Insect communities inhabiting *Inonotus radiatus* growing on *Alnus glutinosa* trees at northern and southern shores of boreal lakes

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ABSTRACT

This is a study of the insect community associated to the wood-decaying fungus *Inonotus radiatus* found on *Alnus glutinosa* trees growing in riparian forests at the northern and southern shores of boreal lakes in the province Uppland. Little is known about this particular bracket fungus and its inhabitants. Insects were reared out at the laboratory from samples of fruiting bodies of the fungus taken at five lakes. During the fieldwork in 2009, data about several environmental variables was also taken. After the rearing period, these variables and their effects over the insects were analyzed. Special attention is paid to the comparison between the insect communities living at northern and southern shores of the lakes. We consider the microclimates at the northern and southern shores are different due to the dissimilar sun exposure they receive. The collected insect communities associated to opposite shores are not identical, but the variable shore exposition turned out to be influencing just four of the studied taxa. The variables which turned out to have a greater impact over the insect communities were lake, weight of the fungus and sun exposure. The preferences regarding successional stage of the fruiting bodies by some of the collected taxa are also presented. Most of them seem to be more attracted by older fruiting bodies than by the new and fresher ones. One red-listed beetle species has been recorded during the project, as well as three other species which were included in previous Red Lists although they are no longer on the Swedish Red List. Distributions of insect species are also revised to analyze the accuracy of the Red List.

SAMMANFATTNING

Detta är en studie av insektsamhället som lever i altickor *Inonotus radiatus* på alar i strandskogar på nordliga och sydliga stränder av sjöar i Uppland. Insektssamhället i denna ticka är ganska dåligt utforskat. Prover av tickor samlades in samlades in vid fem sjöar under vintern 2009. Insekter kläcktes fram ur dem på lab. Ett flertal miljövariabler noterades för varje prov och analyser gjordes av vilka av dem som påverkar artanatal och antal individer av specifika arter. Speciellt intresserad var jag av skillanden mellan nordliga och sydliga stränder, med hypotesen att det varmare mikroklimat som finns på de solexponerade nordliga sträderna påverkar var insekterna finns. De insektssamhällen jag hittade var inte identiska mellan nord- och sydstränder, men variabeln visade sig ha effekt bara på fyra av de studerade insektstaxa. Variabler som hade stor effekt var vilken sjö proverna kom från, vikten på provet och solexponering på liten skala, dvs för det enskilda provet. Det fanns också effekter av vilket successionsstadium svampen var i. De flesta arter tycks finnas i äldre, döda fruktkroppar och saknas i de levande färska. En rödlistad skalbaggsart hittades, liksom tre arter som tidigare varit rödlistade. Alla dessa arter är utbredda vid alla de fem sjöar som undersöktes.

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Abstract

This is a study of the insect community associated to the wood-decaying fungus *Inonotus radiatus* found on *Alnus glutinosa* trees growing in riparian forests at the northern and southern shores of boreal lakes in the province Uppland. Little is known about this particular bracket fungus and its inhabitants. Insects were reared out at the laboratory from samples of fruiting bodies of the fungus taken at five lakes. During the fieldwork in 2009, data about several environmental variables was also taken. After the rearing period, these variables and their effects over the insects were analyzed. Special attention is paid to the comparison between the insect communities living at northern and southern shores of the lakes. We consider the microclimates at the northern and southern shores are different due to the dissimilar sun exposure they receive. The collected insect communities associated to opposite shores are not identical, but the variable shore exposition turned out to be influencing just four of the studied taxa. The variables which turned out to have a greater impact over the insect communities were lake, weight of the fungus and sun exposure. The preferences regarding successional stage of the fruiting bodies by some of the collected taxa are also presented. Most of them seem to be more attracted by older fruiting bodies than by the new and fresher ones. One red-listed beetle species has been recorded during the project, as well as three other species which were included in previous Red Lists although they are no longer on the Swedish Red List. Distributions of insect species are also revised to analyze the accuracy of the Red List.

Key words: fungivorous insects, wood-decaying fungi, substrate associations, sun exposure, successional stage, red-listed species, riparian forests, Tineidae, *Dorcatoma, Abdera*

Introduction and aim of the study

Brief description of the study

This project is a study of the insect community associated to the fungus *Inonotus radiatus* growing in decaying wood from alder trees (*Alnus glutinosa*) located at riparian forests on the northern and southern shores of lakes in the hemiboreal vegetation zone. The research work is based on the insects reared out at the laboratory from fruiting bodies collected in the field. The influence of several environmental variables over species richness and distribution of the reared insects is analysed.

Thus, data about occurrence and distribution patterns of the collected insects is presented. We also point out at the reared species currently included in the Swedish Red List, presenting one red-listed species and two more species which were red-listed in the Red List of previous years.

We analyse how sun exposure levels affect the insect community, as well as other variables regarding characteristics of the host tree and of the studied fungi. Concerning the host tree, we consider variables such as distance from the shore, stem diameter, stem type and sun exposure. Concerning the fungus, successional stage, orientation of the fruiting bodies on the trunk, height above the ground and surface on the trunk occupied by the fruiting bodies are the observed variables (Table 1).

The study system

Black alder, *Alnus glutinosa* (L.) Gaertn is a deciduous tree species, belonging to the Betulaceae family. The species is distributed all over Europe and introduced into the Azores and the USA. To date, this fast-growing species has not been very much used in managed forest, although during the last decades there has been an increasing interest concerning its possible use, especially for being a nitrogen-fixing species together with the actinomycete *Frankia*. Regarding its role as possible host tree for insects, it is considered an alternative host for many saproxylic beetle species that predominantly utilize e.g. *Quercus* and *Populus* (Jonsell, 1991).

Inonotus Karst. is a large genus within the Hymenochaetales exhibiting a worldwide distribution (Wagner & Fischer, 2002) whose systematics face many taxonomical problems (Gottlieb et al., 2002). All species live as parasites or saprophytes on a broad variety of angiosperms and gymnosperms and cause white rot decay (Germain et al., 2002; Wagner & Fischer, 2002). This genus is also considered economically important, affecting negatively several productive species as well as ornamental trees (Intini & Tello, 2003).

Inonotus radiatus is a truly saprophytic fungus of deciduous trees, attacking them only when the tissue is dead and often colonizing wood when degradation is already well underway (Gilbertson and Ryvarden, 1986). The fruiting bodies used for this project come exclusively from black alder trees, the main host for this fungus although it has also been reported growing in other deciduous species (Germain et al., 2002; Buczacki & Harris, 1998; Neuman, 1914; Legon & Henrici, 2005; Grand & Vernia, 2005).

Its associated insect community covers different levels inside a complex and species-rich food web, including fungi and wood-boring insects, fungivorous species as well as their predators (parasitoids and hyperparasitoids) and it contributes to maintain the biodiversity of the forest ecosystem.

The study system as a whole is focus on the natural ecotones represented by the riparian forests developed along the lakes shores. Thus, the compared sites differ from each other only in that their edges face either North or South.

Motivations of the study

It is globally accepted that a sustainable management of our forests must be carried out around the world, and the maintenance of biodiversity has been generally considered as a good criterion of sustainability. At the same time, dead wood and its associated saproxylic insect fauna have been recognised as key factors for maintaining biodiversity in forest ecosystems (Bütler Sauvain, Ehnström, 2003; Komonen, 2003; Larsson, 2001; Harmon et al., 1986; Jonsell et al., 2001; Grove, 2002; WWF report, Oct 2004). Human activities threat fungi that depend on dead wood (Bader et al., 1995; Kouki et al., 2001; Olsson, 2008; Stenbacka, 2009; Berg et al., 1995). Thus, a study of a particular system based on decaying wood of black alder trees may help foresters and managers to select the best practices to be applied in forests where this species is present and, at the same time, it increases the general knowledge about the insect fauna related to the microhabitat provided by the snags, logs and standing alder trees colonized by the bracket fungus *Inonotus radiatus*.

Forest edges, and particularly riparian ecotones, gather some specific characteristics which make them very interesting for performing ecological studies. (Naiman & Décamps,1990; Schiemer & Zalewski, 1992; Risser, 1995). According to Komonen (2009), particularly in the Uppland region, these riparian forests represent ecosystems which notably differ from most interior conifer-dominated forests, offering high habitat heterogeneity to the region. Besides, unmanaged riparian zones can represent important habitats for many species, and what is more, to many rare and red-listed species depending on woody debris (Komonen et al., 2008).

In Sweden, buffer zones in riparian forests have been defined and protected appealing the risk of negatively affect water quality of lakes and rivers if these forests were removed. The present study might be useful for future buffer zone design and management of riparian forests having in mind not only the maintenance of water quality, but also protection of biodiversity.

Specifically, fruiting bodies of wood-decaying fungi represent a species-rich and well defined type of substrate that can be manipulated easily (Jonsell et al., 2001; Komonen, 2003; Jonsson & Nordlander, 2006) and particularly, polypores in general are known to offer a great variety of niches which may contain a highly mixed arthropod fauna (Thunes, 1994). To date, most studies on insects in bracket fungi have focused on only a few fungal species. Poorly-known insects and fungi species may vanish from their habitats due to the lack of species-specific information even if advanced nature conservation practices are applied (Schigel, 2009). As many insect species are dependent on various fungi associated with dead wood, it would be desirable to study insect communities associated with species of fungi not yet investigated

(Ehnström, 2003). Thus, material collected from *I. radiatus* will be especially interesting and will contribute in first place, to enlarge the ecological knowledge of fungivorous insects in general.

Furthermore, if the use of *Alnus glutinosa* in forestry systems will increase, the information provided in this project may be very useful for its future management, especially when considering the management of dead wood. Knowledge about its associated insect community is fundamental for the planning of a sustainable management of the black alder forests in Sweden.

Another important motivation was the search for red-listed species. In intensively managed forests in Sweden, over 900 species that depend on dead and decaying wood are red-listed (Berg et al., 1994). When red-listed species are recorded during a project, all information regarding their distribution patterns, occurrences and requirements, makes the research particularly interesting for its use in nature conservation studies or practices.

The decision of collecting samples from the northern and southern shores of the lakes was taken attending to a particular question we wanted to investigate. We suggest that the microclimates created in the decaying wood located at opposite shores differ from each other due to their different orientation with regard to the sun. We consider that consequently, the sun exposures at each of the shores are significantly different. Little is known about the differences between sun exposures levels according to orientation of the edge of a non-managed forest, but assuming they are actually different, it is interesting to test if these differences have a real impact over the insect community or not. The importance of sun exposure as a factor shaping a certain insect community has been demonstrated in several studies focused on insect requirements regarding light exposure levels (Komonen & Kouki, 2005; Lindhe et al., 2005).

Even taking into consideration the characteristics of this study, if important responses by the insect community against any of the considered environmental variables are found, the results might be useful for a better understanding of similar systems, although the considered species taking a part of the system could be different. For instance, this is the case for the variable successional stage of the fungi, since many studies have already demonstrated that this is a quite important factor affecting fungivorous insect communities (Thunes, 1994; Jonsell & Nordlander, 2004; Jonsell et al, 1998; Jonsell et al., 2001; Graves, 1960).

Aim of the project

The presented motivations led me to define the following objectives for the present project:

1) Present original data of the insect community associated to *Inonotus radiatus* in riparian *Alnus glutinosa* stands in Uppland, obtained by rearing out the insects at the laboratory from fruiting bodies collected in the field.

2) Compare the communities living at the northern and southern shores of the selected lakes, to analyze if the different sun exposure levels characterizing the shores significantly affect these communities.

3) Analyze the influences over the distribution and frequency of the collected insects of other environmental variables, such as sun exposure, lake, weight of the fruit body samples and successional stage of the fruiting bodies.

4) Take a closer look to the distribution patterns and responses by the reared species taking into account the accuracy of the red-listing criteria.

