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Saproxylic beetles (Coleoptera) on dead birch trunks decayed by different polypore species

Lauri Kaila, Petri Martikainen, Pekka Punttila & Evgeniy Yakovlev

Kaila, L., Finnish Museum of Natural History, Zoological museum, P.O. Box 17, FIN-00014 University of Helsinki, Finland
Martikainen, P. & Punttila, P., Department of Zoology, Division of Ecology, P.O. Box 17, FIN-00014 University of Helsinki, Finland
Yakovlev, E., Forest Research Institute of the Karelian Centre of the Russian Academy of Sciences, Pushkinskaya 11, SU-185610 Petrozavodsk, Russia

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Saproxylic beetle assemblages on dead birch trunks decayed by *Fomes fomentarius*, *Phellinus igniarius* (coll.) and *Fomitopsis pinicola* were studied using trunk-window traps. As controls served dead birch trunks without polypore sporocarps, living birches and dead spruce trunks with *F. pinicola*. Six data sets with varying combinations of trunk types were collected from southern and eastern Finland and Russian Karelia. The species-abundance distributions in all trunk types and data sets resembled log-series distribution. Two-way indicator species analyses (TWINSPAN) indicated that distinct beetle assemblages were associated with different polypore species, although variation among the samples was considerable. Both the median number of beetle species and individuals per trap were higher on *F. fomentarius* and *F. pinicola* compared to other treatments. Individual beetle species occurred unevenly among the trunk types, presumably indicating association with the polypore species decaying the trunk. The living conditions of many saproxylic beetles could probably be improved in the managed forests by leaving dead and dying wood in the thinning and clearcutting phases of the stand rotation. If such a practice were to become standard, the continuity of decaying trees of particular kinds could be secured which, in turn, is necessary for viable populations of specialized saproxylic beetles.

1. Introduction

Decaying wood hosts a great variety of insects, especially beetles (Saalas 1917, 1923, Palm 1951, 1959). Decaying wood itself is a very heterogenous substance. For instance, the tree species, the diversity and quality of fungus species decaying the wood, the degree of decay, and the quality and structure of the surrounding biotope are variables that may affect the occurrence of saproxylic insect species. This heterogeneity probably maintains the large diversity of sapro-

xylic organisms in boreal forests (e.g. Ehnström & Walden 1986, Siitonen & Martikainen 1994).

Intensive management has led to a reduction of natural forests in Finland. According to Rassi et al. (1992a), only about 5% of forests in southern Finland are more than 120 years old, but most of even these forests are managed and structurally uniform. In particular the regular thinning of stands and removing of dead and dying trees have diminished the resources for saproxylic species and have thus impoverished the saproxylic fauna in managed forests. In Finland, 314 forest invertebrate species are regarded as threatened, and 196 of these are associated with decaying wood (Rassi et al. 1992b).

Obviously the reduction of dead wood in forests has not reduced the numbers of all saproxylic species equally. Certain species have evidently declined dramatically, whereas others are still common (e.g. Saalas 1917, 1923, 1949, Rassi et al. 1992b). This difference is probably a consequence of forest management practices. Some particular kinds of decaying wood, e.g. stumps and logging residue in clear-cuts and in thinned stands, are common in managed forests, whereas large decaying deciduous trees are almost absent. Thus, certain saproxylic species can survive in managed forests, whereas the habitats of others may have become too scarce to support viable populations.

Understanding the specialization patterns of saproxylic species is important in developing conservation strategies for the preservation of these organisms. As protected forest reserves are mainly small and isolated patches within large areas of managed forests, the reserves are not sufficient for the conservation of saproxylic fauna. Small and isolated populations inhabiting the reserve face a high extinction risk due to stochastic effects (for a discussion on the subject, see Burkey 1989). There are already some practical recommendations for taking the saproxylic fauna into account in forest management practices (Ehnström et al. 1986, Korhonen 1993), but experimental background for this is still weak.

The existing information about the beetles associated with decaying wood is almost exclusively based on qualitative observation. Quantitative data on the host preferences are very scarce in the literature (but see Paviour-Smith 1960, Väisänen et al. 1993). The aim of this paper is to explore the beetle assemblages on birch trunks decayed by three very common perennial polypore species, *Fomes fomentarius, Phellinus igniarius* (coll.) and *Fomitopsis pinicola* using a quantitative sampling method. In addition, we focus on the occurrences of the most abundant beetle species on different trunk types and discuss the implications of our results for forest management.

2. Material and methods

2.1. The polypore species

The following summary is based on Ryvarden (1976), Niemelä (1993), Niemelä & Kotiranta (1982), and our own observations.

Fomes fomentarius is predominantly a lethal parasite of birch but it occurs less abundantly also on other deciduous trees. It kills the tree rather rapidly, and the sporocarps normally appear after the death of the tree. The sporocarps may be alive for many years after the death of the tree until the wood has rotted to a white paper-like consistency. *F. fomentarius* causes white rot using lignin from the tree and leaving the cellulose fibres behind.

