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AN INTERNATIONAL AIR POLLUTION SURVEY BY SCHOOL CHILDREN USING LICHENS

(participation of the Czech Republic in 1995/96)

Internationale Erhebung über die Luftverunreinigung mit Hilfe von Flechten durch Schüler

(Beteiligung der Tschechischen Republik in 1995/96)

by

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Key words: Lichens, air pollution, bioindication, growth forms, education.

Schlagwörter: Flechten, Immission, Bioindikation, Wuchsform, Ausbildung.

Summary: Air Pollution Project Europe for children involves the cooperation of 13 countries. The project includes two separate parts: Acid Rain Project (measuring the acidity of the rain) and The Lichen Project. An extensive lichen project was included for the first time in 1994. The school children investigated lichen growth on three different types of trees: deciduous (excl. birch), coniferous and birch. They examined the growth form of lichens (i.e. fruticose, foliose and crustose thalli) and the total number of different lichen species according to the growth form on each tree. In addition, they examined the degree of lichen coverage, type of locality (town/industrial area or woodland/farmland) and distance from air pollution source. In 1995/96 the school children in the Czech Republic examined 2396 trees in total. Results of the project in the Czech Republic are presented and comparisons with other participating countries are discussed. The results of the project coincide in principle with the results of scientific research.

Zusammenfassung: Das „Air Pollution Project Europe" für die Kinder umfaßt 13 zusammenarbeitenden Länder. Das Projekt besteht aus 2 selbstständigen Teilen:

das Projekt über die saueren Niederschläge (es wurde die Azidität der Niederschläge gemessen) und das Flechten-Projekt. Ein extensives Flechten-Projekt wurde das erste Mal im 1994 einbezogen. Die Schüler untersuchten den Bewuchs der Flechten an 3 verschiedenen Typen der Rinde: an den Laubgehölzen, an den Nadelbäumen und an der Birke. Sie untersuchten die Wuchsform der Flechten und die Zahl der unterschiedlichen Flechten-Arten nach der Wuchsform an jedem Baum. Weiter wurden die nachfolgenden Angaben festgestellt: der Deckungsgrad der Flechten, der Typ des Fundortes (Stadt- u. Industrie-Landschaft bzw. forst- u. landwirtschaftliche Landschaft) und die Entfernung vom Imissionszentrum. Die Schüler in der tschechischen Republik untersuchten im Schuljahr 1995/96 insgesamt 2396 Bäume. Die Ergebnisse des Projektes in der Tschechischen Republik werden vorgestellt und mit denen anderer am Projekt beteiligter Länder verglichen. Diese Ergebnisse entsprechen im Prinzip den Ergebnissen der wissenschaftlichen Forschung.

Air pollution, together with acid rain as its consequence, are a serious problem in the whole of Europe. Many susceptible plants and animals are damaged and human health is also injured. Large areas of destroyed forest ecosystems in Central Europe as well as vanishing lichens are warning symptoms of environmental change.

The sensitivity of lichens to air pollution is a well known phenomenon which has been studied very intensively during the last 30 years. In addition an extensive survey of water pollution and air pollution performed by school children in Britain was done in the early seventies. Water pollution in rivers and streams was surveyed using various indicator species of invertebrates (MELLANBY 1974). Air pollution was estimated using a simple indicator scale (GILBERT 1974), in which a few lichen species (*Lecanora conizaeoides, Xanthoria parietina, Evernia prunastri, Parmelia* sp. and *Usnea* sp.) growing on acid stone, alkaline stone and trees in zones of different SO_2 pollution, were constructed. Results coincided very well with results obtained with the scale used by HAWKSWORTH & ROSE (1970). In the nineties, another project investigating air pollution by school children on an international basis was initiated. This paper summarizes the results from the Czech Republic in this project.