Materials and methods

Sampling sites

Five different lakes oriented from east to west were selected for the collection of the samples; Erken, Aspdalssjön, Tämnaren, Valloxen and Ekoln. They are all located in a hemiboreal landscape within a radius of 50 km around Uppsala in the region of Uppland, central Sweden (Fig. 1).
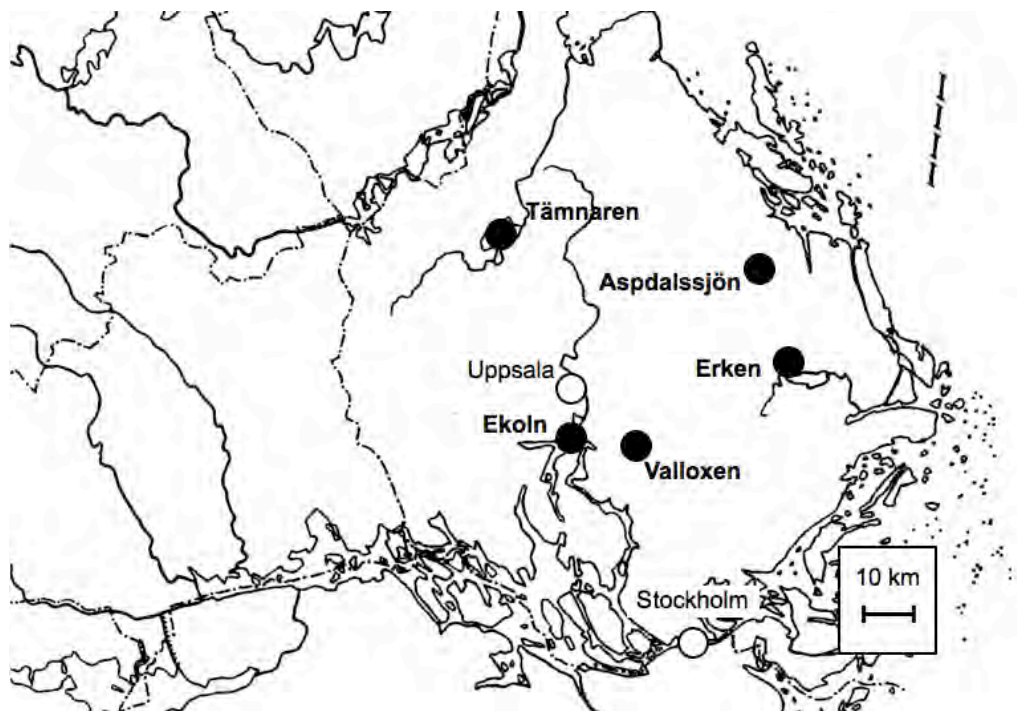
Figure 1. Map showing the five lakes selected as sampling sites

Sampling

Fruiting bodies of *Inonotus radiatus* growing on ten different *Alnus glutinosa* trees were collected from each shore (northern and southern shores) at every lake. However, only 8 samples were found at the southern shore of Aspdalssjön and 11 samples were taken from the northern shore at Erken lake and southern shores at Tämnaren and Ekoln lakes. Thus, a total of 100 samples were gathered between January 27th and February 11th of 2009. Each sample contained several fruiting bodies growing on the trunk of a particular *Alnus glutinosa* tree.

The samples were selected while walking on the ice along the riparian forests by the shores. We were looking for black alder trees as the fungus is most frequent on them. Thus, any snag, log or living and standing trunk of black alder with fruiting bodies of *Inonotus radiatus* could be object of our study.

When several possible trees with fruiting bodies were located in a small area, we decided to take the most separated samples from each other and we left some of

them untouched, looking for new samples a bit farther along the shore. We collected the fruit bodies in 5 litres plastic bags. In this way, when the sample was that small that the bag could not be completely full after taking it, we took most of the fruiting bodies growing on that tree, but always at least three of them remained untouched for protection of the fungi and the related fauna. If the collection of the fruit bodies coming from one tree required more than one 5 litres bag, only one bag with fruit bodies was collected for that particular tree, trying to get fruit bodies of all present sizes and decaying stages.

Measured variables

For each sample we collected the following data:

RT90 coordinates from a GPS of the location of each sample were recorded, as well as the following environmental variables: `distance from the shore´, `stem type´, `stem diameter´, `size of the fungi´, `height above the ground´, `successional stage´, `exposition side´ and `sun exposure´ (Table 1). A summary table with all the environmental data collected for each sample is presented in Appendix 1.

A tree caliper was used to measure the stem diameter at breast height (150 cm) for every sample. A metric tape was used to measure the height above the ground of the first and the last fruiting body growing on the trunk and the distance from the shore. Stem type, successional stage, orientation of the fruiting bodies on the trunk and sun exposure level were defined by the field team in situ. An axe or knife was used to detach the samples from the host tree, trying to get as little woody material and bark as possible. Ice-probing sticks and ice-prods (*ispik* and *isdubbar* in Swedish) complete our field equipment as safety tools.

Table 1. Environmental variables measured

Variable	Categories	Comments
Distance from the shore	Numeric	
Stem type	Laying Erect	
Stem diameter	Numeric	Breast height
Size of the fungi	Numeric	Surface over the trunk occupied by the fruiting bodies
Height of the first fruiting body	Numeric	Height above the ground where the first fruiting body grows on the trunk
Height of the last fruiting body	Numeric	Height above the ground where the last fruiting body grows on the trunk
Successional stage	A = living B = newly dead, some holes C = dead with many holes or cracks D = dead and falling apart M = more than one stage	
Orientation	N, S, E, W, SE, SW, NE, NW	Orientation of the fruiting bodies on the trunk
Sun exposure	1 = total exposition 2 = intermediate 3 = shaded	

Rearing

The samples were taken to the laboratory where they were placed in separate rearing boxes (Fig. 2). Samples that were wet or still frozen were dried for a few days before they were enclosed in the boxes. The lids of the boxes were taped for preventing the escape of insects. Two glass vials were inserted in every box where insects attracted to the light were collected. The emerging insects were preserved in jars with 70% ethanol, except for the moths, which were kept dry in a refrigerator to facilitate their conservation and further determination.

Figure 2.- Samples at the laboratory in rearing boxes with glass vials

The first insects were collected on the 20th of February and since that date the collecting period lasted for about 8 weeks. During the first week of this period, the vials were examined daily. In the next three weeks, insects were collected three times a week while during the fifth and sixth week, the vials were emptied twice a week. Finally, a last collection was made on the 16th of April, after one and a half weeks with only a few new individuals coming out each day.

After the rearing period every box was opened and examined to collect insects remaining inside the boxes. Not all the insects from the samples are attracted to light and some others simply could not reach the vials during the rearing period. The samples were sieved using five grids of different sizes to find and collect those remaining individuals (Fig. 3). At the same time, since the samples were not homogeneous regarding size, the dry weight of each sample was measured with one gram precision. The opening period lasted from April 16th to May 8th.

Figure 3.- Opening period: sieving and weighing fungi and collecting the last insects
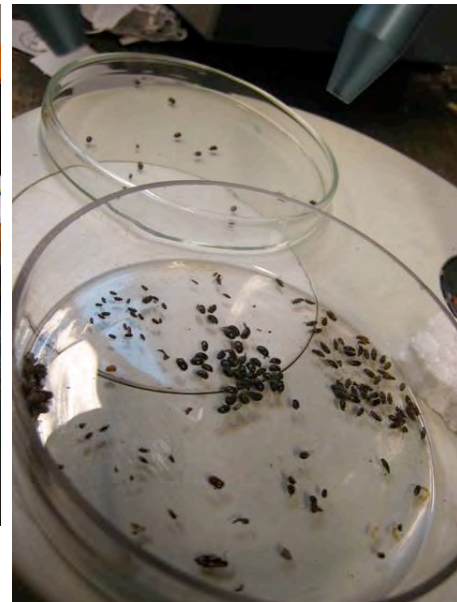
Species determination and classifications

Identification of the reared insects was carried out by Clara González Alonso supported by Mats Jonsell, except for three of the collected moths which were identified by Bengt Å. Bengtsson (*Eupithecia icterata, Ectoedemia* (probably *subbimaculella,* otherwise *E. albifasciella*) and almost certainly *Scoparia ambigualis*).

Most of the groups, families and species were determined by morphological characters using keys and microscope when needed. Determination of the moth *Nemapogon cloacella* required genitalia preparation for its morphological similarity to *Nemapogon wolffellus* (Fig. 4). A total of 22 individuals collected during the rearing period were examined. 12 of them turned out to be males and they were clearly determined as *N. cloacella.* The remaining 10 females, as well as the other 19 individuals collected during the opening of the boxes, were assumed to be the same species as the examined males.

Figure 4.-Nemapogon cloacella specimen and genitalia preparation for its determination

From the total of 75 taxa defined during the determination, most of them correspond to species names. A few others refer to genus or family names. The rest of the taxa were morphospecies named with non-scientific names by Clara González Alonso for this project, each of these taxa corresponding, in most of the cases, with a single species (genus and/or family name have been determined for most of these taxa).

Red List categories follow three different versions of the Swedish Red List. The present list was published in 2005 (Gärdenfors 2005). However, also species red-listed in earlier versions (Ehnströmm et al., 1993 & Gärdenfors 2000) were considered as the former red-listing suggest that they have a higher interest in nature conservation than never red-listed species, although they do not reach the present limit for being red-listed.

The taxa were also classified in different groups regarding their relation to the fungi. The defined categories were: fungivorous, saproxylic, parasitoids, hyperparasitoids, others and unknown. The insects feeding directly on the fungi material belong to the fungivorous category. The ones feeding strictly on the woody material of our system are here named saproxylic. Parasitoids are the insects parasiting any of the fungivorous or saproxylic species. Consequently, hyperparasitoids are the ones being parasitoids of the parasitoids of saproxylic or fungivorous species. The insects classified as others are the ones which do not depend on our fungi/wood or on the directly related insects for feeding, so we considered we found them on the samples because either they found a nice place for hibernating on the fruiting bodies or they were there just by chance. The classification was based on literature (Nationalnyckeln, 2005; Baranowski, 1985; Palm, 1959, Koch, 1989-1992 and Hansen, 1964) and supervisor's opinion.

Statistical analyses

- Insect communities overview:

Rank-abundance curves were elaborated by ranking the species in sequence from most to least abundant (and from the species with the highest number of occurrences to the one with the lowest) along the horizontal axis. Their abundances and occurrences are displayed in log10 format on the vertical axis, so that species whose abundances/occurrences span several orders of magnitude can be easily accommodated on the same graph. Rank-abundance curves were also plotted separately for comparing the communities related to northern and southern shores. Interpretation of these curves was based on theoretical literature and applied studies (Feinsinger, 1948; Magurran, 2004; Encora, 2009; Ecoplexity, 2009)

- Variable associations:

A model was run using SAS 6.12 for Macintosh (SAS, 1989-96) to conduct **multivariate Poisson regressions** for some particular taxa. Poisson distributions were assumed because this distribution usually fits count data when many counts are zero (Quinn & Keough, 2002).

A total of 18 taxa, corresponding to the taxa with more than 10 occurrences and being either fungivorous and saproxylic species or parasites and predators of the previous ones, were included (Table 10).

Not all the environmental variables were included in the model. It was run for each taxa including the variables `weight´, `lake´, `shore´ and `sun exposure´ in that order. The variable `stem type´ was excluded for the analyses because only one sample corresponded to a laying tree, being the rest from erected stems. `Distance from the shore´ had also too little variation for being included in the model and `exposition side´ had too many categories for this type of analysis. `Stem diameter´ was excluded

because it was positively correlated to the variable `weight´, so it would probably explain almost the same part of the variation as the weight does. The same applies to the variable `size of the fungi´, also positively correlated to `weight´. These correlations were analyzed with STATGRAPHICS, using 2-tailed Pearson correlations and transforming the variables by the logarithmic function. For most of the studied groups, there was not enough data for the first category of `successional stage´ and that is the reason why this variable was also excluded from these regressions.

- <u>A closer look to the variable `Successional stage´:</u>

To provide a wide view of the effect of the successional stage of the fruiting bodies over the insect community, the number of species in different successional stages was plotted in sample-based **rarefaction curves**. Again, only the insects directly related to the fungi were considered. The software Estimate S was used for computing the expected species accumulation curves with 95% confidence intervals (sample-based rarefaction curves in the terminology of Gotelli & Colwell 2001).

In addition, a model including `successional stage´ was run for the only 6 taxa which had enough data for this purpose. The **multivariate regressions** only include now the variables `weight´ due to the need of taking into account the heterogeneity regarding size of the samples, and `successional stage´.

