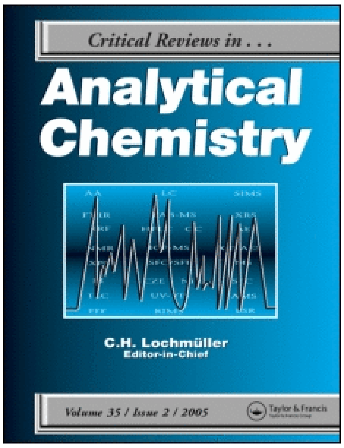

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Monitoring of the Environment in the Czech Republic with an Orientation on Food Chains*

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ABSTRACT: Some activities realized as a part of the project *Evaluation of the State of the Environment: Monitoring of Contaminants in Food Chains* in the Czech Republic have been briefly reviewed.

KEY WORDS: monitoring, pollutants, food chains, pollen, spruce needles.

I. INTRODUCTION

In June 1992, the Government of the Czech Republic passed a resolution, No. 408, introducing an additional system of monitoring pollutants in the Czech Republic. Like other systems of monitoring (air, water, forest ecosystems, soils, etc.), this system was founded to bring a deeper insight on the entry of pollutants into the components of flora and fauna, especially those forming a food chain with an impact on man. Monitoring of pollutants in the food chain is a part of the research project undertaken by the Institute of Chemical Technology in Prague, in cooperation with many institutions and laboratories in the Czech Republic since 1995.

The primary task of the project is to collect data on the concentration of selected pollutants in selected matrices and to seek relation between them. The selection of matrices does not contain agricultural commodities only, but also some other biomarkers and even bulk. The selection was also directed by a demand to minimize any duplicity between different systems of monitoring. Several monitoring programs are covered under our project: standard monitoring program, extended monitoring program, and monitoring of long-range transfer.

Along with these activities, several research subprojects are oriented toward new matrices, new pollutants, and new methods suitable for evaluation of the loading of the environment in the Czech Republic. From the above-mentioned, only the subproject related to the study of morphology and chemical composition of spruce needles (*Picea abies*) as biomarker of the loading of the environment is mentioned here. A subproject oriented toward use of fish as bioindicator is mentioned in the contribution by J. Hajšlová in this issue.

II. MONITORING PROGRAMS

Twenty-two localities in the Czech Republic were selected, from where selected commodities or matrices of biota (Table 1) were sampled according to standard monitoring program. One of the conditions for selection of the localities was their agricultural exploitation. There was no intention to include some heavily loaded localities of the Czech Republic.

Among five of these localities, an extended selection of matrices was used (Table 1) in the hope of reaching a better insight into the mutual relation between the loading of different matrices (extended monitoring program).

An additional monitoring program (Project *Zephyr*) was oriented on the monitoring of long-range transfer of heavy metals and polycyclic aromatic hydrocarbons (PAH). This monitoring

* See figures and tables following text but before references.

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program gets advantage from very special geographical features of the Czech Republic with mountains on the boarders. Six sampling devices were fixed on TV towers in these localities and one was fixed on the TV tower in Prague. Along with the sampling the data on wind was monitored in the hope to found a correlation between content of the pollutants and direction of the wind.

III. RESEARCH SUBPROJECTS

Spruce needle wax acts as a natural sampler of some pollutants and for this reason determination of PAH and PCB in this matrix is also included into the extended monitoring program. The subproject on spruce needles should answer the question if the morphology and chemical composition of the spruce needle waxes reflect the anthropogenic stress of forests. Morphology and chemical composition of the surface wax layers of spruce needles (*Picea abies*) of the trees from five localities of the extended monitoring program were studied. Several methods were used for characterization of wax: scanning electron microscope, gas and liquid chromatography (content of the main components, including terpenes and carotens) and Raman spectroscopy. Relation of the collected data to the data on content of polycyclic aromatic hydrocarbons and other pollutants is followed. A comparison with conclusions of the ICP Forests program (International Cooperative Program on Assessment and Monitoring of Air Pollution Effects on Forests) is planned for selected localities.

IV. EVALUATION OF DATA

The database for standard monitoring program has more than 40,000 records to date. All these data are accessible via a special program *Monitor* allowing one to browse and make various comparisons. Some evaluation of the data for 1995 to 1997 were published in special publications.[1] The crucial question is connected with trends we should await in pollution. Even though we have only limited database for this purpose a tentative evaluation were obtained for some matrices. The methodology we adopted is illustrated here on the data for pollen.

The database contains 147 total data for pollen. Using 12 polycyclic aromatic hydrocarbons as variables, it is possible to show by Principal Component Analysis (PCA) that two main components carry about 90% information and variables (content of PAH) are strongly clustered (Figures 1 and 2).

