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Anna CHRZAN[1], Maria MARKO-WORŁOWSKA[1]
and Tomasz ŁACIAK[2]

HEAVY METALS IN THE SOIL AND IN THE ORGANISMS OF THE INVERTEBRATES INHABITING THE SOIL

METALE CIĘŻKIE W GLEBIE I ORGANIZMACH BEZKRĘGOWCÓW GLEBOWYCH

Abstract: The heavy metals that get into the organisms influence their vital processes. In order to evaluate the toxicity of metals to mesofauna of the soil the diversity, the number and the content of the Cd, Pb, Ni and Zn in the soil and in the body of the fauna of grass habitats were analysed. The chosen areas were situated near the roads with different rates of traffic flow and, to compare, in the city park. The soils were characterized by similar pH reaction and the low humidity. They differ in the content of the heavy metals. The soil in the city park showed the lowest concentration of Pb and low for the other heavy metals and, at the same time, the highest density of mesofauna.

Keywords: soil mesofauna, abundance, diversity, heavy metals

The heavy metals derived from antropogenic pollution of the air, water and soil disperse in these habitats and contaminate directly or indirectly through the plants or organic matter the organisms living there [1]. Their harmful influences consist of the possibility of cumulating in the living organisms and of their chronic toxicity [2].

The high density of heavy metals influence negatively the biological processes of the soil by reducing its fertility, enzymatic activity and by changes in its acidification. The high content of the metals can be toxic to microflora, plants and soil animals as well as for the man, because they become in less or higher degree the part of the food chain [3, 4]. The mechanisms of the harmful influences of the heavy metals on the living organisms are diverse and can lead to physiological changes causing the death of cells

[1] Department of Ecology, Wildlife Research and Ecotourism, Institute of Biology, Pedagogical University of Krakow, ul. Podbrzezie 3, 31–084 Kraków, Poland, email: chrzan@ap.krakow.pl, mmw@ap.krakow.pl

[2] Department of Zoology, Institute of Biology, Pedagogical University of Krakow, ul. Podbrzezie 3, 31–084 Kraków, Poland, email: tlaciak@ap.krakow.pl

and tissues, and can be responsible for mutation- and cancer-causing changes in the organisms [5].

In order to evaluate the toxicity of the metals to mesofauna of the soil the diversity, number and the content of Cd, Pb, Ni and Zn were examined in the soil as well as in the fauna dwelling there.

Materials and methods

The material analysed was the soil from four lawn situated near roads with different rates of traffic flow and, for comparison, the soil from city park 200 m distant from the road.

Locality I situated around 1 m from the street;
Locality II situated around 5 m from the street;
Locality III situated around 4 m from the street;
Locality IV situated around 0.5 m from the street;
Locality V situated around 200 m from the street.

With the use of the soil frame of the size of 25 × 25 cm the set of samples was taken on the selected localities in spring 2008. The soil frame was thrust into the soil on the depth of 10 cm. Each series consisted of 16 tests on the surface of around 1 m^2.

Mesofauna was scampered away by employing the dynamic method in the modified Tullgren apparatus. After marking the select mesofauna its density and diversity were analysed.

Soil moisture and its pH, its temperature as well as the content of Cd, Pb, Ni and Zn were determined by using AAS method in the soil and in the mesofauna scampered away.

Dry samples of the soil and of the mesofauna were mineralized. For this purpose dry samples of the soil and the mesofauna was poured over 3 cm^3 of 65 % HNO_3, heated to the temperature of 120 ^oC and left for 4 hours. The filtered liquid was poured into measuring flasks and filled with distilled water to the volume of 25 cm^3. In solutions of the soil prepared in this way the content of heavy metals was determined by atomic absorption spectrometer (AAS – Cole-Parmer, BUCK 200A).

Results

The soil analysed were characterized by similar, slightly alkaline reaction (pH 7.33–7.74) and similar humidity within the range 16.1 to 20.4 % (Table 1).

Table 1

Comparison of selected parameters of the soils in the studied localities in Krakow

Selected parameters	Locality I	Locality II	Locality III	Locality IV	Locality V
Soil moisture [%]	16.5	16.1	20.4	18.9	18.85
Soil pH [-]	7.33	7.38	7.72	7.74	7.53
Area temperature [^oC]	11.5	9.8	12.6	12.9	8.5
Soil temperature [^oC]	9.3	11.1	11.4	11.9	8.8

These small differences in the humidity have no influences on the density of the mesofauna. The noticeable differences in the diversity on the analysed areas were not detected. The important differences in the research were connected with the content of the heavy metals in the soil as well as in the mesofauna dwelling there (Table 2).

Table 2

Comparison of mesofauna in the soils of the selected localities in Krakow

Selected parameters	Locality I	Locality II	Locality III	Locality IV	Locality V
Abundance of pedofauna [sp. no. per m^2]	440	566	396	592	1484
Diversity [number of taxonomic groups]	9	9	10	9	11

However, in the body of the mesofauna the highest concentration of Cd was detected in the I area, Ni in the V area and Zn in the I area (Fig. 1), where the soil was characterized by the lowest concentration of the above-mentioned elements. Whereas as far as Pb is concerned, its highest concentration was detected in the body of the mesofauna on the II area, where, at the same time, the highest content of this element in the soil was noted (Fig. 1).

