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# THE CONTENT OF RISK ELEMENTS IN BONES OF BANK VOLE (*MYODES GLAREOLUS*) AND WOOD MOUSE (*APODEMUS SYLVATICUS*) FROM KOLÍŇANY AREA (SLOVAKIA)

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**ABSTRACT**

The content of selected risk elements (Fe, Cu, Zn, Ni, Mg, Na, K) in the femora of bank vole (*Myodes glareolus*) and wood mouse (*Apodemus sylvaticus*) from Kolíňany area (Slovakia) which is characterized by a high degree of environmental pollution was investigated in the present study. The rodents were trapped in this locality in February 2011. Higher concentrations of Mg and Na were detected in the bones of wood mouse in comparison with those of bank vole ($P<0.05$). Moreover, the concentrations of Cu, Zn and Ni were significantly higher in the bones of both species in our study in comparison with the values which were obtained in the same animal species on the same site in February 2007. Therefore, our results demonstrate increased accumulation of these elements in the femora of *Myodes glareolus* and *Apodemus sylvaticus* and thus give an evidence of still ongoing contamination of this locality.

**Keywords:** Risk elements. Bone. Bank vole. Wood mouse. Atomic absorption spectrophotometry.

## INTRODUCTION

Many investigations have been performed to determine risk elements accumulation in selected organs of various animal species (Stawarz *et al.,* 2003; Jancova *et al.,* 2006; Kolesarova *et al.,* 2008; Gasparik *et al.,* 2012). In general, rodents are ideal for monitoring environmental pollution as well as for evaluating the exposure risk for people living in contaminated areas. The bank vole (*Myodes glareolus,* formerly *Clethrionomys glareolus*) is a small microtine rodent that is common throughout Europe and it is one of the most common woodland rodents in Slovakia. Seeds, fruits and green vegetation constitute about 44% of their food, insects, earthworms and other invertebrates between 9 and 23%, depending on the season, and in winter they add tree bark to their food (Zemanek 1972; Gdula-Argasinska *et al.*, 2004). This species has been used to monitor environmental pollution from a variety of technogenic sources up to date (Milton *et al.,* 2003; Topolska *et al.,* 2004). The wood mouse (*Apodemus sylvaticus*) belongs to the most dominant rodent species in Slovakia. The diet of the wood mouse consists of roots, grains, seeds, berries, nuts, grasses, grain kernels, fruits and insects (Nowak, 1991). The content of many elements in various organs has also been investigated in this species (Milton *et al.,* 2002; Milton *et al.,* 2004).

Since bone can serve as a good biomarker of long-term accumulation of various xenobiotics, we analysed concentrations of selected risk elements (Fe, Cu, Zn, Mg, Na, K) in the femora of two rodent species: bank vole and wood mouse. The rodents were trapped at

Kolíňany area (Slovakia) which is considered as a heavily polluted region. Research to identify concentration of various risk elements in the bones of *Myodes glareolus* and *Apodemus sylvaticus* was carried out in this locality also in February 2007 and the results demonstrated higher concentrations of Pb, Fe, Cu and Zn in bones of bank voles from the Kolíňany site as compared to those from the Nováky site (Martiniaková *et al.,* 2011). Also, higher content of Ni and Zn was found in the femora of wood mouse from Kolíňany locality in comparison with Nováky area (Martiniaková *et al.,* 2010). So, in addition to the determination of risk elements content in the femora, we compared the present results with those obtained four years ago.

**MATERIALS AND METHODS**

The individuals of bank vole (*Myodes glareolus,* n=12) and wood mouse (*Apodemus sylvaticus,* n=7) were obtained by means of the standard teriological methods and procedures from wood ecosystems (Jančová *et al.,* 2006) in February 2011. The rodents were trapped near the water pond in Kolíňany (Nitra district, Slovakia; Figure 1) which is located approximately 100 km far from the town Nováky and it is considered to be a heavily polluted region. All animals used in the experiment were adult (4-5 months old), in good physical condition, without pathological-anatomical changes.