Phellinus igniarius (coll.) infects many deciduous tree species, and it is common on birch. The species is at first a parasite, causing heart rot in the tree for many years. After the death of the host the fungus continues its growth as a saprophyte, the live sporocarps persisting for a long time. It does not kill the host as rapidly as *F. fomentarius*, the sporocarps often appearing when the tree is alive; the death of the host tree may occur many years later. *Ph. igniarius* causes white rot.

Fomitopsis pinicola infects both deciduous and coniferous trees. The sporocarps appear only after the death of the host. This species causes brown rot, using cellulose from the tree and leaving lignin.

2.2. The beetle species included in the analyses

The species included in the study are according to the available literature saproxylic (in the sense of Speight 1989) in their living habits. Some

species are fungivores or xylophagous, others are probably detritivores or generalists, and certain species are known or suspected to be predators. As references for the living habits we mainly used Saalas (1917, 1923, 1949) Hansen (1950, 1951), Benick (1952) and Palm (1959). In addition, further information about Leiodidae and other slime-mould feeding beetles was obtained from Lawrence & Newton (1980), Chandler (1991), and Chandler & Peck (1992), and about Cisidae from Paviour-Smith (1960) and Lawrence (1973). The nomenclature follows Silfverberg (1992). The families included in the assemblage analyses are listed in Table 1. The families Staphylinidae, Latridiidae, Cerylonidae and Cryptophagidae, as well as the genus *Epuraea* (Nitidulidae), were not included in the analyses because of identification problems. The scolytids attack weakened or recently dead trees, and they are not associated with later stages of decay. We therefore excluded them from the analyses, too. These excluded groups made up roughly 30% of the individuals in the whole material. The numbers of the species included in the species-level analyses are presented in Table 2.

2.3. Sampling method and design

We collected the samples using trunk-window traps. A description of the trap is given in Kaila (1993). Traps were placed on standing trunks. The deposition height of the traps varied between 0.5–2.5 m, measured from the lower margin of the window. If polypore sporocarps were present in the trunk, the traps were placed as close to them as possible. If the sporocarp was broader than 8 cm, we wedged the window into the sporocarp. This apparently did not affect the sporocarps, as they rapidly grew tightly against the window, and we could not observe any desiccation of sporocarps due to the wedging. The material was collected during the summers of 1990–1992 in southern and eastern Finland, and in Russian Karelia. The traps were checked at intervals of two weeks to one month.

In the comparisons we used six different types of birch trunks in various combinations (see below): As control trunks for the dead ones we used living birches with no signs of decay (LBc). No saproxylic beetles can live in such trunks, and thus these samples controlled the general mobility of the beetles; dead trunks without any polypore sporocarps (DBc), dead trunks with sporocarps of *F. fomentarius* (DBf), dead trunks with sporocarps of *Ph. igniarius* (DBi), living trunks with *Ph. igniarius* (LBi), and dead trunks with sporocarps of *F. pinicola* (DBp). In addition, we took samples from dead spruce trunks with sporocarps of *F. pinicola* (DSp). The different trunk types will be called 'treatments' below. The two treatments with *Ph. igniarius* (4 and 5) were kept separated only in the species-level analyses in the first data set (Heinola 1990; see below). As it appeared to be difficult to find sites where all the three polypore species and dead trunks without sporocarps would have been sufficiently abundant, we made different combinations of comparisons in different sites (see Table 3).

At each sampling site we measured the tree canopy coverage, the proportions of the total basal area of different tree species, and the total basal area of standing dead trees. We also made a general description of the vegetation in each site and measured the height and diameter of the sampling trunks, the number and size of polypores within one metre above each trap, and the deposition height of the trap. The analyses on the effects of these factors, among others, will be

Table 1. The beetle families included in the analyses, with the total number of species in the samples.

Family	Species	Family	Species
Aderidae	2	Lucanidae	2
Anobiidae	6	Lymexylidae	1
Anthribidae	1	Melandryidae	12
Buprestidae	2	Mordellidae	6
Cerambycidae	11	Mycetophagidae	7
Cisidae	16	Nitidulidae[b]	10
Colydiidae	1	Rhizophagidae	9
Cucujidae	5	Salpingidae	4
Dermestidae	2	Sphindidae	2
Elateridae[a]	19	Tenebrionidae	8
Endomychidae	2	Tetratomidae	1
Erotylidae	6	Trogossitidae	3
Eucnemidae	3		
Leiodidae	17	Total	158

[a] Excl. species living in the soil
[b] Excl. Epuraeini and Meligethinae

published in another context. Here we make only brief comments on occasions where the above variables may have affected the present results. A brief description of the sampling sites is given below.

