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POTENTIALLY TOXIC METALS IN THE ONISCIDEA AND DIPLOPODA FROM BUCHAREST

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Abstract — Nine potentially toxic metals were found in samples of soil and three species of Oniscidea (*Trachelipus arcuatus*, *Cylisticus convexus*, and *Armadillidium vulgare*) and one of Diplopoda (*Megaphyllum unilineatum*) from three urban parks of Bucharest: Fe, Cu, Co, Cr, Mn, Zn, Hg, Pb, and Cd.

Key words: Toxicity, soil metals, Oniscidea, Diplopoda, Bucharest, Romania

INTRODUCTION

The term "*heavy metals*" is poorly defined and has been used inconsistently, being usually applied to the group of metals and metalloids with a specific weight greater than 4 g/cm^3. Therefore, the elements which will be investigated by us (e.g., Cd, Cr, Co, Cu, Fe, Hg, Mn, Ni, Pb, and Zn) will be addressed with the more appropriate term *potentially toxic metals* (PTM). It should be noted that some of them, which are essential nutrients in small quantities, become toxic in excess. Hence, the assessment of their bioaccumulation is vital in providing a precise evaluation of environmental wealth, a parameter strongly linked with human health and the social-economic life (Vesper, 2004).

The importance of urban areas resides in their economic, scientific, educational, and cultural values. Due to their characteristics, mainly to the patchiness of soil and vegetation and the multiple sources of pollution, these areas have a high intrinsic vulnerability to pollution and a low natural attenuation capacity. This being the case, they are the best target areas for our study.

In the present work, our intent is to give a preliminary evaluation of the PTM concentrations in some species of Oniscidea and Diplopoda from three urban parks of Bucharest. These two groups were chosen because they are among the dominant groups of the arthropod decomposer community of soil in many habitats and as such are key systemic regulators of the ecosystem functions of decomposition and nutrient recycling. As they respond quickly to environmental impact, they are potentially useful as bio-indicators (Paoletti and Hassall, 1999).

Our study shows a high degree of novelty in that it approaches an actual environmental concern, one which only recently has been addressed in Bucharest (Mihai et al., 2007). The paper represents a continuation of our previous work (Giurginca, 2006) recording the presence of 14 species of Oniscidea and four of Diplopoda – among them a species new to science from the genus *Bulgardicus* Strasser, 1966 – collected exclusively in the parks of Bucharest.

MATERIAL AND METHODS

Samples of soil were collected from three urban parks of Bucharest, namely Herăstrău Park (situated in the northern part of town), Lia Manoliu National Stadium (in the eastern part), and Tineretului Park (in the southern part) (Fig. 1).

Three species of Oniscidea (*Cylisticus convexus*, *Trachelipus arcuatus*, and *Armadillidium vulgare*) and one species of Diplopoda (*Megaphyllum unilineatum*) were collected for our study. All samples were collected during the interval June–August 2007.

Our sample preparation followed the procedure suggested by Drobne and Hopkin (1995): **1.** drying at 60^{0}C for 12 h; **2.** wet grinding; **3.** heat treatment with 65% *aqua regia* (HNO_3) (Merck) and 37% HCl (Merck); **4.** dilution with 1M HNO_3; **5.** filtering and addition of doubly distilled water to a volume of 50 mL.

Fig. 1. Locations of sampling sites in Bucharest: 1 – Herăstrău Park; 2 – National Stadium; 3 – Tineretului Park.

In order to evaluate the concentrations of Pb, Cd, Fe, Cu, Co, Cr, Mn, and Zn, an atomic absorbtion spectrometer (AAS) of the Vario 6 type (Analytik, Jena) was used. A DMA 80 Hg analyzer (Millestone, Italy) was used for Hg.

The preparatory operations – plotting of calibration curves and optimization of the working conditions – were done with Merck standard solutions (1000 mg/l for each element).

