Examensarbete
i ämnet naturvårdsbiologi 20 poäng

The lichen flora on decorticated logs of *Ulmus glabra*

Per Larsson
2003

Handledare: Göran Thor

Institutionen för naturvårdsbiologi
SLU
Box 7002
750 07 Uppsala

Nr 111
Uppsala 2003

Abstract

The interest in dead wood ecology has increased the last years. There have been many studies made on lichens on woody substrates of conifers in boreal forest, but this is the first study on the lichen flora on woody substrate in broad-leaved deciduous forest. In this study the lichen flora was inventoried on 30 decorticated logs of Wych elm, *Ulmus glabra* in three areas close to Ekoln bay in lake Mälaren South of Uppsala. Totally 36 lichen taxa and one non-lichenised fungus were recorded. According to literature 47 % of these lichen species were earlier not known as lignicolous. The study showed that the number of taxa increased with distance to the log base and decreased with measured log diameter. The highest diversity was found on logs in a stage of intermediate decay. One rare species was present on the logs, *Bacidia vermifera.*

Sammanfattning

Under de senaste åren har intresset om ekologin kring död ved ökat. Det har gjorts en hel del studier kring lavar på barrträdsved i boreala skogar, men detta är den första studien av lavfloran på ädellövved. Trettio avbarkade lågor av skogsalm *Ulmus glabra* inventerades på tre platser vid Mälarviken Ekoln söder om Uppsala. Totalt hittades 36 taxa av lavar och en olicheniserad svamp. Av de funna arterna var enligt litteraturen 47 % inte kända som vedväxande. Antalet taxa ökade med avståndet till lågans bas och minskade med lågans uppmätta diameter. Högst diversitet fanns på lågorna med intermediär nedbrytningsgrad. En ovanlig art hittades på lågorna, nämligen *Bacidia vermifera.*

Introduction

Background

The interest in coarse woody debris (CWD) in forest ecosystems has increased the last years. There are studies made on the lichen flora on woody debris (e. g., Qian et al. 1999, Chlebicki et al. 1996, McAlister 1997) and many studies are made on lichens on coniferous wood in boreal forests (e.g., Söderström 1988, Forsslund et al. in prep., Berg et al. 2002, Jüriado et al. 2003, Henningson & Lundström 1970, Crites & Dale 1998). However, there are some studies that have included broad leaved trees wood in their study but never as a main aim of the study (e.g. Arup et al. 1999). In Arup et al. (1999) the issue was to make an inventory of an area and include all epiphytic lichens but some woody substrate was also included. The woody substrates that were inventoried were mostly *Quercus* sp. and *Pinus sylvestris*. Wood of *Quercus* is known to have a rich lichen flora, but the knowledge of the lichen flora from other broad-leaved deciduous tree species is scarce (Thor, pers. comm.). It is estimated that in Sweden almost 200 species of lichens are lignicolous (Hallingbäck 1997). According to Leif Andersson (pers. comm.) the crustose lichen flora on logs is strongly neglected and there are indications that many obligate lignicolous crustose lichens have been decreasing in abundance during the last century.

A natural forest system is characterised by the presence of trees in all age classes from seedlings to CWD. The constant supply of CWD is caused by age, wind, insects, fungal pests and fire. In forest systems manipulated by human, CWD is in shortage due to forestry. This scarcity of CWD in forests is a threat to the epixylous and saproxylic organisms (Chlebicki et al. 1996, Siitonen 2001). Decaying CWD is a temporary substrate and dispersal is therefore critical for the survival of species of lichens growing on logs. Lignicolous species must in order to persist in a long term, continually disperse to new logs. (Samuelsson et al. 1994, Hallingbäck 1997)

Ulmus glabra Wych elm

In Sweden *Ulmus glabra* is a common broad-leaved deciduous tree species. Other broad-leaved deciduous trees include e g., *Acer platanoides, Fraxinus excelsior, Quercus robur* and *Tilia cordata*. In Sweden *Ulmus glabra* is common in southern Sweden up to the river Dalälven, but have scattered locations north of this border (Hultén 1971). In 2001 there was, 80 x 10^3 ha broad-leaved deciduous forests and 1.3 % of the standing volume of broad-leaved deciduous trees was *Ulmus* spp. (Skogsvårdsstyrelsen 2002).

The elm immigrated to Sweden 9000 years ago and was a dominating tree species in southern Sweden 7000 years ago. The elm has declined since the Beech *Fagus sylvatica* immigrated 2000 years ago (Arvidsson 1982). Since 1918 the elms in Europe have been under infection by the Dutch Elm Decease (DED). The decease is cased by the fungus *Ophiostoma ulmi* and is spread chiefly by elm bark beetles (*Scolytus* spp.) and the infected trees are dying by drying (Watson 1988). The DED came to Sweden in the beginning of the 1950's but a more aggressive strain was detected in the 1960's in England and 1979 in Sweden (Arvidsson 1982, Watson 1988). In Sweden the spread of the pathogen is tried to be stopped by removal of the infected trees which has often been used as firewood. The removal of infected trees has partly been done due to the Swedish plant protection law 1972:318 (Höglund 1998). Elms have very deep root systems (Almgren et al. 1984). When the trees are dying of DED, they often have the time to decorticate before they are falling because of the deep root system. The low economical interest in *Ulmus glabra*, caused by the DED and the relativity small amount of stands in Sweden, can be a reason to the poor research on *Ulmus glabra* in Swedish ecological systems.

Aim of the Study

Since the lichen flora on woody substrates from broad-leaved deciduous trees is scarcely known, the first task must be a survey of these substrates. It is not possible to protect the lichen flora if it is not known. There can also be a concern about the continuity in woody substrates from broad-leaved deciduous trees due to a decrease in regeneration and a gap in the stand age with few trees in middle age (Skosvårdsstyrelsen 2002). Especially the woody substrate from elms can be a shortage in the future cased by the DED.

The aim of this study is to describe the lichen flora of *Ulmus glabra* logs for the first time in Sweden.

Methods

Study Sites

The study was carried out in three areas; Krusenberg, Morga hage and Vårdsätra Naturpark (appendix 1). Common for all three study sites were the occurrence of elm logs with bare wood, and the short distance to open water, which in all three cases was Ekoln bay in lake Mälaren.

Krusenberg

Krusenberg is located 13 km south of Uppsala and the study was performed in two small isolated woods. The first wood is located 200 m NV from the Krusenberg manor. The tree layer was mainly *Ulmus glabra*, *Fraxinus excelsior* and more close to the water *Alnus glutinosa*. The shrub layer was poor with mainly *Ribes alpinum* and saplings from the dominating tree species. The field layer was around 40-50 cm high and dense, with tall herbs such as *Aegopodium podagraria* and *Lilium martagon*. The second wood is located 600 m NV from Krusenberg manor and had a tree layer dominated by *Ulmus glabra*. The shrub layer was manly tree saplings and very poor. The field layer was sparse and consisting mostly of *Aegopodium podagraria.*

Morga Hage

Morga hage is located 10 km south of Uppsala and is a part of the nature reserve Kungshamn-Morga. The tree layer was mainly *Ulmus glabra* and *Fraxinus excelsior*. The shrub layer was dense and totally dominated by *Corylus avellana*, and the field layer was dominated by *Poaceae* and small herbs such as *Ranunculus ficaria* and *Anemone hepatica*. During the survey the area was grazed by cattle.

Vårdsätra Naturpark

Vårdsätra naturpark is located 8 km south of Uppsala. The tree layer is dense and dominated by *Acer platanoides, Alnus glutinosa, Fraxinus excelsior* and *Ulmus glabra*. The shrub layer is dominated by *Corylus avellana, Prunus padus, Ribes alpinum, R. uva-crispa, Viburnum opulus* and saplings of the dominating tree species. The field layer is sparse and common species are *Actaea spicata* and *Aegopodium podagraria* as well as seedlings from the dominating tree species. The area was until 1909 a grazing area with scattered large trees. Vårdsätra naturpark has been a nature reserve with no management since 1909. Because of this, the area is now a dense forest.

Selection of Logs

In each of the study sites, ten logs of *Ulmus glabra* with six chosen criteria (see below) were selected for the study. The criteria were giving the logs a minimum length and thickness in areas with similarly light and hydrology conditions

- A minimum diameter of 15 centimetres.
- A minimum length of 2 meters.
- A decay of stage 2, 3 or 4 (Table 1).
- Free from bryophytes and macrofungi to at least 2/3.
- Not incline more than 10º.
- Located within a forest and not very sun exposed.

