid fungi - ca 30 host species; 61 RR

Ascomycota, lignicolous - ca 10 host species; 16 RR

Jelly fungi/Slime moulds– ca 10/5 host species; 16/15RR;

Database structure: numbers of fungus gnat species and rearing records



- Total in Europe - 1097 species of fungus gnats
- Fungal hosts unknown - 680 species (62 %)
- Fungal hosts known - 417 species (38 %)
- Of these numbers of rearing records from named fungi

Rearing records no:	1	2	3	4	5	6	7	8	9	≥10 (max 259)	Totally 3362
Fungus gnat species, no:	84	83	53	33	22	17	16	18	12	79	417

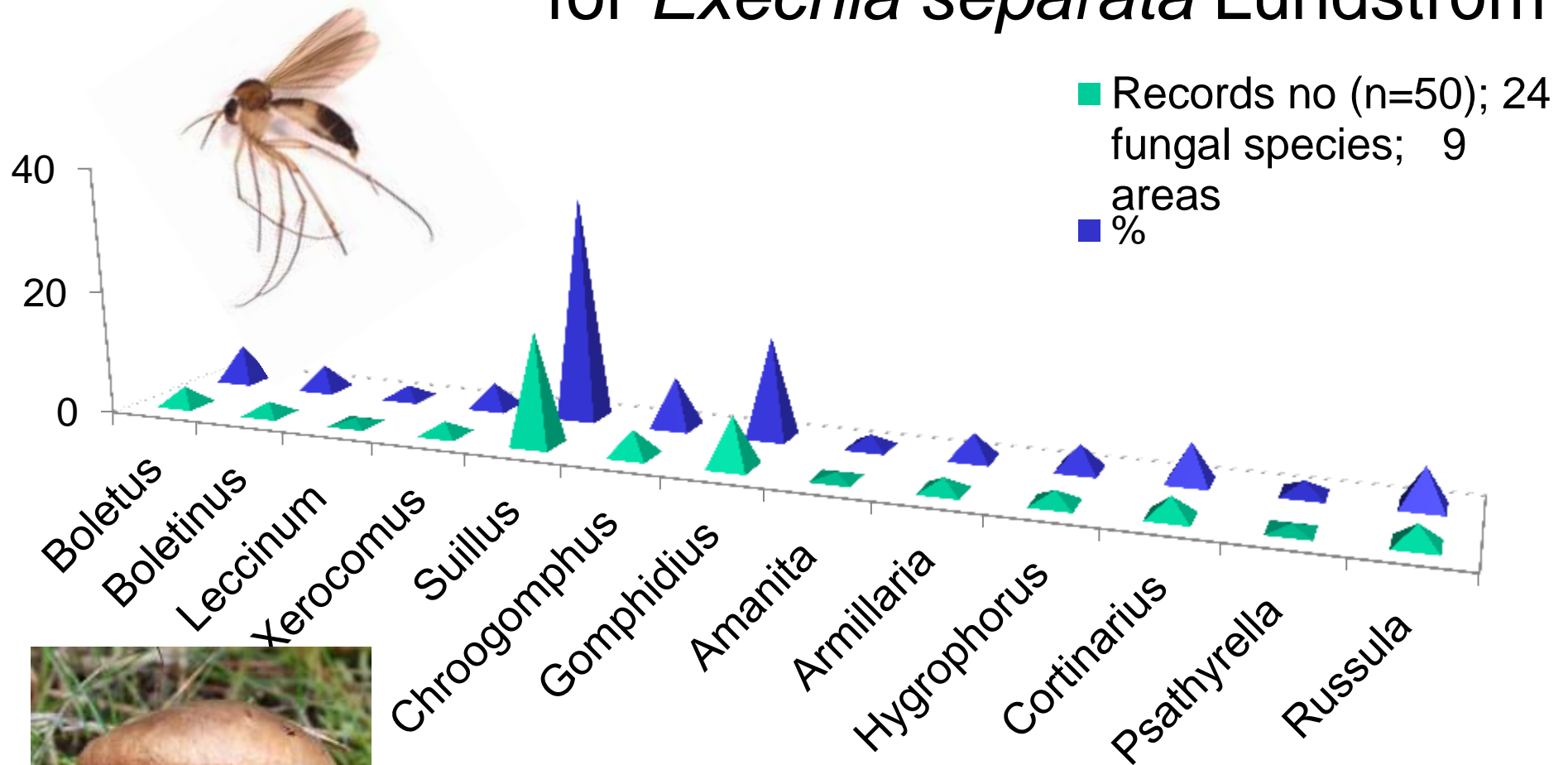
Numbers of fungus gnat species according their preference to host fungi. **A: soft macrofungi**

	Unsufficient data (≤ 2 records)	No preferences	Confined to this group	Confined to particular genus/species	Total
Agaricales	12	111	31	3/0	157
Boletales	5	77	1	0/0	83
Russulales	2	87	4	4/0	97
Hydnums, ramaroid & clavarioid	1	32	1	0/0	34
Pezizales	0	33	1	0/0	34

