# ASSESSMENT OF HEAVY METAL IN ROE DEER (*CAPREOLUS CAPREOLUS*) AS ZOOMONITOR SPECIES IN ECOLOGICAL MONITORING IN BULGARIA

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*Key words:* roe deer, bio-indication, heavy metals, liver, kidneys

*Abstract:* The heavy metals are persistence, accumulate and do not easily break down in the environment. Due to their toxic effects in plants, animals and human they come within the category of priority pollutant of the environment. To this group belong and metals Copper (Cu) and Zinc (Zn) also called essential or micronutrients and are toxic when taken in excess of requirements. As potential zoo monitoring species the roe deer (Capreolus capreolus) from the territories of Bulgaria completely suits the requirements for a bio indicator of the environmental quality.

The aim of this study is to be held analysis of zoo-monitor characteristics of the roe deer in regard to the content of Cu and Zn in roe deer liver and kidney – Its vital internal organs in which takes place the most accumulation of heavy metals categorized as priority environmental pollutants.

Samples of the issues of investigated organs were collected from 15 adult male individuals inhabiting in Eastern Bulgaria, during the legal hunting of these animals, at the time of the hunting season in the country. The concentration of the investigated metals was analyzed with the flame atomic absorption spectrometer and the final results were presented as Mean values of heavy metals residuals (X [mg/100g dry weight]) and their absolute (SD) variation.

The results showed no statistical significant differences between concentration of the Cu as well as Zn in the two investigated organs (the concentration of Cu: in liver = 6,5431 ± 8,93 and in kidney = 2,7948 ± 3,36 and concentration of Zn: in liver = 13,4818 ± 24,14 and in kidney = 26,9318 ± 42,50).

The present examination and statistical analysis of the defined concentration of investigated essential elements have established the initial norm of their variation described by the ±95% confidence interval of their mean values. The obtained results can be used both as a bio-indicator marker to assess the quality of the environment in which the roe deer inhabit, as well as to assess their physiological status.

# ОЦЕНКА НА НАЛИЧИЕТО НА ТЕЖКИ МЕТАЛИ В СЪРНАТА (*CAPREOLUS CAPREOLUS*) КАТО ЗООМОНИТОР В ЕКОЛОГИЧНИЯ МОНИТОРИНГ В БЪЛГАРИЯ

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*Ключови думи:* сърна, био-индикация, тежки метали, черен дроб, бъбреци

*Резюме:* Тежките метали са устойчиви, не се разпадат лесно, поради което се натрупват в околната среда. Те оказват токсично въздействие върху растенията, животните и човека поради което те попадат в категорията на приоритетните замърсители. Към тази група спадат и химичните елементи мед (Cu) и цинк (Zn), микроелементи които са от съществено значение за доброто физиологично състояние на бозайниците, но притежават и токсично въздействие върху биотота, когато се приемат в по-голямо количество от необходимото.

Като потенциален зоо мониторен вид сърната (Capreolus capreolus) в България напълно отговаря на изискванията за био индикатор на качеството на околната среда. Целта на това изследване е да се анализират характеристиките на сърната като зоо монитор по отношение на съдържанието на Cu и Zn в черния й дроб и бъбреците – жизненоважни вътрешни органи, в които се извършва относително високо натрупване на тежки метали, категоризирани като приоритетни замърсители на околната среда.

*Проби от изследваните органи бяха събрани от 15 възрастни мъжки индивида обитаващи Източна България, чрез законен лов на вида по време на ловния сезон в страната. Концентрацията на изследваните метали е анализирана, чрез пламъчен атомно-абсорбционен спектрометър и крайните резултати са представени като средни стойности на концентрациите на изследваните елементи (X [mg/100g сухо тегло]) и тяхната абсолютна изменчивост (SD).*

*Резултатите показаха статистически не значителни разлики между концентрациите на Cu, а също така и Zn и в двата изследвани органа (концентрацията на Cu: в черния дроб = 6,5431 ± 8,93 и в бъбрека = 2,7948 ± 3,36; концентрацията на Zn: в черния дроб = 13,4818 ± 24,14 и в бъбрека = 26,9318 ± 42,50).*

