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INFLUENCE OF THE HEAVY METALS POLLUTING THE SOIL ON THE PEDOFAUNA OF THE SELECTED PARKS IN KRAKOW

ODDZIAŁYWANIE METALI CIĘŻKICH ZANIECZYSZCZAJĄCYCH GLEBĘ NA PEDOFAUNĘ WYBRANYCH PARKÓW W KRAKOWIE

Abstract: The high density of the metals in the soil, due to its toxic influence to the microflora, plants as well as to the pedofauna (mesofauna), can negatively affect the functioning of the soil subsystem. In order to evaluate the toxicity of the metals to mesofauna of the soil 3 areas were chosen where the diversity, the number and the content of Cd, Pb, Ni, Cu, Fe and Zn in the soil were detected. The humidity, temperature and pH of the soil were also analyzed. The chosen areas were situated in 3 different city parks in Krakow. The significant differences of the Cd, Pb, Ni, Cu, Fe and Zn content as well as in the density and diversity of the mesofauna were noted. It was detected that cadmium is toxic to the mesofauna. The nickel and the zinc have the similar effects.

Keywords: pedofauna, mesofauna, diversity, abundance, heavy 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 impact of many metals on environment. The heavy metals deriving from these processes disperse in the environment and pollute air, water, soil and organisms [1, 2].

The high density of the metals in the soil, due to its toxic influence to the microflora, plants as well as to the pedofauna (mesofauna), can negatively affect the functioning of the soil subsystem.

The high content of some heavy metals in the soil can influence negatively the soil subsystem due to its toxic impact on the microflora, plants and pedofauna.

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The aim of the research was to evaluate the content of Cd, Pb, Ni, Cu, Fe and Zn and the density and diversity of soil mesofauna in the chosen localities in the parks.

Material and methods

In order to evaluate the toxicity of some metals to soil mesofauna and the density and diversity of the mesofauna 3 localities on which the soil samples were taken in 2007 were chosen. The diversity and density of the mesofauna were detected. The humidity, temperature, soil pH, and Cd, Pb, Ni, Cu, Fe and Zn content were also subjected to the analysis. The methods of taking of the samples, their number, the methods of catching the pedofauna and the way of the evaluation of the content of the metals are presented in the separated article [3]. The selected areas were situated in 3 different city parks in Krakow:

- locality I – Park in Mogila around 300 m distant from the traffic lane,
- locality II – Planty (the green zone) at Gertrudy street near the busy street,
- locality III – Bednarski Park in Podgorze around 200 m distant from the main road.

Results

The soil in the selected localities of the city park had the neutral pH – from 6.75 to 6.9 (Table 1). The small differences in the humidity and the soil temperature were detected (Table 1).

Table 1

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

Selected parameters	Locality I ^a	Locality II	Locality III
Dampness of the soil [%]	12.3	17.18	13
pH value of the soil	6.9	6.75	6.78
Temperature of air in the area [°C]	19.5	26.1	18.6
Temperature of the soil [°C]	12.4	17.5	11.9

^a Locality I – Park in Mogila around 300 m distant from the traffic lane; Locality II – Planty (the green zone) at Gertrudy street near the busy street; Locality III – Bednarski Park in Podgorze around 200 m distant from the main road.

The significant differences of the Cd, Pb, Ni, Fe and Zn contents as well as in the density and the diversity of the mesofauna were noted. The acceptable content of the metals in the soil containing anthropogenic pollutions according to Kabata-Pendias et al [4] are 70 mg Pb, 150 mg Zn and 1 mg Cd/kg. In the soil of the localities analyzed the instance of exceeding of the acceptable content of the metals was detected only in relation to lead (locality II) and cadmium (Table 2).

Table 2

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

Metal	Locality I ^a	Locality II	Locality III
	[mg/kg]		
Cd	1.896	1.893	2.784
Pb	49.623	100.835	69.207
Ni	10.119	21.155	20.544
Cu	11.01	38.189	17.038
Fe	1074.122	774.836	544.58
Zn	7.173	13.637	9.475

^a See Table 1.

The content of Cd in the soil in the localities I and II are almost equal (1.896 i 1.893 mg/kg accordingly), whereas in the soil in the III locality the highest (almost 3 times higher than the acceptable content mentioned above) Cd content and at the same time the lowest density and the diversity of the mesofauna were noted (Tables 2, 3).

Table 3

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

Selected parameters	Locality I ^a		Locality II		Locality III	
Abundance of pedofauna [sp.no.per m ²]	4280		920		510	
Diversity [number of taxonomic groups]	18		15		10	
Index of domination in the taxonomic groups [%]	<i>Acarina</i>	38.1	<i>Collembola</i>	35.9	<i>Acarina</i>	44.1
	<i>Collembola</i>	30.6	<i>Acarina</i>	21.8	<i>Collembola</i>	13.7
	<i>Thysanoptera</i>	9.7	<i>Lumbricidae</i>	11.4	<i>Chilopoda</i>	13.7

^a See Table 1.

In the soil of Mogilski Grove, as the results concerning the mesofauna reflect, the lowest concentration of Pb, Ni, Cu and Zn was detected. The highest density and the diversity of the mesofauna were detected in above-mentioned locality (Tables 2, 3). In the same locality the biggest number of iron in the soil were noted that is connected with its nearest location from the main source of emission of the Fe-metallurgic complex in Nowa Huta. However, this content of Fe has no significant impact on the mesofauna analyzed. In the soil in the locality II (near the busy road) more than 2 times bigger concentration of Pb, Ni, Zn and 3 times bigger in case of Cu in comparison with the Mogilski Grove were determined. The density of the mesofauna was 4 time smaller in the locality II than in the locality I (Tables 2, 3).

Conclusions

1. As the research data show, cadmium is toxic in relation to the mesofauna that is connected with the fact that the smallest density and the diversity were determined in the soil with the biggest Cd content.

2. The results from the locality situated near the busy road confirm the negative influence of the high concentration of Pb, Ni and Zn in relation to the pedofauna (mesofauna). The biggest density and the diversity of the fauna analyzed were found in the locality in which the smallest content of the Pb and Cd, Ni, Cu and Zn was noted.

3. The research did not show the important influence of the Fe concentration determined for the mesofauna. The statistic of the probability correlation between the content of each metal and the density of the mesofauna indicates the growth, but in case of each metal analyzed $p > 0.05$.

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Abstrakt: Zwiększona zawartość metali w glebie może niekorzystnie oddziaływać na funkcjonowanie podsystemu glebowego poprzez toksyczny wpływ na mikroflorę, rośliny, a także pedofaunę i funkcjonowanie podsystemu glebowego. W celu oceny toksyczności metali dla mezofauny glebowej wyznaczono 3 stanowiska badawcze, na których zbadano jej zróżnicowanie, zagęszczenie, a także zawartość Cd, Pb, Ni, Cu, Fe i Zn w glebie. Zbadano również wilgotność, temperaturę oraz pH gleby. Odnotowano różnice w zawartości metali ciężkich oraz w zagęszczeniu i zróżnicowaniu mezofauny. Stwierdzono także toksyczny wpływ kadmu na mezofaunę. Nikiel i cynk ma wpływ na mezofaunę podobny jak kadm.

Słowa kluczowe: pedofauna, mezofauna, zagęszczenie, różnorodność, metale ciężkie