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Metal Concentrations in Tissues of Common Hamsters (*Cricetus cricetus* [L.]) from an Agricultural Area in Germany

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Common or European hamsters are typical inhabitants of the Palaearctic steppe zone and have adapted themselves very well to arable land, especially grain fields (Smit and Wijngaarden 1981). The reasons for the decline of the common hamster in Germany and Western Europe have been strongly linked to changes in agricultural practice (Backbier et al. 1998). The use of pesticides, especially, has often been discussed as a possible reason for the decline and reduced reproduction rates (inter alia Wendt 1984; Backbier et al. 1998). E.g. mercury, an important compound of pesticides in former times, was supposed to increase mortality during hibernation in common hamsters (Wendt 1984). In a previous study, however, it was shown that persistent organochlorine residues in the hamster are very low at present, mostly around the edge of the detection limit (Kayser et al. 2001). Therefore they have been classified as not dangerous to the hamster or its fertility (Kayser et al. 2001). The aim of this study was to describe the concentrations of some potentially important pollutants, like mercury and other heavy metals, in the tissues of common hamsters from Saxony-Anhalt.

MATERIALS AND METHODS

Femoral muscle (n=15) and kidney samples (n=11) from the carcasses of common hamsters were collected between 1995 and 1998. With one exception, all hamster samples came directly from or adjacent to the landscape Magdeburger Börde, one of the main distribution areas for this species in Germany. Intensive farming is typical in this area. The burrow density after hibernation which represents the density of adult hamsters varies between nearly zero up to 2 animals/ha locally, in the mean 0.5 to 1 individual/ha. The animals had been killed by traffic, agricultural means, or by birds of prey and carnivores. Most carcasses were found during an ecological study with the help of radio telemetry. They were dissected at the Institute of Zoology of the Martin-Luther-University Halle-Wittenberg. Juvenile and adult hamsters could be distinguished by weight and body length.

Muscle and kidney samples were analyzed for Pb (lead), Cd (cadmium), Hg (mercury) and Cu (copper) in the laboratory of the state veterinary and food research department in Stendal, Saxony-Anhalt. This laboratory is accredited by the notified accreditation agency. The detection limit in all tissue samples ranged

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from 0.001 mg/kg (Hg), 0.002 mg/kg (Cu, Pb) to 0.005 mg/kg (Cd). All samples were prepared by the application of pressure, following method § 35 of the German LMBG law (method no. 00.00-19/1) and using standard detection methods. Copper levels were determinated by flame atomic absorption spectrometry, using the AAS 4100 (Perkin-Elmer) apparatus (LMBG method no. 00.00-19/2); lead and cadmium levels were detected by atomic absorption spectrometry in a graphite tube on an AAS 4100 Tl (Perkin-Elmer) (LMBG method no. 00.00-19/3). Mercury analysis was carried out on a FCAS-AAS 4100 (Perkin-Elmer) using cold steam atomic spectrometry (LMBG method no. 00.00-19/4). All methods were according to the European commissions standard reference methods for the analysis of residues of heavy metals and arsenic from 26.06.1990 (90/515/EWG). Two reference-materials spiked with heavy metals (producer Dr. Ehrenstorfer GmbH, Augsburg) were determined in each charge of analysis (=12 samples). The analysis-charge is correct, if the concentration of the known heavy metals is found in the range of the median ± two standard deviation. The recoveries varied between 90 and 110 %.

RESULTS AND DISCUSSION

Residues of heavy metal and copper were detected in all muscle and kidney samples of the common hamster from Saxony-Anhalt. All analyzed metals were found in all kidney and seven muscle samples. In seven of the 15 muscle samples, no cadmium could be detected, in four no mercury and in one no lead. Due to accumulation, the metal concentration found in the kidneys was higher than in the muscle samples. But higher values in the kidney were not correlated with higher values in the muscle sample of the same animal and vice versa. Altogether, mercury and cadmium concentrations were low, and in all muscle samples near the edge of the detection limit (Figure 1). Also the maximum values were low compared to background values of German agricultural loess soils (Utermann et al. 1999) and may be a reflection of the ubiquitous distribution of heavy metals in German agricultural soils.