Results

General data for the whole community

A total of 6,427 individuals comprising 75 different taxa were reared out and collected during the study (Table 3). Of these, 3,834 individuals from 37 taxa, were directly related to the fungi (fungivorous, saproxylic, parasitoids or hyperparasitoids).

Species belonging to 21 different families of Coleoptera were found. At least 40 different beetle species were collected and 28 out of this 40 were determined to species level. Nine of these were fungivorous species and 7 saproxylic species.

The rest of the material is completed by 7 Lepidoptera species (4 of them are fungivorous tineid moths), 9 Diptera taxa belonging to at least 6 different families, 13 Hymenoptera taxa from a minimum of 7 different families, some Hemiptera, Thysanoptera, two species of Neuroptera, Psocoptera, pseudoscorpions and unidentified larvae (Table 2).

Table 2. Individuals classified by order/groups and its representation in the total community

Order/group	Individuals	%total
Diptera	2348	36,5
Coleoptera	2316	36,0
Larvae (unidentified)	748	11,6
Hymenoptera	528	8,2
Lepidoptera	223	3,5
Thysanoptera	110	1,7
Pseudoscorpions and mites	58	0,9
Neuroptera	50	0,8
Hemiptera	31	0,5
Psocoptera	15	0,2
Total	**6427**	**100**

Only the beetle *Dorcatoma substriata* is currently included in the Swedish Red List (fig.5.3). It is classified under the category `NT´, "near threatened". Three additional beetle species were included in earlier versions of the Red List: *Abdera affinis* (NT in the 1993Red List) and *Abdera flexuosa* (NT in the 2000 Red List)*,* as well as *Tetratoma fungorum* (NT in the 2000 Red List).

Table 3. Number of individuals of the collected taxa (in brackets occurrence, i.e number of samples on which a taxa was found). Most of the presented taxa correspond to scientific species names. Some of them are morphospecies names given by the author for this project.
NT = species classified as "near threatened" in the last Swedish Red List
(NT) = species classified as "near threatened" in earlier versions of the Swedish Red List

Taxa	Order	Family	Group	Red list category	Individuals (Occurrence)
Abdera affinis	Coleoptera	Melandryidae	Fungivorous	(NT)	573(29)
Abdera flexuosa	Coleoptera	Melandryidae	Fungivorous	(NT)	407(37)
Cis bidentatus	Coleoptera	Ciidae	Fungivorous		26(8)
Dorcatoma dresdensis	Coleoptera	Anobiidae	Fungivorous		267(26)
Dorcatoma substriata	Coleoptera	Anobiidae	Fungivorous	NT	64(17)
Enicmus fungicola	Coleoptera	Latridiidae	Fungivorous		1(1)
Ennearthron cornutum	Coleoptera	Ciidae	Fungivorous		631(54)
Orthocis alni	Coleoptera	Ciidae	Fungivorous		1(1)
Tetratoma fungorum	Coleoptera	Tetratomidae	Fungivorous	(NT)	2(2)
Anaspis thoracica	Coleoptera	Scraptiidae	Saproxylic		22(17)
Cerylon histeroides	Coleoptera	Cerylonidae	Saproxylic		4(3)
Dasytes caeruleaus	Coleoptera	Melyridae	Saproxylic		7(6)
Dasytes plumbeus	Coleoptera	Melyridae	Saproxylic		1(1)
Denticolis linearis	Coleoptera	Elitaridae	Saproxylic		1(1)
Trichaceble floralis	Coleoptera	Melyridae	Saproxylic		1(1)
Triplax	Coleoptera	Erotylidae	Saproxylic		1(1)
Agonum thoreyi	Coleoptera	Carabidae	Others		3(1)
Anthicus antherinus	Coleoptera	Anthicidae	Others		1(1)
Badister	Coleoptera	Carabidae	Others		5(1)
Brachytarsus nebulosus	Coleoptera	Anthribidae	Others		1(1)
Carabidae	Coleoptera	Carabidae	Others		19(5)
Cercyon	Coleoptera	Hydrophilidae	Others		1(2)
Chrysomelidae	Coleoptera	Chrysomelidae	Others		10(10)
Coccidula scutellata	Coleoptera	Coccinellidae	Others		21(16)
Coccinellidae	Coleoptera	Coccinellidae	Others		3(3)
Corticaria impressa	Coleoptera	Latridiidae	Others		1(1)
Curculionidae	Coleoptera	Curculionidae	Others		2(2)
Cyphon padi	Coleoptera	Scirtidae	Others		1(1)
Dromius queadrimaculatus	Coleoptera	Carabidae	Others		3(3)
Dyschirius globosus	Coleoptera	Carabidae	Others		3(3)
Galerucella nymphaeae	Coleoptera	Chrysomelidae	Others		101(15)
Hidraena	Coleoptera	Hydrophilidae	Others		5(3)
Hydrophilidae	Coleoptera	Hydrophilidae	Others		47(11)
Limnebius	Coleoptera	Hydraenidae	Others		1(1)
Phyllotreta undulata	Coleoptera	Chrysomelidae	Others		4(4)
Pterustichus minor	Coleoptera	Carabidae	Others		1(1)
Silis nitidula	Coleoptera	Cantharidae	Others		1(1)
Staphylinidae	Coleoptera	Staphylinidae	Others		73(18)
Archinemapogon yildizae	Lepidoptera	Tineidae	Fungivorous		109(21)
Nemapogon cloacella	Lepidoptera	Tineidae	Fungivorous		41(15)
Nemapogon nigralbellus	Lepidoptera	Tineidae	Fungivorous		3(3)
Nemapogon picarellus	Lepidoptera	Tineidae	Fungivorous		66(15)
Eupithecia icterata	Lepidoptera	Geometridae	Others		1(1)
Ectoedemia	Lepidoptera	Nepticulidae	Others		1(1)
Scoparia ambigualis	Lepidoptera	Crambidae	Others		2(2)
Cecidiomyidae2	Diptera	Cecidiomyidae	Fungivorous		64(9)
Chloropidae1	Diptera	Chloropidae	Unknown		15(3)

Tipulidae1	Diptera	Tipulidae	Fungivorous	21(4)
Tinydip	Diptera			30(2)
Tachinidae1	Diptera	Tachinidae	Parasitoids	56(25)
Mycetophilidae1	Diptera	Mycetophilidae	Fungivorous	17(11)
Sciaridae1	Diptera	Sciaridae	Fungivorous	1638(21)
Cecidiomyidae1	Diptera	Cecidiomyidae	Fungivorous	498(51)
Dipteras no determ.	Diptera			9(5)
HymRen	Hymenoptera		Parasitoids	1(1)
Tenthredinidae1	Hymenoptera	Tenthredinidae	Others	2(2)
Tenthredinidae2	Hymenoptera	Tenthredinidae	Others	2(2)
Ichneumonidae1	Hymenoptera	Ichneumonidae	Parasitoids	14(6)
Perilampidae1	Hymenoptera	Perilampidae	Hyperparasitoids	57(16)
Perilampidae2	Hymenoptera	Perilampidae	Hyperparasitoids	12(9)
Mymaridae1	Hymenoptera	Mymaridae	Parasitoids	8(6)
HymBlan	Hymenoptera		Parasitoids	10(6)
HymPats	Hymenoptera		Parasitoids	8(4)
PteromalidaeS	Hymenoptera	Chalcidoidea (superfam) Pteromalidae	Parasitoids	42(12)
Chalcidoidea1	Hymenoptera	Chalcidoidea (superfam)	Parasitoids	31(7)
Hymenop1	Hymenoptera	Ichneumonidae and Braconidae	Parasitoids	318(53)
Hymenopteras no det.	Hymenoptera			22(12)
Thysanoptera	Thysanoptera		Fungivorous	110(6)
Hemiptera	Hemiptera		Others	18(10)
Loricula elegantula	Hemiptera	Microphysidae	Others	13(9)
Neuroptera black	Neuroptera		Others	46(14)
Neuroptera brown	Neuroptera		Others	4(2)
Psocoptera	Psocoptera			15(7)
Cosas				19(4)
Larvae				748(39)
Pseudoscorpion			Saproxylic	39 (16)
Grand Total				6426(741)

The most abundant taxa reared out from the samples was a fungivorous Diptera belonging to the Sciaridae family (Table 4 and fig. 5.1). The number of individuals collected was 1,638, coming out from 21 different samples. The second place in total numbers is occupied by the collected *larvae*, being 748 individuals from 39 of the samples. The third and fourth places are taken by two fungivorous Coleoptera species, *Ennearthron cornutum* and *Abdera affinis,* with 631 and 573 individuals respectively (54 and 29 occurrences). They are followed for one fungivorous Diptera species of the Cecidiomyidae family, referred to as *Cecidiomyidae1* in this paper. The total amount for this species is 498 individuals, being present in 51 different samples. *Abdera flexuosa*, also a fungivorous Coleoptera, has 407 individuals coming from 37 different samples (Table 4).

The most frequently found species, reared out from 54 different samples, was *Ennearthron cornutum* (Table 5 and fig. 5.2). It is closely followed, with 53 occurrences, by the category *Hymenop1,* which includes parasitoids Hymenoptera from the Ichneumonidae and Braconidae families. Quite frequent was also *Cecidiomyidae1* which appeared in 51 of the rearing boxes. The different *larvae* were collected from 39 of the samples, and the beetles of the Melandryidae family, *Abdera flexuosa* and *Abdera affinis,* were present in 37 and 29 of the samples respectively (Table 5).

Table 4. Most abundant taxa:

Most abundant taxa	Number of individuals
Sciaridae1	1638
Larvae	748
Ennearthron cornutum	631
Abdera affinis	573
Cecidiomyidae1	498
Abdera flexuosa	407
Hymenop1	318
Dorcatoma dresdensis	267
Thysanoptera	110
Archinemapogon yildizae	109
Galerucella nymphaeae	101
Staphylinidae	73
Nemapogon picarellus	66
Dorcatoma substriata	64

Table 5. Most frequent taxa per sample:

Most frequent taxa	Occurrence
Ennearthron cornutum	54
Hymenop1	53
Cecidiomyidae1	51
Larvae	39
Abdera flexuosa	37
Abdera affinis	29
Dorcatoma dresdensis	26
Tachinidae1	25
Sciaridae1	21
Archinemapogon yildizae	21
Staphylinidae	18
Dorcatoma substriata	17
Anaspis thoracica	17
Perilampidae1	16

Figure 5.
1. Specimen of the most abundant taxa named Sciaridae1
2. Specimens of the most frequent taxa, E. cornutum
3. Specimen of the red-listed species D. substriata