Table 1. *The decay classes was used in the study. Based on McCulloughs (1948) decay classes.*

Decay classes	Definition
1	The log is still covered with bark
2	The log is almost totally without bark and the surface is completely intact
3	The bark is totally absent and the surface has started to crack up
4	The log surface is cracked up and started to loose small fragments of the surface
5	The log have lost big parts of the surface

Inventory

A sample line was placed on the uppermost part of the log. At the sample line a plot with the size 10 × 10 cm was placed perpendicular to the line with the middle on the line at every 30 cm starting at the logs basal part. Every plot contained 16 subplots, with size 2.5 × 2.5 cm. The first plot was placed 30 cm from the logs basal part and the last area was placed at least 30 cm from the end of the log. For every plot, the number of subplots a species occurred within was noted. Lichens which could not be defined to species in the field were collected and later determined.

In case there were any bryophytes, macrofungi (e.g. fungi with sporocarp > 5 mm) or bark in the plot, the number of subplots they were present in, was noted.

Decay stage for all logs was estimated. In some cases different parts of the log were at different decay classes. In these cases the log was classified to the dominating stage.

Statistical Analysis

Differences between study sites and decay stages were analyzed both with Detrended Correspondence Analysis (DCA) (McCune & Mefford 1997) to analyse possible difference in species composition and t-test as presented in Zar (1996) for difference between diversity indexes. To detect possible difference between decay stages and number of species Kruskal-Wallis test was used with following nonparametric multiple comparisons with unequal sample sizes. Spearman Rank correlation was used to analyse differences between plots along the log. Specimens which only could be determined to genera were treated as species in the analyses.

Results

Logs and Inventoried Plots

Totally 30 logs were inventoried. The average diameter of the log base was 36 cm (min. 20 cm, max. 80 cm, SD = 11.8) and the average length 470 cm (min. 210 cm, max. 920 cm, SD = 202). Totally 416 plots were recorded. Of these, 127 (30%) plots were without any lichens. Lichens were absent on one of the 30 logs.

Bryophytes and Macrofungi

Bryophytes were present in 173 subplots in 36 plots of which one plot on a log of decay stage 2, nine in decay stage 3 and 26 plots in stage 4. Macrofungi were not noted in any plot. Most of the logs which were not inventoried due to the amount of bryophytes were in decay stage 4.

Lichens

A total number of 36 taxa, which six only could be determined to genera, were found on the 30 logs (Appendix 2). The fraction of crustose lichens was 15 (42 %) taxa within 12 genera. There were 15 species which only occurred on one log and ten species which occurred on more than five logs. Seven species occurred on ten or more logs; *Caloplaca obscurella, Candelariella xanthostigma, Hypogymnia physodes, Micarea prasina, Parmelia sulcata, Physconia enteroxantha* and *Xanthoria polycarpa*. There were 14 species that occurred in less than five subplots, and the five most frequent lichens in the plots were *Candelariella xanthostigma, Catillaria atropurpurea, Parmelia sulcata, Phaeophyscia orbicularis* and *Physconia enteroxantha*.

Among the 36 taxa, three species are interesting to highlight.

- *Bacidia vermifera* is very rare in Sweden (Hultengren 1997) with very few resent observations. The log where it was found was located in Morga hage.
- *Sarcosagium campestre* is rare in Sweden (Hultengren 1997) and mostly found on decaying bryophytes and soil. *S. campestre* were found on 4 logs located in Morga hage and Vårdsätra naturpark.
- *Leptogium teretiusculum* is less common and is indicating high nature values (Nitare 2000). This species were found on two logs in Morga hage.

A cumulative species curve was made to see if the line tends to level off with the number of examined logs (Fig. 1).

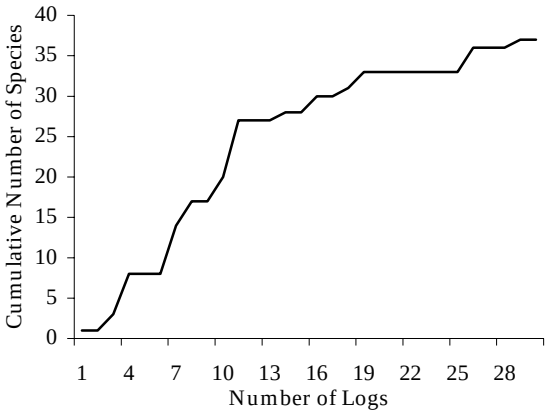

Fig 1. Cumulative number of species as a function of number of examined logs. Total number of taxa 36, Total number of logs 30.

Lichens and the Substrate

According to literature (Foucard 2001; Hallingbäck 1997; Purvis 1992; Krog 1994, Santesson 1993) only 19 (53 %) of the lichens found, are listed as lignicolous (specimens which only is determined to genera are not included). Five of these are uncommon as lignicolous. None of the species found are obligate lignicolous species (Table 2). All except one species are known also as corticolous.

Table 2. *The selection of substrate by the lichens found, according to literature*

		Substrate		
Species	Saxicolous	Terricolous	Corticolous	Lignicolous
Bacidia vermifera	-	-	●	●
Calicium salicinum	-	-	●	●
Caloplaca flavorubescens	○	-	●	○
Caloplaca holocarpa	●	-	●	●
Caloplaca obscurella	-	-	●	○
Candelariella xanthostigma	-	-	●	○
Catillaria atropurpurea	-	-	●	●
Catillaria nigroclavata	-	-	●	●
Cladonia pyxidata	-	●	○	○
Evernia prunastri	○	○	●	○
Hypogymnia physodes	●	●	●	●
Lecania cyrtella	-	-	●	-
Lecanora chlarotera	-	-	●	●
Leptogium teretiusculum	○	○	●	-
Melanelia fuliginosa	●	-	●	-
Melanelia subargentifera	●	-	●	-
Micarea prasina	○	○	●	●
Mycobilimbia carneoalbida	-	●	●	-
Ochrolechia androgyna	●	●	●	-
Parmelia sulcata	●	○	●	●
Parmeliopsis ambigua	○	-	●	●
Peltigera praetextata	●	●	●	-
Phaeophyscia orbicularis	●	-	●	-
Phlyctis argena	●	-	●	-
Physcia tenella	○	-	●	-
Physconia enteroxantha	○	-	●	-
Placynthiella icmalea	●	●	●	●
Rinodina pyrina	-	-	●	●
Ropalospora viridis	-	-	●	-
Sarcosagium campestre	-	●	-	●
Xanthoria polycarpa	○	○	●	●

● = common on substrate, ○ = uncommon on substrate

Lichen Distribution on Logs

There is a positive correlation both between number of species ($r = 0.313$, $p < 0.001$) and frequency of lichens ($r = 0.346$, $p < 0.001$) to distance from log base (Fig. 2A, C). There is also a negative correlation between the number of species ($r = -0.188$, $p < 0.001$) and frequency of lichens ($r= -0.226$, $p < 0.001$) to log diameter (Fig. 2B, D).