1. *Heinola 1990*, southern Finland (61°10′N 26°08–16′E). The sampling was performed in five study plots lying at distances of 1–30 km from each other in *Ta*: Heinola and in *Sa*: Pertunmaa. In four of the study plots the age of the forest was ca. 80 yrs and the tree-species composition varied as follows: birch 50–90%, pine 0–20%, spruce 0–20%, aspen 0–20%. The tree canopy coverage varied between 60–80%, and the field layer vegetation consisted of low grasses and herbs covering about 70–100% (abundant species included *Pteridium aquilinum*, *Vaccinium myrtillus*, *Melica nutans*, *Deschampsia flexuosa*, *Melampyrum pratensis*, etc.). The total basal area of standing dead trees was about 5 m^2/ha. The fifth site was the moist and sunny south-facing edge of a bog with dying and dead, relatively thin birches. The sampling period was 22nd May – 28th September 1990.

2. *Heinola 1991*, southern Finland. The sampling was performed in two of the study plots from the year 1990: the site in Pertunmaa (61°21′N, 26°16′E) and the sunny edge of a bog in Heinola (61°10′N, 26°16′E). The sampling period was 13th April – 14th September 1991.

3. *Kirkkonummi 1991*, southern Finland (60°11′N, 24°17–22′E). The sampling was per-

Table 2. The abundances of the beetle species included in the species-level analyses, the proportions of the species of the total catch and the numbers of trunks used in sampling in the six data sets. The numbers in parentheses have not been included in the species-level analyses. The collecting sites were: A Heinola 1990, B Heinola 1991, C Kirkkonummi 1991, D Kivach, E Puumala, F Ilomantsi. The descriptions of the collecting sites are given in the text.

Species (abbr: name, family)	Sites: A	B	C	D	E	F	%	Total
Anisotoma humeralis (Le)	744	597	547	402	(12)	78	14.9	2380
Anisotoma glabra (Le)	279	(156)	(39)	44	(6)	104	3.9	628
Agathidium discoideum (Le)	–	–	–	134	–	(2)	0.9	136
Agathidium confusum (Le)	(58)	288	(37)	56	(8)	(8)	2.9	455
Dorcatoma punctulata (An)	(7)	(1)	–	(29)	(3)	29	0.4	69
Dorcatoma dresdensis (An)	219	140	(36)	57	–	13	2.9	465
Dorcatoma robusta (An)	1589	355	377	60	(11)	(10)	15.1	2402
Dorcatoma substriata (An)	(13)	(23)	–	–	–	–	0.03	36
Cyllodes ater (Ni)	–	–	–	46	–	–	0.03	46
Cychramus variegatus (Ni)	(6)	(34)	(6)	236	(1)	–	1.8	283
Cychramus luteus (Ni)	(13)	(31)	(22)	86	(14)	–	1.0	166
Glischrochilus hortensis (Ni)	(306)	118	(43)	120	(10)	(1)	3.7	598
Rhizophagus dispar (Rh)	(150)	(87)	(35)	(48)	57	111	3.1	488
Rhizophagus bipustulatus (Rh)	(62)	(95)	136	–	(6)	–	1.9	299
Rhizophagus cribratus (Rh)	263	116	(6)	(7)	(15)	–	2.6	407
Triplax russica (Er)	1997	233	(7)	130	(15)	(66)	15.3	2448
Ropalodontus strandi (Ci)	(94)	(77)	(52)	(3)	(15)	(15)	1.6	256
Bolitophagus reticulatus (Te)	338	(133)	(219)	(31)	125	(70)	5.7	916
Orchesia micans (Me)	(206)	(25)	(2)	(24)	(6)	(10)	1.7	273
Treatments (number of traps)								
LBc Live control	–	10	–	–	–	–		
DBc Dead control	23	10	9	–	–	–		
DBf *F. fomentarius*	48	20	25	18	7	7		
DBi *Ph. igniarius* (dead trunk)	7	3	–	–	–	–		
LBi *Ph. igniarius* (live trunk)	6	5	–	–	–	–		
DBp *F. pinicola*	–	–	–	10	5	–		
DSp *F. pinicola* on spruce	–	–	–	–	4	7		

formed on two study plots: in *N*: Kirkkonummi and Siuntio, 5 km from each other. Both sites were moist shores of lakes. The sites were dominated by birch (90–100%). The tree-canopy coverage in Kirkkonummi was 45% and in Siuntio 60%. The field layer vegetation consisted of tall herbs and grasses, e.g. *Phragmites australis*, *Calamagrostis* spp., *Lysimachia vulgaris* and *Filipendula ulmaria*. The total basal area of standing dead trees was about 14 m^2/ha. In this comparison the control trunks were thinner than trunks with *F. fomentarius*, which may have biased the results, as according to our preliminary analyses the thickness of the trunk may correlate positively with catches of some beetle species. The sampling period was 12th April – 15th September 1991.