Rank-abundance and rank-occurrence plots are presented in figure 6 to have a general overview of the species composition of the whole insect community. The plot's span from left to right on the graph reflects the number of taxa representing our insect community, comprising the 75 taxa. The "tail" of the plots, meaning the horizontal lines consisting of those species, a total of 17, with only one individual/occurrence, shows us the taxa whose individuals may be present or absent just by chance.
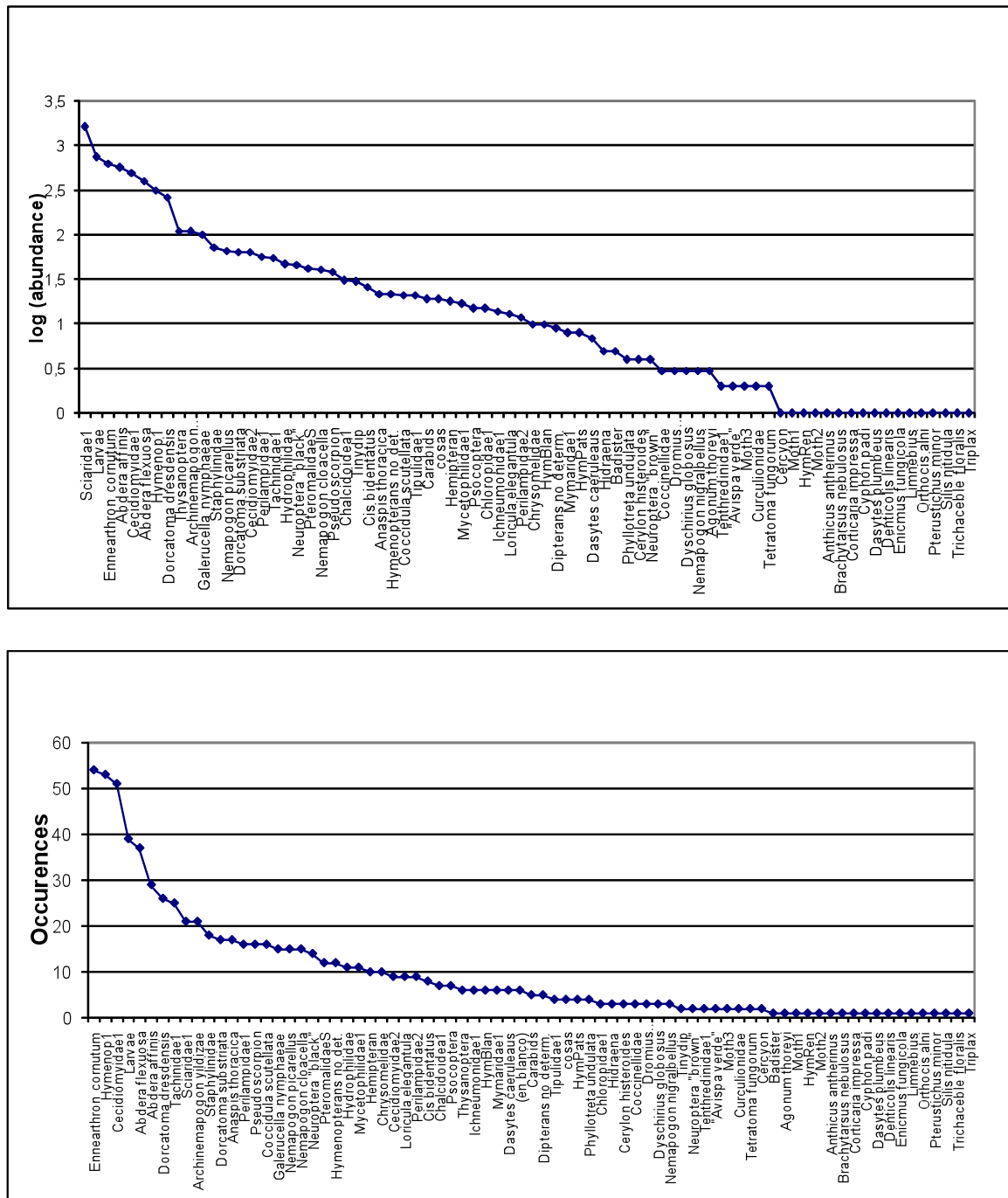
Figure 6. *Species composition: rank-abundance and rank-occurrence plots*

General data for northern and southern communities

From the total number of 6,427 individuals collected during the project, 3,590 (≈56%) were obtained from the southern samples, while 2,837 (≈44%) were found in the samples corresponding to the northern shores. Both shores have presence of all the orders which have been identified. Percentage and number of individuals belonging to each order or group are presented in table 6.

Table 6. Individuals and percentages classified by order/group for northern and southern shores

Order/group	North (individuals)	South (individuals)	%total North	%total South
Coleoptera	981	1335	34,6	37,2
Diptera	736	1612	25,9	44,9
Larvae (unidentified)	575	173	20,3	4,8
Hymenoptera	263	265	9,3	7,4
Thysanoptera	104	6	3,7	0,2
Lepidoptera	91	132	3,2	3,7
Neuroptera	35	15	1,2	0,4
Pseudoscorpions and mites	32	26	1,1	0,7
Hemiptera	10	21	0,4	0,6
Psocoptera	10	5	0,4	0,1
Total	**2837**	**3590**	**100**	**100**

The red-listed species *Dorcatoma substriata* is present in both shore expositions, gathering a total of 64 individuals; 34 from 8 of the northern samples and 30 more from 9 of the southern samples. *Abdera affinis, Abdera flexuosa and Tetratoma fungorum,* the three species included in earlier versions of the Swedish Red List, are also present at both of the shore expositions.

The most abundant taxa in the northern samples were: *larvae, Sciaridae1, Abdera affinis, Cecidyiomidae1* and *Ennearthron cornutum.* At the southern samples were: *Sciaridae1, Ennearthron cornutum, Abdera flexuosa, Abdera affinis* and *Cecidyiomidae1* (Table 7).

Regarding species richness, from the 75 defined taxa, 51 out of them turned out to be present in both northern and southern shores. 62 taxa were identified in the northern samples and 63 in the southern samples. Thus, a total of 11 taxa appeared only in the South, while the same number of taxa appears only in the North. Most frequent taxa at northern and southern shores are presented in table 8.

Table 7. Most abundant taxa sorted in decreasing order in northern and southern samples

Most abundant taxa			
North	Number of individuals	South	Number of individuals
Larvae	575	*Sciaridae1*	1290
Sciaridae1	348	*Ennearthron cornutum*	379
Abdera affinis	298	*Abdera flexuosa*	307
Cecidiomyidae1	269	*Abdera affinis*	275
Ennearthron cornutum	252	*Cecidiomyidae1*	229
Hymenop1	166	*Larvae*	173
Thysanoptera	104	*Dorcatoma dresdensis*	164
Dorcatoma dresdensis	103	*Hymenop1*	152
Abdera flexuosa	100	*Galerucella nymphaeae*	89
Cecidiomyidae2	53	*Archinemapogon yildizae*	67
Staphylinidae	51	*Nemapogon picarellus*	40
Archinemapogon yildizae	42	*Dorcatoma substriata*	30
Perilampidae1	36	*Chalcidoidea1*	30
Dorcatoma substriata	34	*Tachinidae1*	27

Table 8. Most frequent taxa sorted in decreasing order in northern and southern samples

Most frequent taxa			
North	**Occurrence**	**South**	**Occurrence**
Hymenop1	29	*Cecidiomyidae1*	27
Ennearthron cornutum	28	*Ennearthron cornutum*	26
Cecidiomyidae1	24	*Larvae*	24
Abdera flexuosa	18	*Hymenop1*	24
Larvae	15	*Abdera flexuosa*	19
Staphylinidae	14	*Abdera affinis*	16
Abdera affinis	13	*Dorcatoma dresdensis*	13
Dorcatoma dresdensis	13	*Sciaridae1*	12
Tachinidae1	13	*Archinemapogon yildizae*	12
Coccidula scutellata	13	*Tachinidae1*	12
Neuroptera "black"	10	*Galerucella nymphaeae*	10
Anaspis thoracica	10	*Dorcatoma substriata*	9
Sciaridae1	9	*Nemapogon picarellus*	8
Archinemapogon yildizae	9	*Perilampidae1*	8

Rank-abundance plots for northern and southern insect communities are presented in figure 7 and identification of each plotted point with the name of the taxa it represents at each of the shores, are shown in table 9.

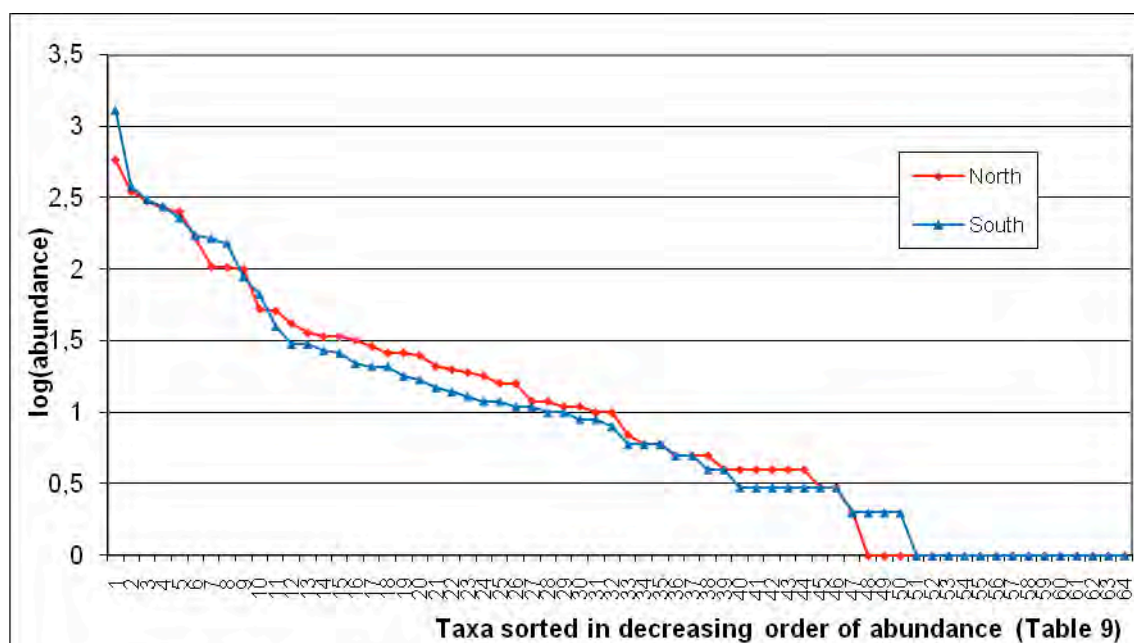***Figure 7.*** *Rank-abundance plots for insect communities in the North and the South of the studied lakes*

Table 9. Correspondence of the represented taxa in figure 7 for northern and southern shores

x	Categories South	Categories North	x	Categories South	Categories North
1	Sciaridae1	Larvae	34	Dipterans no determ.	HymBlan
2	Ennearthron cornutum	Sciaridae1	35	Thysanoptera	Ichneumonidae1
3	Abdera flexuosa	Abdera affinis	36	Psocoptera	Mymaridae1
4	Abdera affinis	Cecidiomyidae1	37	Tinydip	Badister
5	Cecidiomyidae1	Ennearthron cornutum	38	HymBlan	Tipulidae1
6	Larvae	Hymenop1	39	HymPats	Mycetophilidae1
7	Dorcatoma dresdensis	Thysanoptera	40	Chrysomelidae	Loricula elegantula
8	Hymenop1	Dorcatoma dresdensis	41	Coccidula scutellata	HymPats
9	Galerucella nymphaeae	Abdera flexuosa	42	Dromius queadrimaculatus	Hidraena
10	Archinemapogon yildizae	Cecidiomyidae2	43	Nemapogon nigralbellus	Cerylon histeroides
11	Nemapogon picarellus	Staphylinidae	44	Mymaridae1	Dipterans no determ.
12	Dorcatoma substriata	Archinemapogon yildizae	45	Agonum thoreyi	Dyschirius globosus
13	Chalcidoidea1	Perilampidae1	46	Neuroptera "brown"	Phyllotreta undulata
14	Tachinidae1	Dorcatoma substriata	47	Tenthredinidae1	Chalcidoidea1
15	PteromalidaeS	Neuroptera "black"	48	Perilampidae2	Chloropidae1
16	Staphylinidae	Hydrophilidae	49	Coccinellidae	Dasytes caeruleaus
17	Perilampidae1	Tachinidae1	50	Phyllotreta undulata	Neuroptera "brown"
18	Nemapogon cloacella	Nemapogon picarellus	51	Cercyon	Coccinellidae
19	Pseudoscorpion	Tinydip	52	Tenthredinidae2	Tenthredinidae2
20	Tipulidae1	Pseudoscorpion	53	Moth3	Moth3
21	Hydrophilidae	Nemapogon cloacella	54	Corticaria impressa	Curculionidae
22	Chloropidae1	Carabids	55	Curculionidae	Tetratoma fungorum
23	Mycetophilidae1	Coccidula scutellata	56	Cyphon padi	Moth1
24	Hemipteran	PteromalidaeS	57	Dasytes plumbeus	HymRen
25	Neuroptera "black"	Cis bidentatus	58	Denticolis linearis	Moth2
26	Hymenopterans no det.	Galerucella nymphaeae	59	Hidraena	Anthicus antherinus
27	Cecidiomyidae2	Anaspis thoracica	60	Pterustichus minor	Brachytarsus nebulosus
28	Anaspis thoracica	Hymenopterans no det.	61	Silis nitidula	Enicmus fungicola
29	Cis bidentatus	cosas	62	Tetratoma fungorum	Limnebius
30	Ichneumonidae1	Psocoptera	63	Trichaceble floralis	Orthocis alni
31	Loricula elegantula	Perilampidae2	64	Triplax	
32	Cosas	Chrysomelidae			
33	Dasytes caeruleaus	Hemipteran			

Variable associations of individual taxa

The multivariate Poisson regressions performed for the selected 18 taxa reveal the influence of different environmental variables over these groups (results in Appendix 2). They finally include 6 Coleoptera species, 3 Lepidoptera species, 4 Diptera groups, 3 Hymenoptera groups, pseudoscorpions and larvae (Table 10).

