OCCURRENCE OF RISK ELEMENTS CADMIUM AND LEAD IN SMALL TERRESTRIAL MAMMALS IN UPPER NITRA REGION

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Abstract
The content of accumulative metals cadmium and lead was investigated in fresh parenchymal organs (liver and kidney) of small terrestrial mammals (Apodemus sylvaticus, Micromys minutus, Sorex araneus and Myodes glareolus) from the area of Upper Nitra region. ET-AAS method was used for analysis of total content of these risk elements. The content of Cd ranged from 0.093 mg.kg^{-1} in liver, and 0.048 mg.kg^{-1} in kidney. Mean accumulation of Pb in the fresh tissues was 0.714 mg.kg^{-1} (liver) and 0.024 mg.kg^{-1} (kidney). In 15 cases content of Cd or Pb exceeded limits set for wild animals (game). Herbivorous species had more limit exceeding values in lead accumulation in liver on the Koš area, and shrews showed the most limit exceeding values in accumulation of cadmium on the both trapping localities. The highest content of the metals was found on the locality Koš – near dunghills, where the accumulation of Pb in liver achieved value 4.86 mg.kg^{-1}.

Keywords: lead, cadmium, liver, kidney, small terrestrial mammals, Upper Nitra region

1 Introduction

Region of Nitra (Ponitrie) belongs to the most polluted regions, loaded by anthropogenic activities (mining, chemical industry, power plant, agriculture). Good evidence for monitoring and evaluation of pollution impact provides bioaccumulation ability of organisms.

The aim of the work was to evaluate occurrence and bioaccumulation of selected risk elements (cadmium and lead) in small terrestrial mammals trapped from two natural areas. Accumulative metals cadmium and lead were investigated in fresh parenchymal organs (liver and kidney) of small terrestrial mammals (*Myodes glareolus, Apodemus sylvaticus, Micromys minutus* and *Sorex araneus*) from the area of Upper Nitra. Determination was done by ET-AAS method. Small terrestrial mammals are considered as sentinels for anthropogenic load of land.

2 Characterisation of trapping localities

2.1 Koš wetlands and surrounding

Wetlands in Koš area (1358 ha) were created in depression after mining activities. The area belongs to Upper Nitra endangered area. Koš wetlands present a new phenomenon in the land (area of 6-8 ha with natural regeneration of willows, poplars and macrophyte vegetation), which enhances land diversity, and which are important from the biodiversity point of view. Future of these valuable secondary biotopes is very uncertain; therefore the company responsible for their formation by the mining process is required according to law to perform the recultivation of area affected by mining activities.

Theriological investigation was realized on several localities: river Nitra, behind the lake 7, stack of straw - dunghills, stream, stream 2, canal), which were characterized with the

following biotopes: stem vegetation in backwater and swamps, fragments of willow-poplar vegetation, canals, abandoned grove of fruit, field margins and stack of straw (Ružičková et al., 1996).

2.2 Rokoš and close surrounding

European important area Rokoš is located in Trenčín region, districts Prievidza and Bánovce nad Bebravou. Studied area was located in south-eastern part of Strážovské vrchy. Southern border of the area of interest presents Hornonitrianska kotlina, eastern border is Malá Magura and stream Nitrica. Western border presents stream Bebrava. The area of interest belongs to geomorphological unit Strážovské vrchy, subunit Nitrické vrchy and part Rokoš.

Trapping of small terrestrial mammals was performed on the following localities: Jankov vŕšok, square 2 (oak-hornbeam forest); Látkovce (scrub vegetation with *Prunus spinosa*); Nitrianske Sučany 2 (glade vegetation); Kostolná hora (glade vegetation); Ješkova Ves nad Nitricou (riparian vegetation) (Ružičková et al., 1996).

3 Material and methods

3.1 Sample preparation

Small terrestrial mammals – herbivorous and carnivorous were trapped according to standard trapping methods. Caught small terrestrial mammals' species were as follows: *Sorex araneus* Linnaeus, 1758; *Apodemus sylvaticus* (Linnaeus, 1758); *Myodes* (*Clethrionomys*) *glareolus* (Schreber, 1780); *Micromys minutus* (Pallas, 1771). Samples were prepared using standard procedures and standards. Fresh tissues were wet digested at 140°C in the mixture of HNO_3 and H_2O_2 in high-pressure vessels (type ZA-1) for 120 min (Baláž et al., 2009).