4. *Kivach 1991*, Russian Karelia (62°17′N, 33°53′E). The sampling was performed in a moist forest stand with old birches and younger spruces (birch 50%, spruce 30%, pine 20%). The field layer vegetation was dominated by *Calamagrostis arundinacea*, *Vaccinium myrtillus* and *V. vitis-idaea*. The basal area of the tree species was not measured. The sampling period was 31st May – 26th September 1991.

5. *Puumala 1992*, southern Finland (61°38′N, 28°00′E). The sampling was performed in an old primaeval forest, where the tree species composition was birch 20%, spruce 55%, pine 5%, and aspen 20%. The tree canopy coverage was about 70%. The field layer vegetation was dominated by *Vaccinium myrtillus* (90%) and other abundant plant species included *Maianthemum bifolium*, *Calamagrostis arundinacea*, *Melampyrum pratensis* and *Rubus saxatilis*. The total basal area of standing dead trees was about 5 m^2/ha. The traps were deposed lower on the spruce trunks compared to birch trunks, which may have distorted the results, as according to our preliminary analyses the deposition height of the trap may correlate negatively to beetle catches. The sampling period was 18th May – 4th September 1992.

6. *Ilomantsi 1992*, eastern Finland (62°58′N, 31°23–24′E). The sampling was performed in a moist old primaeval forest in Koivusuo Strict Nature Reserve (birch 18%, spruce 68%, pine 14%). The tree canopy coverage was about 80%, and the field layer vegetation consisted of *Vaccinium myrtillus* (40%), *Carex* spp. (30%), *Equisetum sylvaticum* (10%) and *Vaccinium vitis-idaea* (10%). The total basal area of standing dead trees was about 7 m^2. The spruce trunks were thicker than those of birches ($H = 9.04$, $P = 0.003$). The sampling period was 26th May – 27th August 1992.

2.5. Statistical analyses

We used two-way indicator species analysis (TWINSPAN, Hill 1979; default pseudospecies cut-level settings applied, only species occurring in > 5% of the samples were included) to classify the individual samples of the six data sets according to the beetle catches. We used these classifications for a rough evaluation of the similarities among the treatments. We examined the structure of the beetle assemblages in the treatments by plotting observed species-abundance distributions using octaves (Preston 1962) as abundance classes. We used rarefaction (Sim-

Table 3. Total sample sizes and numbers of species included in the assemblages-level analyses in the treatments. For treatment abbreviations, see Table 2.

	Treatment						Total	
	LBc	DBc	DBf	-Bi	DBp	DSp	Ind.	spp.
Heinola 1990		1540	5508	481			7529	99
Heinola 1991	156	451	2193	392			3192	99
Kirkkonummi 1991		368	1579				1947	73
Kivach 1991			1129		652		1943	68
Puumala 1992			319		107	102	528	57
Ilomantsi 1992			623			195	818	78
Total	156	2359	11513	873	759	297	15957	158

berloff 1978) to compare the numbers of species for standardized sample sizes in the treatments.

We compared the occurrences of individual species among the treatments using Kruskal-Wallis non-parametric one-way ANOVA with Tukey-type *a-posteriori* comparisons (Zar 1984). On occasions when only two treatments were compared, Mann-Whitney rank-sum tests were used. Species occurring in at least 2/3rds of the samples were included in the analyses in each data set.

3. Results

The total material of the six data sets consisted of 15957 individuals of 158 saproxylic beetle species (Table 3). The vast majority of the species were represented by a small number of individuals. The five most abundant species were *Triplax russica* (2448 exx.), *Anisotoma humeralis* (2380 exx.), *Dorcatoma robusta* (2402 exx.), *Bolitophagus reticulatus* (916 exx.) and *Anisotoma glabra* (628 exx.). These species made up 55% of the total catch. The five most frequently caught species were *Anisotoma humeralis* (in 196 of the total of 222 traps), *Dorcatoma robusta* (155), *Triplax russica* (147), *Anisotoma glabra* (135) and *Cis jacquemartii* (*C. glabratus* not separated) (134).

3.1. Beetle assemblages in the treatments

In general, all the species-abundance distributions resembled log-series distribution. In all treatments, the majority of the species were scarce and only a few abundant. The distributions in each treatment among the data sets were rather consistent, and the differences among the treatments were relatively small. As regards the most abundant species in the treatments in samples from *F. fomentarius*, *A. humeralis* was among the three most abundant species in four, *B. reticulatus*, *D. robusta* and *T. russica* in three, and *Rhizophagus dispar* in two of the six data sets (Table 4). The species composition between the two data sets on *Ph. igniarius* differed greatly, and only *Dorcatoma dresdensis* was included among the three most abundant species in both data sets. Similarly, only *C. jacquemartii* was found among the three most abundant species in the two data sets on *F. pinicola* on birch. Taking the two sample series from spruce into account, there were no abundant species common to all four sample series on *F. pinicola*, although *A. humeralis* and *Ennearthron laricinum* were among the three most abundant species in one sample from both birch and spruce. *A. humeralis* and *D. robusta* were among the three most abundant species in all three data sets on dead trunks without sporocarps. These two species and *T. russica* were among the three most abundant species most often in the 16 sample series.