In order to select the variables included in the model, correlation between different environmental variables were studied using 2-tailed Pearson correlations. Positives correlations were found for the variables `stem diameter´ and `weight´, and `size of the fungi´ and `weight´. The correlation between `stem diameter´ and `weight´ has a value of 0.608, while the correlation between `size of the fungi´ and `weight´ has a value of 0.617. A p-value of 0.000 was obtained in both cases so the correlations are highly significant at the 0.01 level. Highlighted by these results, we considered appropriated to exclusively include the variable `weight´ in the model and draw future conclusions for the three variables based on their significant positive correlations (Fig.8).
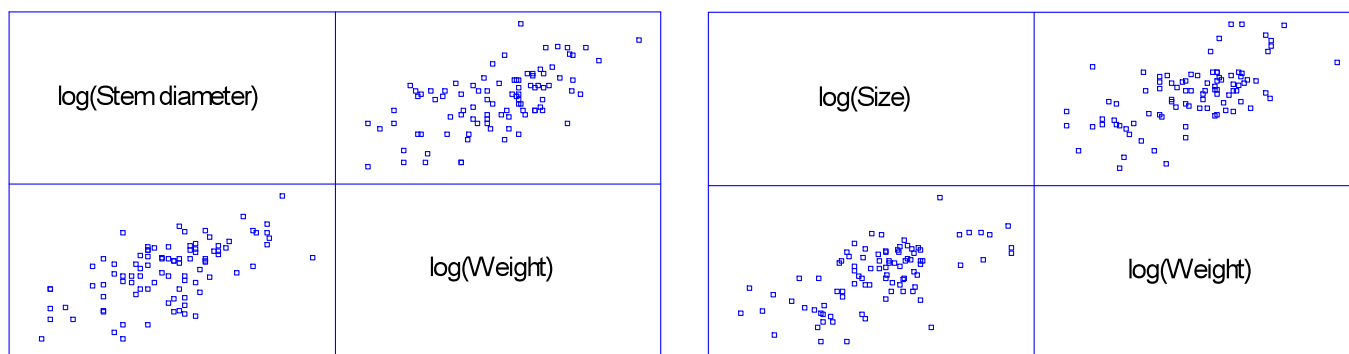
Figure 8. Significant positive correlations between `stem diameter´ and `weight´, and `size of the fungi´ and `weight´

From the four variables included in the model (`weight´, `lake´, `shore´ and `sun exposure´), the variable `**weight´** resulted to significantly explain part of the variation for 10 of the studied populations. Its influence was found to be significant for one beetle species *(Abdera* affinis), the 3 Lepidoptera species (*Archinemapogon yildizae, Nemapogon cloacella* and *Nemapogon picarellus)*, 2 Hymenoptera taxa (*Perilampidae1* and *Hymenop1*), 3 Diptera (*Sciaridae1, Cecidiomyidae1* and *Tachinidae1)* and the larvae.

The variable `**lake´** was also significant in the model for 10 of the taxa; the beetles *Abdera flexuosa* and *Dorcatoma substriata*, the moths *Archinemapogon yildizae* and *Nemapogon cloacella,* the Diptera taxa *Mycetophilidae1, Sciaridae1* and *Cecidiomyidae1,* the Hymenoptera *PteromalidaeS* and *Hymenop1*, the larvae and the pseudoscorpions. Distributions by lake of these affected taxa are plotted in the graph below (Figure 9).
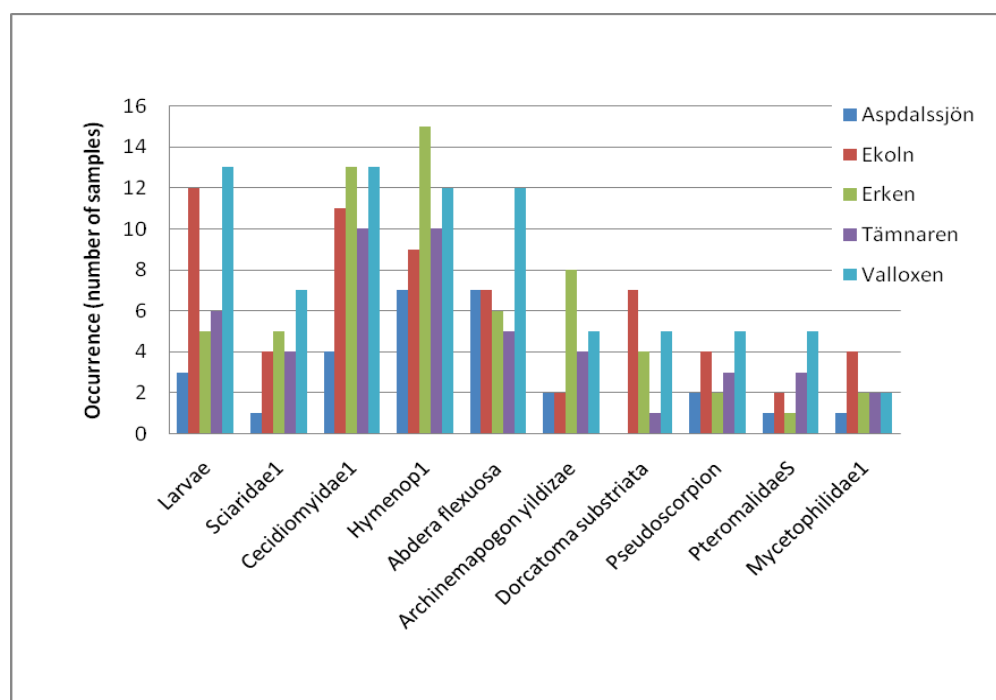
Figure 9. Distribution by lake of the ten taxa affected by this variable

The next variable, `**shore**´, turned out to be significant only for four of the taxa; the Coleoptera *Abdera flexuosa,* the Dipteras *Mycetophilidae1* and *Sciaridae1* and the *larvae*. All of them except *larvae,* are less abundant at the northern shore.

The last variable in the model, `**sun exposure**´ was significant for six of the populations; 3 beetles (*Abdera flexuosa, Dorcatoma dresdensis* and *Ennearthon cornutum)*, the moth *Archinemapogon yildizae*, the Diptera *Mycetophilidae1* and the Hymenoptera *PteromalidaeS* (Table 10).

Table 10. Summary table with the results from the multivariate Poisson regressions

| Taxa/Variables	Individuals (Occurrence)	Weight	Lake	Shore	Sun exposure
Abdera affinis	573 (29)	Y (+)	N	N	N
Abdera flexuosa	407 (37)	N	Y	Y (N-)	Y (1-)
Dorcatoma dresdensis	267 (26)	N	N	N	Y (1-)
Dorcatoma substriata	64 (17)	N	Y	N	N
Ennearthron cornutum	631 (54)	N	N	N	Y (1-)
Anaspis thoracica	22 (17)	N	N	N	N
Archinemapogon yildizae	109 (21)	Y (+)	Y	N	Y (2-)
Nemapogon cloacella	41 (15)	Y (+)	N	N	N
Nemapogon picarellus	66 (15)	Y (+)	N	N	N
Tachinidae1	56 (25)	Y (+)	N	N	N
Mycetophilidae1	17 (11)	N	Y	Y (N-)	Y (1+)
Sciaridae1	1638 (21)	Y (+)	Y	Y (N-)	N
Cecidiomyidae1	498 (51)	Y (+)	Y	N	N
Perilampidae1	57 (16)	Y (+)	N	N	N
PteromalidaeS	42 (12)	N	Y	N	Y (1-)
Hymenop1	318 (53)	Y (+)	Y	N	N
Larvae	748 (39)	Y (+)	Y	Y (N+)	N
Pseudoscorpion	39 (16)	N	Y	N	N

Where,

Y (= yes): when the variable is significant
N (= no): when the variable is not significant
(+): variable positively related with the abundance of the species
(N-): the species is less abundant at the northern shore
(N+): the species is more abundant at the northern shore
(1-): abundance of the species increases at less exposed sites
(1+): abundance of the species increases at more exposed sites
(2-): exposure level 2 is the one with the lowest abundance of that species

A closer look to the variable `Successional stage´

Almost 50% of the collected samples were included in the M (mixture of several stages) category of this variable. Near 25% of the samples contained fruiting bodies at successional stage D (dead and falling apart) and 12% at stage C (dead with many holes or cracks). Samples with fresher fruiting bodies were less abundant in the field, so only 8% of the total samples were classified as A (living) stage and another 8% as B (newly dead, some holes) stage. Figure 10 shows the proportions of the samples taken from the northern and southern shores regarding successional stage of the fruiting bodies.
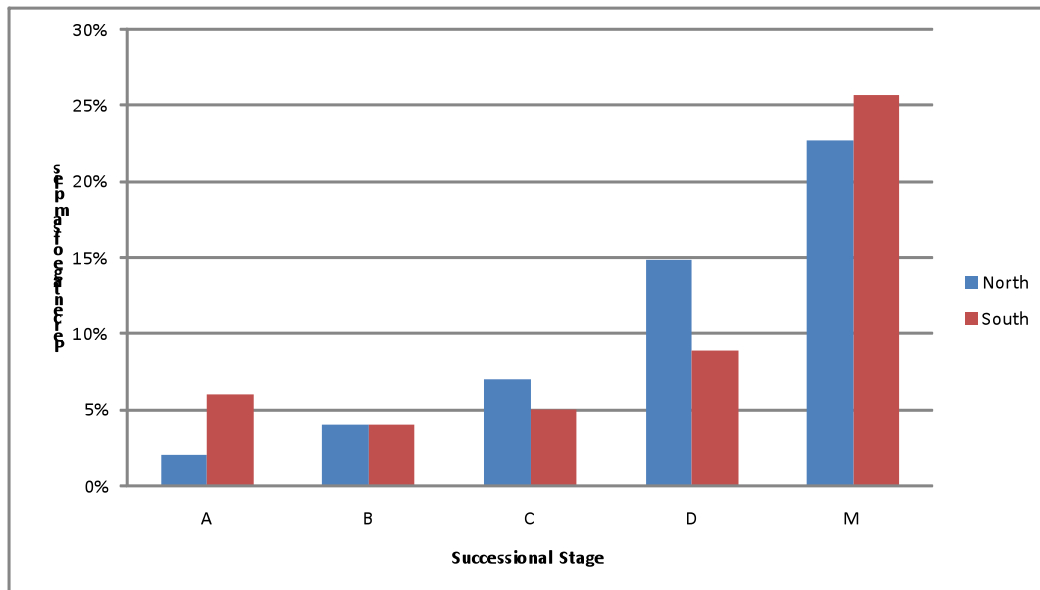
Figure 10. *Collected samples classified by shore and successional stage of the fruiting bodies on them*