Analysis of the same set was carried out also by a fuzzy cluster method. Classification of the data to four prototypes, characterized by different content of individual polycyclic aromatic hydrocarbons (Table 2), is given in Table 3. This table indicates that about 85% of the samples belong to only two prototypes III and IV. Prototype IV by nearly 78% can describe a background level of contamination of pollen by PAH in the Czech Republic.

Trends in the content of PAH in individual localities in the years 1995 to 1997 is illustrated in Table 3, showing classification of samples to the individual prototypes. Ten localities belong in all years to the prototype *IV* with the lowest content of PAH, but there is, on the other hand, one locality belonging exclusively to the prototype III.

ACKNOWLEDGMENTS

The financial support of Ministry of Environment of the Czech Republic (project *Evaluation of the State of the Environment: Monitoring of Contaminants in Food Chains, No. MR/14/95*) is gratefully acknowledged.

TABLE 1
Matrices and Analytes

Matrices	Heavy Metals	PCB+ OCP	PAH	Number of localities
Hare – muscle	+	+		22
Hare – liver	+	+		22
Hare – kidney	+			22
Hare – marrow		+		5
Roebuck – muscle	+	+		22
Roebuck – muscle	+	+		22
Roebuck – liver	+	+		22
Roebuck – kidney	+	+		22
Potatoes	+	+		22
Wheat	+		+	22
Colza	+		+	22
Lucerne	+		+	22
Pollen	+	+	+	22
Fish	+	+		5
Moss	+	+	+	5
Spruce	+	+	+	5
Phytobentos	+	+	+	5
Zoobentos	+	+		5
Bulk	+	+	+	22

[1]Heavy metals: As, Cd, Cu, Hg, Ni, Pb, Zn; PCB polychlorinated biphenyls; OCP organochlorinated pesticides; PAH polycyclic aromatic hydrocarbons.

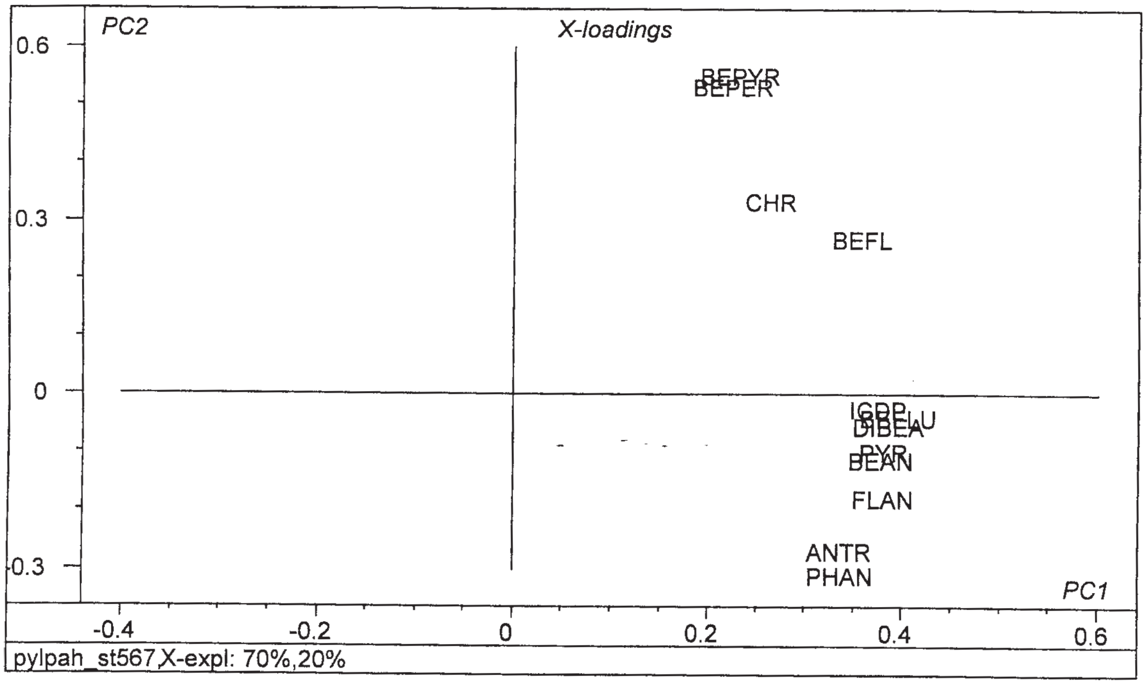

FIGURE 1. Loading plot for pollen and PAH from a PCA model.

