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DISTRIBUTION OF EPIPHYTIC LICHENS INDICATING AIR POLLUTION IN ESTONIA

Die Verbreitung epiphytischer Flechten, Indikatoren der Luftverunreinigung in Estland

by

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Key words: Epiphytic lichens, indicator species, mapping of distribution, air pollution.

Schlagwörter: Epiphytische Flechten, Indikatorarten, Flechtenkartierung, Luftverunreinigung.

Summary: The aim of this study is to map the distribution of the indicator species of epiphytic lichens with different toxicity-tolerance all over Estonia. The distribution maps of 32 epiphytic lichens are based on the 10 x 10 km squares of UTM-grid system. The maps have been constructed using Alan Morton's program DMAP. Frequency of occurrence of indicator species (%) in totally studied 303 squares is calculated.

The sampling sites in parks of old estates, churchyards and old cemeteries outside towns have been chosen as homologous as possible. Because of the need to minimize the variation derived from the effect other than air pollution factors on lichens standardized methods for the choice of phorophytes were used. The floristic composition was determined on the trunks of 1470 *Tilia cordata* and *Acer platanoides* at the height of 1,3 m in two expositions (N, S) in a quadrat of 2 x 2 dm.

Zusammenfassung: Das Ziel der vorliegende Studie ist die Kartierung der Verbreitung von Indikatorarten epiphytischer Flechten mit unterschiedlicher Toxitoleranz in ganz Estonia. Die Verbreitungskarten von 32 epiphytischen Flechten basieren auf den 10 x 10 km Feldern des UTM-Rastersystems. Die Karten wurden unter Verwendung des Alan Morton's Programms DMAP erstellt. Die Frequenz des Auftretens der Indikatorarten wurde in % der gesamten 303 Rasterfelder errechnet.

Die Sammelorte in Parks alter Gutshöfe, Kirchhöfe und alter Friedhöfe außerhalb von Städten wurden so gleichförmig wie möglich ausgewählt. Um den Effekt der Luftverunreinigungen auf die Flechten besser ableiten zu können, wurden lediglich zwei Baumarten ausgewählt. Auf *Tilia cordata* und *Acer platanoides* wurde die Artenzusammensetzung der Flechten in einer Stammhöhe von 1,30 m in zwei Expositionen (N, S) in einem Quadrat von 2 x 2 dm untersucht.

Introduction

The history of lichen monitoring in Estonia goes back to the second half of the 18th century (Eesti suursamblikud, 1994). Today almost 800 species of lichens are found in Estonia but the distribution of most of them has not been systematically investigated. At the same time the distribution areas of common lichens are decreasing mainly due to air pollution. The air pollution monitoring is carried out only at a few sites in 9 towns of Estonia and by identifying 2-3 air pollutants concentrations (KESKKOND, 1995). For that reason, supported by George Soros Open Estonia Foundation, we started in 1992 mapping of the distribution of certain species of indicators of epiphytic lichens which aim is to gather true information on the present distribution of those indicators as well as to obtain information on air pollution in Estonia.

Materials and Methods

The territory of Estonia is 45.000 sq km. The mapping of the distribution of lichens was conducted on the basis of the UTM-grid system (10x10 km squares). This system is widely used in floristic and faunistic mapping projects in Europe. Distribution maps were generated by DMAP (A Computer Program for Distribution and Coincidence Map Plotting), designed by Alan MORTON (PARMASTO, 1991).

Distribution maps of following lichen species were constructed. **Toxicity-sensitive** *Anaptychia ciliaris* (L.) KÖRB. (with the frequency of occurrence* of 81%), *Lobaria pulmonaria* (L.) HOFFM. (1%), *Melanelia subargentifera* (NYL.) ESSL. (39%), *Pertusaria albescens* (HUDS.) M. CHOISY & WERNER (43%), *Physconia distorta* (WITH.) J. R. LAUNDON (67%), *P. perisidiosa* (ERICHSEN) MOBERG (69%), *Pleurosticta acetabulum* (NECK.) ELIX & LUMBSCH. (10%), *Ramalina baltica* LETTAU (8%), *R. fastigiata* (PERS.) ACH. (38%), *R. fraxinea* (L.) ACH. (74%), *R. pollinaria* (WESTR.) ACH. (74%), **medium toxicity-tolerant** *Evernia prunastri* (L.) ACH. (80%), *Physcia adscendens* (FR.) H. OLIVIER (35%), *P. aipolia* (EHRH. ex HUMB.) FÜRNR. (16%), *Ramalina farinacea* (L.) ACH. (96%), **neutrophilous** *Candelariella xanthostigma* (ACH.) LETTAU (80%), *Melanelia exasperatula* (NYL.) ESSL. (50%), *Phaeophyscia orbicularis* (NECK.) MOBERG (74%), *Physconia enteroxantha* (NYL.) POELT (86 %), *Xanthoria candelaria* (L.) TH. FR. (35%), *X. fulva* (HOFFM.) POELT & PETUTSCHNIG (17%), *X. parietina* (L.) TH. FR. (80%), *X. polycarpa* (HOFFM.) TH. FR. ex RIEBER