The first level of TWINSPAN divisions separated samples from *F. fomentarius* from the others in all data sets, except in the one from Ilomantsi (Fig. 1). Similarly, the *F. pinicola* samples from both birch and spruce tended to separate from the samples of the other treatments in the two first levels of TWINSPAN divisions.

Table 4. The occurrences of individual beetle species among the three most abundant species in the treatments (see Table 3 for the codes of the treatments). The species are ranked alphanumerically. In two sample series (5 and 6), the ranks are divided among the species with the same sample sizes. For species and treatment abbreviations, see Table 2 and Fig. 1.

	Treatment						
Species	LBc	DBc	DBf	DBi	LBi	DBp	Total
1. Anhum	1	3	4	1	1	1	11
2. Dorob		3	3	1			7
3. Trrus		1	3	1			5
4. Boret			3		0.5		3.5
5. Angla		2	1				3
6. Agcon	1			1			2
7. Cijaq					2		2
8. Cyvar			1		1		2
9. Dodre				2			2
10. Rhdis			2				2
11. Enlar					1	0.7	1.7
12. Agsem						1	1
13. Dopun						1	1
14. Glqua			1				1
15. Haper						1	1
16. Hyder	1						1
17. Habin						0.7	0.7
18. Rhcri						0.7	0.7
19. Ciqua					0.5		0.5