The rarefaction curves obtained for all the reared insects directly related to the fungi show us the expected species accumulation curves (Figure 11). Each curve tells us the number of species expected to be collected when we have a certain number of samples from that particular successional stage. Thus, if we had the same number of samples from each successional stage, we expect to find more taxa in the level C, followed by the number of taxa collected in the level D, and then level M, B and A in this order. Considering the 95% confidence intervals, the significance difference is only statistically demonstrated for the samples belonging to the successional stages C, D and M against the samples belonging to the successional stages A and B.
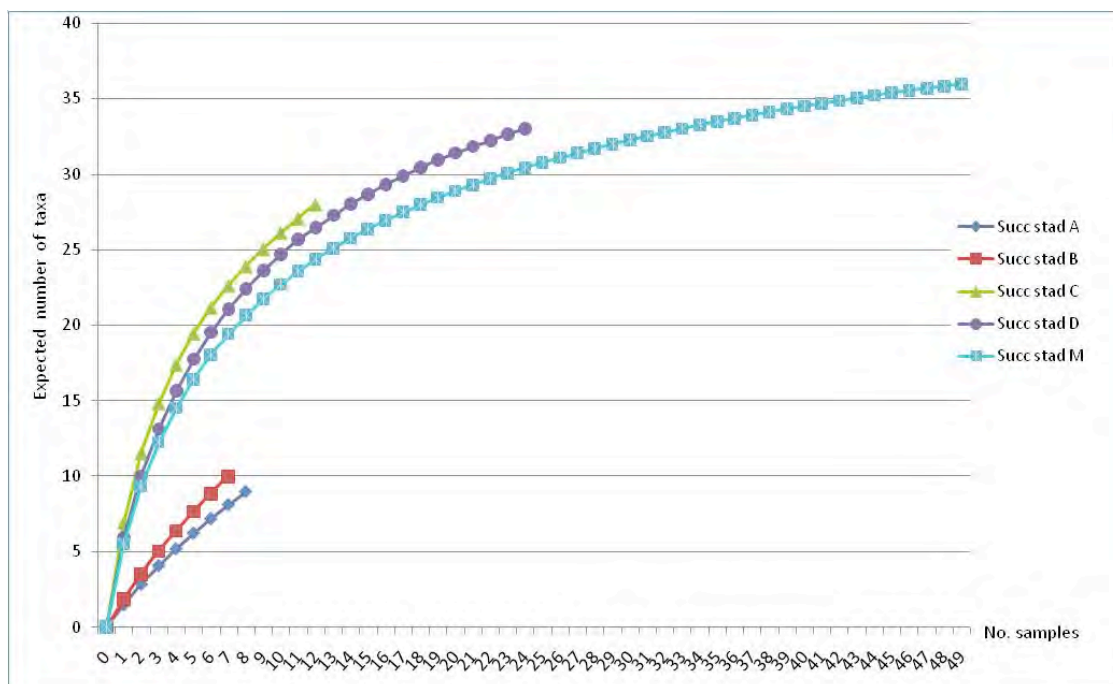
Figure 11. *Rarefaction curves for the different succesional stages*

For 6 taxa I tested a model including the variables `weight´ and `successional stage´. The obtained results are presented in table 11 and graphs in figure 12 represent

frequency of the analysed taxa depending on the successional stage of the fruiting bodies.

Table 11. Influence of the variable `successional stage´ over 6 taxa:

Taxa/Variables	Weight	Successional Stage
Ennearthron cornutum	N	Y
Archinemapogon yildizae	Y	Y
Nemapogon cloacella	Y	Y
Mycetophilidae1	N	N
Cecidiomyidae1	Y	N
Larvae	Y	Y

Where, **Y** (=yes): the variable is significant **N** (=no): the variable is not significant
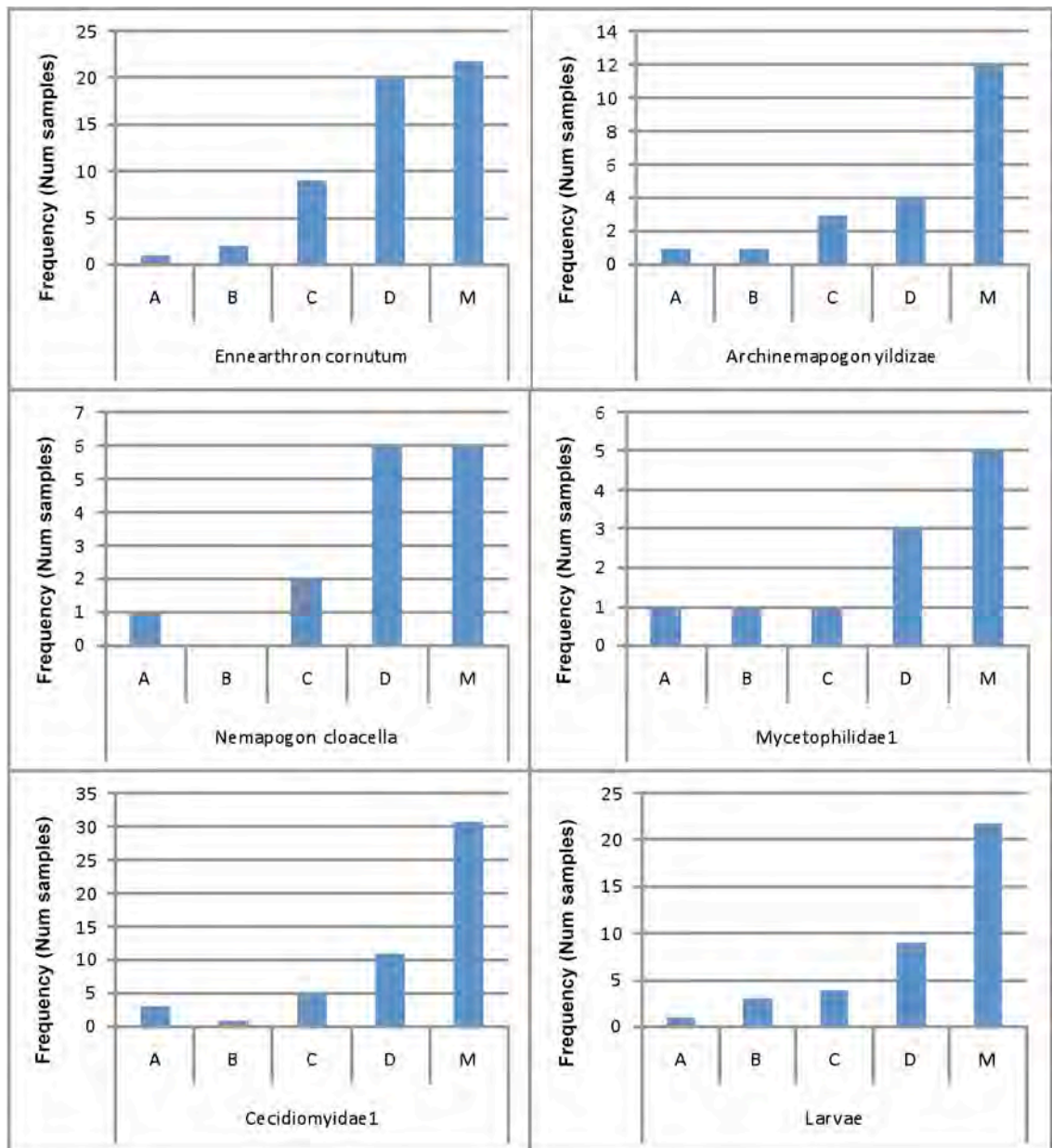
Figure 12.- *Frequency by `successional stage´ of six taxa*

Red-listed species and their distributions

According to the B-criterion used for red-listing, we assume that the red-listed species should have a restricted distribution compared to the not red-listed. That is why we present a table showing the number of samples at each lake where a species was present, i.e. frequency by lake, for the 10 species which turned out to be influenced by this variable according to the multivariate regressions (table 12).

Table 12. Frequency by lake of the taxa where this variable is significant

Specie	Aspdalssjön	Ekoln	Erken	Tämnaren	Valloxen	Total
Larvae	3	12	5	6	13	39
Sciaridae1	1	4	5	4	7	21
Cecidiomyidae1	4	11	13	10	13	51
Hymenop1	7	9	15	10	12	53
Abdera flexuosa	7	7	6	5	12	37
Archinemapogon yildizae	2	2	8	4	5	21
Dorcatoma substriata	0	7	4	1	5	17
Pseudoscorpion	2	4	2	3	5	16
PteromalidaeS	1	2	1	3	5	12
Mycetophilidae1	1	4	2	2	2	11

Discussion

General remarks about the collected data

Fulfilling the first aim of the project, valuable original data about the insect community related to *Inonotus radiatus* have been gathered during the project. A few other studies presented data about the insects related to this particular fungus, but never covered the whole community. In contrast, these investigations were focused on only some orders, for instance, Coleoptera and Lepidoptera (Jonsell & Nordlander, 2004) or only Diptera (Ševčík, 2004). Compared to the presented data by Jonsell and Nordlander regarding fungivorous Coleptera, *Tetratoma fungorum* was reared in the present study while it was only found on other fungal species in their paper. On the other hand, they reported the species *Cis alter, Cis jacquemartii, Cis glabratus* and *Bolitophagus reticulatus* which were not collected from my samples. Regarding Lepidoptera species, four more species that were absent in their paper have been recorded during this project; *Nemapogon nigralbellus, Achillea millefolium, Scoparia ambigualis* and *Ectoedemiya.* Ševčík presented four species of Diptera, two of them from the Mycetophilidae family (*Sciophila hirta* and *Dynatosoma fuscicorne*), one Ditomyiidae (*Ditomyia fasciata*) and one Cecidiomyiidae (*Lestodiplosis polypori*), all of them collected from *Inonotus radiatus* samples. In the present project, determination of Diptera was completed only at family level, but we present at least 2 species of Cecidiomyiidae, one of Mycetophilidae and species belonging to the Chloropidae, Tipulidae, Tachinidae and Sciaridae families. This last family takes an important part of the gathered insect community; however, it was not recorded during Ševčík study.

Interpreting the rank-abundance plot for the whole community (fig.7), we can see a species rich community composed by many taxa, specially having in mind that not all of these taxa have been determined to species level. The curve, as it has been founded for other insect communities, shows a steep gradient, which indicates low evenness; the high ranking species have much higher abundances than the low ranking species. These dominant taxa correspond to fungivorous Coleoptera, Diptera and Hymenoptera, although the unidentified larvae are also very numerous. At the same time, the rank-occurrence plot also presents a steep slope in the beginning of the curve, which points out that only a few taxa have a high frequency on our samples, while more than 36% of the taxa were only present in ten or less samples out of the 100 studied samples.

Comparing the rank-abundance plots obtained for the northern and southern communities (fig. 8) we observe that the tail for the northern curve is a bit longer than the one for the southern curve, so in the North a few more taxa seems to be present in the samples just by chance. Other than their tails, though, the shapes for both plots are quite similar, with a relatively steep slope in the beginning of the curves, indicating, as it did for the global community, low evenness. However, sequence of species is different which make the composition of each community singular. For instance, in the southern community, *Ennearthron cornutum* is the second more abundant taxa, while it is in the fifth position in the northern one. In the North, larvae are the most abundant while in the South it places the sixth position. Thus, communities developed in northern and southern shores have at least a different composition.

Variable associations of individual taxa

The studied taxa showed different responses; none of them were influenced by all four considered variables (table 10). Only one taxa (*Anaspis thoracica*) was not affected by any of the variables and the rest were affected by 1, 2 or 3 variables at the same time. Besides the number of significant variables for each taxon, the affected taxa also show diverse responses against each of these influential variables. These facts can make deciding difficult when defining the right practices for protection, conservation or exploitation if a riparian forest. However, the more we learn about the substrate preferences and requirements of individual taxa, the better we can achieve a sustainable management of our forests.

In first place, the results show that the biggest influence over the studied taxa, is caused by the `weight´ of the samples. We did expect this variable to have an important influence over the populations since previous studies had already demonstrated it. We consider that the inclusion of this variable in the model was essential, since we needed to take into account the heterogeneity of the sample size. All 10 taxa significantly related to the variable `weight´ become more abundant as the weight of the sample increases. This is probably analog to the mentioned positive relation generally found between the amount of deadwood and the abundance of saproxylic beetle species by authors like Økland (1995), Thunes et al (2000) or Grove (2002).

In the same way `stem diameter´ and `size of the fungi´ may also explain part of the variation for the affected taxa, since the positive correlation between these variables and the variable `weight´ was demonstrated (Fig. 8). In general, little is known about the relationship between `stem diameter´ and the fungivorous insects present in the fruiting bodies growing on the stem. However, this argument may be in accordance with authors opinion that found positive relationships between saproxylic insects and stem diameter of the host trees (Jonsell, 1998; Ranius & Jansson, 2000), since positive relation between wood-inhabiting fungi and stem diameter has been demonstrated (Økland et al., 1995). Also, the positive relationship between the size of the fungi and the abundance and species richness of the related insects has been supported by authors like Økland et al. (1995), Komonen & Kouki (2005) or Midtgaard et al (1998). I would like to point out that we found this response for 10 of the study taxa, including all Lepidoptera species and most of the Diptera and Hymenoptera species, but we did not found such a trend for most of our fungivorous beetles. Only *Abdera affinis* was affected by this variable according to our results. Rukke (2002), in his study focused on fungivorous beetles feeding on *F.fomentarius,* found this trend for *D.dresdensis* (in contrast with our results for this species) and some other fungivorous beetles, although he did not found such a trend for *E. cornutum,* which is in accordance with our results.