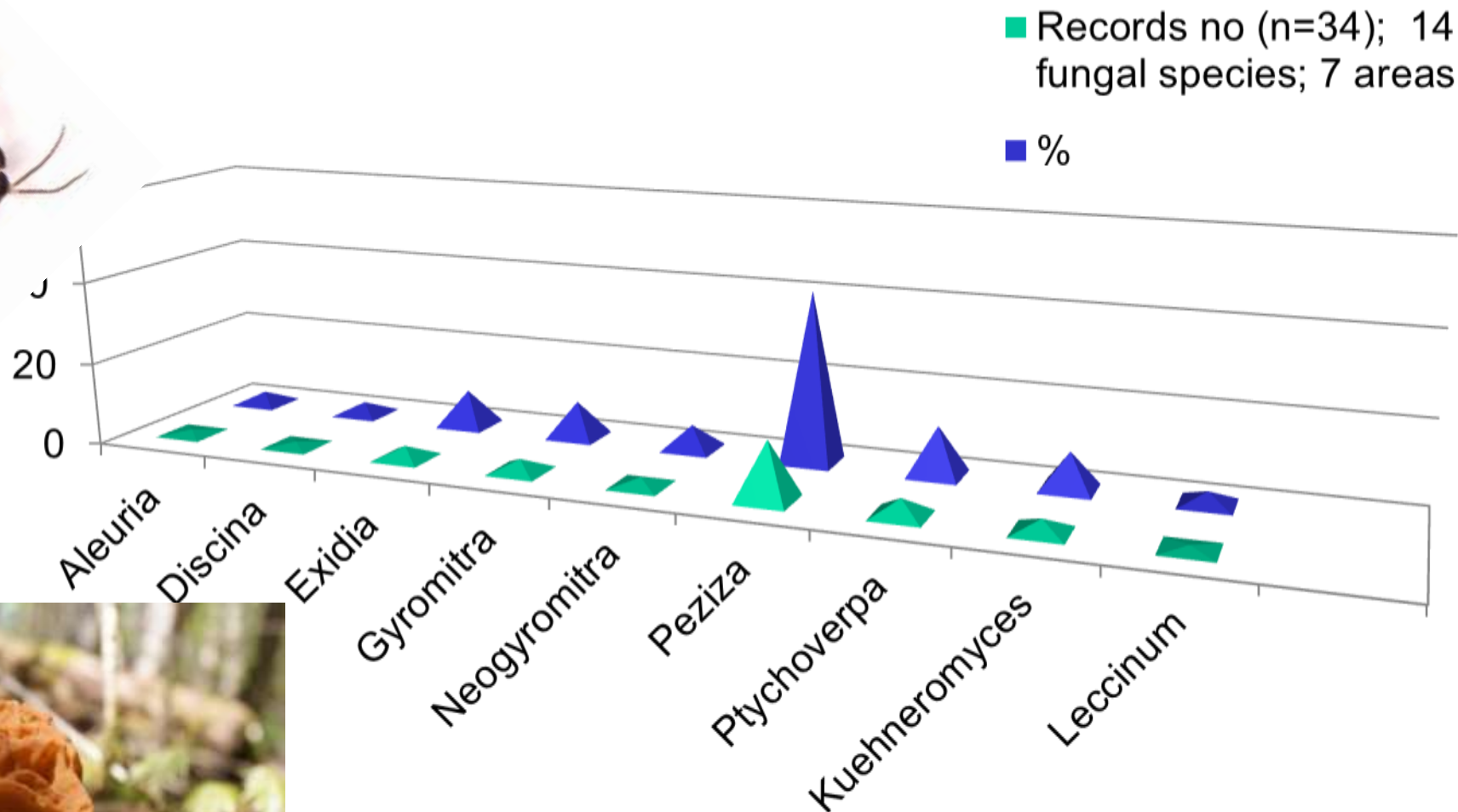
Numbers of **fungus gnat species** according their preference to host fungi. **B: lignicilous fungi**

	Uninsufficient data (≤ 2 records)	No preferences	Confined to this group	Confined to particular genus/species	Total
Polypores soft	109	31	35	0/2	177
Polypores hard	61	24	24	3/2	114
Corticoid fungi	38	0	0/0	0	97
Slime moulds	0	0	4	0/0	4