"Air Pollution Project Europe" for children is coordinated and organised by the Norwegian Society for the Conservation of Nature (Norges Naturvernforbund) in cooperation with 12 other countries (Czech Republic, Denmark, Estonia, Finland, Hungary, Latvia, Lithuania, Poland, Russia, Scotland, Slovakia, Sweden). TEREZA - association for environmental education - is a regional coordinator and is responsible for this project in the Czech Republic. The aim of the project is to increase school children's knowledge of air pollution. By carrying out the investigation themselves, the children achieve a greater understanding of how the environment is being damaged, and realise that each one of us can do something to prevent it happening.

Air Pollution Project Europe has been organized four times. During the

four years between 400.000 and 450.000 pupils from 13 European countries participated (SMEDVIK 1996). The project includes two separate parts: Acid Rain Project (measuring the acidity of the rain) and The Lichen Project. An extensive lichen project was included for the first time in 1994 (LIŠKA & SRNĚNSKÝ 1995). To achieve a better knowledge of lichens among school children, various publications have been produced (brochures with an introduction to the biology and ecology of lichens, guide for fieldwork with identification key and sensitivity scale with colour photographs and paintings of bioindicator species etc.) and seminars for teachers and tutors have also been organised.

Lichens are well-known as organisms which are susceptible to air pollution, namely sulphur dioxide emissions and acid rain. Epiphytic lichens growing on tree bark are the most sensitive. The school children investigated lichen growth on three different types of tree bark: deciduous, coniferous and birch. They examined the growth form of lichens (i.e. fruticose, foliose and crustose thalli) and the total number of different lichen species according to the growth form on each tree. In addition, they examined the degree of lichen coverage, type of locality (town/industrial area or woodland/farmland) and distance from air pollution source.

In 1995/96 the school children in the Czech Republic examined 2396 trees in total. The structure of the data set (proportion of different types of tree bark and proportion of different growth forms) was very similar to the data set based on investigations in previous years. The most frequently examined substrate of lichens was deciduous tree bark; the least frequent tree was birch. The most frequent thallus type and the highest number of lichen species per tree were found among crustose species (9 species); the least frequent were fruticose species. The most suitable substrate for epiphytic lichens seems to be the bark of deciduous trees where the highest number of lichen species was found. There is good correspondence between the number of species per tree and the map of air pollution in the Czech Republic (average yearly concentrations of sulphur dioxide); in the areas with the highest air pollution levels, trees with a poor lichen flora were found, and some types of lichens were not found here. The most sensitive lichens are fruticose species, and the most tolerant are crustose species. Therefore, fruticose and foliose lichens are the most suitable for air pollution bioindication. However, a detailed investigation (e.g. estimations of trees at different localities) is needed for bioindication; isolated findings of trees with no lichens are not representative for this purpose. Nevertheless, a high proportion of trees with a poor lichen flora, or trees without lichens, is significant for polluted areas.

Differences between different types of landscape increased with increasing sensitivity of lichens. The highest differences between different types of landscape were revealed for fruticose lichens (Table 1).

Table 1: Frequency of lichen thallus types in different types of landscape.

lichen thallus	Frequency [%]	
	town/industrial	**wood/farmland**
fruticose	5.1	14.5
foliose	24.0	56.5
crustose	90.3	83.1

The average number of lichen species per tree was 2 species. Crustose lichens were the most common growth form. On average, foliose lichen species were found on each second tree and fruticose lichen species were found on each sixth tree. In addition the differences between both types of landscape confirm the high sensitivity of fruticose and foliose lichens. The average number of fruticose and foliose lichen species per tree was three times higher in woodlands/farmlands than in towns and industrial areas. Crustose lichens were the most common growth form in both types of landscape (Table 2).

Table 2: Average number of lichen species per tree.

lichen thallus	type of landscape		**total**
	town/industrial	**wood/farmland**	
fruticose	0.06	0.20	0.16
foliose	0.28	0.76	0.60
crustose	1.37	1.17	1.24
total	1.71	2.13	2.00

The investigation of the degree of lichen coverage yielded the same results as the number of species per tree. The highest cover was in woodlands/farmlands. In these areas where the children found high degrees of coverage, they also found high numbers of species. So, air pollution affects the number of lichen species (biodiversity) as well as the lichen coverage.