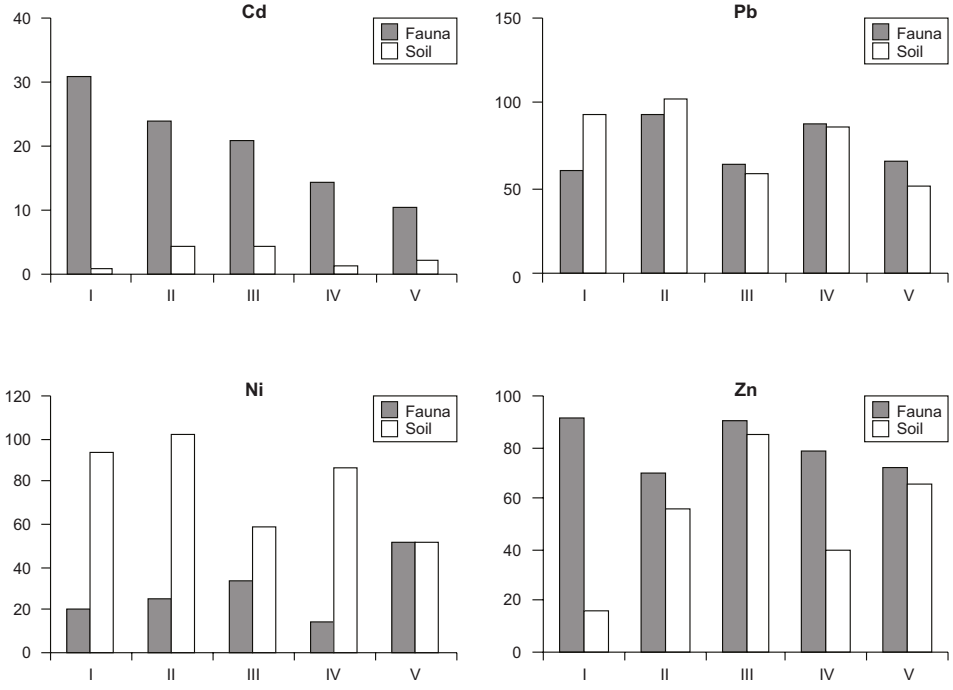

Fig. 1. Heavy metals content in the selected localities

The soil in the city park had the lowest concentration of Pb and relatively low of Cd and Ni. At the same time the highest density of mesofauna was detected in this area. In this area 1484 species in m^2 were noted, whereas in the remaining areas the density of the mesofauna was from more than two to more than three times lower (Table 2). The mesofauna in the city park contained the lowest concentration of Cd, relatively low of Pb and Zn and the highest concentration of Ni in spite of its low content in the soil (Fig. 1). It can be the prove of the fact that direct connection between the content of Ni in the soil and the fauna dwelling there does not exist.

In the areas with the high rates of traffic flow (locality II, III) the highest density of Cd, Ni and Zn and simultaneously the law density of the mesofauna and high content of Cd in their bodies were detected (Table 2, Fig. 1).

Conclusions

1. The small differences in the pH of the soil analysed have no influences on the density of the mesofauna.

2. The high contents of Cd, Pb, Ni and Zn in the soil limits the number of the mesofauna dwelling there.

3. The high contents of Cd and Zn in the soil as well as in the body of the mesofauna is the limiting factor of its density.

4. As far as Cd, Ni and Zn are concerned direct connection between their number in the soil and its number of these metals in the body of the mesofauna dwelling there was not detected.

5. A considerable amount of trees and bushes as well as remoteness from roads protect the soil against Pb.

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METALE CIĘŻKIE W GLEBIE I ORGANIZMACH BEZKRĘGOWCÓW GLEBOWYCH

Zakład Ekologii, Badań Łowieckich i Ekoturystyki, Instytut Biologii
Uniwersytet Pedagogiczny w Krakowie

Abstrakt: W celu oceny toksyczności metali dla mezofauny glebowej zbadano zróżnicowanie, liczebność oraz zawartość Pb, Cd, Ni, Zn zarówno w glebie, jak i w ciele zasiedlającej ją fauny wybranych siedlisk

trawiastych. Badane stanowiska były położone blisko traktów komunikacyjnych o różnym stopniu nasilenia ruchu pojazdów mechanicznych i dla porównania w parku miejskim. Gleby charakteryzował podobny odczyn pH oraz mała wilgotność. Różniły się one natomiast zawartością metali ciężkich. Gleba w parku miejskim wykazała najmniejszą koncentrację Pb i małą pozostałych metali ciężkich, a jednocześnie największe zagęszczenie mezofauny. Natomiast w organizmach badanych zwierząt glebowych stwierdzono duże stężenia metali ciężkich na stanowiskach o dużej koncentracji tych metali w glebie.

Słowa kluczowe: mezofauna, zagęszczenie, metale ciężkie