

Summary of the PhD Thesis

“Diversification of heavy metals and polycyclic aromatic hydrocarbons (PAHs) in *Picea abies* and *Abies alba* needles in the Beskid Śląski and Beskid Żywiecki”

Jacek Borgulat

The PhD thesis prepared at Faculty of Natural Sciences of the University of Silesia in the Department of Biology, Biotechnology and Environmental Protection under the supervision of Aleksandra Nadgórska-Socha, PhD.

Over the years Beskidy was subjected to anthropic pressure from the surrounding industrial regions such as Upper Silesian, Bielski, Karpacki and Rybnicki. Since 1990s due to the closure of many smelters and plants, the participation of deposition of pollution connected with heavy industry (such as sulphur monoxide and nitrogen oxides) has been decreasing. It may be assumed that because of its localization, proximity of large agglomerations and increasing popularity among tourists, the area of Beskidy is still subjected to air pollutions. However, the profile of pollution deposited in forest ecosystems has different nature than during the period of intensive exploitation and industrial use of coal, which took place in the neighbouring industrial districts.

There is not enough information as to the inflow and deposition of air pollution reaching the Beskidy forests due to the lack of measurement stations. Surface of the needles, thanks to its physical and chemical parameters, may be used for the evaluation of the amount of air pollutions and their characteristics reaching a given localization (here as a passive receptor of pollution).

The aim of the study was to specify the selected depositions of atmospheric pollution – 15 PAHs and heavy metals (Zn, Cu, Pb, Ni, Cd and As) through the biomonitoring research with the use of the needles of silver fir (*Abies alba* Mill.) and Norway spruce (*Picea abies* (L.) H. Karst). The following thesis were made in the dissertation: (I) there are differences in the composition of air pollution – PAHs and heavy metals – accumulated from air by 6- and 12-month needles of silver fir and Norway spruce growing in the forests of the Beskid Śląski and Beskid Żywiecki, and (II) one of the reasons of diversification of the content of the selected atmospheric pollution (PAHs and heavy metals) in the needles of silver fir and spruce in the

Beskid forests are emissions from the local sources. Additionally, the presence of heavy metals (Zn, Cu, Pb, Ni, Cd and As) in the needles of silver fir and Norway spruce was compared with the literature data in order to evaluate the environmental risk and potential effect of the selected elements on the examined ecosystem.

The research was carried out for 2 years (4 periods of sample collection) in 12 localizations in the Beskid Śląski and Żywiecki. Additionally, three reference areas were selected, therefore it was possible to indicate the amount and type of pollution which may be accumulated from air by the needles of the selected trees in connection with the emissions from different sources – transport emission, emission related to coal and biomass combustion and emission which appears in urban areas.

The conducted research shows that the majority of PAHs deposited in the young (6-month) needles of silver fir and Norway spruce in the Beskid Śląski and Żywiecki were 2- and 3- ringed low molecular weight PAHs, which appear in the atmosphere mainly in a gas form. Their presence was lower in 12-month needles, in which the presence of 4-, 5- and 6- ringed PAHs due to emissions of anthropogenic nature increases in autumn and winter. Moreover, bigger deposition of 15 PAHs was confirmed on the sites located in the Beskid Śląski against the sites in the Beskid Żywiecki.

Both in silver fir and Norway spruce higher presence of nickel was noticed against the arsenic and cadmium in the dust on the 12-month needles surface. The presence of these elements in 6-month needles in the dust on the needles surface was on the lowest level. The presence of cadmium and lead on the surface of the needles of silver fir and Norway spruce showed small inflow to forest ecosystems in the Beskid Śląski and Beskid Żywiecki.

On the grounds of the conducted analysis, it was shown that one of the reasons of the diversification of the values of the selected air pollution accumulated from air by the needles may be the emissions from local sources. This thesis is confirmed by the dependencies between the number of local emissions sources (buildings and roads), their distance from the sites and the content of some air pollutants (Σ PAHs, Zn, Pb and Ni) accumulated from air by the needles. Moreover, the analysis of the selected coefficients (Flt/Flt+Pyr, Ant/Ant+Phen and Σ COMB/ Σ WWA) executed for 6- and 12-month needles showed that the emission of pyrogenic PAHs in autumn and winter increased. A possible explanation for the received results is the emission connected with coal or wood combustion in domestic stoves on the examined area.

Both in silver fir and Norway spruce the presence of the heavy metals in the needles was on similar level and it showed the following dependency: Zn>Cu>Ni>Pb>Cd>As. The

obtained values of heavy metals should not affect negatively the health of fir and spruce growing in the Beskid Śląski and Beskid Żywiecki mountain forests.