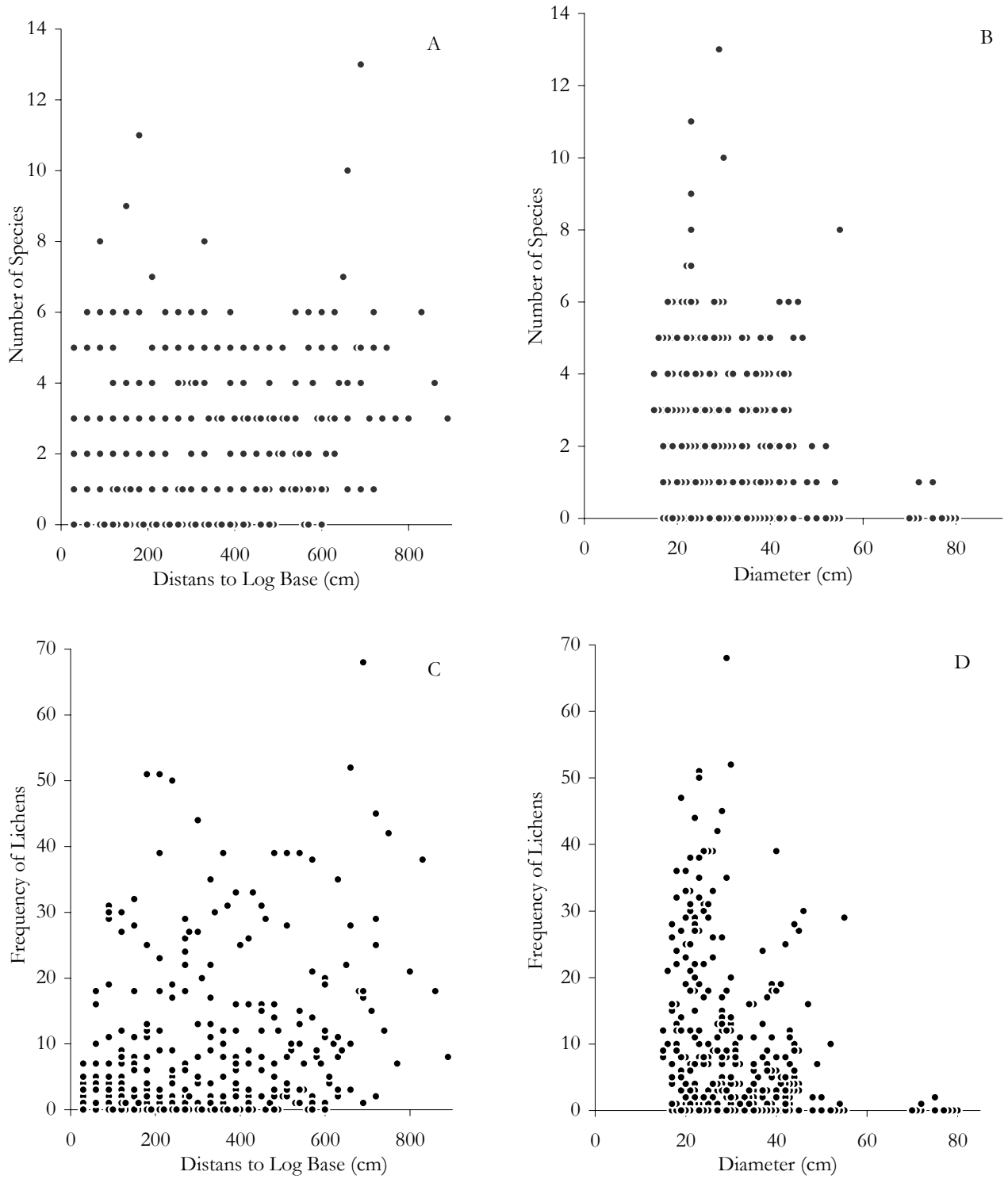

Fig. 2. Correlation between lichens and their distribution on the log. A, there is a positive correlation between the number of species in the plot and distance to log base; B, there is a negative correlation between number of species in the plot and diameter of the log at the plot; C, there is a positive correlation between frequency of lichens in the plot and distance to log base; D, there is a negative correlation between frequency of lichens in the plot and diameter of the log at the plot

Decay Stages and Lichen Distribution

Six of the 30 logs were in decay stage 2, 14 in stage 3 and ten in decay stage 4. Totally 13 lichen taxa were found on logs of decay stage 2, 33 taxa on stage 3 and 15 taxa on logs of decay stage 4.

There is a significant difference in diversity (Shannon index) between the three decay stages (2-3; $t = 13.8$ $p < 0.001$, 3-4; $t = 11.7$ $p < 0.001$, 2-4; $t = 5.4$ $p < 0.001$) (Fig. 3), but no significant difference between decay stage due to number of species ($H = 4.74$, $p = 0.093$). The Kruskal-Wallis test with a following nonparametric multiple comparisons test show that the medians of number of species between decay stage 3 and 2, and stage 3 and 4 were significantly different. The difference between decay stage 2 and 4 was insignificant (Table 3)

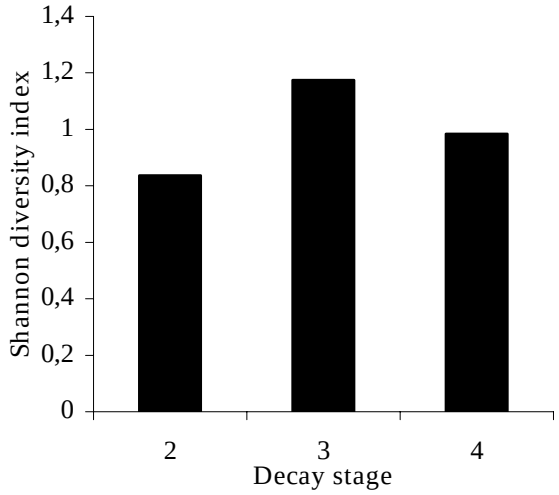

Fig. 3. Diversity index (Shannon) for the three different decay stages.

Table 3. *Difference in diversity index between the decay stages*

Compared Decay stages	t-value	P-Value
3 - 2	4.03	<0.001
3 - 4	6.96	<0.001
2 - 4	1.35	>0,5

An analysis with DCA was not showing any clear connection between decay stage and species composition (Fig. 4).

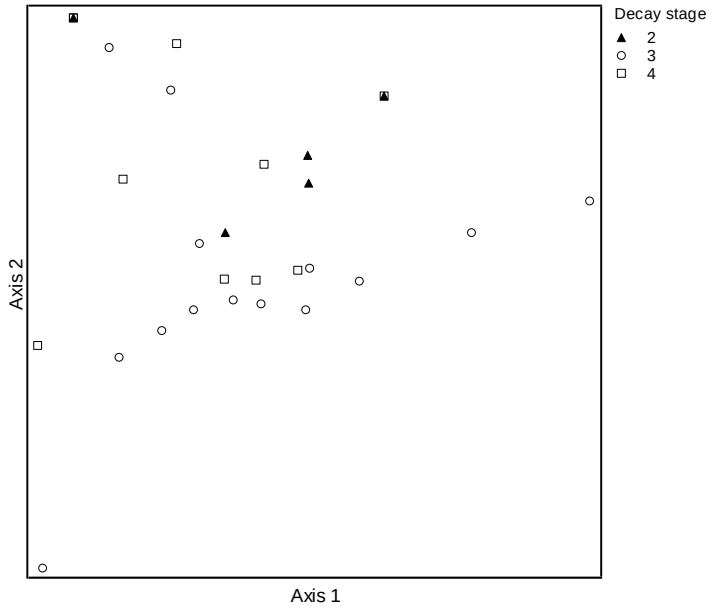

Fig. 4. DCA analysis showing no clear difference between the three decay stages.

Species Diversity in the Study

Even if the study sites were located in the same geographic area and had similar conditions, they differed in diversity (Shannon index) (Table 4). Morga hage was having the highest diversity and Vårdsätra naturpark the lowest. However, a DCA analysis did not show any clear difference in species composition between the sites (Fig. 5).

Table 4. *Statistic test for difference between Shannon diversity indexes for the three study sites*

Compared Study sites	t- value	P-value
Krusenberg-Morga hage	4.43	< 0.001
Morga hage-Vårdsätra np	7.65	< 0.001
Krusenberg-Vårdsätra np	9.10	< 0.001

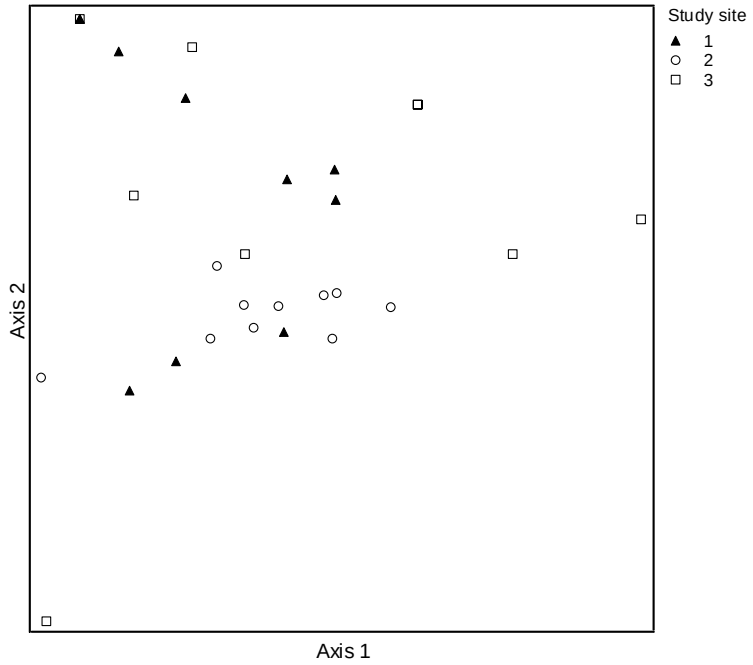

Fig. 5. DCA analyse showing the difference between the three study sites; Krusenberg (1), Moga Hage (2) and Vårdsätra Naturpark (3).