*Настоящото проучване и статистически анализ на концентрациите на изследваните микроелементи разкрива изменчивостта им чрез описание на ±95% доверителен интервал на техните средни стойности. Получените резултати могат да се използват както, като био-индикаторен маркер за оценка на качеството на природната среда, в която сърните обитават, така също и за оценка на тяхното физиологично състояние.*

## Introduction

Contamination and subsequent pollution of the environment by toxic heavy metals (metals with specific weight exceeding 5,000 kg/m$^3$) have become an issue of global concern due to their sources, widespread distribution and multiple effects on the ecosystem. The man with his activities puts increasing demands on nature and because of that environmental pollution remains still the topical issue of the present society. Due to their cumulative behavior and toxicity, however, they have a potentially hazardous effect on ecosystem health. The principal sources of heavy metal pollution include an electric power supply, industry, agriculture, transportation, and tourism. Heavy metals are found in all living organisms where they play a variety of roles. For the purposes of the ecological monitoring of the environment, with a view to assessing the environmental pollution, from the group of heavy metals is commonly used metals such as Pb, Cr and Cd and they are often cited as primary contaminants of concern. Another group of heavy metals is essential for the normal existence of mammals but chronic metabolic disturbances may occur due to the deficiency or excess of these metals in their vital internal organs. Elevated levels of potentially toxic metals put the biota under stress [1]; [2].

Among them are the elements such as Zinc (Zn) and Copper (Cu) which as an essential trace metal plays an important role in many of the body's enzymatic processes. At the same time, these two elements are heavy metals with toxic dose-dependent effect. When they are present in the mammal's organism in quantities inconsistent with their biological function they have a distinct toxicity to animals. These two metals are generally present in agricultural ecosystems at low levels, but the opportunity that they have to accumulate in vital organs of animals such as liver and kidney determines their potential hazardous effect on free-living animals.

Animals, particularly the game species, for example, deer, are a very good indicator of the environmental load because they are constantly exposed to the pollutants in the ecosystem, which they inhabit. To estimate regional levels of contamination, various large herbivores game animal species like roe deer (*Capreolus capreolus*), red deer (*Cervus elaphus*), rein deer (*Rangifer tarandus*) and moose (*Alces alces*) are used as bio indicators species in monitoring programs, which have been set up in different countries in Europe. The application of these species in these programs have shown [3]; [4]; [5]; [6]; [7] that they are good zoo monitors species for the purposes of the bio monitoring applied in the implementation of eco monitoring research at the regional level.

Therefore, determination of an environmental load of heavy metals on Roe deer can serve as an indicator of their presence on the environment. The comprehensive study related to the assessment of levels of essential metals with a toxic dose-dependent effect of roe deer is crucial with respect not only to the assessment of their population health status and assessment of the future development of their populations but also to the evaluation of the quality of its products, human and ecosystem health.

The aim of this study is to be held analysis of zoo monitor characteristics of the roe deer in regard to the content of Cu and Zn in its vital internal organs as liver and kidney in which takes place the most accumulation of heavy metals categorized as priority environmental pollutants.

## Materials and methods

Samples of the issues of investigated organs – liver and kidney were collected from 15 adult male Roe deer inhabiting in Eastern Bulgaria, during the legal hunting of these animals, at the time of the hunting season in the country. Samples were packed separately in polypropylene BD Falcon™ tubes and stored in a freezer (− 20°C) until analysis. The sex and age of every sample was recorded.

The concentration of the investigated metals was analyzed with the flame atomic absorption spectrometer and the final results were presented as Mean values of heavy metals residuals (X [mg/100g dry weight]) and their absolute (SD) variation. Statistics were performed using Statistica for Windows [8]. The level of significance was set at $\alpha = 0.05$. Preparation of samples, digestion procedures of the tissues, the analytical determination and data analysis of investigated of heavy metals – (Zn and Cu) in the Roe deer's liver and kidney was done following the algorithms described in our previous studies [9] of the establishment of their residual in the golden jackal in Bulgaria in its use as a zoo monitor for the purposes of evaluating environmental pollution with heavy metals.