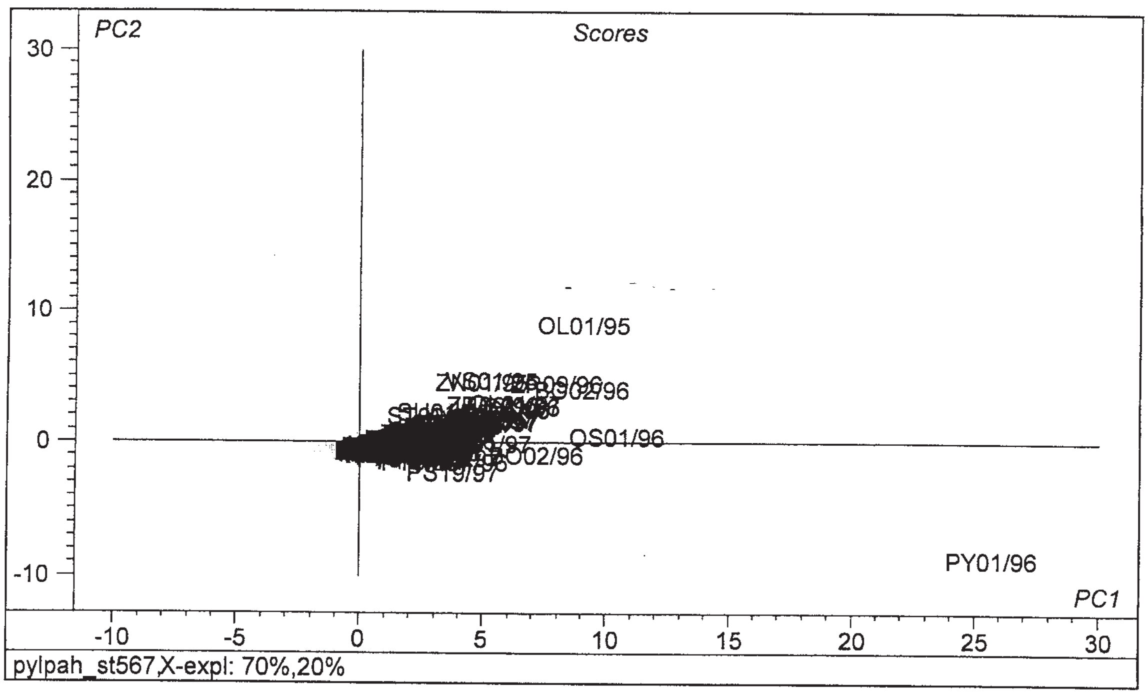

FIGURE 2. Score plot for pollen and PAH from a PCA model.

TABLE 2
Pollen: Content of Individual PAH (μg/kg) in Four Prototypes[1]

	I	II	III	IV
ANTR	26.2	6.68	1.18	0.75
BEAN	36.2	4.71	5.47	1.60
BEFL	11.6	1.44	3.52	0.70
BEFLU	56.6	6.00	6.85	1.53
BEPER	3.13	2.86	7.32	1.26
BEPYR	1.09	2.28	6.36	1.08
DIBEA	8.15	0.29	0.85	0.18
FLAN	285	46.9	21.1	7.82
CHR	7.63	7.82	7.20	1.99
ICDP	45.7	1.59	5.22	1.23
PHAN	609	133	20.1	19.4
PYR	166	29.1	16.4	4.90
% of samples	**0.7**	**4.3**	**17.3**	**77.7**

[1]ANTR anthracene, BEAN benzo[*a*]anthracene, BEFL benzo[*k*]fluoranthene, BEFLU benzo[*a*]anthracene BEPER benzo[*g,h,i*]perylene, BEPYR benzo[*a*]pyren, CHR chrysene, DIBEA dibenzo[*a,h*]anthracene, FLAN fluoranthene, ICDP indeno[1,2,3-*c,d*]pyrene, PHAN phenanthrene, PYR pyrene.

TABLE 3
Polycyclic Aromatic Hydrocarbons in Pollen: Classification of Localities to Prototypes in the Period 1995 to 1997[1]

District	I	II	III	IV
BN				566777
BO				566677777
BV				56677
CB			6	5677
DC				56677
JC				56677
JH				56677777
KV				56677
ME				566677
MO				56677
OL			57	667
OS		67		567
PS		77		566667777
PU				56677
PY	6			5666666777777777
PZ		6		66677
ST			577	666777
SU			57	667
UH			667	567

TABLE 3 (continued)
Polycyclic Aromatic Hydrocarbons in Pollen: Classification of Localities to Prototypes in the Period 1995 to 1997[1]

VS			56677	
ZN			577	66
ZR			667	566777

[1] Years: **5** - 1995, **6** - 1996, **7** - 1997.

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