RESULTS AND DISCUSSION

During the sampling period, nine PTM were found: Fe, Cu, Co, Cr, Mn, Zn, Hg, Pb, and Cd. Their concentrations in each sampled park will be discussed separately. Table 1 gives the concentrations of PTM in Tineretului Park.

The highest concentrations of Hg and Cd in soil were recorded in Tineretului Park. Also, this is the park with the highest concentration of Hg in *A. vulgare* and

Table 1. Concentrations of PTM in Tineretului Park.

Sample	Concentration (mg/g)						Concentration (µg/g)		
	Fe	Cu	Co	Cr	Mn	Zn	Hg	Pb	Cd
Soil	-	-	-	-	-	-	0.40	19.40	0.50
Trachelipus arcuatus	0.75	0.18	0.012	0.22	0.06	0.22	0.70	2.04	0.53
Armadillidium vulgare	1.00	0.26	0.017	0.17	0.072	0.15	0.33	7.50	0.26
Cylisticus convexus	1.17	0.21	0.012	0.07	0.083	0.075	0.34	7.46	0.20

C. convexus. The results of our tests for the Lia Manoliu National Stadium are presented in Table 2.

The National Stadium is the park with the highest concentration of Pb in soil. Similarly, it represents the park with the highest concentrations of Pb and Cd in *A. vulgare* and *C. convexus*.

Table 2. Concentrations of PTM in the National Stadium.

Sample	Concentration (mg/g)						Concentration (µg/g)		
	Fe	Cu	Co	Cr	Mn	Zn	Hg	Pb	Cd
Soil	-	-	-	-	-	-	0.11	48.08	0.25
Armadillidium vulgare	0.645	0.23		1.18		1.35	0.27	14.74	1.00
Cylisticus convexus	0.433	0.34		0.64		1.29	0.30	17.16	0.67

The concentrations of PTM in Herăstrău Park are presented in Table 3.

In Herăstrău Park, we recorded nearly the same concentrations of Pb, Hg, and Cd in soil (and also in A. *vulgare*) as in the National Stadium.

Table 3. Concentrations of PTM in Herăstrău Park.

Sample	Concentration (mg/g)						Concentration (µg/g)		
	Fe	Cu	Co	Cr	Mn	Zn	Hg	Pb	Cd
Soil	-	-	-	-	-	-	0.08	46.75	0.20
Megaphyllum unilineatum	0.47	0.96		0.4		0.23	0.10	9.03	0.08
Armadillidium vulgare	0.66	0.40		0.06		1.5	0.15	11.50	0.66

Much attention has been paid in recent years to pollution caused by lead, mercury, and cadmium (ARB, 1997; OEHHA, 2000). We therefore focused our attention mainly on evaluating their concentration in the investigated taxa, as all three metals are known to be systemic pollutants with no biological functions. However, after penetrating the body, they lead to specific injuries to different organs and systems, even at very low concentrations (Mihai et al., 2007). We compared the mean concentrations of mercury, lead, and cadmium in the sampled taxa in order to evaluate their bioavailability.