Discussion

Logs and Inventoried Plots

Totally 30.5 % of the plots were empty of lichens. This shows that it is probably not competition between the lichens that is the limiting factor for colonisation of the substrate.

Possible explanations for the poor occurrence can be.

- Short lived substrate
- Slow colonisation

- Competition with other organisms such as fungi or bryophytes
- Difficult/poor colonisation or survival conditions

Lichens

The number of lichens found (36 taxa) within this small geographical area demonstrates that elm logs are a rich substrate. In a study made on logs of spruce and pine in managed and old-growth forests, 98 lichen taxa were found (Forsslund et al., manus). Comparing to this study, elm logs has less species. However, Barkman (1958) noted that there are usually less epiphyte species on tree species growing near the limits of their natural distribution area compared to the same tree species in the more central part of their distribution area. The survey took place in the northern part of the distribution of *Ulmus glabra* (Hultén 1971). Forsslunds et al. (manus) also includes two tree species in the study, and five times as many logs. Therefore elm logs are still a rich substrate for lichens. It is likely that the lichen flora is richer in the more central parts of the elm distribution.

When a comparison in lichen flora is made between this study and the Forsslunds et al. (manus) study only eight species can be found in both studies (*Calicium salicinum, Cladonia pyxidata, Hypogymnia physodes, Micarea prasina, Ochrolechia androgyna, Parmeliopsis ambigua, Placynthiella icmalea and Ropalospora viridis).* These eight species are all common in all Sweden and also known from several different substrates.

The cumulative species curve (Fig. 1) does not completely level off. This shows that there are theoretically more species in this geographical area.

Among the found species the most interesting is *Bacidia vermifera*, which is a species with poor knowledge about the species status (Thor, pers. comm.). Only eight specimens are listed after 1980 in the lichen herbarium UPS (internet 1).

Lichens and the substrate

There were no obligate lignicolous lichen species found on the elm logs. It is known that there are several obligate lignicolous lichens which can be found on dead wood of *Pinus sylvestris* and *Picea abies* (Hallingbäck 1997, Santesson 1992). Among the lichens in Forsslund et al. (manus) study on conifer CWD, 30 % were known as obligate lignicolous. The results indicate that there are few obligate lignicolous lichens only occurring on elm logs. Dispersal is critical for the survival for lignicolous species since a decaying log is a temporary substrate. In order to persist, the lichens must disperse to new logs (Samuelsson 1994). It is possible that obligate lignicolous lichens can be found in other parts within the distribution area of elm with a continuity of elm logs in higher densities. All lichen species in this study except *Sarcosagium campestre* are known also as corticolous (Table 2), this despite that wood and bark often have different lichen flora (Barkman 1958). This result can be interpreted that elm logs do not have a lichen flora of their own, but instead are being colonized mostly by the epiphytic lichens occurring within the area.

It is interesting to highlight the substrate choice of the three species that were both among the most abundant and most frequent. *Candelariella xanthostigma* is unusual as lignicolous, *Parmelia sulcata* is known to occur on various kinds of substrates and *Physconia enteroxantha* is earlier not reported as lignicolous (Table 2). Among the species, 40 % was not reported as lignicolous. This is probable a consequence of the absence of studies of the lichen flora on CWD. More studies on

woody substrate of broad-leaved deciduous trees should fill a knowledge gap in the ecology of lichens.

Lichen Distribution on the Log

The abundance of species increased with increased distance from the log base and decreased diameter of the log. The interesting question is if the variation in number of lichens species is due to log diameter or distance. Possible explanations fore the relationship are:

- Better light conditions contribute to better colonisations conditions in the top if the colonisation took place before falling.
- The top was decorticated first which often is the case when elms are dying from Dutch elm disease. The top has because of this a longer time for colonisation.
- The colonisation was better in the top due to more wind etc compared to the base, if the colonisation took place before falling.
- It could be the influence of hydrology or dust from the ground due to the height over the ground.
- The different log dimensions have different chemistry/physical structures.

This study did not include elm wood thinner than 15 cm and therefore it should be interesting to investigate if the trend with more species on smaller diameter is the case also for twigs.

Decay Stages and Lichen Distribution

There is a significant difference in diversity index (Shannon) between the different decay stages. The index show that the logs in decay stage 3 is more diverse than decay stage 4, which is more diverse than logs in decay stage 2. An explanation to these differences could be that logs in decay stage 3 have been exposed to colonisation for a longer time than decay stage 2, and therefore are more diverse. Decay stage 4 might be too soft, and another reason to a lower diversity on logs of decay stage 4 might be a competition from bryophytes, which here were more abundant.

The DCA analysis showed that the variance in floristic composition among the logs within the same decay stage was that great that a possible difference between the stages could not be detected.

Species Diversity in the Study Sites

There was a significant different in diversity (Shannon) between the three study sites with the site Morga hage as the most diverse. Morga hage was also the site with the most open tree layer (but very dense in the shrub layer). It is possible that the light conditions affect the result. Vårdsätra naturpark had the lowest diversity index and had also the most dense tree canopy cover. Wet and fading leaves which cover the logs in the autumn can possibly have a negative effect on lichen survival.

Unsolved Questions

This study does only present results from a very small geographical area with similar conditions (light, humidity, precipitation, climate etc). Therefore a study within a larger geographical area and on sites with other environmental conditions is necessary to present a more complete picture of elm wood as a substrate for lichens.

The lichen flora on the logs with a diameter thinner than 15 cm and branches is still unknown. Therefore it is not possible to conclude which the factor is for the distribution of lichens on elm logs.

The lichen flora on wood of broad-leaved trees is very insufficiently known. It would be most interesting with more studies on logs of broad-leaved tree species.

Acknowledgement

I want to give my gratitude to the following people/ department:

- Göran Thor, for determination of difficult species and for being my supervisor.
- The County Administration of Uppsala for giving permission to enter and perform the study in Vårdsätra Naturpark.
- Göran Hartman, for comments the manuscript.
- Ulf Arup, University of Lund, for determination of one specimen.
- The Department of Conservation Biology for being a stimulating place to write my master thesis.

Referenser

Almgren, G., Ingelög, T., Ehnström, B. & Mörtnäs, A. 1984. *Ädellövskog, ekologi och skötsel*. Skogsstyrelsen, Jönköping.

Arup, U., Ekman, S., Fritz, Ö., Fröden, P., Johansson, T., Knutsson, T., Lindblom, L., Lundkvist, H. & Westberg, M. 1999. Bark– och vedlevande lavar i ädellövskog på ön Jungfrun. *Svensk Botanisk tidskrift 93*: 73-93.

Arvidsson, B. 1982. *Almsjuka, -bakgrund, -utbredning*. Sveriges lantbruksuniversitet, Uppsala.

Barkman, J J. 1958. *Phytosociology and ecology of cryptoamic epiphytes*. Van gorcum & comp. N. V., Assen.

Berg, Å., Gärdenfors, U., Hallingbäck, T. & Norén, M. 2002. Habitat preferences of red–listed fungi and bryophytes in woodland key habitats in southern Sweden – analyses of data from a national survey. *Biodiversity & Conservation 11*: 1479 -1503.

Chlebicki, A., Zarnowiec, J., Cleslinski, S., Klama, H., Bujakiewicz, A. & Zaluski, T. 1996. Epixylites, lignicolous fungi and their links with differnt kinds of wood. *Phytocoenosis 8*: 75-109.

Crites, S. & Dale, M. R. T. 1998. Diversity and abundance of bryophytes, lichens and fungi in relation to woody substrate and successional stage in aspen mixed wood, boreal forests. *Canadian journal of botany 76*: 641-651.

Forsslund, A., Koffman, A., Thor, G. & Dinnétz, P. Species richness of lichens on decaying wood – A comperison between old-growth and managed boreal forest in Sweden. *Manuscript*.

Fucard, T. 2001. *Svenska skorplavar och svampar som växer på dem*. Interpublishing, Stockholm.

Hallingbäck, T. 1997. *Ekologisk Katalog över Lavar* – ArtDatabanken, Uppsala.

Henningsson, B. & Lundström, H. 1970. The influence of lichens, lichen extracts and usnic acid on wood destroying fungi. *Material und Organismen 5*: 19-31.

Höglund, O. 1998. *Sveriges rikes lag*. Nordstedts juridik, Stockholm.