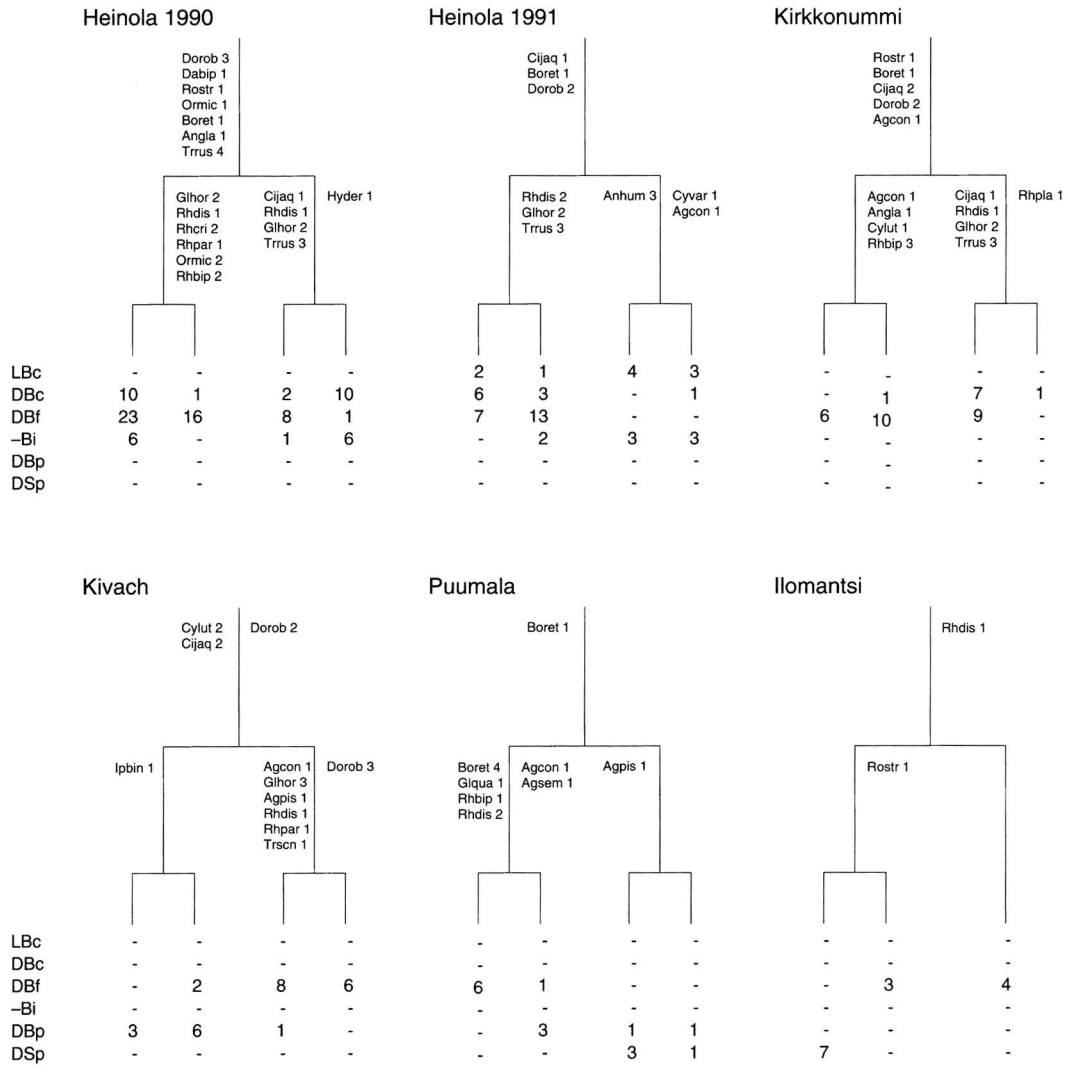

Fig. 1. The grouping of the individual traps in the six data sets in two-way indicator species analyses (TWINSPAN) according to the beetle catches. The indicator species of the divisions together with their abundance values are given. The samples from different treatments are abbreviated as in Table 2. For the species abbreviations, see Table 2. Species not included in Table 2 are *Dacne bipustulata* (Dabip), *Rhizophagus parvulus* (Rhpar), *Cis jacquemartii* (Cijaq), *Ipidia binotata* (Ipbin), *Agathidium pisanum* (Agpis), *Glischrochilus quadripunctatus* (Glqua), *Agathidium seminulum* (Agsem), *Salpingus planirostris* (Rhpla), *Triplax scutellaris* (Trscu) and *Hylecoetus dermestoides* (Hyder).

The samples from *Ph. igniarius* were separated less clearly. The samples from dead trunks without sporocarps were associated differently in all the three data sets where they were included, and most of the samples from the live control trunks associated with *Ph. igniarius*.

The expected numbers of species in samples of standardized sizes did not differ among the three polypore species (Fig. 2). The species richness appeared to be somewhat higher in the samples from dead control trunks although not significantly so, but significantly higher in the

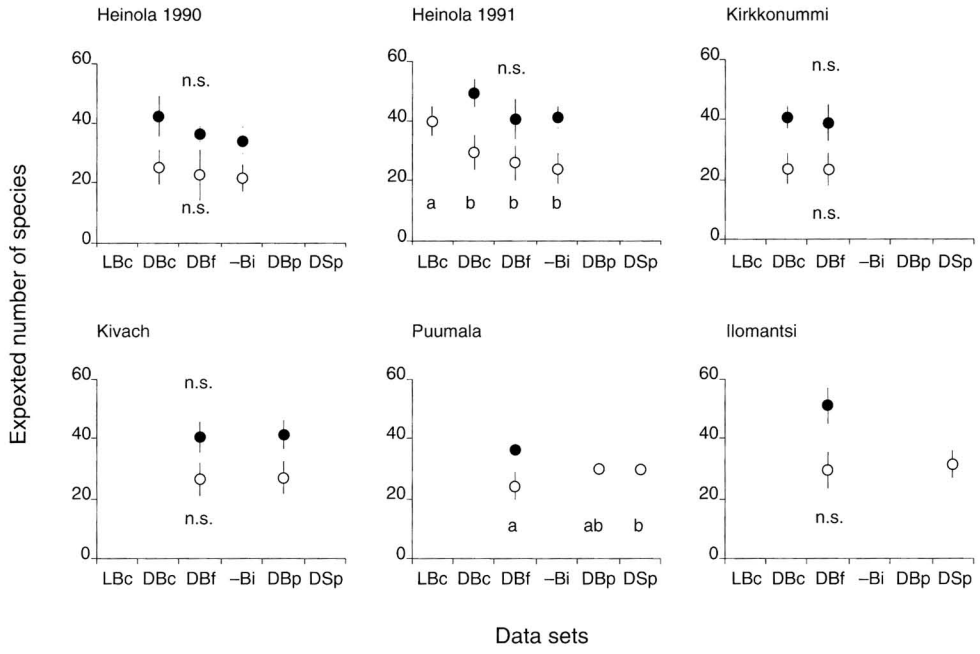

Fig. 2. The expected number of species E(S), with ± 2 *SD* in the six treatments in the six data sets calculated for 100 (open symbols) and 300 (filled symbols) individuals.

samples from the live control trunks. However, the median numbers of both species and individuals per trap were higher on *F. fomentarius* compared to *Ph. igniarius*, but similar compared to *F. pinicola* (Fig. 3). In addition, these numbers tended to be smaller also on the dead control trunks compared to *F. fomentarius*. The median total beetle catch per trap was lowest on the live controls.