Based on his results, Rukke (2002) recommended leaving enough dead wood in the managed forest to assure the existence of *Fomes fomentarius* basidiocarps in order to preserve the diversity of fungivores in the forest. We could extend the recommendation to preserve the fungivorous species associated with our particular scenary; there is a need of maintaining *Alnus glutinosa* trees in the riparian forest and other deciduos species which together provide sufficient dead wood to assure an adequate supply of *Inonotus radiatus* basidiocarps of different qualities. These practices may also impact on the predators, parasitoids and hyperparasitoids related to the system,

since their development probably relies, at least partially, on the presence of these fungivorous species.

The variable `lake´ turned out to be one of the most influential variables in the system, being significant for 10 of the 18 taxa. The 5 studied lakes are geographically close enough for considering their general meteorological and ecological characteristics as common factors, so differences among the habitats provided at each lake probably derive from a lower level than mere geographical location. For a better understanding of the influence of the variable `lake´ over the insect communities, also other related variables characterizing the riparian forest present at each of the lakes should be studied. Thus, some variables that could be analyze in further investigations might be type of riparian forest, its composition, dominant tree species, human influence and/or history of the land, water quality…etc. In this way, we could better understand why a lake represents a more valuable spot for certain insects than other (apparently) similar lake.

The variable `shore´ has not been considered as a variable determining a differential sun exposure level in opposite shores of a lake in any of the classical insect studies. Our results tell us that its influence is important for only 4 of the considered taxa, two of them being Diptera groups. Together with the affected beetle *Abdera flexuosa*, these Diptera seem to prefer the southern shores of the lakes, which we consider as more shaded. The last taxon affected by this variable includes all the unidentified larvae, which are more abundant in the more exposed shores represented by the northern shores. Maybe the larvae are more abundant at the northern shores than at the southern shores just because the insect community develops slower at this shore compared to the opposite one. The most abundant larvae in the north might develop into individuals of the less abundant taxa at the southern shores. In this way, the communities could present a similar structure regarding species composition, while the timing would be different.

At a different spatial scale, the variable `sun exposure´ also shows us the importance of the received light for the individual taxa. It is significant for 6 taxa, including 3 Coleoptera, 1 Lepidoptera and 2 Hymenoptera taxa. The 2 Coleoptera, *Dorcatoma dresdensis* and *Ennearthron cornutum,* being influenced in the model only for this variable, turned out to be more attracted to the most shaded sites. The last Coleoptera affected, *Abdera flexuosa*, is also influenced by the variables `lake´ and `shore´. It is more abundant in the shaded sites than in the most exposed sites, and we mentioned that it is also more abundant in the southern shores considered as more shaded. It seems to be consequently associated with shaded sites at every level. In contrast, the Mycetophilidae Diptera are favored by sun-exposed sites, although they prefer the most shaded shore too. The Lepidoptera species, *Archinemapogon yildizae,* is more abundant in shaded sites and the least abundant in semi-shaded fruiting bodies, but it is not significantly influenced by the shore.

Particularly, the species *Ennearthron cornutum* turned out to be affected only by sun exposure and it clearly prefers fruiting bodies at semi shaded or shaded sites. Some authors obtained similar conclusions for this and other *Ciidae* beetles (Jonsell et al., 2001; Thunes et al., 2000) while some others found beetle species with higher frequencies at more sun exposed sites (Midtgaard et al., 1998).

Although this has not been statistically analyzed in this project, we would like to comment that more than 50% of the collected samples for this study correspond to sun exposure level 2 (intermediate). This fact might indicate the requirements regarding light of the fungus. Consequently, *Inonotus radiatus* populations follow certain distribution patterns that may be indirectly determining the fungivorous insects preferences.

The variable `successional stage´

It seems reasonable to think that the succesional stage of a particular host must be a very important variable for the insects when selecting a substrate. Different species have different preferences and abilities to colonize a substrate depending of its decay stage. This has been demonstrated many times for saproxylic beetles, taking as a variable the stage of decay of the woody substrate they inhabit (e.g. Gibb et al., 2007; Jonsell et al., 1998; Lawrence, 1973; Jacobs, 2004). In the same way, it has been analyzed for the different successional stages of fruiting bodies and their associated fauna (e.g. Thunes, 1994; Jonsell and Nordlander, 2004; Jonsell et al., 2001; Graves, 1960; Klimaszewski & Peck, 1987).

Since during the sampling we collected almost all the samples as we walked along the shores, figure 10 shows us that in the northern shores there are more fruiting bodies in a more advanced successional stage while in the south, there are more fresh fruiting bodies. This has not been statistically tested, but it could corroborate our idea of considering that the macroclimate at northern shores is different from the one in the south, since the development of the fungus differs from one shore to the opposite. We consider this fact might also be affecting the timing and composition of the related insect communities.

The rarefaction curves (fig.11) demonstrate a statistically significant difference between the samples containing fruiting bodies at successional stage C, D or M against the samples with successional stage levels A or B. Thus, with an equal number of samples, we can in general expect finding more taxa inhabiting the samples containing older and more decayed fruiting bodies than in the samples with younger and fresher brackets. The M stage curve appears under C and D curves, but over A and B curves. This is logical if we consider it is a mixture of fruiting bodies of different successional stages. Thus, the M curve will be closer to the curve corresponding to the successional stage which proportion is the highest in the total samples included in the M category.

Although the difference between successional stage C and D turned out not to be significant, we can see in the graph how C stage curve is a little bit over D stage curve. In this case, insects would prefer fruiting bodies in an advanced successional stage, but not the ones which are already too decayed. At the same time, B stage curve is over A stage curve, so even not being significant, the newest brackets seems to attract the least number of insect species. They have probably not been colonized yet. According to these comments, I would say that more insect species can colonize and inhabit a particular fruiting body as the decay level increases, until it reaches a limit of decomposition over which, the richness of insects selecting that particular host decreases again. This trend was already defended for several species of Ciidae by Graves in 1960 and very similar results were presented by Jonsell et al. (2001) for several fungivorous species. Among these species were *Dorcatoma dresdensis,*

Dorcatoma robusta and *Cis lineatocribratus*. Other species wich has been also collected in the present study, such as *Ennearthron cornutum, Cis bidentatus* turned out to follow a slightly different pattern, increasing their frequency with the decay stage of the fruiting bodies. Other species were less frequent in the first successional stage, reached a maximum in the second category to decrease again in the third and the last stage.

Karl H. Thunes (1994) classified fruiting bodies of two different bracket fungi in 5 big groups, and he also presented a similar trend of preference by the related insects. The only difference is that he found more preference for the first stage than we have found.

Similar trend to the one we have found was also presented in a study about red-listed saproxylic invertebrates by Jonsell et al. (1998). They considered 7 different categories of successional stage of the woody substrate and the highest number of species was found associated to the 6th category. The lowest number of species was found in the first successional stage and it increased until the 6th stage, to decline again in the last successional stage.

Four out of the six tested taxa (table 11) are influenced by the successional stage of the fruiting bodies. This variable is not significant for the two Diptera taxa, while it is significant for the Coleoptera species, both Lepidoptera species and the larvae.

According to the multivariate regressions and the graph presented in figure 12, the species *Ennearthron cornutum* is more frequent as more advanced is the decay stage of the fruiting bodies. This is in accordance with the results obtained for the same species in Jonsell et al. (2001). The model shows that the Lepidoptera *Archinemapogon yildizae* has preference for fruiting bodies in successional stage C, then D and finally A and B. In contrast, Jonsell el al. study (2001) pointed out different preferences, being the order B, C, A and D stages. Our results regarding *Nemapogon cloacella* explain that it has a preference for old fruiting bodies, but not too old. It prefers C stage, followed by D stage, A and in last place B stage. *Larvae* do not present a clear tendece for new or decayed fungi. They are attracted to B stage in first place, then D, A and C in that order.

Red-listed species

The species *Dorcatoma substriata*, at present classified as near threatened in the region, turned out to be relatively common in our samples. However, it responded to the variable `lake´ in the regressions and looking at table 12, we can see its distribution is more restricted than for other affected species, e. g. *A. flexuosa. D. substriata* is absent or almost absent in two of the lakes and it concentrates more than 40% of its total occurrences at one particular lake, Ekoln. This matches the B-criterion considered for red-listing, meaning our data supports the idea of maintaining the species on the Swedish Red List. On the other hand, we have not enough data to statistically analyze how the variable `successional stage´ influences this species, but it seems to be a very important variable regarding substrate preferences of this beetle. All the collected specimens were reared only from samples with fruiting bodies at C and/or D successional stage level. Actually, 16 out of a total of 17 samples which turned out to be inhabited by this beetle species contained at least some fruiting bodies at D level. The remaining sample contained exclusively fruiting bodies at successional stage C. It is not present at any sample containing only brackets from the A and B level. Samples with

this beetle classified as M level contain fruiting bodies at D level mixed with fruiting bodies at level C, except 3 samples which were a mixture composed by fruiting bodies belonging to D and A successional stage levels. They might prefer much decomposed fruiting bodies, being able to colonize the fungus only when the decay has advanced to category C.

Abdera affinis is not significantly influenced by the variable `lake´ and it is quite abundant and frequent in our samples, being affected only by the weight of the samples. On the other hand, *A. flexuosa* is also abundant and frequent on the samples and it is affected by the variable `lake´, being more common at the lake Valloxen (Table 12). However, this difference does not make its distribution restricted to this particular lake, being well represented at all of them. These data can corroborate the current exclusion of the two species from the current Red List, not requiring special protection measurements for their right development and conservation.

The only two specimens recorded of the species *Tetratoma fungorum* were recorded from 2 samples taken at Erken lake, one from each shore, containing fruiting bodies at successional stage C and D. Such a low frequency and abundance makes me think this species is not related to this particular fungus. According to Paviour-Smith (1965), the main habitat of this beetle is the birch bracket fungus *Pitoporus betulinos* on birch. Jonsell & Nordlander (2004) also present this beetle species associated with the fungus *Pitoporus betulinus*, in which was the only species it was found on in their study. Therefore, we probably recorded this species just by chance, not being able to draw conclusions about the convenience of being included or not in the Red List.

Observing table 12, we could say that the moth *Archinemapogon yildizae* has a distribution in some way restricted to a few lakes. It is present at all of them, but almost 40% of the samples with this species were from Erken lake. Together with Valloxen, they gather more than 60% of the occurrences for this species. According to this argument, this species may be object of further studies to investigate in depth distribution and evolution of this Lepidoptera, considering its possible inclusion in future Red Lists if this were estimated necessary.

Methodological Remarks

Determination of the collected material could have been more detailed and precise. However, taking into account the limited time and resources available for this project, we consider that the presented data is very valuable. It provides a general overview of the whole insect. The information gathered during the project could be the base for further studies focus on either the total community or specific parts of it. Besides, further determination of the material could be carried out if needed, since the collected individuals are classified and stored in the department where the project was developed. Particularly useful might be the identification of the larvae, due to its importance in number regarding the total community and the differences found among northern and southern samples for this taxon.

The importance of examining the boxes and fruiting bodies after the rearing period must be pointed out too, since it has been crucial for some of the species. For instance, 97.5% of the collected individuals of *Ennearthron cornutum*, were found inside the boxes after the rearing period. This species turned out to be the most

frequently found species, collected from 54 different samples and it is as well one of the most numerous in terms of collected individuals (631). The specimens representing the beetle *Tetratoma fungorum* were also recorded thanks to this careful examination of the samples.

More reliable results from the rarefaction curves could have been obtained if the fruiting bodies of different successional stages would have been always separated in the four categories A, B, C and D. This means not having the M category in our data, but for this purpose the sampling design would need to be changed, and regarding other aims of this project, the design was defined as presented. We could have also adjust the curves by other variable, such as `weight´, but we finally did not take this other possibility which could be analyzed in further investigations.

