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CONTENT OF SELECTED TRAFFIC POLLUTION IN SOIL AND PEDOFAUNA NEAR BUSY TRAFFIC ROADS IN KRAKOW

ZAWARTOŚĆ WYBRANYCH ZANIECZYSZCZEŃ KOMUNIKACYJNYCH W GLEBIE I PEDOFAUNIE PRZY RUCHLIWYCH TRAKTACH KOMUNIKACYJNYCH W KRAKOWIE

Abstract: Two sites situated by busy roads in Krakow – by Dietla Road and by a motorway – were selected to assess the effect of heavy metals on the soil environment. At the studied sites, the soil was analysed for heavy metal content – Pb, Cd, Zn and Cu, its moisture content, pH, and the diversity and density of soil fauna. It was found that the content of the studied metals was significantly lower in the soil by the motorway than in the City Centre soil, namely, Pb – twice, Cu – fivefold, Cd – insignificantly. At this site, the density of pedofauna was considerably higher than in Dietla Road. The results of the studies also indicate that, besides heavy metal content, the moisture content, which was three times higher by the motorway, significantly affected the diversity and density of pedofauna. The content of heavy metals studied by busy transport routes did not show correlation with the content of these metals in the fauna inhabiting it.

Keywords: pedofauna, soil, heavy metals, density, diversity

Heavy metals are one of the most durable and toxic contamination of the soil environment. The content of heavy metals in the soil depends on environmental conditions and anthropogenic pollutions. Due to the intensification of anthropopressure related to communication, the contamination of the soil by heavy metals has increased [1–3].

As a result of consuming of fuels, rubbing of tyres and other vehicles parts Cd, Zn and Pb get into environment.

The danger of soils contaminations related to the use of motor vehicles depends mainly on traffic intensity, distance from the roads as well as lay and use of the land [2, 3]. Trace elements systematically brought into the soil accumulate in its top layer,

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because they are bonded by the soil sorption complex and only very slowly move into the depths of the soil profile. Since heavy metals migrate very slowly in the soil, they are counted among its most persistent pollutants. In the soil environment, heavy metals demonstrate diverse mobility. Lead is strongly bonded by organic matter of soil top layer and only slightly migrates into the depth of the profile, copper is a little more mobile, and zinc relatively easily moves into the depths of the soil [4, 5].

Soils located in the immediate vicinity of busy transport routes are exposed to various transport pollutants, including heavy metals. These metals may enter the food chain with humans being part of it. That is why it is important to monitor their concentration in soils located along busy roads in urban areas.

The aim of the studies was to assess the effect of heavy metals, lead, cadmium, zinc and copper, on the environmental state of soils by busy roads in Krakow.

Materials and methods

Soil studies were carried out at sampling sites located by busy transport routes in Krakow. One was situated in the City Centre at Dietla Road (Locality II), the second one by a motorway (Locality I). At the study sites, series of samples were taken by means of a Morris frame of 25 cm × 25 cm size in the autumn season 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 FAAS method in the soil and in the pedofauna scampered away.

Dry samples of the soil and of the mesofauna were mineralized. For this purpose dry samples of the soil 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 the *atomic absorption spectrometer* (AAS – Cole-Parmer, BUCK 200A).

The correlation coefficient R^2 of the soil fauna density and the heavy metal content was calculated using linear regression.

Contaminations by Pb, Zn, Cd and Cu were evaluated according to Kabata Pendias and others [5].

Results and discussion

The studied soils differed considerably in pH, moisture content and heavy metal content (Table 1).

At site I, located by the motorway, the soil showed acid reaction (5.75) and in the City Centre, it was alkaline. There were also considerable differences in the moisture

content of the soils. At site I, moisture content was found to be almost three times higher than at site II (Table 1).

