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COMPARATIVE ASSESSMENT OF POLLUTION LEVEL IN TWO INDUSTRIAL AREAS USING BIOINDICATORS

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Abstract: Native lichen and moss samples collected from two industrial areas (Zlatna and Baia Mare) were analysed for Pb, Cu and Zn, the main contaminant elements in these regions. The town of Zlatna is build around a mineral processing plant and smelter (S.C. Ampelum S.A.). Release of SO_2 and metals as fine particles of slag cause acid precipitation and metal contamination for more than 30 km down wind from the smelter. The town of Baia Mare is the site of two major plants. The first plant (S.C. Romplumb S. A.) is for manufacturing and recycling metallic Pb used in the car batteries; the second, Phoenix Company, is a chemical and metallurgical plant, similar in mineral processing technologies with that situated in Zlatna town. Obtained data have releaved that the studied industrial regions are strong polluted looking the Pb, Cu and Zn content of analysed samples. It is expected that Zlatna areas is excessively polluted occupying a certain place among the strongest polluted areas on the word because here the mining and metal processing endure more than three century.

Introduction

Air pollutants are removed from the atmosphere by wet and dry deposition processes. Monitoring of air contaminants is necessary to determine impacts upon environment and controls required for abatement.

Lichens and mosses have a long history of use as biological indicators of air quality [3, 4]. The lichens and mosses can be used as pollution monitors in three ways [2]: by identifying and mapping all lichen and moss species in an area; transplanting healthy lichens and mosses into polluted area and measuring their deterioration and sampling an individual species and measuring contaminants accumulated within them.

The terricolouse lichen and -moss species are well-suited for use in metal monitoring, as they are known to be tolerant of pollutants. These cryptogams are easily identified and sampled and are ubiquitous throughout Transilvania. The purpose of this study was to compare two industrial areas from Transilvania, namely Zlatna and Baia Mare, to gain information on pollution levels, in particular Pb, Cu and Zn, the main pollutants in these regions. As biomonitors were used native lichens and mosses, also soil samples from these two areas were analysed.

Experimental

As is well known the town of Zlatna is build around a mineral processing plant and smelter (S.C. Ampelum S.A.). The plant processes a variety of complex products. Release of SO_2 and metals as fine particles of slag cause acid precipitation and metal contamination for more than 30 km down wind from the smelter [5]. The town of Baia Mare is the site of two major plants for processing Pb (S.C. Romplumb S. A.) and Cu (S.C. Allied Deals Phoenix S.A.) ore. The first plant is for manufacturing and recycling metallic Pb used in the car batteries. This plant is the main polluter with Pb and Zn. The second, Phoenix Company, is a chemical and metallurgical plant, similar in mineral processing technologies with that situated in Zlatna town. Thus, the main polluters of the areas is with SO_2 and extent Cu-containing particles.

The lichen, moss and soil samples were collected to be representative for the both investigated areas.

All the lichens species collected belongs to genera *Cladonia* (*Cladonia coniocraea, Cladonia fimbriata, Cladonia caespiticia*)while the mosses to 6 genera (*Ceratodon, Amblystegium, Pohlia, Brachythecium, Weissia, Bryum)* which are toxitolerants.

A 0.75 g amount of vegetable sample was digested with HNO_3/H_2O_2 mixture and diluted to 50 ml with distillate water to the final volume.

A 0.2 g of finely ground soil sample was digested with Lunge reagent (3:1 HNO_3:HCl v/v). The resulting samples was cooled and bulked to 100 ml.

Pb, Cu and Zn from all samples were analysed by flame atomic absorption spectrometry. A Perkin-Elmer Model 3030B atomic absorption spectrometer with an air-acetylene flame was used.

Results and Disscusions

In the Fig. 1 are presented the minimum and the maximum element concentrations for three elements (Pb, Cu and Zn) determined in lichen samples collected in selected sites from Zlatna and Baia Mare industrial areas. The most pollutant element in both studied areas is the Pb. In Baia Mare the Pb range between 176-9513 mg/kg, while in Zlatna between 317-5399 mg/kg. The background level of Pb concentration in *Cladonia* lichens was 40 mg/kg. It is seem from Fig. 1 that the concentration of Pb in Baia Mare is 238 times larger than background level, same time in Zlatna 135 times larger, ones. Our results regarding the Pb accumulation in *Cladonia* species in both industrial sites are much higher (more than 100 times) than detected in same species published in literature [1].

