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INFLUENCE OF SELECTED METALS ON SOIL MESOFAUNA OF GRASS HABITATS SITUATED IN DIFFERENT PLACES IN KRAKOW

WPŁYW WYBRANYCH METALI NA MEZOFAUNĘ GLEBOWĄ SIEDLISK TRAWIASTYCH W RÓŻNYCH MIEJSCACH NA TERENIE KRAKOWA

Abstrac: The researches of the four chosen grass habitats influenced by the anthropopressure of different levels were carried out in autumn (three in the center and one on the west outskirts of Krakow). The goal was to define the accumulation of Cd, Pb, Ni, Cu, Zn, Fe, and Mg in the soils of chosen areas as well as moisture, pH and temperature of the soil. The results were analyzed with regards to density and diversity of mesofauna with particular regard to *Diptera* larvae. The soils differentiate clearly in terms of the concentration of the analyzed metals. In one of the habitats in the center of Krakow where the lowest density and differentiation of both mesofauna and *Diptera* larvae were recorded, the highest concentration values of Cd, Pb, Ni, Zn, Fe and Cu were found. The research show that Cd in concentration more than three times higher on this habitat than on the others, has the biggest influence on the mesofauna number. Whereas the influence of the fact that the temperature of the soils, pH and moisture differ slightly was not detected on the density and the diversity of the mesofauna.

Keywords: soil mesofauna, soil *Diptera* larvae, abundance, diversity, metals

The anthropogenic processes such as: different branches of industry, transport, public utilities, fertilization and the use of pesticides are the main cause of the growth of toxic influence of many metals on the environment. The heavy metals deriving from these processes disperse in the environment and pollute air, water, soil and organisms. The soil pollution is considered to be the indicator of environment quality, besides, the ecological effects caused by heavy metals that pollute the soil depend not only on their quantity but also on their chemical forms, their solubility, the content of organic C and

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sorption qualities of the soil [1]. In the soils with a big content of organic matter and reaction close to neutral the metals are effectively bind and their concentration even with relatively small inflow can rise quickly. Although, when bound, heavy metals are relatively not very harmful and reveal their toxicity at the moment they become soluble forms. At low pH heavy metals are readily soluble and that are easily freed from sorption complex [2, 3]. The presence of above standard concentrations of heavy metals in organisms cause negative mutagenic, carcinogenic, teratogenic effects [3, 4] that prevent them from normal functioning. Cd, Pb, Cr, Zn, Fe and Ni are the elements with high degree of potential danger to the environment [5].

The aim of the research was detection of relations between the number of metal forms (Cd, Pb, Ni, Cu, Zn, Fe and Mg) and quantity and quality of mesofauna with particular regard to *Diptera* larvae in the soils of grass habitats in different places around Krakow.

Materials and methods

For the purpose of the evaluation of the soil contamination with heavy metals and its influence on pedofauna of four sites (three areas situated in Krakow – Srodmiescie and one on the west outskirts) were chosen:

1. the lawn situated near the Vistula river at Podgórska Street;
2. the lawn near route next to Piłsudski bridge;
3. the tree-surrounded lawn in Bednarski Park;
4. the lawn next to the forest in Krakow-Tyniec at Jurandówny Street.

The set of samples was taken on the selected localities in autumn 2007 with the use of the soil cylinder with 10 cm in diameter. The soil cylinder was thrust into the soil to the depth of 10 cm. Each series consisted of 25 samples in the area of around 1 m^2.

Mesofauna was caught by employing the dynamic method width the modified Tullgren apparatus. After marking the selected mesofauna its density and diversity were analysed. Soil moisture and its pH, its temperature as well as the content of Cd, Pb, Ni, Cu, Zn, Fe and Mg were determined.

Dry samples of the soil (2.5 g) were mineralized. For this purpose 20 ml of 65 % HNO_3 was poured over heated to the temperature of 120 °C 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 the solutions prepared in this way the content of heavy metals was determined by atomic absorption spectrometer (AAS - Cole-Parmer, BUCK 200A).

The correlation coefficient between heavy metal contents in soil and number of *Diptera* larvae were calculated with linear type of regression.

Results and discussion

Despite of some differences in pH, the analyzed soils had slightly alkaline reaction [6]. The small differences in moisture and temperature of the soils had not actual influence on the density and diversity of the mesofauna (Table 1, 3).

