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Insect fauna compared between six polypore species in a southern Norwegian spruce forest

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Beetles and gall midges were reared from dead fruiting bodies of the polypore species *Phellinus tremulae*, *Piptoporus betulinus*, *Fomitopsis pinicola*, *Pycnoporus cinnabarinus*, *Fomes fomentarius* and *Inonotus radiatus*. The number of species differed significantly among the polypore species. The variation in species richness conformed well with the hypothesis that more insect species may utilize a fungi species with (1) increasing durational stability, and (2) increasing softness of the carpophores. Strong preferance for certain polypore species was indicated for most of the Cisidae species, and a few species in the other families of beetles and gall midges (Diptera). The host preferances of the Cisidae species were in good agreement with records from other parts of Scandinavia. The host records in two of the gall midge species are new. Many of the species were too low-frequent for an evaluation of host preferances.

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INTRODUCTION

A large number of mycetophagous insects utilize fruiting bodies of wood-rotting fungi as food and breeding sites (Gilberston 1984). The species breeding in Polyporaceae display varying degree of host specificity. Apparently, few species inhabit only one fungus species (Lawrence 1973). Several hypothesis have been suggested to explain the differences between fungi species in species richness and composition of inhabitants, e.g. differences in (1) the durational stability of the fruiting bodies (Hanski 1989), (2) the hyphal structure of the fruiting bodies (Paviour-Smith 1960), (3) the hardness of the fruiting bodies (Klopfenstein and Graves 1989), and (4) differences between the insect species in mouth morphology and feeding strategy (Lawrence 1989). In light of these hypothesis, the present study compares the fauna of beetles and gall midges reared from the fruiting bodies of six common Polyporaceae species: *Fomitopsis pinicola* (Fr.) Karst., *Fomes fomentarius* (Fr.) Kickx, *Piptoporus betulinus* (Fr.) Karst., *Phellinus tremulae* (Bond.) Bond.& Borisov, *Pycnoporus cinnabarinus* (Fr.) Karst. and *Inonotus radiatus* (Fr.) Karst. All six species form sporocarps of a bracket type, and are associated with different ranges of tree species (Ryvarden 1976). The study was restricted to dead sporocarps, in order to avoid the influence of the differences between the successional stages of the sporocarps. An earlier study of *Fomitopsis pinicola* within the same area showed a significant faunistic difference between the successional stages of the sporocarps and the richest fauna in dead sporocarps (Økland & Hågvar 1994).

Studies of polypore fauna have been conducted in Scandinavia in recent time. Thunes (1993) has reared insects from *Fomes fomentarius* and *Piptoporus betulinus* in the western part of Norway, including both beetles and gall midges. Midtgaard (1985) has reared moths of the families Tineidae and Oecophoridae from

most of the present polypore species. Outside Scandinavia, several authors have studied the insect fauna in the present six species of polypores (Benick 1952, Paviour-Smith 1960, Pielou 1966, Pielou & Verma 1968, Ackerman & Shenefelt 1973, Lawrence 1973, Nuss 1975, Klimaszewski & Peck 1987).

The main questions in the present study were: Does the species richness of beetles and gall midges differ significantly between the present polypore species, and what properties of the polypores may contribute to such differences? To what extent do single species show preferances for certain polypore species within the study area, and are the host preferances the same as found in other parts of Scandinavia?

STUDY AREA AND METHODS

The study was conducted in 1992 in the northern part of Østmarka Nature Reserve (12.5 km^2) east of Oslo in Norway (UTM: N 636100, E 148000). The reserve is dominated by old spruce forest (*Picea abies*) with scattered deciduous trees (mainly *Betula verrucosa*, *B. pubescens*, *Populus tremula*, *Salix caprea*, *Sorbus aucuparia*, *Alnus incana* and *Prunus padus*). The area has a generally high density of dead wood.

On 14 April 1992, 30 dead sporocarps were collected from each of the polypore species, except for *Pycnoporus cinnabarinus*, with only 13. Each sporocarp was placed in a plastic funnel closed with black textile on the top and a collecting vial with ethylene-glycol in the bottom. The rearing traps were placed in an outdoor cage house with a natural climate, and were operated until the beginning of September 1992. All adult beetles and gall midges were identified to species according to catalogs of Silfverberg (1979) and Skuhràva (1986). Kruskal Wallis non-parametric analysis of variance was applied to test the differences in species occurrences between the polypore species (Freund 1992).

RESULTS

Altogether, 30 species of beetles and 5 species of Cecidomyiidae were reared. The number of species varied significantly among the polypore species, and the largest number was found in *Piptoporus betulinus*, *Fomitopsis pinicola* and *Fomes fomentarius* (**Table 1**). The other polypore species harboured relatively few insect species.