The concentrations of selected risk elements (Fe, Cu, Zn, Ni, Mg, Na, K) were determined in both femora of investigated rodents (n=38) with the method of atomic absorption spectrophotometry (Perkin Elmer 4100 ZL) in a graphite furnace (Stawarz *et al.,* 2003). The tissue samples were kept at -18° C until analysis. In the laboratory the samples were dried at 105ºC until dry mass was obtained. Then, the bones were weighed (minimum 2 g) and digested in concentrated nitric acid at 90º C for 10 hours. Before the analysis, the samples were diluted to 25 ml with distilled water. All metal concentrations were expressed on a dry weight basis in $mg.kg^{-1}$. From the final data, basic statistical characteristics were calculated (mean, standard deviation, minimum, maximum, median). Since the distribution of observed levels of risk elements was normal according to Shapiro-Wilk test, the parametric T-test was used for species comparisons. T-test was also applied for comparison of our data with those obtained in February 2007 (Martiniaková *et al.,* 2010, 2011).

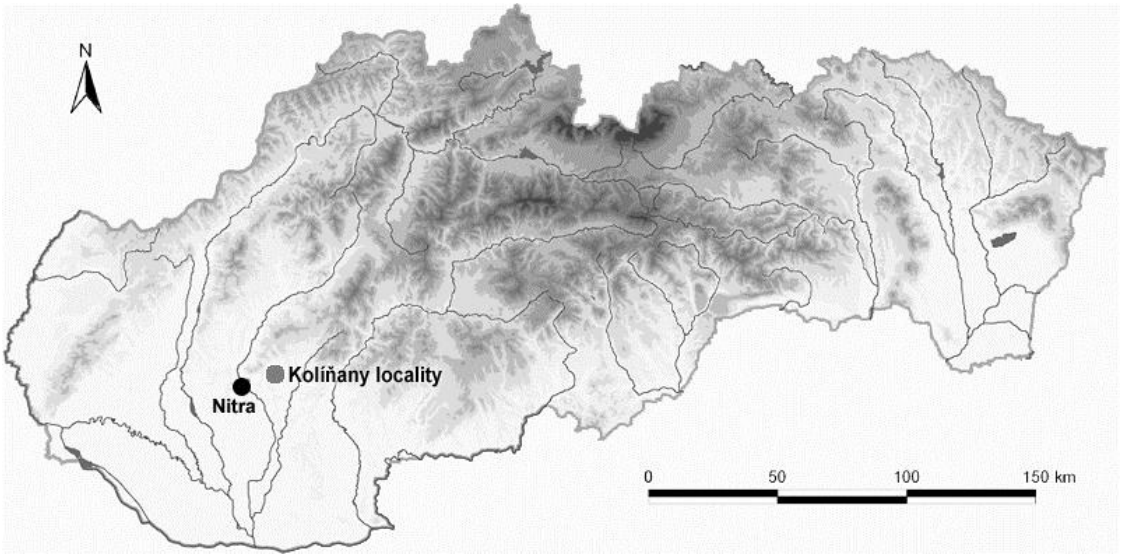


*Figure 1*

**Map of investigated locality.**

**RESULTS AND DISCUSSION**

The concentrations of selected risk elements (Fe, Cu, Zn, Ni, Mg, Na, K) in the femora of *Myodes glareolus* and *Apodemus sylvaticus* from Kolíňany area are listed in Table 1. Higher concentrations of all investigated elements were detected in the bones of wood mouse; however, significant differences were observed only for concentrations of Mg and Na ($P<0.05$). We observed higher concentrations of Zn in the femora of *Myodes glareolus* compared with the data reported by Milton *et al.* (2003). These investigators analysed Zn concentration ($173 \pm 5.1$ μg $g^{-1}$ dry weight) in the femora of bank voles trapped at the contaminated, unused Pb mine at Frongoch in west Wales. In contrast, Zn concentration in the femora of bank voles from Kolíňany area was lower as value reported by Milton and Johnson (1999) who analysed femora of laboratory-bred bank voles exposed to increased levels of dietary Zn.

The concentrations of Cu, Zn and Ni were significantly higher in the bones of both species *Myodes glareolus* and *Apodemus sylvaticus* in our study in comparison with the values which were obtained in the same animal species on the same site (Kolíňany) in February 2007 (Table 2). In addition, the bones of wood mouse also included a significantly higher content of Fe as compared to the value from 2007. Therefore, our results demonstrate increased accumulation of these elements in the femora of both rodents investigated and thus give an evidence of still ongoing contamination of this locality. This fact can be explained by intensive agricultural production and subsequent contamination of soil, water, and food, by road traffic pollution as well as by various factories in industrial zones in western Slovakia known from the history affecting also nowadays situation (e.g. production of Ni in Sereď and its damping place, Gasparik *et al.,* 2012). Intensive agricultural production and the use of chemicals are characteristic for the whole region of Nitra. It is generally known that an application of agricultural chemicals can lead to a higher accumulation of specific elements, including Fe, Cu and Zn into the soil. In addition, there is heavy road traffic near the capture locality, which is also considered to be a significant source of risk elements that have a potential ability to be transported by air flow over large distances. There is also a possibility of falling dust being transported in the air from large industrial regions, such as Bratislava, Vienna, Budapest, or factories nearby Nitra region. This hypothesis may be supported by studies indicating the possibility of the long range transportation of various xenobiotics (Coggins *et al.,* 2006).