Table 1

Comparison of selected parameters of the soils in the selected localities in Kraków

Selected parameters	Locality 1	Locality 2	Locality 3	Locality 4
Soil moisture [%]	14.06	17.26	14.28	13.99
Soil pH [–]	6.59	7.07	7.44	7.23
Area temperature [°C]	22.3	19.9	18.6	14.0
Soil temperature [°C]	17.7	18.0	13.7	11.0

The interpretation of the results in terms of the soil pollution degree might be difficult, because there are no norms concerning pollution of the soils of grass habitats by heavy metals. The norms used for cultivated soils are based on the total content of metals [2, 7]. As the research shows, the total quantity of Cd, Pb, Ni, Zn and Fe on position no. 2 was characteristic for polluted cultivated soils (Table 2). This result indicates that there is an influence of distance from industry, routes, forested or tree-covered areas on location of the places with high heavy metals concentration in the soils.

Table 2

Contents of heavy metals in the soils of the selected localities in Krakow [mg/kg]

Metal	Locality 1	Locality 2	Locality 3	Locality 4
Cd	2.051	7.254	2.147	0.944
Pb	197.26	215.923	54.13	46.881
Ni	20.549	25.515	16.18	8.214
Cu	34.08	83.442	15.5	3.418
Zn	10.118	24.192	8.13	3.335
Fe	506.284	747.836	427.73	207.407
Mg	4212.276	3053.807	1359.70	502.575

Locality 1 – the lawn situated near the Vistula river at Podgorska street; locality 2 – the lawn near route next to Pilsudski bridge; locality 3 – the tree surrounded lawn in Bednarski Park; locality 4 – the lawn next to the forest in Krakow-Tyniec at Jurandowny Street.

As the results concerning mesofauna and *Diptera* larvae indicate, quantity of metals analyzed influences concentration of this pedofauna group. On no. 2 site, where the highest concentration of all analyzed metals, apart from Mg, was found, the lowest density of mesofauna and *Diptera* larvae was determined (Table 3).

Table 3

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

Selected parameters	Locality 1	Locality 2	Locality 3	Locality 4
Abundance of pedofauna [sp.no.per m^2]	8600	5100	6235	6389
Abundance of larvae *Diptera* [sp.no.per m^2]	725	275	1100	1125
Diversity (number of taxonomic groups)	17	13	15	18

The analysis of the results show that the influence of the analyzed elements presented in the soil on *Diptera* larvae density is significant (Table **4**).

Table **4**

The correlation coefficient between heavy metals contents in soil and number of *Diptera* larvae R^2

Metal	Cd	Pb	Ni	Zn	Fe	Mg	Cu
R^2	0.8368	0.8513	0.8012	0.9097	0.8553	0.9066	0.9686

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WPŁYW WYBRANYCH METALI NA MEZOFAUNĘ GLEBOWĄ SIEDLISK TRAWIASTYCH W RÓŻNYCH MIEJSCACH NA TERENIE KRAKOWA

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Abstrakt: Badania przeprowadzono w okresie jesiennym na czterech wybranych stanowiskach trawiastych (trzy w centrum i jedno na zachodnich obrzeżach Krakowa) będących pod wpływem różnego stopnia antropopresji.

Określono akumulację pierwiastków: Cd, Pb, Ni, Cu, Zn, Fe i Mg w glebach stanowisk, a także ich wilgotność, odczyn oraz temperaturę. Otrzymane wyniki opracowano w odniesieniu do zagęszczenia i zróżnicowania mezofauny, ze szczególnym uwzględnieniem larw muchówek *Diptera*. Gleby stanowisk zasadniczo różniły się koncentracją badanych metali. Na jednym ze stanowisk w centrum Krakowa, gdzie stwierdzono najmniejsze zagęszczenie i zróżnicowanie mezofauny, w tym również najmniejsze zagęszczenie i różnorodność larw Diptera odnotowano największą zawartość Cd, Pb, Ni, Zn, Fe i Cu. Z badań wynika, że największy wpływ na liczebność mezofauny ma kadm, którego koncentracja jest na ww. stanowisku ponad trzykrotnie większa niż na pozostałych. Nie stwierdzono natomiast wpływu niewielkich różnic w temperaturze gleb, wartości pH, a także wilgotności na zagęszczenie i zróżnicowanie mezofauny.

Słowa kluczowe: mezofauna glebowa, larwy *Diptera*, zagęszczenie, różnorodność, metale