(78%), **toxicity-tolerant** *Parmelia sulcata* TAYLOR (91%), *Phlyctis argena* (SPRENG.) FLOT. (99%), *Physcia stellaris* (L.) NYL. (17%), *P. tenella* (SCOP.) DC.(96%); **acidophytic** *Hypogymnia physodes* (L.) NYL. (45 %), *Melanelia fuliginosa* (FR. ex DUBY) ESSL. (21%), *Platismatia glauca* (L.) W.L.CULB. & C.F.CULB. (13%), *Pseudevernia furfuracea* (L.) ZOPF. (12%).

The lichen species mapped, their substrates *(Tilia cordata* and *Acer platanoides)* and habitats (old estate parks, cemeteries and church yards out of towns) were selected by lichenoindicational considerations. The selection of single trees (separately growing, healthy, straight, with average diameter of 28 cm) was also made according to standard requirements on lichen substrates in lichenoindicational mapping.

The assessment of lichen toxicity tolerance was made on the basis of literature data as well as on original lichenoindicational studies of the authors carried out in Estonia (SEAWARD, HITCH, 1982; HERBEN, LIŠKA, 1986; INSAROVA et al., 1992; LIIV, 1989, 1992).

The floristic composition at a height of 1.3 m in N and S exposition of 20x20 cm square, and coverage (%) of every single species of lichen in the square were determined on all the trees. In addition we recorded all species of lichens up to the height of 2 m that grew on the trees.

* Frequency of occurrence indicates the number of 10x10 km UTM squares where a certain species grows in relation to all the studied UTM squares (%).

Results and discussion

The distribution maps of 32 indicator species are based on lichen finds in 1993-1995, in total 1470 trees that grow in 382 estate parks, cemeteries or churchyards; the total number of UTM-grid system squares with the area of 10x10 km studied was 303.

The most common lichens on lime and maple are toxicity-tolerant *Phlyctis argena, Physcia tenella* and medium toxicity-tolerant *Ramalina farinacea.*

The most seldomly occurring lichens on lime and maple are toxicity-sensitive *Lobaria pulmonaria, Ramalina baltica* and *Pleurosticta acetabulum.*

Co-occurrence of toxicity-sensitive lichens is presented on Fig. 1. *Anaptychia ciliaris* which is very rare in Estonian towns with population over 20, 000 is found almost everywhere in rural areas on lime and maple in Estonia. *Melanelia subargentifera* is also very rare in towns and in SW Estonia. The occurrence of this species in NE, E and SE Estonia obviously reflects its preference of inland climate. Also neutrophilous *Xanthoria candelaria* tends to prefer inland climate as it does not occur on lime and maple in West-Estonian islands. Maritime climate is definitely preferred by toxicity-sensitive *Ramalina fastigiata.*

Relatively common on lime and maple is *Hypogymnia physodes* which

favours acidic bark or bark acidified due to pollution. The species is most common in S Estonia where acid precipitation has been registered. There is acidic base rock in S Estonia as opposite to N and W Estonia, where the base rock is formed of carbonate rocks. The distribution of the lichens *Platismatia glauca* and *Pseudevernia furfuracea* which typically grow on acidic or acidified substrate, on lime and maple in Estonia, is very similar to the distribution of *Hypogymnia physodes*. They both tolerate the moderate SO_2 pollution. The above mentioned lichens as well as acidophytic *Melanelia fuliginosa* do not grow on lime and maple in NW Estonia. According to this in NW Estonia there is cleaner air than in other regions in Estonia.