Hultén, E. 1971**.** *Atlas över växternas utbredning i Norden*.- 2:a uppl. Generalstabens litografiska anstalts förlag, Stockholm.

Jüriado, I., Paal, J. & Liira, J. 2003. Epiphytic and epixylic lichen species diversity in Estonian natural forests. *Biodiversity & Conservation 12*: 1587 -1607.

Krog, H., Østhagen, H. & Tønsberg, T. 1994. Lavflora, Norske busk og bladlav. Universitetsforlaget, Oslo.

McAlister, S. 1997. Cryptogam communities on fallen logs in Duke forest, North Carolina. *Journal of vegetation Science 8*: 115 -124.

McCullough, H.A.1948. Plant succession on fallen logs in a virgin spruce-fir forest. *Ecology 29*: 508-513.

McCune, B. & Mefford, M. J. 1997. *PC-ORD. Multivariate Analysis of Ecological Data. Version 3.19*. MjM Software, Glenden Beach, Oregon.

Moberg, R. & Holmåsen, I. 2000. *Lavar en fälthandbok*. Interpublishing. Stockholm.

Nitare, J. 2000. *Signalarter. Indikatorer på skyddsvärd skog. Flora over kryptogamer*. Skogsstyrelsens Förlag, Jönköping.

Purvis, O. W., Coppins, B. J., Hawksworth, D. L., James, P. W. & Moore, D. M. 1992. *The lichen flora of Great Britain and Ireland*. Natural History Museum Publications, London.

Qian, H., Klinka, K. & Song, X. 1999. Cryptogams on decaying wood in old-growth forests of southern coastal British Colombia. *Journal of vegetation science 10*: 883-894.

Samuelsson, J.,Gustafsson, L. & Ingelög, T. 1994. *Dying and dead trees –a review of their importance for biodiversity*. Swedish Treatened Species Unit, Uppsala.

Santesson, R. 1993. *The lichens and lichenicolous fungi of Sweden and Norway*. SBT-förlaget, Lund.

Siitonen, J. 2001. Forest management, coarse woody debris and saproxylic organisms: Fennoscandian boreal forests as an example. *Ecological Bulletins 49*: 11-41.

Skogsvårdsstyrelsen. 2002. *Skogsstatistisk årsbok*. Skogsvårdsstyrelsen, Jönköping.

Söderström, L. 1988. The occurrence of epixylic bryophyte and lichens species in an old natural and managed forest stands in Northeast Sweden. *Biological Conservation 45*: 169-178.

Zar, J.H. 1996. *Biostatistical Analysis*. Prentice-Hall, Inc, New Jersey.

Internet references

http://www-hotel.uu.se:8888/cgi-bin/wwwdrive.fytotek/beginner [The UPS herbarium search for Bacidia vermifera] Accessed 2003-07-29

Appendix 1

Map over the three study sites.

APPENDIX 2

Complete list of taxa

Taxon	plots	Number of subplots	Logs
Bacidia vermifera	4	8	1
Calicium salicinum	8	55	1
Caloplaca flavorubescens	2	2	1
Caloplaca holocarpa	1	1	1
Caloplaca obscurella	57	133	10
Candelariella xanthostigma	110	396	12
Catillaria atropurpurea	61	334	9
Catillaria nigroclavata	1	1	1
Cladonia sp.	1	1	1
Cladonia pyxidata	1	2	1
Evernia prunastri	10	24	5
Hypogymnia physodes	50	191	11
Lecania cyrtella	9	14	3
Lecanora chlarotera	27	100	6
Leptogium teretiusculum	2	2	2
Melanelia fuliginosa	23	40	5
Melanelia subargentifera	12	28	2
Micarea prasina	52	168	15
Mycobilimbia carneoalbida	1	1	1
*Mycocalicium subtile**	14	51	2
Ochrolechia androgyna	26	126	2
Parmelia sulcata	69	337	17
Parmeliopsis ambigua	1	1	1
Peltigera praetextata	1	1	1
Pertusaria sp.	3	3	3
Phaeophysea orbicularis	63	371	9
Phlyctis argena	12	34	3
Physconia enteroxantha	65	302	10
Physconia sp.	1	1	1
Physia sp.	1	1	1
Physia tenella	11	43	3
Placynthiella icmalea	1	3	1
Ramalina sp.	21	80	5
Rinodina pyrina	1	1	1
Ropalospora viridis	3	16	1
Sarcosagium campestre	45	247	4
Xanthoria polycarpa	99	219	16

* Non-lichenised fungus

Appendix 3

Total data set. Found species followed by number of sample plots occurrences.

Krusenberg

Log nr:	1																	
Decay stage	4																	
Distance from log base (cm)	100	130	160	190	220	250	280	310	340	370	400	430	460	490	520	550	580	610
Diameter at sample area (cm)	40	37	37	35	34	34	33	34	35	34	32	30	30	28	27	25	23	22
Sample area	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R
Micarea prasina	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9	3	8	4
Bryophytes	10	7	12	7	7	3	7	9	4	15	12	6	0	5	3	3	0	0

comments First meter not able to survey

Log nr:	2						
Decay stage	2						
Distance from log base (cm)	30	60	90	120	150	180	210
Diameter at sample area (cm)	55	55	54	50	48	48	45
Sample area	A	B	C	D	E	F	G
Micarea prasina	0	0	0	0	0	2	0
Bryophytes	0	0	0	0	0	0	0

comments

Log nr:	4															
Decay stage	3															
Distance from log base (cm)	30	60	90	120	150	180	210	240	270	300	330	360	390	420	450	480
Diameter at sample area (cm)	35	35	35	34	33	32	32	31	30	30	30	29	29	29	28	28
Sample area	P	O	N	M	L	K	J	I	H	G	F	E	D	C	B	A
Catillaria atropurpurea	0	1	0	0	0	0	2	1	0	0	1	0	0	0	0	0
Hypogymnia physodes	0	0	0	0	2	0	0	0	0	0	0	0	0	1	3	0
Micarea prasina	3	2	0	0	0	11	0	1	0	4	12	8	3	10	5	5
Bryophytes	0	0	2	0	0	0	7	4	4	6	0	5	0	0	2	2

comments

Log nr:	5					
Decay stage	4					
Distance from log base (cm)	30	60	90	120	150	180
Diameter at sample area (cm)	50	52	55	45	40	40

Sample area	A	B	C	D	E	F
Caloplaca obscurella	0	0	2	0	0	0
Catillaria atropurpurea	0	1	8	0	0	2
Hypogymnia physodes	0	9	8	7	0	3
Lecanora chlarotera	0	0	3	0	0	0
Micarea prasina	2	0	5	0	0	0
Parmelia sulcata	0	0	1	0	0	0
Phaeophysea orbicularis	0	0	1	0	0	0
Xanthoria polycarpa	0	0	1	2	0	1
Bryophytes	1	2	0	0	0	0

comments

Log nr: 6
Decay stage 3

Distance from log base (cm)	30	60	90	120	150	180	210	240	270
Diameter at sample area (cm)	30	32	35	32	27	27	27	25	25
Sample area	A	B	C	D	E	F	G	H	I
Hypogymnia physodes	1	0	0	2	0	0	0	0	0
Micarea prasina	3	0	1	2	0	0	0	0	0
Xanthoria polycarpa	1	1	1	0	0	0	0	0	0
Bryophytes	0	0	1	0	0	0	0	0	0

comments

Log nr: 7
Decay stage 2

Distance from log base (cm)	30	60	90	120	150	180	210	240	270
Diameter at sample area (cm)	38	38	37	37	37	35	33	32	32
Sample area	A	B	C	D	E	F	G	H	I
Hypogymnia physodes	0	1	2	0	0	0	2	1	0
Parmelia sulcata	1	0	0	0	0	0	0	0	0
Xanthoria polycarpa	0	0	0	0	2	0	0	0	0
Bryophytes	0	0	0	0	0	0	5	0	0

comments

Log nr: 8A
Decay stage 2

Distance from log base (cm)	30	60	90	120	150	180	210	470	500	530	560	590	620	650	680	710	740	770	800	830	860	890
Diameter at sample area (cm)	28	28	28	27	28	28	28	27	25	25	25	23	23	22	22	22	21	21	21	21	21	20
Sample area	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V