3.2 Determination of total Cd and Pb by ET-AAS technique

Determination was done by atomic absorption spectrometry equipped by electrotermal atomisation (ET-AAS) on SpectrAA-200 apparatus. For ET-AAS technique, cadmium and lead hollow cathode lamps operate at a wavelength of 228.8 nm and 217.0 nm, respectively. Atomizing environment was graphite cell heated to 2600 °C, floated solution was HNO_3 (1 %) and modifier was ortophosphoric acid 0.1 %. Both methods used were optimalized and subjected for validation. The results from validation showed that limits of detection (LOD) were 0.0045 mg Cd $.kg^{-1}$ and 0.0046 mg Pb $.kg^{-1}$ and limits of quantitation (LOQ) were 0.0107 mg Cd $.kg^{-1}$ and 0.0138 mg Pb $.kg^{-1}$.

3.3 Evaluation of results

Calculation of results was done in Excel program and the results were compared with the limit values for the heavy metals in fresh tissue of wild animals – game, which are published in Food codex (www.svssr.sk) as follows: Pb = 1.0 mg/kg and Cd = 0.1 mg/kg.

4 Results and discussion

Cadmium (Cd) is nonessential element with high migration ability in food chain (Hunter et al., 1987). It belongs to accumulative poisons and its content in organism increases during the life (Toman et al., 2003). The main exposure ways of Cd intake are inhalation from air and intake from food. Distribution of Cd in tissues of small terrestrial mammals was in order: kidneys > liver >> muscles (Lodenius et al., 2002). Cd shows cancerogenous effects, high exposure affects hypertensis and decalcification of bones. Epidemiologic approach uses the Cd analysis of hair, which is proposed test for Cd exposure (Prousek, 2005).

Lead (Pb) is the most common heavy metal, which markedly accumulates in sediments, sludge, moreover in microorganisms and plants (Prousek, 2005). Human organism can absorb Pb mostly via air, fewer via food and skin (Makovníková et al., 2006). The highest Pb concentration in animals was found in liver, kidneys, spleen, bones, bone marrow and in muscles. Over 90 % of absorbed Pb is transported to bones (Ma, 1989). Pb has neurotoxic effect on organism and becomes a potential carcinogen (Toman et al., 2003).