Table 1

Soil characteristics of the selected localities in Krakow

Selected parameters	Locality I	Locality II
Dampness of soil [%]	35.5 (31.9-41.5)	13.5 (12.5–15.2)
pH value of soil	5.75 (5.45–5.9)	7.21 (6.73–7.57)
Cd in the soil [mg/kg]	1.30 (1.08–1.63)	1.41 (1.01–1.95)
Pb in the soil [mg/kg]	43.96 (34.54–51.48)	105.71 (60.86–126.29)
Zn in the soil [mg/kg]	79.97 (73.80–85.92)	27.65 (7.61–62.29)
Cu in the soil [mg/kg]	11.55 (10.06–12.11)	45.011 (19.95–67.48)

Differences in Cd, Pb, Zn and Cu contents were observed at the studied sites. It was found that the total amount of cadmium, lead and copper in the City Centre soil was higher than by the motorway, whereas Zn content was more than twice lower here (Table 1 and Fig. 1).

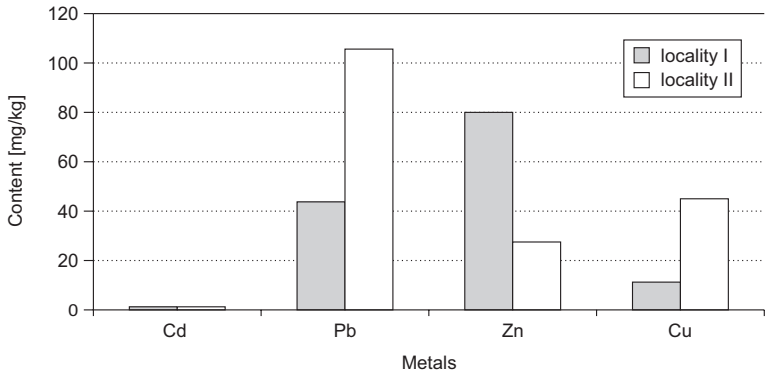

Fig. 1. Heavy metal content in the selected localities

The critical concentrations of the metals in the soils containing the anthropogenic contaminations, according to Kabata-Pendias and others [5] are: 70 mg Pb, 150 mg Zn and 1 mg Cd/kg. In the soil of the site II the exceeding of critical concentration of Pb and Cd was observed. The critical concentrations of Cd exceeded in the site I and II as well (Table 1).

An increased Cr, Ni and Cu contents in soils neighbouring busy road transport routes in urban and open areas were noticed in studies by Czarnowska et al [2] and Jarmul and Kamionek [6].

However, low concentrations of heavy metals in the vicinity of transport routes were found, among others, by Klimowicz and Melke [7] and Kolembasa et al [8].

Results concerning mesofauna and macrofauna indicate that the amount of the studied metals affects the density and diversity of pedofauna. Higher diversity and

significantly higher density was found at the site by the motorway than in the City Centre of Krakow (Table 2).

Table 2

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

Selected parameters	Locality I	Locality II
Abundance of pedofauna [sp. no. per m^2]	32064	1008
Abundance withoute *Acarina i Collembola* [sp. no. per m^2]	2768	452
Diversity (number of taxonomic groups)	16	12

The results of the analysis indicate that the effect of the studied elements, Cd, Pb and Cu, in the soil on the density of pedofauna is significant.