**CONCLUSION**

The accumulation of selected risk elements (Fe, Cu, Zn, Ni, Mg, Na, K) in the femora of bank vole (*Myodes glareolus*) and wood mouse (*Apodemus sylvaticus*) from Kolíňany area was investigated in the present study. We detected higher concentrations of Mg and Na in the bones of wood mouse in comparison with those of bank vole ($P<0.05$). The concentrations of Cu, Zn and Ni were significantly higher in the bones of both species in our study in comparison with the values which were obtained in the same animal species on the same site four years ago. Our results give an evidence of still ongoing contamination of this locality.

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*Table 1*

**The concentrations of selected risk elements in the femora of *Myodes glareolus* and *Apodemus sylvaticus* from Kolíňany area.**

| Species | | Fe | Cu | Zn | Ni | Mg | Na | K |
|---|---|---|---|---|---|---|---|---|
| | | (mg.kg$^{-1}$) | | | | | | |
| *Myodes glareolus* (1) | x | 197.26 | 62.63 | 241.73 | 26.94 | 3621.17 | 2009.03 | 4494.19 |
| | sd | 67.36 | 19.45 | 19.28 | 5.59 | 930.98 | 160.99 | 1360.8 |
| | min | 123.24 | 42.08 | 217.74 | 19.26 | 2520.95 | 1842.77 | 3001.16 |
| | max | 286.58 | 88.79 | 268.94 | 32.06 | 4954.51 | 2219.02 | 6269.48 |
| | med | 197.92 | 61.8 | 245.03 | 29.21 | 3417.08 | 2005.39 | 4106.39 |
| *Apodemus sylvaticus* (2) | x | 215.46 | 68.78 | 244.74 | 30.79 | 4458.25 | 3414.29 | 5181.79 |
| | sd | 44.78 | 13.58 | 46.58 | 20.21 | 1054.46 | 767.41 | 656.43 |
| | min | 171.68 | 52.82 | 196.79 | 9.32 | 3603.09 | 2932.01 | 4370.7 |
| | max | 277.32 | 85.34 | 294.54 | 58.09 | 5880.7 | 4555.29 | 5716.8 |
| | med | 206.41 | 68.49 | 243.81 | 27.87 | 4174.6 | 3084.93 | 5319.83 |
| T - test | | | | | | + | + | |

x – mean, sd – standard deviation, min – minimum, max – maximum, med – median, P<0.05 (+)

*Table 2*

**Comparison of Fe, Cu, Zn and Ni concentrations in the femora of *Myodes glareolus* and *Apodemus sylvaticus* with those obtained by Martiniaková et al. (2010, 2011).**

| Species / study | | Fe | Cu | Zn | Ni |
|---|---|---|---|---|---|
| | | (mg.kg$^{-1}$) | | | |
| *Myodes glareolus* – present study | x | 197.26 | 62.63 | 241.73 | 26.94 |
| | sd | 67.36 | 19.45 | 19.28 | 5.59 |
| *Myodes glareolus* – study of Martiniaková et al. (2011) | x | 212.99 | 4.16 | 188.55 | 9.52 |
| | sd | 52.27 | 2.1 | 21.61 | 2.8 |
| | T - test | | + | + | + |
| *Apodemus sylvaticus* – present study | x | 215.46 | 68.79 | 244.74 | 30.79 |
| | sd | 44.78 | 13.58 | 46.58 | 20.21 |
| *Apodemus sylvaticus* – study of Martiniaková et al. (2010) | x | 109.1 | 3.33 | 147.55 | 7.8 |
| | sd | 35.61 | 1.06 | 13.35 | 0.84 |
| | T - test | + | + | + | + |

x – mean, sd – standard deviation, P<0.05 (+)

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