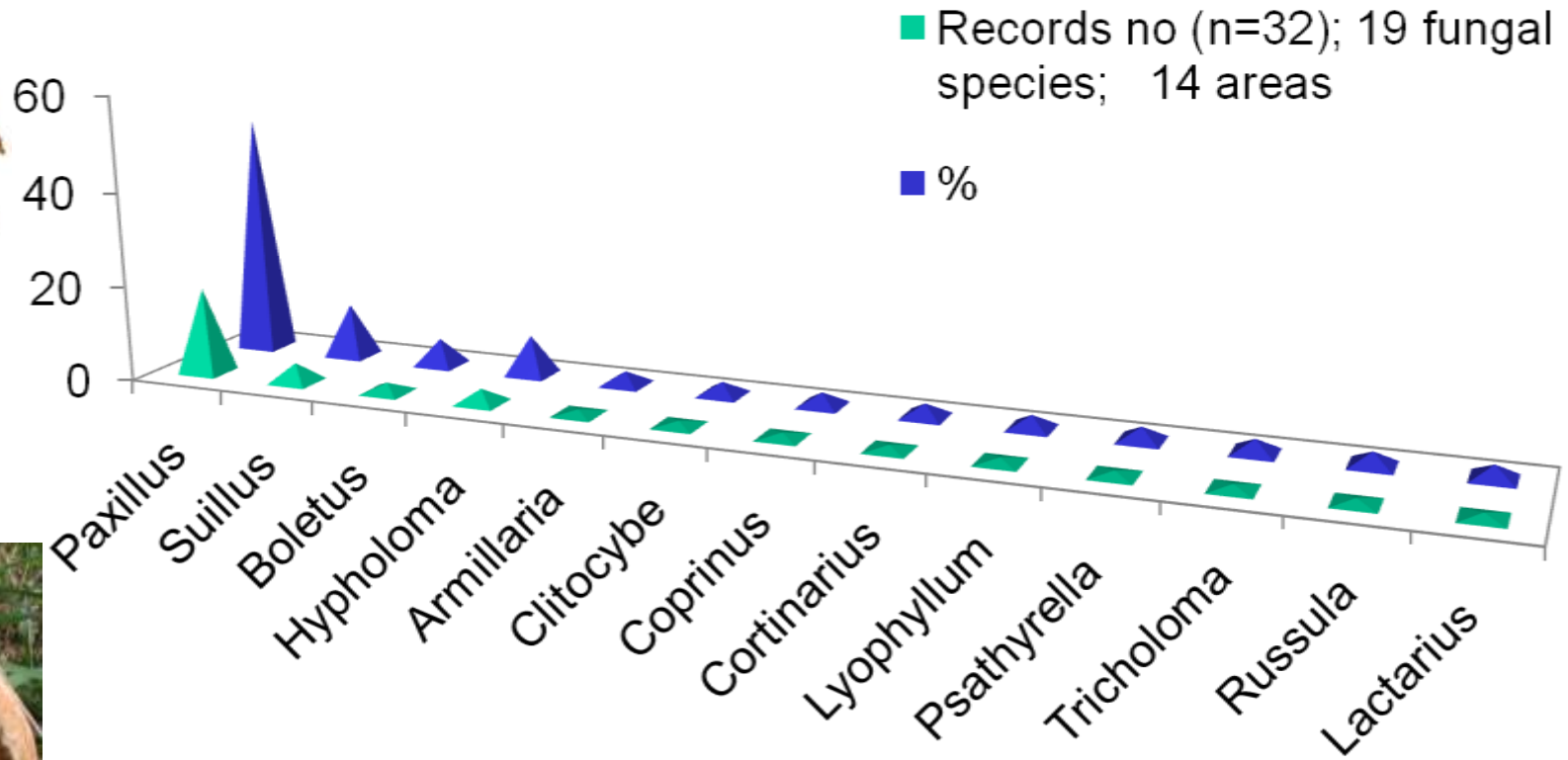
Number and proportion (%) of host fungal records for *Exechia separata* Lundström



Number and proportion (%) of host fungal records for *Allodia barbata* Lundström



Number and proportion (%) of host fungal records for *Bolitophila hybrida* Meigen, 1804



Further reading

Buxton P.A. 1960. British Diptera associated with fungi. 3. Flies of all families reared from about 150 species of fungi. *Entomologist's monthly Magazine* 96:61–94.

Jakovlev J. 1994. Palearctic Diptera associated with fungi and myxomycetes. Petrozavodsk: Karelian Research Center, Russian Academy of Sciences, Forest Research Institute. p.1–127. [In Russian with English summary].

Jakovlev, J. 2012. Fungal hosts of mycetophilids (Diptera: Sciarioidea excluding Sciaridae): a review, *Mycology: An International Journal on Fungal Biology*, 3:1, 11-23

Chandler P.J. 2010. Associations with fungi and Mycetozoa. In: *A Dipterist's handbook*. 2nd ed. Chandler P, editor. Orpington (England): The Amateur Entomologists' Society. *The Amateur Entomologist* 15:417–441.

Ševčík J. 2010. Czech and Slovak Diptera associated with fungi. Slezské zemské muzeum. Opava. 112 p.

Thank you for the attention!



Known fungal hosts for *Mycetophila finlandica* Edwards 1913

Fungal host	Country	Reference
<i>Tricholomopsis rutilans</i>	Great Britain	Buxton 1960
<i>Tricholomopsis rutilans</i>	Great Britain	Chandler 1978
<i>Tricholomopsis rutilans</i>	Czech Republic	Lastovka 1971
<i>Tricholomopsis decora</i>	Czech Republic	Sevcik 2006
<i>Tricholomopsis rutilans</i>	Finland	Hackman & Meinander 1979
<i>Tricholomopsis rutilans</i>	Finland	Jakovlev 2011
<i>Tricholomopsis rutilans</i>	Russian Karelia	Jakovlev 1995
<i>Tricholomopsis rutilans</i>	Estonia	Kurina 1991