3.2. Occurrences of individual species among the treatments

The median numbers of *Bolitophagus reticulatus*, *Dorcatoma robusta*, *Rhizophagus dispar*, *R. bipustulatus*, *Ropalodontus strandi* and *Glischrochilus hortensis* were highest in traps attached to *F. fomentarius*. *Triplax russica* and *Anisotoma humeralis* showed a somewhat similar pattern. The only species that was more abundant on traps attached to *Ph. igniarius* compared to other treatments was *Dorcatoma dresdensis*, although this occurred abundantly also in the traps on *F. fomentarius*. Two species, *Dorcatoma punctulata* and *Cychramus luteus*, were caught most abundantly on *F. pinicola*, although the small sample sizes and infrequent occurrences do not permit definite conclusions. *Anisotoma glabra* appeared to be more numerous on birch compared to spruce. The median catches of *Rhizophagus cribratus*, *Cychramus variegatus*, *Cyllodes ater* and *Agathidium confusum* did not differ among the treatments. All saproxylic species were scarce in samples from living trees, despite the short distances (5–15 m) of these trunks from the dead ones. The median numbers of some of the above mentioned beetle species in the treatments are presented in Fig. 4.

4. Discussion

The species-abundance distributions and the standardized numbers of species were rather similar among the treatments, indicating that the assemblage structure of the samples was similar. However, the median numbers of individuals and

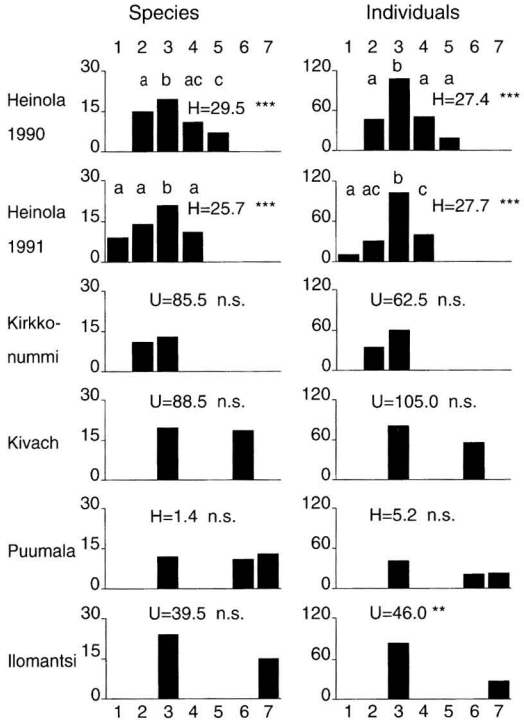

Fig. 3. The median numbers of species and individuals per trap in the treatments in the six data sets. Differences among the medians were tested with the Kruskal-Wallis one-way ANOVA or Mann-Whitney rank-sum test. The letter code indicates the locations of differences according to *a posteriori* tests when more than two treatments were compared. (ns = $P > 0.05$; * = $P < 0.05$, ** = $P < 0.01$, *** = $P < 0.001$) The codes for the treatments on the horizontal axis are (1) live control trunks, (2) dead control trunks without visible polypore sporocarps, (3) trunks with *F. fomentarius*, (4) dead trunks with *Ph. igniarius*, (5) live trunks with *Ph. igniarius*, (6) trunks with *F. pinicola* and (7) spruce trunks with *F. pinicola*.

species appeared to be higher in the samples from trunks with *F. fomentarius* compared to *Ph. igniarius* and the control trunks. The standardized samples from live controls were more diverse than the others because the total sample was extremely small, consisting of a random collection of saproxylic beetles flying around in the forest stand. The considerable differences in the relative abundances of many beetle species among the treatments and the segregation of the samples from trunks decayed by *F. fomentarius* and *F. pinicola* indicate that different polypore species host distinct assemblages. Many beetle species were abundant also on the dead control trunks without polypore sporocarps. Such trunks may have been colonized by a large number of fungus species which, in turn, may offer living conditions to a variety of saproxylic beetle species.

As even the most abundant beetle species were associated with particular types of decaying birches, it can be concluded that the quality of the trunk, which varies e.g. depending on the polypore species decaying the trunk, plays a major role in the formation of the species assemblage. However, the trunk types treated in this paper represent only a small fraction of the variety of different microhabitats that decaying birch trunks provide. A large number of fungus species on birch host specialized beetle species (e.g. *Daldinia*, *Pleurotus*, *Piptoporus* and *Trametes* spp.). In addition, different tree species in different environmental conditions host their own fungus species and their specialist beetles.

Taking the diversity of assemblages into account, it is evident that we should enhance the continuous availability of decaying wood in various ecological conditions to meet the requirements of both the fungus species and the specialized saproxylic beetles in the managed forests. The importance of dead wood for saproxylic beetles is evident as several species that are rare in Finnish samples were abundant in this study and other sampling schemes (unpubl. data) in Russian Karelia, where decaying wood is more abundant in forests compared to the Finnish forests. Management measures for attaining such a goal consist mainly of leaving dying and dead wood behind in the thinning and clearcutting phases of the stand rotation. If such management practices were standard, this could locally secure the continuity of trunks in different phases of decay with varying decomposer ecosystems which, in turn, is a prerequisite for the survival of viable populations of specialized saproxylic species.

