CONTENT OF SULPHUR AND FLUORINE COMPOUNDS IN PINE NEEDLES AS AN INDICATOR POLLUTION IN POLAND

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Our preliminary findings indicate that the content of total sulphur and soluble fluorides in needles of the Scots pine reflects the degree of air pollution with sulphur and fluorine compounds. A project for a map of air pollution in Poland, based on chemical analysis of Scots pine needles, is presented. Results of the total sulphur and soluble fluoride content in 2-year old needles from 15 to 25 year trees should yield a picture of air pollution with sulphur and fluorine compounds. The first stage will involve the preparation of a map of the area between the Warsaw and Plock agglomerations. This area will be divided into 10 squares with side dimension of 25 km each. Samples will be taken at 5 different sites in each square and also approximately every 5 km along a straight line between these two towns.

INTRODUCTION

degree of environmental pollution and threat to plant life (HÄLLGREN and NYMAN, 1977; HOLUB and KONTRISOVA, 1973; HUTTUNEN et al., 1979; NAVARA et al., 1974; 1978; POSTHUMUS, 1976; 1979). mostly concerned with small areas in the The first stage of our studies involves the vicinity of single sources of emission or elaboration in 1981 of a section of such a map municipal centers. In the case of studies on for the area between the Warsaw and Plock pollution of large areas involving biological methods mostly epiphytes and annual plants were used (GILBERT, 1976; LAAKSOVIRTA and OLKKONEN, 1977; BRENNER and analysis of Scots pine needles, covering the Poland.

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Determination of the accumulation of whole area of Poland. In the future we would elements in the assimilatory organs of plants like to attempt, together with scientists from has been employed by many scientists as an the Scandinavian countries and from other indirect method for the evaluation of the countries in Northern and Central Europe, to draw up, if possible, a similar map for a much larger area.

The Scots pine is very common throughout Europe and takes up air pollutants in all the seasons. These two factors determine the Elaborations of this type have, however, been choice of this species as an indicator plant. agglomerations. Experience acquired during this preliminary stage will be put to use in the main program.

We are mainly interested in the level of SKYE, 1976). Our project provides the sulphur and fluorine compounds which pose drawing up of an air pollution map, based on the greatest threat to the vegetation in

DISCUSSION OF THE RESULTS OF PRELIMINARY STUDIES

In the previous years, in preparation for the currently presented program, we made preliminary methodical studies. To this end we chose two areas with different degree of air pollution. The heavily polluted area was Nadleśnictwo Panewnik in the Upper Silesian Industrial region in which the SO₂ concentration in the air at the time of the studies was 40 to $500 \mu \text{g/m}^3$ and fluorine 4.0 to 16,4 μ g/m³, respectively. The area with low degree of air pollution, which can be taken as the indigenous background, was the central part of Puszcza Bialowieska in which the content of SO2 in the air did not exceed 20 μ g/m³, and of fluorine 1,3 μ g/m³.

In order to study the effect of age of needles, age of trees, time of sample collection and individual differences on the accumulation of pollutants we set up the first experiment. Needles were collected every two be taken approximately every 5 km, also in months from the second and third whorls of approximately 5, 10, 20 and 40 year old trees in fresh pine forest site from April, 1976 to August, 1977. In each case samples were taken from eight trees with similar appearance. In order to examine the effect of ecological type of forest site, in August and February additional samples were taken from eight approximately 20 year old trees in dry pine, fresh pine, mixed pine broad leaf and marsh forest sites. The washed, dried and ground needles were analysed for total sul- it were possible to analyze a greater number phur content which reflects pollution of the of samples and to make more frequent trips air with sulphur compounds (mainly SO₂) and for soluble fluorides as an indicator of contamination with fluorine compounds.

Suggested methodology of the studies

The area of Poland will be divided into squares with side 25 km. In each square 5 sample collection sites will be chosen, providing they are not in the direct vicinity of communication routes, industrial plants and lated by the needles.

larger groups of buildings. A sample will be formed by mixing needles collected from 30 trees 15-25 years old with similar appearance, growing near each other.

In the preliminary stage, which will take place in 1981, we will collect samples in the manner described above in 10 squares between Warsaw and Plock. Warsaw is a great urban and industrial agglomeration with approximately 1300 thousand inhabitants and many industrial plants. Plock, a town numbering approximately 100 thousand inhabitants, is an important center of the petrochemical industry. Between both towns is a lowland agricultural and forest area without any larger urban or industrial centers. To verify the method of squares we will also collect samples along a straight line between both agglomerations. Samples will this case from 30 trees 15 to 25 year old. A comparison of the results of both methods will allow to avoid in the future any errors caused by method of sample collecting. Because of the large number of samples we had to decide on one period of sample collection. Basing on the preliminary studies described above we decided to collect 2-year old needles in June when the levels of total sulphur and fluorides should reflect the mean annual accumulation of these compounds. If to the sampling sites it would be the most advantageous to collect needles from the previous year's growth in October, February and June, from 20 year old trees. Calculation of the mean would then give the closest value to the mean annual accumulation of pollutants (table 1). The interpretation of the results must take into account meteorological data for the studies areas. Particular attention should be paid to the size of precipitation which significantly affects the amount of sulphur and fluorine compounds accumu-

Table 1. Factors influencing the accumulation of total sulphur and soluble fluorides in the needles of Scots pine in polluted environment.

Factor	Total sulphur	Soluble fluorides	Recommendations
Specimen /individual/ variation		at n=8; =0,05; relative standard deviation 12–32 %	•
Age of trees	cant differences between	In 28,8-31,1 % cases signifi- cant differences between trees of different age	
Age of needles	cumulation in older needles; statistically proven in 29,1 % cases	From the moment of the full development of needles of the current growth/December-February/similar levels of fluorides in both types of needles	year's growth or current growth needles after their
Type of forest site	No significant effect	No significant effect	Samples can be taken from different types of sites
Time of sample collection	Marked maximum in the winter months and minimum in autumn; to a great degree dependent on changes in SO ₂ concentrations	difficult to relate to fluoride	

Final recommendation: Choose 30 twenty year old trees; collect previous year's needles October, February, and June or June.

FINAL REMARKS

In the case of the succes of the biological for forecasts of the industrial development of protection of threatened vegetation and also environment in a large part of Europe.

method for the evaluation of the degree of our country. Co-operation with scientists pollution of large areas, suggested by us, it from other countries could result in the could be of great importance for the elaboration of a picture of danger to the

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