Significant preferances for certain polypore species was indicated for most of the Cisidae species (**Table 1**). *Cis glabratus* was exlusively reared from *Fomitopsis pinicola*, and *Cis jacquemarti* from *Fomes fomentarius*. *Sulcacis affinis* showed preferance for *Pycnoporus cinnabarinus*, but was also reared from Piptoporus betulinus. *Cis quadridens* and *C. nitidus* were most common in *Piptoporus betulinus*, but these species were also found in *Fomitopsis pinicola* and *Fomes fomentarius*.

Species in the other beetle families were in most cases too low-numbered for evaluation of host preferances (**Table 1**). Exceptions were *Bolitophagus reticulatus* (Tenebrionidae) with a clear preferance for *Fomes fomentarius*, and *Leptusa fumida* (Staphylinidae) occuring most often in *Fomes fomentarius* and *Fomitopsis pinicola*.

Two species of Cecidomyiidae (Diptera) were frequent in the present study, and one of them, *Lestodiplosis polypori*, was significantly more numerous in *Fomitopsis pinicola*, *Fomes fomentarius* and *Piptoporus betulinus* (**Table 1**).

Table 1. *Number of insect adults reared from dead fruiting bodies of (A) Phellinus tremulae, (B) Fomitopsis pinicola, (C) Fomes fomentarius, (D) Piptoporus betulinus, (E) Pycnoporus cinnabarinus and (F) Inonotus radiatus. Difference between polypore species were tested with Kruskal-Wallis test (H) for all insect species exceeding a mean of four individuals pr. polypore species. Significance levels: *** p < 0.001, ** p < 0.01. * p < 0.05, and n.s. if p > 0.05.*

Polypore species:	A	B	C	D	E	F	H	sign.
name:	Ph.trem.	Fom.pin.	Fom.fom.	Pip.bet.	Pyc.cin.	In.rad.		
life cycle:	perennial	perennial	perennial	annual	annual	annual		
context:	very hard	hard	hard	soft	soft	soft		
Cisidae:								
Cis boleti	0	0	0	43	0	0	4,25	n.s.
Cis glabratus	0	219	0	0	0	0	113,86	***
Cis jacquemarti	0	0	283	0	0	0	133,69	***
Cis nitidus	0	3	5	119	0	0	15,42	***
Cis quadridens	0	12	0	86	0	0	22,09	***
Cis dentatus	0	0	1	0	0	0		
Enearthron cornutum	0	0	0	8	0	0		
Octotemnus glabriculus	0	0	0	2	0	0		
Sulcacis affinis	0	0	0	14	173	0	83,18	***
Staphylinidae:								
Agariochara latissima	0	0	0	1	0	0		
Amischa decipiens	0	0	0	1	0	0		
Amischa nigrofusca	0	0	0	1	0	0		
Dinaraea arcana	0	0	1	0	0	0		
Euplectus decipiens	0	0	1	0	0	0		
Ischnoglossa prolixa	0	0	3	0	0	0		
Leptusa fumida	4	9	15	1	0	0	17,68	**
Megarthrus sinuatocollis	0	0	0	1	0	0		
Pachygluta ruficollis	0	1	0	0	0	0		
Proteinus macropterus	0	0	0	1	0	0		
Quedius plagiatus	0	1	0	0	0	0		
Other beetle families:								
Abdera flexuosa	0	0	0	0	0	4		
Anaspis rufilabris	0	0	0	2	0	0		
Atomaria alpina	0	1	0	0	0	0		
Bolitophagus reticulatus	0	0	26	0	0	0	22,72	***
Cortinicara linearis	0	1	0	0	0	0		
Dinerella elongata	0	0	5	0	0	0		
Dorcatoma dresdensis	0	3	1	0	0	2		
Ips typographus	1	0	0	0	0	0		
Rhizophagus dispar	0	3	2	2	0	1		
Thymalus limbatus	0	0	0	1	0	0		
Cecidomyiidae:								
Winnertzia nigripennis	0	46	19	0	0	0	10,15	ns
Lestodiplosis polypori	0	30	44	19	1	0	26,22	***
Excrescentia mutuata	0	0	9	0	0	0		
Corinthomyia brevicornis	0	6	1	0	0	0		
Aprionus sp.	0	3	0	0	0	0		
Number of species	2	14	15	16	2	3	75,05	***

DISCUSSION

A combination of two hypothesis conforms well with the distribution of species richness recorded in the six polypore species: (1) Increasing durational stability makes the fruiting bodies suitable for more species, and (2) increasing softness implies that more species may utilize the fruiting bodies. The durational stability of the sporophores is of obvious significance to the insect fauna in fungi (Hanski 1989). The polypores have generally higher durational stability compared to the gilled mushrooms (Richardson 1970). The present study comprises both annual and perennial species of polypores. However, for the present fauna the duration of the fruiting bodies after death must be a more important factor than the duration of the living stage. The largest number of species was reared from an annual polypore species, *Piptoporus betulinus*, which has long been known to harbour a fairly rich insect fauna (Pielou 1966, Pielou & Verma 1968). The fruiting bodies of this species may be quite big. Even though this species is annual, the dead fruiting bodies may persist up to three years (Gilbertson 1984). In moist condition, these fruiting bodies are quite soft and comparable to Agaricales. The softness is supposed to increase the access and success of development for several insect species compared to harder polypore species (Klopfenstein & Graves 1989). At the same time, these fruiting bodies are more long-lasting than in Agaricales. The few species reared from the very hard fruiting bodies of *Phellinus tremulae* conforms well with the factor of hardness. However, few species were also reared from the soft fruiting bodies of *Pycnoporus cinnabarinus* and *Inonotus radiatus*. The durational stability of carpophores in these species appears to be shorter than in *P. betulinus*, since their carpophores are relatively small and may be eaten up within short time.