Candelariella xanthostigma	0	1	1	2	4	4	2	1	1	0	0	1	2	2	4	0	0	0	0	6	5	2
Hypogymnia physodes	2	3	1	1	3	6	1	0	0	0	0	4	4	11	9	8	9	3	12	16	9	5
Melanelia fuliginosa	0	0	0	0	0	0	0	0	0	0	0	0	0	3	2	3	1	1	2	5	2	0
Micarea prasina	1	0	1	0	1	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1
Parmelia sulcata	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
Phaeophysea orbicularis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Physia sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Physia tenella	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
Ramalina sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
Sarcosagium campestre	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Xanthoria polycarpa	0	0	0	0	0	1	0	0	1	1	0	2	4	3	2	4	2	3	7	9	2	0
Bryophytes	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

comments Bark between G and H (2.40m -4.70m)

Log nr: 8B

Decay stage 3

Distance from log base (cm)	30	60	90	120	150	180	210	240	270	300	330
Diameter at sample area (cm)	20	20	21	20	19	19	19	18	18	17	18
Sample area	A	B	C	D	E	F	G	H	I	J	K
Calicium salicinum	8	12	8	7	6	6	7	1	0	0	0
Catillaria nigroclavata	1	0	0	0	0	0	0	0	0	0	0
Lecanora chlarotera	2	4	9	5	10	6	7	9	7	3	1
Melanelia fuliginosa	1	1	1	0	0	0	1	3	2	2	0
Parmelia sulcata	8	15	10	10	10	9	16	16	15	14	13
Pertusaria sp.	0	0	0	0	0	0	0	0	0	0	1
Ramalina sp.	3	4	9	2	1	6	13	10	12	6	9
Xanthoria polycarpa	0	0	5	4	5	0	3	2	0	1	0
Bryophytes	0	0	0	0	0	0	0	0	0	0	0

comments

Log nr: 9

Decay stage 3

Distance from log base (cm)	30	60	90	120	150	180	210	240	270	300	330
Diameter at sample area (cm)	30	30	29	29	28	27	25	24	22	21	20
Sample area	A	B	C	D	E	F	G	H	I	J	K
Candelariella xanthostigma	1	0	0	0	0	0	0	0	0	0	0
Parmelia sulcata	0	0	0	0	0	1	0	0	0	0	0
Bryophytes	0	0	0	0	0	0	0	0	0	0	0

comments

Log nr:	10									
Decay stage	3									
Distance from log base (cm)	30	60	90	120	150	180	210	240	270	300
Diameter at sample area (cm)	25	25	24	24	23	23	23	23	22	22
Sample area	A	B	C	D	E	F	G	H	I	J
Caloplaca flavorubescens	0	0	0	0	1	1	0	0	0	0
Caloplaca obscurella	0	1	0	0	2	2	4	0	0	0
Candelariella xanthostigma	2	6	13	12	11	11	8	13	13	12
Catillaria atropurpurea	0	0	0	0	0	2	0	4	0	1
Lecania cyrtella	1	0	0	0	2	3	0	0	1	0
Lecanora chlarotera	2	3	1	2	3	1	0	4	2	8
Mycocalicium subtile	1	4	0	1	2	5	4	3	0	1
Parmelia sulcata	1	4	7	8	9	13	16	13	12	13
Phlyctis argena	0	0	9	6	0	3	4	0	0	0
Ramalina sp.	0	0	0	1	1	1	1	0	0	0
Xanthoria polycarpa	0	0	1	0	1	9	14	13	1	9
Bryophytes	0	0	0	0	0	0	0	0	0	0

comments

Morga hage

Log nr:	1																									
Decay stage	3																									
Distance from log base (cm)	30	60	90	120	150	180	210	240	270	300	330	360	390	420	450	480	510	540	570	600	630	660	690	720	750	
Diameter at sample area (cm)	45	44	43	43	43	42	40	39	39	37	38	36	35	35	34	32	32	31	31	30	29	30	29	28	27	
Sample area	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	X	Y	Z	
Bacidia vermifera	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	2	2	0	0	
Caloplaca holocarpa	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	
Caloplaca obscurella	0	1	0	0	0	0	0	2	0	1	2	0	0	0	1	1	0	1	0	10	13	2	7	3	7	
Candelariella xanthostigma	0	0	0	0	0	0	7	4	2	1	3	2	1	3	3	1	0	6	1	9	8	12	15	5	4	
Evernia prunastri	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	6	3	0	
Lecania cyrtella	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	
Lecanora chlarotera	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	
Melanelia subargentifera	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	
Phaeophysea orbicularis	2	1	6	5	5	3	16	6	7	9	8	10	10	4	5	0	0	0	0	10	10	16	16	16	16	
Physconia enteroxantha	0	1	0	1	2	1	3	0	3	2	3	2	3	3	1	1	0	1	1	7	9	8	14	15	12	
Physconia sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	
Physia tenella	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	0	0	
Ramalina sp.	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	
Rinodina pyrina	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	
Sarcosagium campestre	2	5	0	5	4	2	13	6	5	0	0	0	1	5	6	4	2	2	0	1	0	3	0	0	0	

Xanthoria polycarpa	0	1	1	0	0	2	0	1	1	0	1	0	0	1	0	0	0	0	0	1	0	0	0	3	3
Bryophytes	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

comments

Log nr: 2
Decay stage 3

Distance from log base (cm)	30	60	90	120	150	180	210	240	270	300	330
Diameter at sample area (cm)	32	31	31	30	28	27	26	26	24	23	23
Sample area	A	B	C	D	E	F	G	H	I	J	K
Caloplaca obscurella	0	0	0	0	0	0	4	3	5	0	2
Candelariella xanthostigma	0	0	0	0	0	1	0	0	0	7	9
Catillaria atropurpurea	0	6	10	5	6	9	16	10	12	5	8
Lecanora chlarotera	1	0	0	0	0	0	0	0	0	1	1
Micarea prasina	0	0	0	0	0	0	0	0	3	0	1
Parmelia sulcata	0	0	2	0	0	0	0	0	0	0	0
Pertusaria sp.	0	0	0	0	0	0	0	0	0	0	1
Phaeophysea orbicularis	0	0	1	0	0	0	1	1	0	0	0
Physconia enteroxantha	0	0	0	0	0	1	1	1	2	13	12
Xanthoria polycarpa	0	1	0	0	1	2	1	3	0	1	1
Bryophytes	0	0	0	0	0	0	0	0	0	0	0

comments

Log nr: 3
Decay stage 4

Distance from log base (cm)	30	60	90	120	150	180	210	240	270	300	330	360	390	420	450	480	510	540	570	600	630	660	690	720
Diameter at sample area (cm)	35	35	35	35	34	34	34	33	33	32	31	31	31	31	30	30	29	28	28	27	25	25	24	25
Sample area	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	X	Y
Caloplaca obscurella	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0
Candelariella xanthostigma	0	0	1	0	1	1	2	1	0	1	1	1	2	0	3	4	1	0	1	2	3	6	9	11
Catillaria atropurpurea	0	0	0	0	0	0	0	0	0	0	0	2	3	1	0	0	0	0	0	0	0	2	3	3
Evernia prunsastri	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	3	0	0	0	0	0
Micarea prasina	1	0	9	7	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0
Parmelia sulcata	0	0	0	0	0	0	0	0	0	0	1	1	2	5	4	4	10	10	7	5	4	0	1	0
Pertusaria sp.	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Phaeophysea orbicularis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	2	1	1	0	0	8
Phlyctis argena	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	1	0	0	0	1	0	0	0	1
Physconia enteroxantha	0	0	0	0	0	0	0	0	0	0	0	5	0	0	1	3	4	7	1	2	0	2	2	6
Xanthoria polycarpa	0	1	1	0	0	1	0	0	2	0	0	1	1	2	2	2	1	2	0	0	0	0	0	0
Bryophytes	3	1	3	8	2	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0

comments

Log nr: 4
Decay stage 3

Distance from log base (cm)	30	60	90	120	150	180	210	240	270	300	330	360	390	420	450	480	510	540	570	600	630	660	690	720
Diameter at sample area (cm)	30	30	30	29	29	28	29	28	28	28	27	26	26	26	25	25	24	24	23	23	22	22	21	20
Sample area	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	X	Y
Candelariella xanthostigma	0	2	2	7	6	6	2	5	7	4	0	1	1	0	0	3	0	1	2	2	0	3	1	3
Catillaria atropurpurea	0	0	0	1	0	0	0	6	6	0	0	4	10	8	10	12	15	15	13	10	3	9	5	12
Evernia prunastri	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1
Melanelia subargentifera	0	1	0	1	7	7	0	0	0	0	1	5	1	0	0	0	0	0	1	1	1	0	0	0
Mycobilimbia carneoalbida	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
Parmelia sulcata	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Phaeophysea orbicularis	3	2	0	0	5	0	0	1	5	0	2	16	16	11	15	12	12	15	13	9	10	9	9	7
Physconia enteroxantha	0	0	0	0	0	0	0	4	6	4	3	13	14	7	15	12	12	8	8	6	5	7	3	2
Xanthoria polycarpa	0	0	0	0	0	0	1	1	1	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0
Bryophytes	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