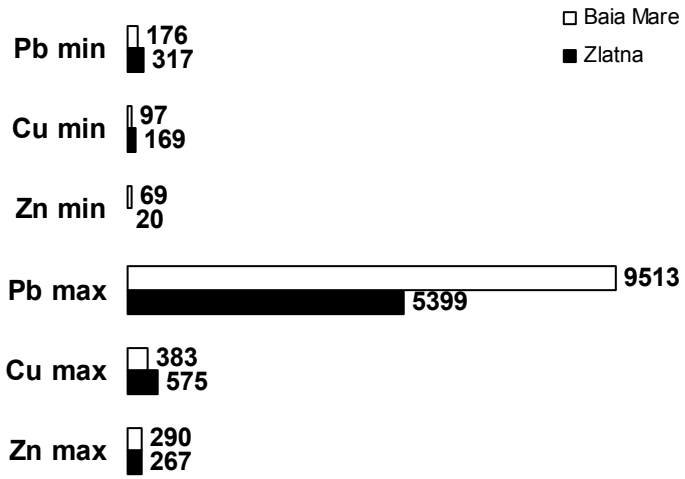

Fig. 1: The minimum and maximum concentrations of Pb, Cu and Zn (mg/kg) determined in lichens collected from Zlatna and Baia Mare areas

In moss samples, same as in the lichens, the Pb was the most contaminant element, that exceeded the background concentration 161 times in Zlatna, respectively 47 times in Baia Mare (Fig. 2). We observed that the minimum and the maximum Pb, Cu and Zn concentrations in Zlatna are bigger than in Baia Mare. May be the age of the mosses, or their exposure to the pollutants is more favourable in Zlatna than in Baia Mare causing a higher accumulation.

The pH values of Zlatna soils range between 3.1-4.7, while in Baia Mare between 4.4-7.1. These pH values are sufficiently low to considerable increase the bioavailability of metals.

In Baia Mare collected soil samples the concentration of Cu (2646 mg/kg) is the highest followed by Pb (1893 mg/kg) concentration (Fig. 3.). In Zlatna the Pb concentration is the highest (1680 mg/kg) and only 600 mg/kg the Cu. The Cu and Pb concentration in both industrial areas compared with the normal value of these elements in soils (Pb-20 mg/kg, Cu-20 mg/kg, Zn-100 mg/kg) [6] exceed by considerable margin of these.

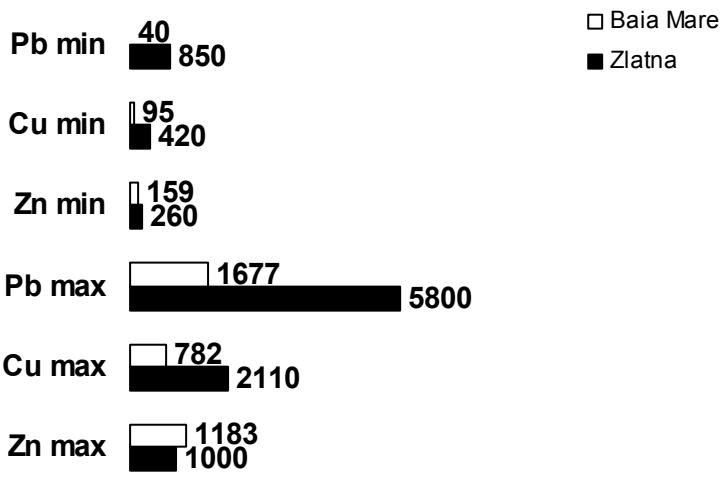

Fig. 2: The minimum and maximum concentrations of Pb, Cu and Zn (mg/kg) measured in moss samples collected from Zlatna and Baia Mare areas