As can be seen from Fig. 1, the highest mercury concentration was found in

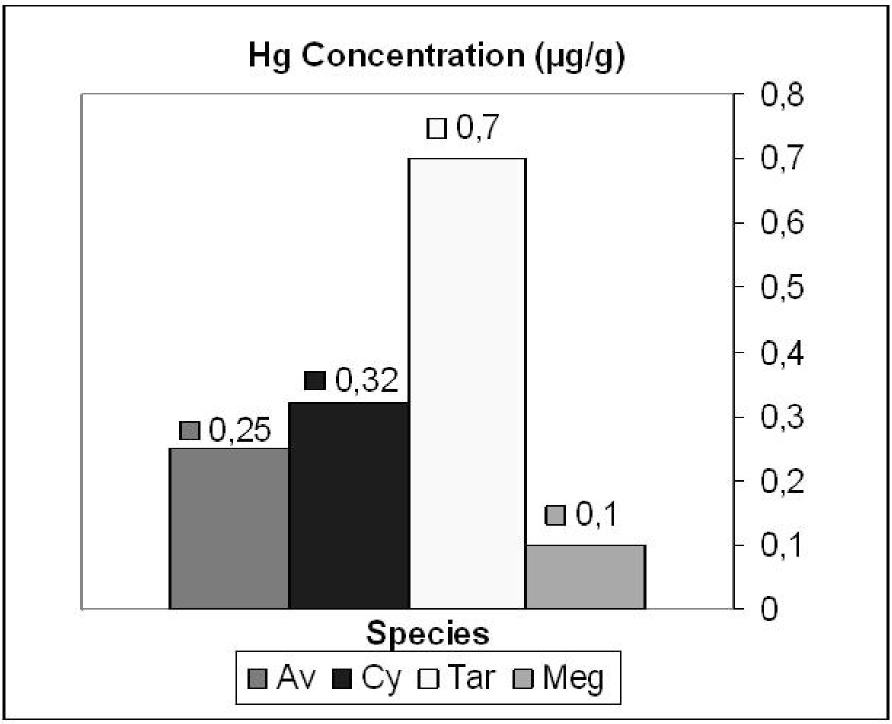

Fig. 2. Mercury concentrations in Av – *Armadillidium vulgare*, Cy – *Cylisticus convexus*, Tar – *Trachelipus arcuatus*, and Meg – *Megaphyllum unilineatum*.

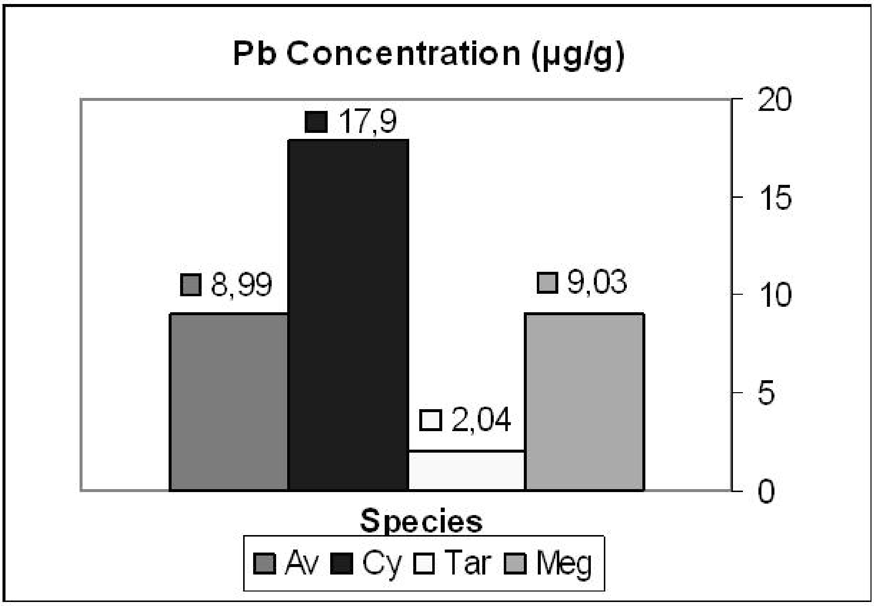

Fig. 3. Lead concentrations in Av – *Armadillidium vulgare*, Cy – *Cylisticus convexus*, Tar – *Trachelipus arcuatus*, and Meg – *Megaphyllum unilineatum*.