## Results

Descriptive statistics for Zn and Cu in the liver and kindly tissue of the investigated Roe deer are presented in Figure 1.
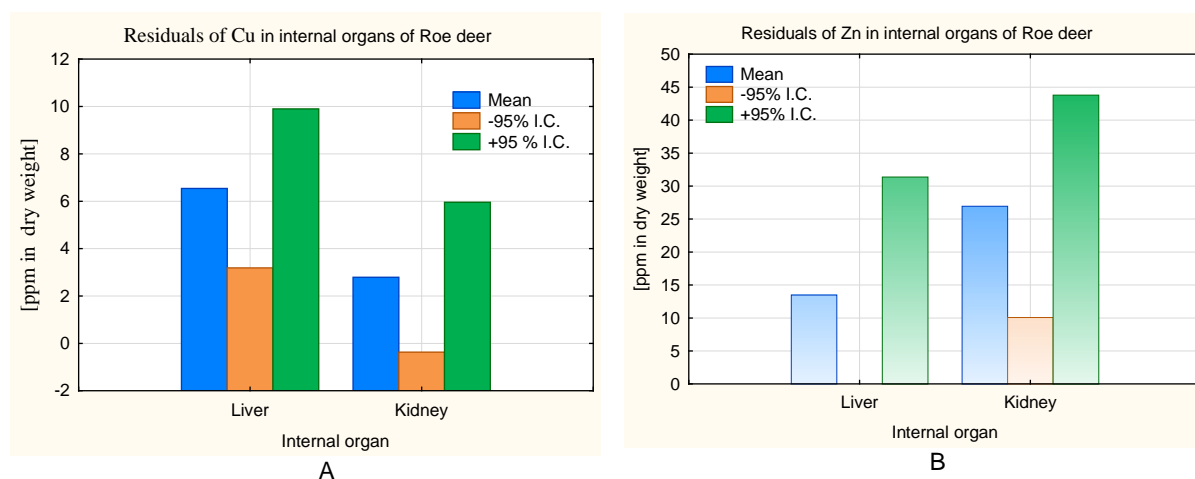


Fig. 1. The mean value and its ±95 % confidence intervals of residuals(X [mg/100g dry weight]) of Copper (A) and Zinc (B) in liver and kindly of adult roe deer in north-eastern Bulgaria.

The results showed no statistical significant differences between concentration of the Cu as well as Zn in the two investigated organs (the concentration of Cu: in liver = 6, 5431 ± 8, 93 and in kidney = 2, 79 ± 3, 36 and concentration of Zn: in liver = 13, 48 ± 24, 14 and in kidney = 26, 93 ± 42, 50). Typical of the average values of the concentration of the investigated metals in both the organs are the high values of SD by which they are established. Hence, it is worthwhile to determine the levels of the ±95% confidence interval of their mean values.

## Discussion and conclusion

As the results of studies on animals are applicable also to humans it indicates the importance of the use of the zoo monitors as an indirect way for an investigation to the negative influence of environmental contamination and need of assessment of the potential risk associated with it. The evaluation of bio indication data requires unconditionally the sufficient knowledge about respective bio indicators and noxious substances and their particular environment of the dwelling. All this requires that the receipt and use of bio indication data be tied to the specific conditions of the zoo monitor's habitat.

The conducted study is in line with the requirements of the environmental monitoring and paint a picture of the load of the internal organs of the roe deer with heavy metals with their toxic dose-dependent effect. The element levels reported here for roe deer reflect an agroecosystem environment and represent baseline values for the Northeast population of this species in Bulgaria.

The present examination and statistical analysis of the defined concentration of investigated heavy metals has established the initial norm of their variation described by the ± 95% confidence interval of their mean values and can be used as a bio indicative marker for evaluating the quality of the natural environment which inhabits, but also for the evaluation of the physiological condition of the roe dee individuals, contribute to species conservation in the Northeast Bulgaria.

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