The average number of lichen species per tree in the Czech Republic is lower in comparison with other countries; the difference is about 20% (Tab. 3).

Table 3: Comparison of the average number of lichens per tree in the Czech Republic and in all countries participating in the project.

lichen thallus	average species number	
	Czech R.	**all countries**
fruticose	0.16	0.44
foliose	0.60	0.91
crustose	1.24	1.25
total	2.00	2.60

The highest differences are in the case of sensitive fruticose and foliose lichens: the average number of foliose lichens was about one third lower in the Czech Republic than the average value obtained from all countries but the average number of fruticose lichens was almost three times lower. However, the average number of crustose lichens per tree was almost the same in the Czech Republic as the value obtained from all countries. A very low average number of species per tree was found in towns and industrial areas (about five times lower in comparison with average values from all countries, Tab. 4). In the Czech Republic there were also bigger differences between both types of landscapes: In woodlands/farmlands the average number of lichens per tree was lower in all three growth forms in comparison with results obtained from all countries (Tab. 5) but the differences were not so high as in the case of towns and industrial areas.

Table 4: Comparison of the average number of lichens per tree in towns and industrial areas in the Czech Republic and in all countries participating in the project.

lichen thallus	average species number	
	Czech R.	**all countries**
fruticose	0.06	0.31
foliose	0.28	0.68
crustose	1.37	1.13
total	1.71	2.12

Table 5: Comparison of the average number of lichens per tree in woodlands and farmlands in the Czech Republic and in all countries.

lichen thallus	average species number	
	Czech R.	**all countries**
fruticose	0.20	0.52
foliose	0.76	1.04
crustose	1.17	1.32
total	2.13	2.88

Air pollution levels are relatively high in the Czech Republic in towns and industrial areas and the background concentration levels are also higher here. Results of this project confirm this situation. The results of this project coincide with the results of scientific lichen research.

It was confirmed that quite young children, using simple methods, can make useful observations and obtain reasonable results. The results are rather rough but they coincide in principle with the results of specialists. However, a very important value of such a project is in the activity of young people and their understanding of the effects of air pollution and environmental deterioration. Moreover, they increased their knowledge of an interesting - but often neglected - group of plants. Many of them became „experts" on lichens eg. among friends in school, in family etc. using latin names of lichens and special terms (eg. thallus and soredia). Perhaps some of them will study lichens and could become „professional experts" in future.

Conclusions

Air Pollution Project Europe for children (coordinated and organised by the Norwegian Society for the Conservation of Nature) involves the cooperation of 13 countries. The aim of this project is to increase school children's knowledge of air pollution. The project has been organized four times. During the four years between 400.000 and 450.000 pupils participated. The project includes two separate parts: Acid Rain Project (measuring the acidity of the rain) and The Lichen Project. An extensive lichen project was included for the first time in 1994.

The school children investigated lichen growth on three different types of tree bark: deciduous, coniferous and birch. They examined the growth form of lichens (i.e. fruticose, foliose and crustose thalli) and the total number of different lichen species according to the growth form on each tree. In addition,

they examined the degree of lichen coverage, type of locality (town/industrial area or woodland/farmland) and distance from air pollution sources. In 1995/96 the school children in the Czech Republic examined 2396 trees in total. The best bioindication results were obtained using fruticose lichens growing on the bark of deciduous trees. The average number of fruticose and foliose lichen species per tree was three times higher in woodlands/farmlands than in towns and industrial areas. The most tolerant to air pollution were crustose lichens.

Results of the project in the Czech Republic are presented and comparisons with other participating countries are discussed. Air pollution levels are relatively high in the Czech Republic in the towns and industrial areas and background concentration levels are also higher here. The average number of lichen species per tree in the Czech Republic is lower in comparison with other countries (namely in the case of sensitive fruticose and foliose lichens). Very low average numbers of species per tree occur in towns and industrial areas (about five times lower in comparison with the average values from all countries). In the Czech Republic there are also bigger differences between both types of landscapes. The results of the project coincide with the results of scientific research.

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