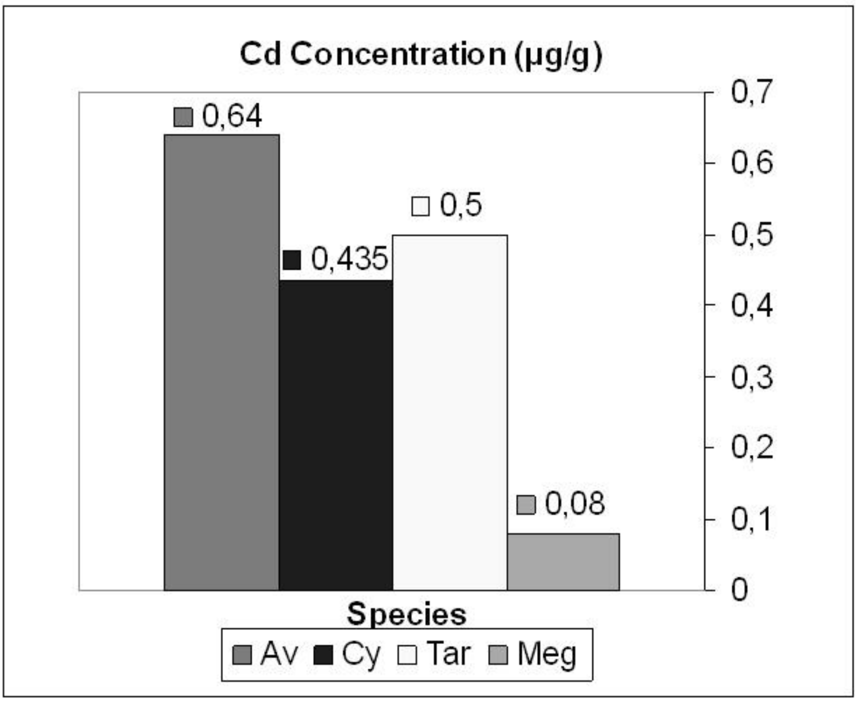

Fig. 4. Cadmium concentrations in Av – *Armadillidium vulgare*, Cy – *Cylisticus convexus*, Tar – *Trachelipus arcuatus*, and Meg – *Megaphyllum unilineatum*.

T. arcuatus, followed by *C. convexus* and *A. vulgare*, while *M. unilineatum* had the lowest level of bioaccumulation.

On the contrary, the highest lead concentration was recorded in *C. convexus*, followed by *M. unilineatum* and *A. vulgare* (see Fig. 2). Significantly, both *C. convexus* and *M. unilineatum* were collected in a park, but near a major road with heavy traffic.

For cadmium, the highest concentration was found in *A. vulgare*, followed by *T. arcuatus* and *C. convexus* (see Fig. 3).

As far as the other metals are concerned, the highest levels of zinc, chromium, and cobalt were found in *A. vulgare*. As for iron and manganese, the highest concentrations were recorded in *C. convexus*, while the highest level of copper was found in *M. unilineatum*. The lowest concentrations of zinc, chromium, cobalt, iron, manganese, and copper were identified in *T. arcuatus*.

The obtained data indicate the highest levels of bioaccumulation in *A. vulgare* (for four metals out of nine sampled) and *C. convexus* (for three out of nine), while the lowest ones were recorded in *T. arcuatus* and *M. unilineatum* (for one metal out of nine in each species). Excepting cobalt and manganese, which were not found in *M. unilineatum*, all the other metals were present in the sampled taxa.

At the present level of our investigations, we can say that *Cylisticus convexus* may be useful in assessing contamination with lead, mercury, iron, and manganese; *Trachelipus arcuatus* can be used to assess contamination with mercury and cadmium; while *Armadillidium vulgare* may be useful in assessing contamination with cadmium and, due to its presence in almost all types of habitat, the contamination with lead, mercury, zinc, and cobalt.

CONCLUSIONS

Nine potentially toxic metals were found in samples of soil and three species of Oniscidea and one of Diplopoda from three urban parks of Bucharest: Fe, Cu, Co, Cr, Mn, Zn, Hg, Pb, and Cd.

For the next level of our study, we intend to collect samples of soil and the same species of Oniscidea and Diplopoda every month in order to investigate variation of PTM concentrations throughout the year.

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