There was found to be no significant correlation between age and metal concentration. However, kidney samples of adult hamsters (n = 7) had a higher cadmium and a slightly higher mercury concentration than those of juveniles (n = 4). Because of the low sample size, this effect is not statistically significant.

Lead and its compounds are extremely toxic (Falbe and Regitz 1995). Concentrations in organs between 5 and 10 mg/kg dry weight are considered to be significant and a sign of lead toxification in racoons (Diethers and Nielsen 1978). All other values for acute toxification of or critical concentrations in mammalian tissue are even higher (summary in: Gutleb 1995). Cadmium and its compounds are very toxic, particularly serious can be an accumulation in liver and kidney tissues and chronic poisoning (Falbe and Regitz 1995). Therefore the application of cadmium and its salts for plant protection is not allowed anymore (Falbe and Regitz 1995). 200 mg/kg wet or 1000 mg/kg dry weight in kidneys are classified as critical values in mammals (Friberg et al. 1974) and 100 mg/kg wet weight as the limit for damage to the kidneys (Gutleb 1995). The maximum found in this

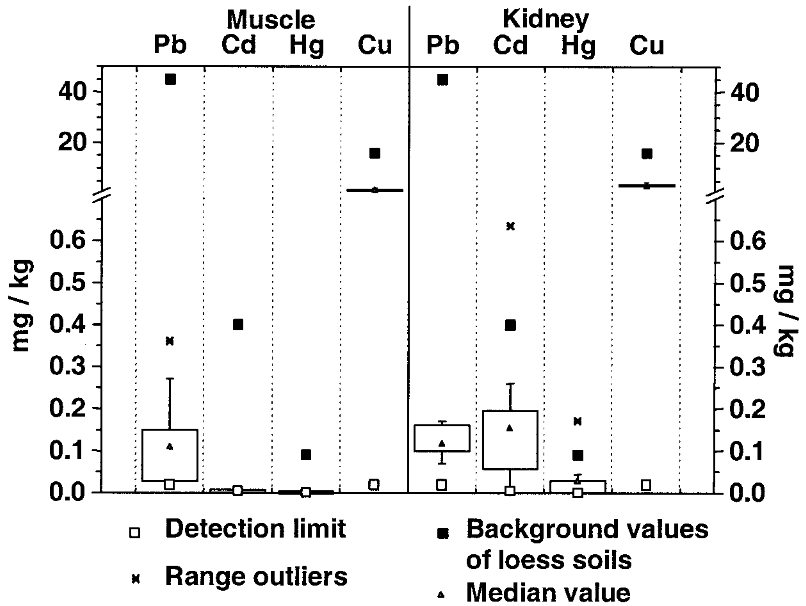

Figure 1. Box-plots showing median value, interquartile range, range outliers of heavy metals and copper in common hamster muscle and kidney samples from Saxony-Anhalt, Germany in relation to background values of German agricultural loess soils (Utermann et al. 1999).

study of 0.6 mg/kg in a kidney, did not indicate any negative effects on the vitality of the common hamster. The use of mercury as a pesticide has decreased because of its high toxicity and a use ban (Falbe and Regitz 1995). Until 1990 organic mercury compounds were used in the agriculture in the research area. Methyl mercury, in particular, accumulates in the body, has a long biological half-life, and is extremely toxic (Falbe and Regitz 1995). Weber et al. (1998) found similar low mercury contents in red kite eggs (*Milvus milvus*) from the same study area that this hamster research took place, and a decreasing concentration since 1990/91. This leads to the conclusion that, in contrast to former assumptions (Wendt 1984), mercury today plays not an important role as a factor in causing increased mortality during hibernation in the common hamster. In consequence of the low mean age of hamsters of one year and a maximum of 3 years (own unpubl. data) the long period of presence of mercury in the body (Falbe and Regitz 1995) is not important. The maximum value found of 0.17 ppm could hardly have any harmful effects on the hamsters. Even in a study of the highly loaded eggs of sparrow hawks (*Accipiter nisus*) with values up to 12 ppm, no direct connection between mercury content of eggs and the number of fledglings was found (Weber et al. 1997). Copper is an essential trace element for humans and other vertebrates. A deficiency can lead to keratin changes, depigmentation, lower growth rates and higher embryo mortality (Anke et al. 1980). This often occurs in localities with low copper levels like pleistocene sands, but also as a result of sulphur dioxide and cadmium emissions (Anke et al. 1980). Metal copper acts non-toxically, normal concentrations in the liver of mammals ranging from 10 to 50 mg/kg (Gutleb