From England and North America the species of Cisidae have been described to occur in "host preferance groups", in which certain species of Cisidae are associated with certain polypore species (Paviour-Smith 1960, Lawrence 1973). The present results correspond well with such a model. Most Cisidae species showed strong preferances for certain polypore species. *Cis glabratus* and *Cis jacquemarti* occurred only in hard and perennial polypores, while most other species of Cisidae were more numerous in soft and annual polypore species. The host preferances of the three most numerous species, *Cis glabratus* , *Cis jacquemarti* and *Sulcacis affinis*, were the same as recorded in the western part of Norway (Thunes 1993) and in different parts of Sweden (Bengt Ehnström & Mats Jonsell pers. comm.). A closer examination of each insect species might reveal differences in mouth morphology and feeding strategy which are correlated with the hyphal structure and hardness of their host fungi species.

The model of "host preferance groups" may apply to other insects than Cisidae, like e.g. certain species in Cecidomyiidae and other families of Coleoptera. *Bolitophagus reticulatus* was numerous and exclusively found in *Piptoporus betulinus*, similar to what has been recorded by other researchers (Thunes 1993, Ehnström pers. comm.). *Leptusa fumida* was most numerous in *Fomes fomentarius* from Østmarka; however, this species was most numerous in *Piptoporus betulinus* in a study from western Norway (Thunes 1993). A final statement about such differences is avoided due to the low number of fruiting bodies applied in the present study.

For the low-frequent species, the present results are not sufficient for any conclusion about host preferences. The adults of many Staphylinidae species are known to be polyphagous and occur in a wide range of short-lived fungal habitats, while their larvae often show a more narrow host range (Newton 1984). Trapcaptures from *Fomitopsis pinicola*

indicated that a long list of Staphylinidae species may visit the fruiting bodies without breeding here (Økland & Hågvar 1994). Many of the species reared in low numbers are supposed to have their optima in some other habitats, while they may sporadically occur in the present polypore species. E.g. one individual of *Ips typographus* was reared from *Phellinus tremulae*, while it is well documented that *I. typographus* normally hibernates under the bark of dead spruces or in the forest litter (Biermann 1977). However, it cannot be excluded that many species possess clear preferances among the present species of polypores, even though they occurred in low numbers.

Gall midges of fungi are not well studied. *Excrescentia mutuata* Mamaev and Berest was described from the Carpathiens in 1991 (Mamaev & Berest 1991). From the present material the host and the female of this species are described for the first time (Økland 1995). The present host records are probably new for *Corinthomyia brevicornis* (Felt 1907), while the species *Winertzia nigripennis* Kieffer 1896 and *Lestodiplosis polypori* (Loew 1850) have already been recorded from various species of polypores.

From a management perspective, it should be noticed that the presence of dead deciduous trees is essential for five of the present polypore species: *F. fomentarius*, *P. betulinus*, *P. tremulae*, *P. cinnabarinus* and *I. radiatus*. Birch (*Betula* sp.) appears to be a "key species" (Hunter 1990) for the present fauna, since birch is the main host for three of the most species-rich polypore species: *F. fomentarius*, *P. betulinus*, *P. cinnabarinus*.

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SAMMENDRAG

Insektfauna sammenlignet mellom 6 kjukearter i en sørnorsk granskog

Biller og gallemygg ble klekket fra døde fruktlegemer av kjukeartene *Phellinus tremulae*, *Piptoporus betulinus*, *Fomitopsis pinicola*, *Pycnoporus cinnabarinus*, *Fomes fomentarius* and *Inonotus radiatus*. Det var signifikant variasjon i artsantall mellom kjukeartene. Variasjonen i artsantall samsvarte bra med hypotesene om at flere insektarter kan utnytte en soppart ved (1) økende varighet, og (2) økende mykhet av kjukefruktlegemene. Sterk verstspreferanse ble funnet hos de fleste Cisidae artene og hos visse arter blant de øvrige billene og gallemyggene. Vertspreferansen hos Cisidae artene samsvarer med registreringer fra andre steder i Skandinavia. For to av gallemyggartene er vertsbeskrivelsene nye. Mange av artene var for lavfrekvente for en vurdering av vertspreferanse.

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