The influence of carbonate dust can be noticed everywhere in Estonia - neutrophilous lichens that prefer eutrophicated substrate, such as *Candelariella xanthostigma, Melanelia exasperatula, Phaeophyscia orbicularis, Physconia enteroxantha, Xanthoria parietina* are widely spread.

The species indicating acidic air pollution *Hypogymnia physodes, Peudevernia furfuracea, Platismatia glauca, Melanelia fuliginosa* are mostly found in NE, S and SE Estonia (Fig. 2). Large oil-shale power stations are situated in NE Estonia that in addition to alkaline oil-shale dust emit also huge amounts of SO_2 (over 100.000 tons a year) and other acidic pollutants. The reason of air pollution in S and SE Estonia is mainly the long-range transboundary air pollution from western and central Europe as there are no local pollution sources there.

The results of large-scale mapping of the distribution of indicator species of lichens are definitely not the basis for making concrete conclusions on air pollution situation. Therefore, in addition to the inventory of the present distribution of the indicator species of lichens, this study gives information on the general situation of air pollution in Estonia.

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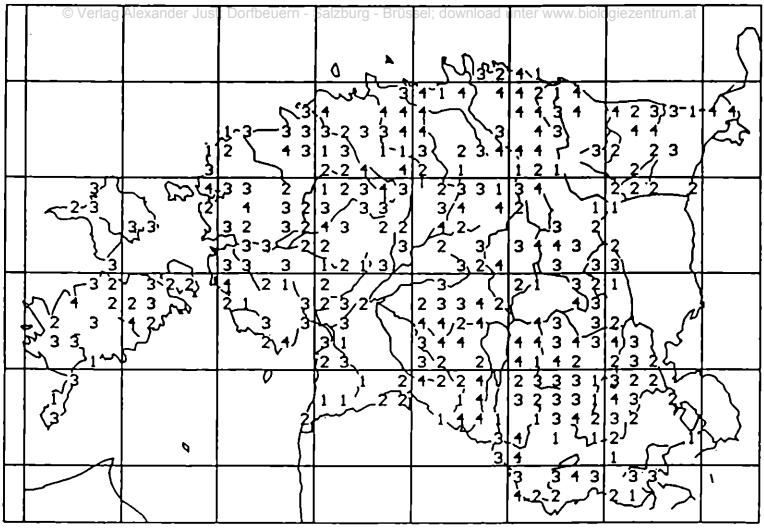

Fig. 1: Co-occurrence of toxicity-sensitive lichens *Anaptychia ciliaris, Melanelia subargentifera, Physconia distorta* and *Ramalina fraxinea* on lime and maple in Estonia. The number indicates the number of above mentioned species occurring in the respective UTM square.

1 - one species
2 - two species
3 - three species
4 - four species

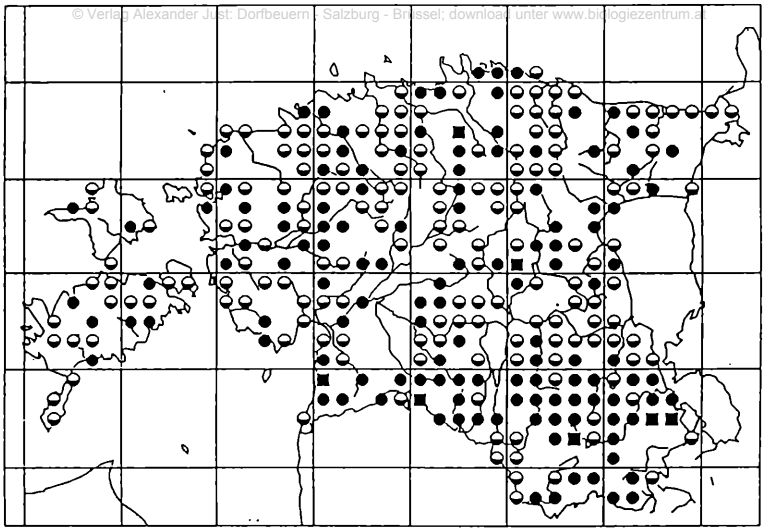

Fig. 2: Co-occurrence of both toxicity-sensitive and acidophytic lichens on lime and maple in Estonia.

- ■ acidophytic lichens only
- ● acidophytic and toxicity-sensitive lichens together
- ◒ toxicity-sensitive lichens only