Our data contained records of 18 beetle species included in the Finnish list of threatened animals (Rassi et al. 1992b). Most of these species occurred only in very few traps. Some of these species often occur on other tree species, e.g. *Tomoxia bucephala* on aspen, and they may

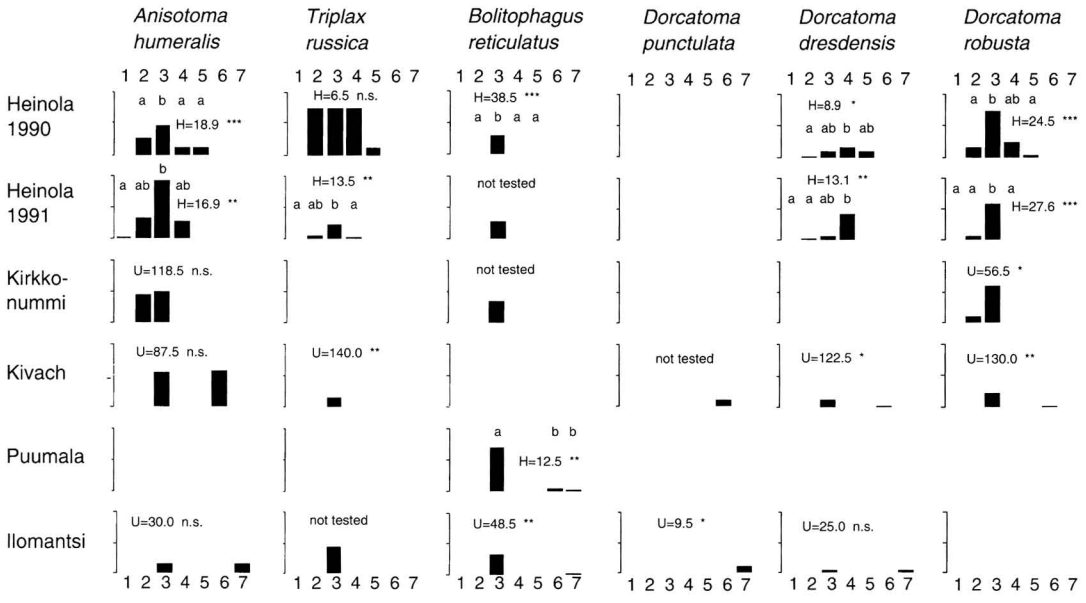

Fig. 4. The median numbers of six species in the six data sets. Differences among the medians were tested with the Kruskal-Wallis one-way ANOVA or Mann-Whitney rank-sum test. For details, see the legend to Fig. 3.

have entered the trap by chance. *Mycetophagus quadripustulatus*, *Cyllodes ater* and *Triplax rufipes* are often found on soft fungi, e.g. *Pleurotus*, growing on dead trunks. Perhaps this is the reason why they did not show clear occurrence patterns among the polypore species included in our study.

The relatively poorly known anobiid species of the genus *Dorcatoma* have been reported as feeding on fungi growing on dead wood, but more precise information is scarce in the literature, except for scattered findings with identified fungus species (Hansen 1951, Palm 1955, Lundberg 1963, Baranowski 1975). Our results indicate that these closely related species have different occurrence patterns: *D. dresdensis* was most abundant on *Ph. igniarius*, occurring also on *F. fomentarius*, *D. robusta* appeared to occur exclusively on *F. fomentarius*, and *D. punctulata* mainly on *F. pinicola*. In these data, the red-listed species *D. substriata* occurred only at one site, where 11 individuals were caught from a single trunk with *F. fomentarius* (Heinola 1990), and in the next year, 23 individuals were caught from a dead control trunk which was later found to contain sporocarps of *Inonotus obliquus* growing under the bark (Heinola 1991). In 1993 the species was found in *Sb:* Suonenjoki on birch with *I. obliquus* (I. Rutanen, pers. comm.).

Peltis grossa seemed to occur more commonly on *F. pinicola* than *F. fomentarius*, as it was found in six traps of 26 attached *to F. pinicola*, and only in one trap of 125 on *F. fomentarius*. Our observations in the field also support the association of *P. grossa* to *F. pinicola* (unpubl.). *Dircaea quadriguttata* was found twice from traps attached to *F. fomentarius* on the warm and sunny edge of a bog (Heinola 1990 and 1991). *Cyllodes ater* occurred abundantly in Kivach, where e.g. *Agathidium pallidum* and *Ceruchus chrysomelinus* were also found.

The main conclusions emerging from our data are that (1) the polypore species decaying the trunk is important for individual saproxylic beetle species and further, (2) there are specialized beetle assemblages associated with the trunks decayed by different polypore species.

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