1995). In one analyzed hamster liver, copper concentration was only 3.9 mg/kg. Together with the results of Figure 1, the copper status in hamster seems to be very low. Further investigation on this topic is necessary to exclude a deficiency.

This lead to the conclusion that at present metal contamination is not the cause of the decline of the common hamster. Other factors like habitat changes as a result of changing agricultural practice have to be taken into consideration.

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REFERENCES

Anke M, Grün M, Partschefeld M, Groppel B (1980) Die Mangan-, Zink-, Kupfer- und Kadmiumversorgung bzw. -belastung des Rotwildes (*Cervus elaphus* L.), Damwildes (*Cervus dama* L.), Rehwildes (*Capreolus capreolus* L.) und Muffelwildes (*Ovis ammon musimon,* Pallas 1811) in der DDR. Beitr Jagd-Wildforschg 9: 47-74

Backbier LAM, Gubbels EJ, Seluga K, Weidling A, Weinhold U, Zimmermann W (1998) Der Feldhamster *Cricetus cricetus* (L., 1758), eine stark gefährdete Tierart. Margraten, The Netherlands

Dithers RW, Nielsen SW (1978) Lead poisoning of racoons in Connecticut. J Wildlife Dis 14: 187-192

Falbe J, Regitz M (1995, ed.) CD Römpp Chemie Lexikon. Georg Thieme Verlag, Stuttgart, New York. Version 1.0

Friberg L, Piscator M, Nordberg GF, Kjellstrom T (1974) Cadmium in the environment II. CRC Press, Cleveland

Gutleb ACh (1995) Umweltkontaminationen und Fischotter in Österreich eine Risikoabschätzung für *Lutra lutra* (L., 1758). PhD Thesis Veterinärmed Univ Wien, Austria

Kayser A, Voigt F, Stubbe M (2001) First results on the concentrations of some persistent organochlorines in the common hamster *Cricetus cricetus* (L.) in Saxony-Anhalt. B Environ Contam Toxicol 67: 712-720

Smit CJ, Wijngaarden Av (1981) Threatened Mammals in Europe. Akad Verlagsgesellschaft Wiesbaden, Germany

Utermann J, Düwel O, Fuchs M, Gäbler H-E, Gehrt E, Hindel R, Schneider J (1999) Methodische Anforderungen an die Flächenrepräsentanz von Hintergrundwerten in Oberböden. Umweltbundesamt Texte 95/99

Weber M, Fieber W, Stubbe M (1998) Persistente clororganische Verbindungen, Quecksilber und radioaktive Nuklide in Eiern von Rotmilanen (*Milvus milvus*) aus Sachsen-Anhalt. J Ornithol 139: 141-147

Weber M, Gedeon K, Meyer H (1997) Zur Schadstoffbelastung des Sperbers (*Accipiter nisus*) im Erzgebirge. Mitt Ver Sächs Ornithol 8: 95-104

Wendt W (1984) Chronobiologische und ökologische Studien zur Biologie des Feldhamsters (*Cricetus cricetus* L.) unter Berücksichtigung volkswirtschaftlicher Belange. PhD Thesis Univ Halle-Wittenberg