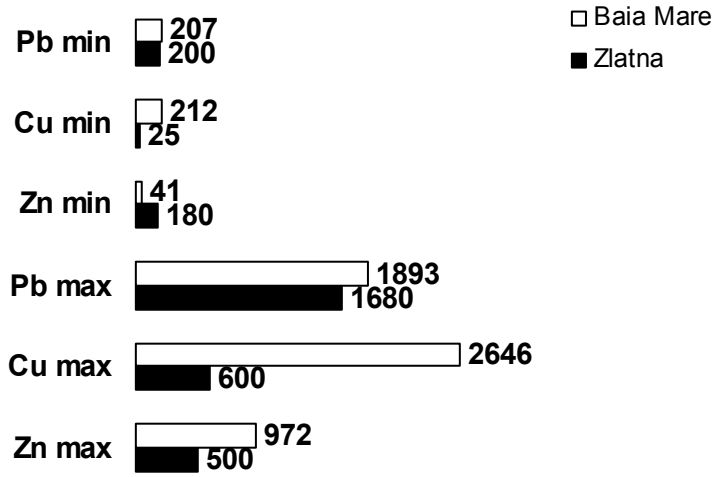

Fig. 3: The minimum and maximum concentration of Pb, Cu and Zn (mg/kg) determined in soil samples collected from Zlatna and Baia Mare areas

Table 1: The average value of heavy metals (mg/kg) calculated in lichens, mosses and soils collected from the studied sites of Zlatna and Baia Mare areas

	Zlatna			Baia Mare		
	Pb	Cu	Zn	Pb	Cu	Zn
lichens	1590	340	182	2140	206	161
mosses	2700	1413	650	610	292	522
soils	684	221	329	918	708	327

Conclusions

From the comparison with the backgrounds data it is apparent that all three analysed elements are generally enhanced in the lichens, mosses and soils, too in the both studied areas. In table 1 are presented the calculated mean values for the three analysed elements from all sites of the two industrial areas. The total metal content of the studied samples were 1963 mg/kg in Baia Mare and 2703 mg/kg in Zlatna. Based on these data we can conclude that the studied industrial regions are strong polluted looking the Pb, Cu and Zn content of analysed samples. As it was expected Zlatna areas is excessively polluted occupying a certain place among the strongest polluted areas on the word, because here the mining and metal processing endure more than three century.

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EVALUAREA COMPARATIVĂ A GRADULUI DE POLUARE, ÎN DOUĂ CENTRE INDUSTRIALE, CU AJUTORUL BIOINDICATORILOR

(Rezumat)

Lucrarea de faţă prezintă evaluarea gradului de contaminare cu Pb, Cu şi Zn, prin monitorizare pasivă, utilizând lichenii şi muşchii nativi din zonele industriale Zlatna şi Baia Mare – cunoscute centre industriale, puternic poluate. S-a constatat, că datorită poluării avansate, ambele zone studiate prezintă o floră lichenologică mult redusă, atât ca diversitate, cât şi ca abundenţă. Astfel, în ambele zone au putut fi identificaţi doar lichenii aparţinând genului *Cladonia* (*C. coniocraea, C. fimbriata, C. caespiticia*), licheni cunoscuţi de altfel, pentru toxisensibilitatea lor mai redusă.

Muşchii par mai toxitoleranţi, astfel, s-au determinat 11 specii diferite, aparţinând la 6 genuri (*Ceratodon, Amblystegium, Pohlia, Brachythecium, Weissia, Bryum*).

Pentru o şi mai bună evaluare a zonelor investigate, din punctele în care s-au colectat muşchii şi lichenii s-au prelevat şi probe de sol, care au fost analizate din punct de vedere al conținutului în Pb, Cu şi Zn. În lucrare sunt prezentate concentrațiile minime şi maxime, determinate atât în muşchi şi licheni, cât şi în probele de sol.

Concentrațiile obținute pentru cele 3 metale au depăşit valorile normal admise. În ambele oraşe, atât în muşchi, cât şi în licheni, Pb-ul este cel mai poluant element. În cazul acestuia, acumularea sa în licheni, în ambele oraşe, este de peste 100 de ori mai mare decât în proba martor, în timp ce în muşchi este de peste 161 ori mai mare în Zlatna şi de 47 ori mai mare în Baia Mare. Analiza probelor de sol a arătat că pH-ul acestora este puternic acid în ambele zone studiate, mărind astfel bioaccesibilitatea metalelor grele analizate. Concentrațiile acestor metale în sol sunt mai scăzute decât în muşchi şi licheni. Cu toate acestea, concentrațiile de Cu şi Pb sunt peste valorile normal admise.

Pe baza datelor obținute, s-a concluzionat că zona industrială Zlatna este mai poluată decât Baia Mare.