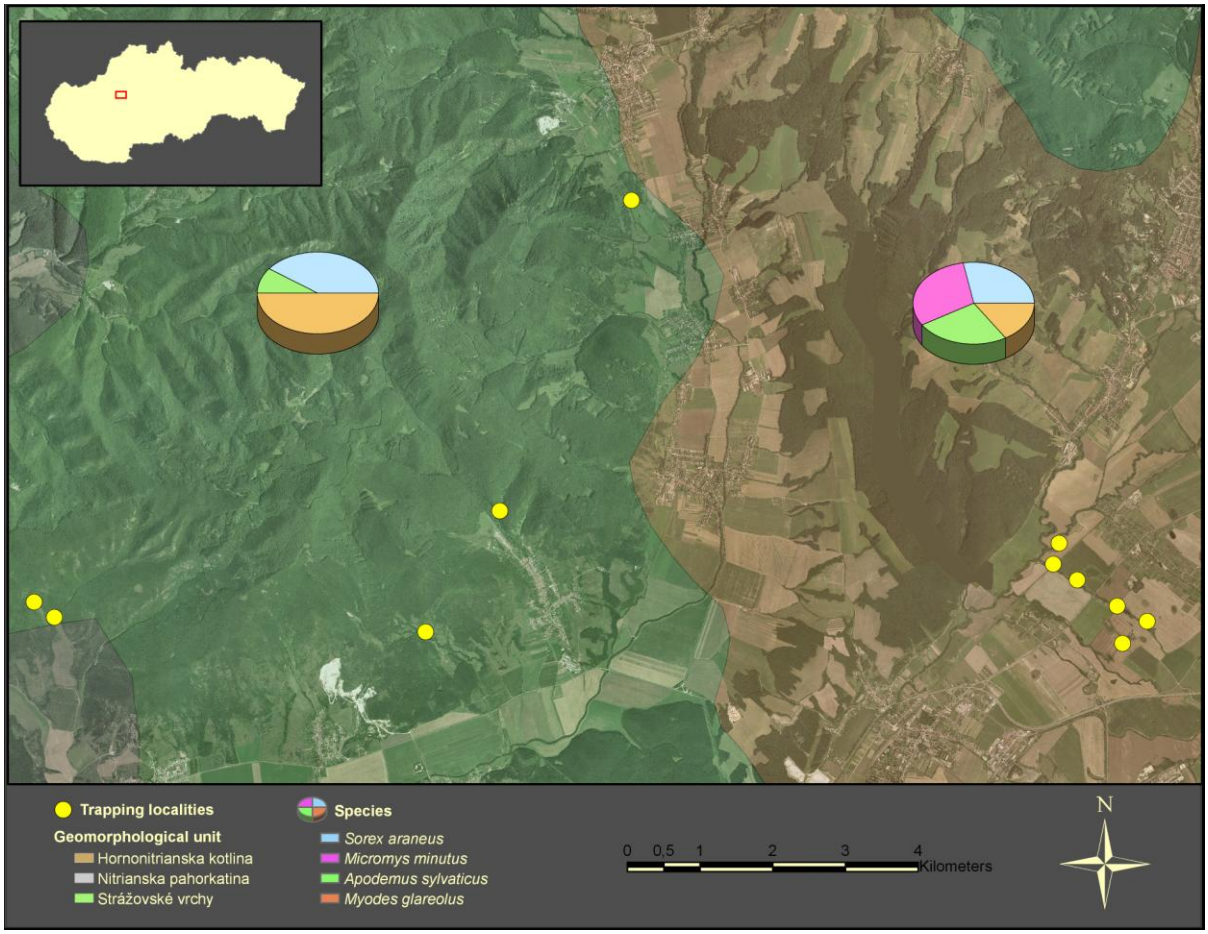

Fig. 1 Trapping localities (Jakab, 2010)

The study was done in two natural areas (Fig.1). The results are showed in tables 1 and 2. More polluted was Koš, which has higher impact of industry and agriculture.

Table 1 Content of Cd and Pb in fresh liver

Examined species	Koš				Rokoš			
	Cd [mg/kg]		Pb [mg/kg]		Cd [mg/kg]		Pb [mg/kg]	
	mean	s_d	mean	s_d	mean	s_d	mean	s_d
Apodemus sylvaticus	0.014	0.012	2.105	2.109	0.052	–	–	–
Sorex araneus	0.168	0.088	0.577	0.390	0.319	0.247	0.056	0.048
Myodes glareolus	0.007	0.006	2.149	1.252	0.056	0.072	0.091	0.106
Micromys minutus	ND	–	1.121	0.694	–	–	–	–

s_d – standard deviation, ND – not detected

The mean content of Cd and Pb in liver was 0.008 mg/kg and 1.514 mg/kg for herbivorous species, and 0.168 mg/kg and 0.577 for shrews from the Koš area. Mean accumulation of Cd

in liver and kidney from herbivorous species, trapped on Rokoš area, 0.052 mg/kg, and 0.037 mg/kg in kidney. Lead accumulation in shrews from Rokoš was 0.056 mg/kg in liver and 0.064 mg/kg in kidney. The highest contents of the metals were found on locality Koš – near dunghills, where the accumulation of Pb in liver of *A. sylvaticus* achieved value 4.86 mg/kg.

Table 2 Content of Cd and Pb in fresh kidney

Examined species	Rokoš			
	Cd [mg/kg]		Pb [mg/kg]	
	mean	s_d	mean	s_d
Apodemus sylvaticus	ND	–	0,007	–
Sorex araneus	0.131	0.092	0.064	0.106
Myodes glareolus	0.043	0.028	0.010	0.016

s_d – standard deviation, ND – not detected

In 15 cases the content of Cd or Pb exceeded limits set for wild animals (game). Herbivorous species (*A. sylvaticus*, *M. glareolus*, and *M. minutus*) originated from the area of Koš showed limit exceeding accumulation in liver in seven cases (table 3). On the other hand, no limit exceeding values of cadmium in both tissues were observed in these species. Shrews showed higher accumulation of cadmium on the both trapping areas. Individuals originated from Koš had limit exceeding values in liver, and those from Rokoš showed high Cd levels in liver and kidney, as well. There was no limit exceeding value of investigated metals in the tissues of herbivorous species, trapped in Rokoš area.

Table 3 Number of cases exceeding limits for Cd and Pb content in wild animals (game)

Examined species	Koš				Rokoš			
	Cd		Pb		Cd		Pb	
	liver	kidney	liver	kidney	liver	kidney	liver	kidney
Apodemus sylvaticus	0	0	2	0	0	0	0	0
Sorex araneus	3	0	0	0	4	3	0	0
Myodes glareolus	0	0	2	0	1	0	0	0
Micromys minutus	0	0	3	0	0	0	0	0

5 Conclusions

Investigation of accumulation of heavy metals in the tissues of selected small terrestrial mammals was used as a preliminary study of potential metal contamination of wild animals. Our results confirmed the correlation between contamination by heavy metals and occurrence of the metals in parenchyma tissues, moreover we could see the different contamination in species, belonging to different food chain levels. Seeing that the small terrestrial mammals present wide spread group of animals, which could be used in estimation of environmental pollution by contaminants.

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