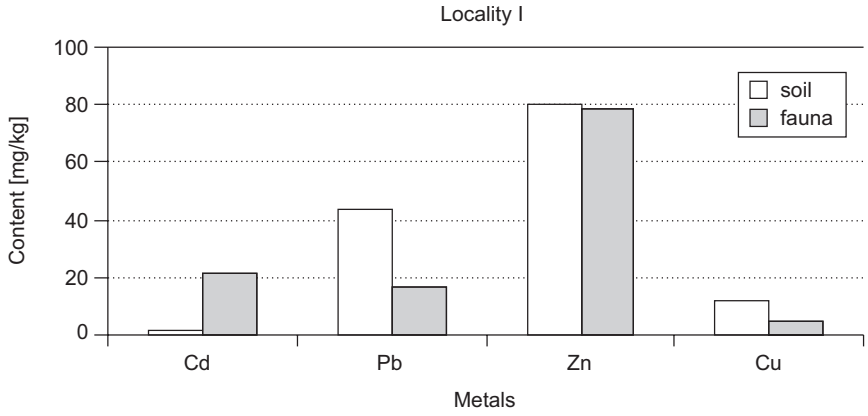

Fig. 2. Heavy metals content in the soil and in fauna by the motorway

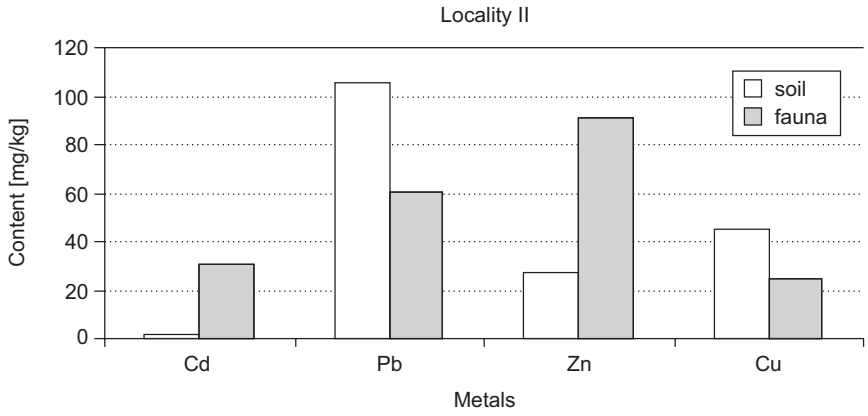

Fig. 3. Heavy metal content in the soil and in fauna in Dietla Road

The content of heavy metals studied by busy transport routes did not show correlation with the content of these metals in the fauna inhabiting it. At both sampling sites, the Cd content in the studied pedofauna was higher than in the soil, while the Pb and Cu amount was lower than in the soil (Fig. 2 and Fig. 3).

At the sampling site by the motorway, Zn content was equally high in the soil and fauna (Fig. 2).

Conclusions

1. In the studied soils located by the motorway, the contamination of the soil with Pb, Cd and Cu was found to be much lower than in the City Centre of Krakow.
2. The diversity and density of pedofauna is considerably affected by the concentration of heavy metals.
3. The density of soil fauna is also significantly affected by moisture content of the soil.
4. No direct correlation was found between Cd, Zn, Pb and Cu contents in the soil and the amount of these metals in the bodies of mesofauna inhabiting it.

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Abstrakt: Do oceny wpływu metali ciężkich na środowisko glebowe wybrano dwa stanowiska usytuowane przy ruchliwych ulicach Krakowa – przy ulicy Dietla i przy autostradzie. Na badanych stanowiskach dokonano analizy gleby pod kątem zawartości metali ciężkich – Pb, Cd, Zn i Cu, jej wilgotności, odczynu oraz różnorodności i liczebności fauny glebowej. Stwierdzono, że w glebie przy autostradzie zawartość

badanych metali ciężkich była znacznie mniejsza niż w glebie śródmiejskiej, Pb – dwukrotnie, Cu pięciokrotnie, Cd – nieznacznie. Na tym stanowisku zagęszczenie pedofauny było znacznie większe niż przy ulicy Dietla. Wyniki badań wskazują również, że na różnorodność i zagęszczenie pedofauny znaczący wpływ, oprócz koncentracji metali ciężkich, ma również wilgotność gleby, która była trzykrotnie wyższa przy autostradzie. Zawartość badanych metali ciężkich w glebie przy ruchliwych traktach komunikacyjnych nie wykazywała korelacji z ilością tych metali w faunie ją zamieszkującej.

Słowa kluczowe: fauna glebowa, gleba, metale ciężkie, zagęszczenie, różnorodność