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Appendix 1. Summary table presenting the measured environmental variables at the 5 different lakes

Sample	Shore	Lake	Stem diam (cm)	Dist. Shore (cm)	Weight (g)	Size2 (cm^2)	Height first fungus (cm)	Height last fungus (cm)	Successional stage	Exposition side	Sun exposure
1	North	Erken	31	480	265	1800	150	270	M	SE	2
2a	North	Erken	26	800	210	375	0	15	C	S	3
2b	North	Erken	26	800	200	1800	40	240	C	S	3
3	North	Erken	15	800	225	576	24	60	M	E	1
4	North	Erken	26	640	205	960	100	220	C	E	1
5	North	Erken	22	80	137	1040	70		M	NW	2
6	North	Erken	16	160	220	1400	0	400	C	N	1
7	North	Erken	11	0	210	960	30	90	D	S	1
8	North	Erken	28	0	245	1600	0	320	M	NE	1
9	North	Erken	13	2080	355	825	0	56	C	SE	3
10	North	Erken	14	800	150	160	0	40	C	N	3
11	South	Erken	22	1120	281	1725	0	230	A	S	3
12	South	Erken	27	4480	325		0	300	M	S	3
13	South	Erken	39	480	375	>5600	0	2000	M	S	2
14	South	Erken	24	320	130	660	30	140	D	NE	1
15	South	Erken	24	800	290	1400	0	170	M	S	2
16	South	Erken	44	1120	430	10380	0	340	A	All	2
17	South	Erken	17	640	265	1140	0	190	C	N	2
18	South	Erken	21	4480	405		0	220	M	NW	2
19	South	Erken	20	960	205	355,2	0	74	M	NE	3
20	South	Erken	36	640	495		0	800	M	NE	2
21	North	Aspdalssjön	17	1440	130	1200	0	200	D	N	3
22	North	Aspdalssjön	15	1760	150	1320	0	220	D	NE	2
23	North	Aspdalssjön	18	1120	114	555	74	130	B	NE	3
24	North	Aspdalssjön	27	1760	145	1278	28	170	B	NE	3
25	North	Aspdalssjön	19	320	211	1800	50	400	M	S	2
26	North	Aspdalssjön	16,5	1280	250	1170	55	210	A	NE	3
27	North	Aspdalssjön	12	1440	190	480	0	80	M	NE	3
28	North	Aspdalssjön	10	1440	122	60	0	90	M	N	2

Sample	Shore	Lake	Stem diam (cm)	Dist. Shore (cm)	Weight (g)	Size2 (cm^2)	Height first fungus (cm)	Height last fungus (cm)	Successional stage	Exposition side	Sun exposure
29	North	Aspdalssjön	12	250	155	525	0	160	D	S	2
30	North	Aspdalssjön	10	960	180	800	0	50	C	NE	2
31	South	Aspdalssjön	7	1920	78	76,8	28	48	B	S	2
32	South	Aspdalssjön	8,5	1280	62	259,2	18	58	M	W	2
33	South	Aspdalssjön	7	1760	114	1008	150	220	D	W	3
34	South	Aspdalssjön	14,5	800	190	1200	0	200	M	SW	1
35	South	Aspdalssjön	11	1920	98	900	90	400	B	NE	2
36	South	Aspdalssjön	11	1440	72	560	32	60	C	N	1
37	South	Aspdalssjön	34	1440	160	1680	160	300	M	N	1
38	South	Aspdalssjön	6,5	160	42	250	25	70	B	W	2
39	South	Tämnaren	40	640	360	3900	0	155	M	SW	2
40	South	Tämnaren	16	240	270	600	0	120	M	All	2
41	South	Tämnaren	22	160	150	900	0	110	M	SW	2
42	South	Tämnaren	11	0	124	1625	0	130	A	All	1
43	South	Tämnaren	18	80	160	920	0	230	M	NE	2
44	South	Tämnaren	13	80	135	486	0	90	A		2
45	South	Tämnaren	22	160	82	180	0	20	D	NE	2
46	South	Tämnaren	21	160	215	1200	0	120	M	E	1
47	South	Tämnaren	23	0	210	1330	0	95	M	E	2
48	South	Tämnaren	23	0	275	1725	0	180	M	NE	1
49	South	Tämnaren	16	240	116	344	0	15y25	D	S	2
50	North	Tämnaren	25	1440	108	96	0	20	D	S	2
51	North	Tämnaren	18	1520	210	1865	0	210	M	N	3
52	North	Tämnaren	22	1120	70	300	0	70	D	N	3
53	North	Tämnaren	19	880	270	1530	0	170	M	All	2
54	North	Tämnaren	20	800	94	140	0	110	M	NE	2
55	North	Tämnaren	21	240	210	800	0	175	M	S	2
56	North	Tämnaren	25	400	170	1600	0	110	D	N	3
57	North	Tämnaren	24	640	260	900	0	220	M	All	3
58	North	Tämnaren	16	160	250	420	0	70	D	N	1
59	North	Tämnaren	11	80	74	50	0	50	M	NE	2

Sample	Shore	Lake	Stem diam (cm)	Dist. Shore (cm)	Weight (g)	Size2 (cm^2)	Height first fungus (cm)	Height last fungus (cm)	Successional stage	Exposition side	Sun exposure
60	North	Valloxen	13	480	190	420	120	180	M	S	1
61	North	Valloxen	13	1920	42	420	0	56	M	all	3
62	North	Valloxen	20	1120	72	260	10	50	M	E	2
63	North	Valloxen	8	2080	80	220	33	60	M	N	1
64	North	Valloxen	20	0	205	1080	20	110	M	N	1
65	North	Valloxen	19	1440	150	240	0	60	M	N	3
66	North	Valloxen	65	3040	215	1485	90	200	D	W	3
67	North	Valloxen	24	160	240	780	25	220	D	S	2
68	North	Valloxen	15	1600	175	480	0	60	M	S	2
69	North	Valloxen	14,5	800	102	384	0	45	M	S	2
70	South	Valloxen	44	640	280	1200	0	700	M	N	2
71	South	Valloxen	15	1440	114	1275	90	??	C	S	2
72	South	Valloxen	16	0	185	900	15	100	B	W	1
73	South	Valloxen	21	160	74	250	15	100	M	E	2
74	South	Valloxen	13	160	56	234	0	30	M	N	1
75	South	Valloxen	16	320	250	1170	0	290	M	N	1
76	South	Valloxen	14	80	130	600	0	80	D	E	1
77	South	Valloxen	16	320	56	2250	70	200	D	E	2
78	South	Valloxen	21	160	195	4000	40	750	M	NW	2
79	South	Valloxen	13	320	150	562,5	30	320	M	W	2
80	North	Ekoln	29	400	230	435	0	145	B	E	2
81	North	Ekoln	19	0	86	267,5	0	80	D	S	2
82	North	Ekoln	32	640	300	480	0	90	D	W	2
83	North	Ekoln	45	400	320	1320	0	350	D	S	2
84	North	Ekoln	23	400	250	900	0	220	M	E	2
85	North	Ekoln	44	240	355	7200	0	900	D	W	2
86	North	Ekoln	22	560	370	684	0	120	B	S	3
87	North	Ekoln	24	160	66	600	20	55	D	S	1
88	North	Ekoln	50	160	760	2650	0	500	M	all	1
89	North	Ekoln	32	2400	295	600	0	360	A	W	1

Sample	Shore	Lake	Stem diam (cm)	Dist. Shore (cm)	Weight (g)	Size2 (cm^2)	Height first fungus (cm)	Height last fungus (cm)	Successional stage	Exposition side	Sun exposure
90	South	Ekoln	7	320	114	378	20	110	C	E	2
91	South	Ekoln	22	400	96	1800	20	190	D	E	2
92	South	Ekoln	21	400	114	1540	15	125	D	E	3
93	South	Ekoln	12	160	210	160	0	170	A	E	2
94	South	Ekoln	39	160	180	669,5	0	900	M	S	2
95	South	Ekoln	7	80	62	315	15	50	C	S	2
96	South	Ekoln	26	320	375	4800	70	600	A	S	2
97	South	Ekoln	12	240	48	97,5	40	170	D	N	2
98	South	Ekoln	18	80	215	6375	0	800	M	ES	2
99a	South	Ekoln	29	160	245	11160	0	500	M	ES	2
99b	South	Ekoln	29	160	275	11160	0	500	M	ES	2

Appendix 2. Poisson Regression models for species tasted for associations with environmental variables (numbers in bold meaning significant result):

Source	NDF	Chi-Square	Pr > Chi	Source	NDF	Chi-Square	Pr > Chi
Abdera affinis				*Perilampidae1*			
WEIGHT	1	3,3314	0,0680	WEIGHT	1	4,7566	**0,0292**
LAKE	4	7,7680	0,1005	LAKE	4	6,6050	0,1583
SHORE	1	0,4649	0,4953	SHORE	1	2,9308	0,0869
SUN EXPOSURE	2	2,3555	0,3080	SUN EXPOSURE	2	4,8231	0,0897
Abdera flexuosa				*Tachinidae1*			
WEIGHT	1	0,9623	0,3266	WEIGHT	1	4,5855	**0,0322**
LAKE	4	15,8163	**0,0033**	LAKE	4	3,3776	0,4967
SHORE	1	5,2708	**0,0217**	SHORE	1	0,1507	0,6978
SUN EXPOSURE	2	6,9169	**0,0315**	SUN EXPOSURE	2	2,8694	0,2382
Anaspis thoracica				*Mycetophilidae1*			
WEIGHT	1	1,1514	0,2833	WEIGHT	1	1,6885	0,1938
LAKE	4	5,3138	0,2562	LAKE	4	12,9735	**0,0114**
SHORE	1	0,6169	0,4322	SHORE	1	8,3271	**0,0039**
SUN EXPOSURE	2	2,4936	0,2874	SUN EXPOSURE	2	20,2128	**0,0001**
Dorcatoma dresdensis				*PerilampidaeS*			
WEIGHT	1	2,3311	0,1268	WEIGHT	1	3,5571	0,0593
LAKE	4	6,5717	0,1603	LAKE	4	29,2773	**0,0001**
SHORE	1	1,5356	0,2153	SHORE	1	0,6540	0,4187
SUN EXPOSURE	2	5,9428	**0,0512**	SUN EXPOSURE	2	16,7170	**0,0002**
Dorcatoma substriata				*Sciaridae1*			
WEIGHT	1	0,8032	0,3701	WEIGHT	1	48,0835	**0,0001**
LAKE	3	13,3792	**0,0039**	LAKE	4	11,7625	**0,0192**
SHORE	1	0,2297	0,6317	SHORE	1	2,4697	0,1161
SUN EXPOSURE	2	5,4365	0,0660	SUN EXPOSURE	2	0,8022	0,6696
Ennearthron cornutum				*Cecediomyidae1*			
WEIGHT	1	1,5185	0,2179	WEIGHT	1	11,7135	**0,0006**
LAKE	4	1,2319	0,8728	LAKE	4	14,4910	**0,0059**
SHORE	1	3,0421	0,0811	SHORE	1	0,0119	0,9131
SUN EXPOSURE	2	5,1122	0,0776	SUN EXPOSURE	2	0,9723	0,6150
Archinemapogon yildizae				*Hymenop1*			
WEIGHT	1	18,5121	**0,0001**	WEIGHT	1	8,6680	**0,0032**
LAKE	4	23,9053	**0,0001**	LAKE	4	18,8975	**0,0008**
SHORE	1	2,1320	0,1442	SHORE	1	0,2089	0,6477
SUN EXPOSURE	2	9,6170	**0,0082**	SUN EXPOSURE	2	4,4534	0,1079
Nemapogon cloacella				*Larvae*			
WEIGHT	1	19,3544	**0,0001**	WEIGHT	1	4,7452	**0,0294**
LAKE	3	3,2237	0,3584	LAKE	4	47,7341	**0,0001**
SHORE	1	0,1329	0,7154	SHORE	1	8,1265	**0,0044**
SUN EXPOSURE	2	2,5243	0,2830	SUN EXPOSURE	2	2,8077	0,2456

Nemapogon picarellus				*Pseudoscorpion*			
WEIGHT	1	4,2025	**0,0404**	WEIGHT	1	3,2552	0,0712
LAKE	4	4,4218	0,3519	LAKE	4	13,2013	**0,0103**
SHORE	1	1,8034	0,1793	SHORE	1	0,0356	0,8503
SUN EXPOSURE	2	1,6084	0,4474	SUN EXPOSURE	2	3,4397	0,1791

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