Epiphytic Lichen Monitoring within the EU/ICP Forests Biodiversity Test-Phase on Level II plots

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April 2003

I. Introduction

Lichens are long-living, sessile organisms with a low dispersal potential and a high sensitivity to environmental influences, changes in landscape management and past regional ecological disturbances such as fire and forest clearance. Epiphytic lichens depend on a range of climatic parameters, which are related to forest stand structure and history. Generally, the most important ecological factors are light availability, bark pH, level of eutrophication, and precipitation. Besides the fact that in extensively managed habitats the lichen flora can often be more species rich than vascular plant flora, lichens can be monitored during the entire year, making them a potential tool for a biodiversity assessment (Scheidegger et al. 2002, Asta et al. 2002). Furthermore, the percentage of endangered forest lichens is high compared to other organisms. Especially in autochthonous and old-growth forest stands a high number of red-listed and conservation dependent species can be expected.

II. Objectives for lichen monitoring within the test-phase

The epihytic lichen frequency of the plot is estimated with the objectives to

- monitor the lichen species richness and frequencies at EU/ICP Forests Level II plots
- evaluate the relation between lichen diversity and influencing factors (e.g. stand structure and -composition, deposition). This objective follows the overall aim of the test-phase to validate keyfactors for forest biological diversity.
- test the suitability of the monitoring approach. This objective follows the overall aim of the test-phase to test a methodology for biodiversity assessment and -evaluations specifically for EU/ICP Forests Level II plots
- set a baseline for monitoring future changes on a plot-level

III. Selection of sampling trees on the Level II plots

Monitoring of epiphytic lichens is carried out on living trees only, which are selected on existing Level II plots. All trees are selected within the Level II minimum plot area of 0.25 ha. It is important to have similar sample plot sizes throughout all plots. In case of larger Level II plots a subplot of the required size is randomly selected within the boundary of the Level II plot. Only trees with a minimum circumference of 50 cm are considered.

A pre-stratification is carried out for each plot/subplot by means of the existing data base:

- All trees on the plot/subplot are classified into two groups, one with acidic bark (group A), the other with more or less neutral bark (group B).
- All trees on the plot/subplot are classified into two diameter classes, one with dbh ≤ 36 cm, the other with dbh > 36 cm.

In boreal forests of Scandinavia where diameters of trees are generally smaller the tresholds are adapted to this conditions in the following way:

- southern plots: dbh ≤ 18 cm / dbh > 18 cm / minimum diameter = 13 cm
- northern plots: dbh ≤ 25 cm / dbh > 25 cm / minimum diameter = 20 cm

To get comparable data, both the lichen species and their frequencies have to be assessed on the plot/subplots following a standardized approach. Therefore 12 sampling trees are selected randomly by tree numbers from the existing data base.

The proportion of trees on the plot/subplot in the following four groups is then calculated:
p1 = (N trees in class A ≤ 36 cm dbh) / N trees
p2 = (N trees in class A > 36 cm dbh) / N trees
p3 = (N trees in class B ≤ 36 cm dbh) / N trees
p4 = (N trees in class B > 36 cm dbh) / N trees

with: N trees = number of trees on the plot
p1 + p2 + p3 + p4 = 1.0

For each of the four pre-stratified groups a proportional number of trees is then randomly selected on the plot/subplot according to the following formula:

Number of sampling trees in group 1 = 12 * p1
Number of sampling trees in group 2 = 12 * p2
Number of sampling trees in group 3 = 12 * p3
Number of sampling trees in group 4 = 12 * p4

With the total number of sampling trees = 12.

To get a better estimation of the species richness of the plot for each of the four pre-stratified groups additional trees are selected randomly until at least three trees per group have been selected. This addition is also essential in order to link the Level II test-phase with existing European networks (e.g. BioAssess (Scheidegger et al. 2002), Lacope). In the protocol this addional trees have to be marked specially.

Example:
In case that according to the tree species abundance proportions on the plot, trees have been selected in group1 : group2 : group3 : group4 following a distribution of
1 : 2 : 8 : 1,
two additional trees in group1, one additional tree in group2, and two additional trees in group4 have to be selected, increasing the total number of selected trees to 17.

IV. Selection of relevés at each sampling tree

At each of the selected trees four directions of the compass (N, W, S, E) are marked at 150 cm above ground level e.g. by giving its position in relation to measurement point of dbh. Four frequency grids (Figure 1) are set up as shown in Figure 2. The marks define the centres of the short upper sides of the four narrow frequency grids. The upper margin of the frequency grid is fixed at 150 cm hight above the ground. The frequency ladders are marked with the respective sector, N,E,S,W. In general, branches that are inside the grid are not considered (but see note below). The frequency of each lichen species is noted per tree as the number of grids in which the species occurs. This procedure is continued for all sampling trees. Lichens growing on branches are usually not considered in this method. However, if the trunks are typically densely branched (usually fine and rather short branches, e.g. on spruce) in the parts where the grid should be placed, also the lichens growing on branches should be considered. In this case, lichens are projected from the branches onto the surface of the grid and the frequency of the lichens is counted. The precise procedure on how branches were considered in the relevés must be carefully documented. In case that bark was harvested on *Quercus suber*, the trees are not selected. In case of leaning or not straight grown trees, the inclination at 150 cm height is measured and recorded.