comments

Log nr: 5
Decay stage 4

Distance from log base (cm)	30	60	90	120	150	180	210	240	270
Diameter at sample area (cm)	44	43	43	42	42	42	41	41	40
Sample area	A	B	C	D	E	F	G	H	I
Candelariella xanthostigma	0	0	0	0	0	0	0	0	3
Parmelia sulcata	3	0	0	0	0	0	0	0	0
Xanthoria polycarpa	2	1	0	0	0	0	0	0	0
Bryophytes	0	0	0	0	0	0	0	0	0

comments

Log nr: 6
Decay stage 3

Distance from log base (cm)	30	60	90	120	150	180	210	240	270	300	330	360	390	420	450	480	510	540	570	600	630	660	690	720
Diameter at sample area (cm)	26	27	26	26	25	25	25	24	24	24	23	24	23	23	23	22	22	22	21	21	20	20	20	20
Sample area	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	X	Y
Caloplaca obscurella	0	2	1	0	1	0	0	0	1	0	2	0	0	0	1	0	3	1	0	1	1	3	0	2
Candelariella xanthostigma	1	1	2	4	4	1	1	1	1	5	0	0	2	1	0	1	0	0	0	0	0	0	0	0
Cladonia pyxidata	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Leptogium teretiusculum	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Micarea prasina	0	0	0	0	0	0	0	0	4	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0

Parmelia sulcata	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Physconia enteroxantha	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Sarcosagium campestre	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Xanthoria polycarpa	0	0	1	0	1	0	0	1	0	0	0	0	0	0	0	1	0	0	1	0	1	0	1	0
Bryophytes	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

comments

Log nr: 7

Decay stage 4

Distance from log base (cm)	30	60	90	120	150	180	210	240	270	300	330	360	390	420	450	480	510	540	570	600	630	660
Diameter at sample area (cm)	45	45	45	44	44	44	44	43	43	43	42	42	42	42	42	41	41	40	39	39	38	37
Sample area	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V
Caloplaca obscurella	0	2	2	2	3	10	3	2	1	1	0	1	0	0	2	1	0	1	1	0	1	0
Candelariella xanthostigma	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	1	2	1	0	0	0	1
Parmelia sulcata	3	0	0	0	3	2	4	0	0	1	0	0	0	0	0	0	0	0	0	0	2	0
Phaeophysea orbicularis	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0
Physconia enteroxantha	0	0	0	0	0	0	1	0	1	0	0	0	4	0	0	0	0	0	0	0	0	1
Ramalina sp.	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Xanthoria polycarpa	0	0	1	1	0	1	1	0	0	1	2	0	0	0	0	1	2	1	0	0	0	1
Bryophytes	7	2	0	2	0	5	7	11	3	0	0	7	5	0	0	4	5	0	0	0	0	2

comments

Log nr: 8

Decay stage 3

Distance from log base (cm)	30	60	90	120	150	180	210	240	270	300	330	360	390
Diameter at sample area (cm)	49	47	46	45	44	42	40	39	38	35	32	31	29
Sample area	A	B	C	D	E	F	G	H	I	J	K	L	M
Candelariella xanthostigma	0	0	0	0	1	1	0	1	1	1	1	0	0
Catillaria atropurpurea	0	4	8	14	16	12	16	4	5	3	7	5	12
Lecania cyrtella	0	0	3	1	0	1	0	0	0	0	0	0	0
Leptogium teretiusculum	0	0	1	0	0	0	0	0	0	0	0	0	0
Phaeophysea orbicularis	6	4	1	2	1	0	0	0	0	0	0	0	0
Physcia tenella	1	1	14	7	5	7	2	0	0	0	2	0	0
Physconia enteroxantha	0	0	0	0	0	2	0	0	0	0	0	2	0
Ramalina sp.	0	5	0	0	1	0	0	0	0	0	0	0	0
Xanthoria polycarpa	0	2	3	3	4	2	0	0	1	0	1	1	0
Bryophytes	0	0	0	0	0	0	0	0	0	0	0	0	0

comments

Log nr: 9
Decay stage 4

Distance from log base (cm)	30	60	90	120	150	180	210	240	270	300	330	360	390
Diameter at sample area (cm)	42	42	41	40	40	39	39	38	38	37	36	36	35
Sample area	A	B	C	D	E	F	G	H	I	J	K	L	M
Cladonia sp.	0	0	0	1	0	0	0	0	0	0	0	0	0
Micarea prasina	2	1	4	1	0	0	0	0	0	0	0	0	0
Peltigera praetextata	1	0	0	0	0	0	0	0	0	0	0	0	0
Xanthoria polycarpa	0	0	0	0	0	0	0	1	0	0	0	0	0
Bryophytes	0	0	0	0	0	0	0	0	0	0	0	0	0

comments

Log nr: 10
Decay stage 3

Distance from log base (cm)	30	60	90	120	150	180	210	240	270	300	330	360	390	420	450	480	510	540	570
Diameter at sample area (cm)	25	25	25	24	24	24	23	23	22	22	22	22	22	21	21	20	19	18	17
Sample area	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S
Caloplaca obscurella	1	0	0	0	0	0	0	0	0	0	0	0	6	2	3	0	0	0	0
Catillaria atropurpurea	0	0	0	0	0	2	0	0	0	0	1	2	1	1	2	0	0	0	0
Micarea prasina	0	0	0	0	0	0	12	0	0	0	0	0	0	0	0	0	0	0	0
Parmelia sulcata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	7	11	0
Physconia enteroxantha	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	0
Bryophytes	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

comments

Vårdsätra Naturpark

Log nr: 1
Decay stage 4

Distance from log base (cm)	30	60	90	120	150	180	210	240	270	300
Diameter at sample area (cm)	22	21	21	20	19	19	18	18	17	17
Sample area	A	B	C	D	E	F	G	H	I	J
Hypogymnia physodes	0	1	0	0	0	0	0	0	1	0
Bryophytes	2	0	1	0	0	0	0	0	0	0

comments

Log nr: 2
Decay stage 3

Distance from log base (cm)	30	60	90	120	150	180	210	240	270	300
Diameter at sample area (cm)	24	23	23	21	20	19	18	18	17	17
Sample area	A	B	C	D	E	F	G	H	I	J
Phlyctis argena	0	0	0	0	0	0	0	10	1	4
Bryophytes	0	0	0	0	0	0	0	0	0	0

comments

Log nr: 3
Decay stage 2

Distance from log base (cm)	30	60	90	120	150	180	210	240	270	300	330	360
Diameter at sample area (cm)	31	30	30	30	28	27	27	27	25	25	25	24
Sample area	A	B	C	D	E	F	G	H	I	J	K	L
	-	-	-	-	-	-	-	-	-	-	-	-
Bryophytes	0	0	0	0	0	0	0	0	0	0	0	0

comments

Log nr: 4
Decay stage 4

Distance from log base (cm)	30	60	90	120	150	180	210	240	270	300	330	390
Diameter at sample area (cm)	80	79	78	78	77	75	75	75	72	71	72	70
Sample area	A	B	C	D	E	F	G	H	I	J	K	M
Hypogymnia physodes	0	0	0	0	0	0	0	0	0	0	1	0
Micarea prasina	0	0	0	0	0	0	2	0	0	0	0	0
Bryophytes	0	0	0	0	0	0	0	0	0	0	0	0

comments

Log nr: 5
Decay stage 2

Distance from log base (cm)	30	60	90	120	150	180
Diameter at sample area (cm)	55	55	54	54	53	52
Sample area	A	B	C	D	E	F
Hypogymnia physodes	0	0	0	1	0	0
Bryophytes	0	0	0	0	0	0

comments

Log nr: 6
Decay stage 3

Distance from log base (cm)	30	60	90	120	150	180	210	240	270	300	330	360	390	420	450	480	510	540	570	600	630