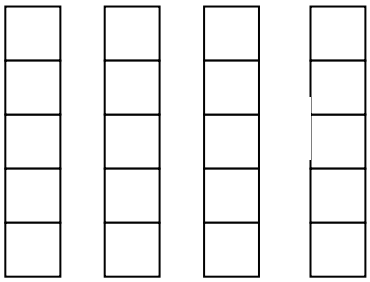

*Figure 1: Four narrow frequency grids for tree relevés (each measuring 10*50 cm)*

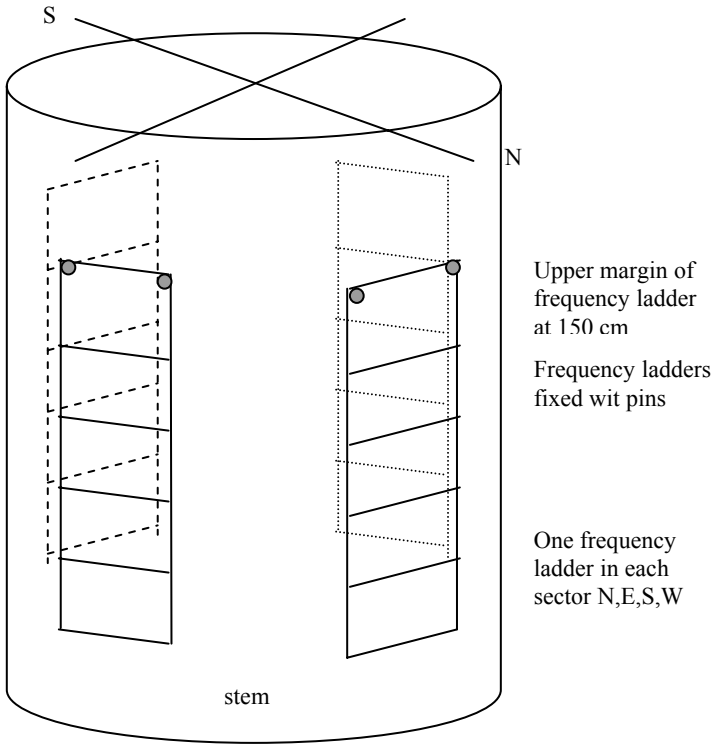

Figure 2. The four frequency ladders are fixed between 150 and 100 cm above ground. The centre of each frequency ladder is oriented to N, E, S, W, respectively.

V. Recoding lichen Relevés

One protocol is recorded for each tree. The tree number is noted. All lichen-forming species are listed which occur inside the four frequency ladders. Lichenicolous fungi and non-lichenised fungi (e.g. *Arthopyrenia* spp.) as well as thalli, smaller than 5 mm are omitted.

The area investigated on one tree is always the same, namely the 2000 cm^2 covered by the four frequency ladders (Figure 2). Species outside this area are not recorded.

For each lichen the number of unit areas (10x10 cm) is counted in which the lichen species occurs (value from 1 to 20).

Collect voucher specimens of each species for identification.

VI. Repetition of sampling

When sampling is repeated after a number of years a new random tree selection following the same method is carried out in order to obtain plot-representative values.

VII. Identification of lichen specimens

Correct identification of specimens may require standard microscopical procedures and thin layer chromatography analyses of the secondary chemical compounds (Culberson & Ammann 1979; Culberson & Johnson 1982; Culberson & Culberson 1994; Huneck & Yoshimura 1996). At least one specimen of each species should be placed in a public herbarium.

VIII. Open issues

The approach outlined above contains a fully operational minimum consent for epiphytic lichens assessment. The method has been devised to be a statistically robust estimator of the lichen diversity in different forest types. It is however beyond the aim of the test-phase to collect complete species lists.

Open points that were still not in detail discussed by the responsible EU/ICP Forests working group and which might be included into the methodology later on are the following:

- The standardised sampling provides representative and quantitative information of trunk inhabiting epiphytic lichens. A comparable approach on twigs, stem base and rocks is very time consuming and especially on twigs representativity is difficult to obtain. However, these habitats cover a significant portion of the lichen diversity in forests.
- Monitoring of epiphytic bryophytes could be carried out within the same frequency ladders on the same trees and synergistic effects would allow to collect additional information with rather small additional efforts. Bryophytes rely on different ecological conditions and their frequency thus offers complementary ecological information.
- A formal definition of objectives has to consider the required precision at a given probability level, the time frame for change detection and the minimum detectable change. In a formal statistical approach sample sizes will depend from these pre-defined objectives. 12 trees will then not be a universal threshold; sometimes this number can be too small; sometimes it might be even too high depending on the inherent variability at the plot scale. The formulation of objectives more precise in this sense requires some pre-information and should be possible based on the results of the test-phase.

IX. References

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