Diameter at sample area (cm)	21	22	21	21	20	20	19	20	19	19	18	18	18	17	17	17	17	16	16	15	15
Sample area	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U
Caloplaca obscurella	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0
Candelariella xanthostigma	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0
Evernia prunsastri	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1
Hypogymnia physodes	0	0	1	0	0	0	1	1	1	0	8	1	4	0	0	0	0	0	0	0	0
Melanelia fuliginosa	0	0	0	0	0	0	0	2	1	1	2	1	1	0	0	0	0	0	0	0	0
Ochrolechia androgyna	0	0	0	0	0	0	1	0	2	0	2	1	2	2	8	10	13	1	2	4	4
Parmelia sulcata	0	0	0	0	0	0	0	0	0	0	2	2	2	2	4	8	5	0	9	0	0
Parmeliopsis ambigua	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
Physconia enteroxantha	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Ropalospora viridis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8	6	2	0
Sarcosagium campestre	0	0	0	0	2	0	1	0	2	4	7	7	6	3	3	7	7	1	3	6	3
Bryophytes	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

comments

Log nr: 7
Decay stage 3

Distance from log base (cm)	280	310	340	370	400	430	460	490	520	550	580	610	640
Diameter at sample area (cm)	22	22	21	21	21	20	20	19	18	17	18	17	15
Sample area	A	B	C	D	E	F	G	H	I	J	K	L	M
Evernia punastri	0	0	0	0	0	0	0	0	0	0	0	0	1
Hypogymnia physodes	0	3	0	0	0	0	3	4	1	0	0	0	1
Melanelia fuligonosa	0	0	0	0	0	0	0	0	0	0	1	0	0
Mycocalicium subtile	16	3	2	6	2	1	0	0	0	0	0	0	0
Ochrolechia androgyna	2	10	13	13	9	16	11	10	6	3	3	2	3
Parmelia sulcata	1	0	0	0	0	0	0	0	0	0	1	0	0
Sarcosagium campestre	8	13	15	12	14	16	15	7	3	4	4	3	4
Bryophytes	0	0	0	0	0	0	0	0	0	0	0	0	0

comments

Log nr: 8
Decay stage 4

Distance from log base (cm)	30	60	90	120	150	180	210	240
Diameter at sample area (cm)	37	36	36	34	34	32	33	31
Sample area	A	B	C	D	E	F	G	H
Micarea prasina	0	0	0	1	1	0	0	0
Parmelia sulcata	0	0	0	0	2	0	0	0
Bryophytes	0	0	0	0	0	0	0	0

comments

Log nr: 9
Decay stage 2

Distance from log base (cm)	30	60	90	120	150	180	210	240	270	300
Diameter at sample area (cm)	42	42	41	40	39	39	38	38	37	37
Sample area	A	B	C	D	E	F	G	H	I	J
Caloplaca obscurella	0	0	0	0	0	0	0	0	7	0
Hypogymnia physodes	0	0	2	0	6	1	0	0	0	0
Lecanora chlarotera	0	0	0	0	0	0	0	0	12	1
Melanelia fuligonosa	0	0	0	1	0	0	0	0	0	0
Micarea prasina	3	1	0	1	0	0	0	1	0	5
Parmelia sulcata	2	0	0	2	0	1	2	2	0	2
Phaeophysea orbicularis	0	0	14	10	2	2	5	0	3	0
Physconia enteroxantha	0	0	0	0	0	0	1	0	0	0
Placynthiella icmalea	0	0	0	0	0	0	0	3	0	0
Xanthoria polycarpa	0	0	3	3	3	2	1	0	2	0
Bryophytes	0	0	0	0	0	0	0	0	0	0

comments

Log nr: 10
Decay stage 4

Distance from log base (cm)	100	130	160	190	220	250	280	310	340	370
Diameter at sample area (cm)	35	34	32	30	29	27	24	23	20	19
Sample area	A	B	C	D	E	F	G	H	I	J
Micarea prasina	0	1	1	0	0	0	2	0	0	0
Bryophytes	2	3	1	5	2	0	0	2	0	4

comments First meter not able to survey

Examensarbeten utförda vid institutionen för naturvårdsbiologi, SLU

(förteckning över tidigare arbeten kan fås från institutionen)

92. Hedblom, Marcus. 2002. Influence of landscape structures on woodcock (*Scolopax rusticola*) roding. Handledare: Göran Hartman, Jonas Lemel, Examinator: Göran Hartman.
93. Brøndum Boberg, Line. 2002. Habitat preferences of the two related bats species *Myotis brandtii* and *Myotis mystacinus* and forestry implications. Handledare: Johnny de Jong, Ingemar Ahlén, Examinator: Åke Berg.
94. Arthursson, Marie. 2002. Population development of beaver (*Castor fiber*) in two parishes in Östergötland County, Sweden. Handledare och examinator: Göran Hartman.
95. Gylje, Sofia. 2003. Foraging behaviour and interactions of three bat species: *Myotis daubentonii*, *Myotis mystacinus* and *Myotis brandtii* (Chiroptera: Vespertilionidae). Handledare: Johnny de Jong, Ingemar Ahlén, Examinator: Åke Berg.
96. Persson, Eva. 2003. Transmission lines corridors as habitats for large herbivores. Handledare: Roger Bergström, Examinator: J-O Helldin.
97. Plahn, Lars. 2003. Avoidance of potentially infanticidal males by female brown bears (*Ursus arctos*): patterns of diel activity. Handledare: Göran Hartman och Jon Swenson, Norges landbrukshøgskole. Examinator: Göran Hartman.
98. Unell, Maria. 2003. Brood sex ratio variation in northern wheatear, *Oenanthe oenanthe*: Is it adaptive and does it make sense? Handledare: Debora Arlt, Tomas Pärt, Examinator: Tomas Pärt.
99. Andersson, Linda. 2003. Varför är vissa miljöer sink-habitat? En jämförelse av matning och ungproduktion hos stenskvätta *Oenanthe oenanthe*. Handledare och examinator: Tomas Pärt.
100. Johansson, Maria. 2003. Invandring av gräsmarksväxter i restaurerade naturbetesmarker i södra Bohuslän. Artsammansättningen i hagmarker restaurerade vid olika tidpunkter. Handledare och examinator: Roger Svensson.
101. Nöjd, Sofia. 2003. Habitat use of two cryptic species of bats (Chiroptera: *Myotis mystacinus* and *Myotis brandtii*). Handledare: Johnny de Jong, Ingemar Ahlén, Examinator: Åke Berg.
102. Jaxgård, Peter. 2003. The lynx-sheep conflict in Sweden: Has predator-proof fencing and lynx control had effect on sheep depredation by Eurasian lynx *Lynx lynx*? Handledare: Jens Karlsson & Henrik Andrén, Examinator: Henrik Andrén.
103. Lötberg, Liv. 2003. Vilka botaniska naturvärden finns vid torplämningar i norra Uppland? Handledare och examinator: Göran Thor.
104. Palmqvist, Sofia. 2003. Territory size, activity and distance travelled by reproducing and non-reproducing wolves during summer in Scandinavia. Handledare: Håkan Sand, Examinator: Henrik Andren.
105. Bokvist, Lena. 2003. Vilka faktorer påverkar habitatvalet hos stenskvättor? Handledare och examinator: Tomas Pärt.
106. Eriksson, Thomas. 2003. Winter activity patterns and behaviour during handling time in the re-establishing wolf population on the scandinavian peninsula. Handledare och examinator: Håkan Sand.
107. Thorell, Daniel. 2003. Red-listed forest species as a conservation tool within the Swedish forest enterprise Sveaskog. Handledare och examinator: Lena Gustafsson.
108. Svensson, Måns. 2003. The lichen flora of wooden buildings in the agricultural landscape. Handledare och examinator: Göran Thor.
109. Lindh, Magnus. 2003. Interaktiva nycklar - en enkel och effektiv metod för artbestämning! Utvärdering av interaktiva nycklar samt karaktärsdatabas och interaktiv nyckel över knappnålslavar i Norden. Handledare och examinator: Göran Thor.
110. Ahlberg, Robert. 2003. Patterns of human disturbance in a miombo woodland and its impact on the bird fauna. Handledare och examinator: Allan Carlson.
111. Larsson, Per. 2003. The lichen flora on decorticated logs of *Ulmus glabra*. Handledare och examinator: Göran Thor.

I denna serie publiceras examensarbeten utförda vid institutionen för naturvårdsbiologi, Sveriges Lantbruksuniversitet (SLU). Tidigare nummer i serien kan i mån av tillgång beställas från institutionen.

Institutionen för naturvårdsbiologi
SLU
Box 7002
750 07 UPPSALA