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ANALYSIS OF THE ACCUMULATION OF MICROELEMENTS IN THE BODY OF SMALL MAMMALS UNDER CONDITIONS OF EXPLOITED ECOSYSTEMS OF THE ARAL REGION

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ANNOTATION
The article discusses the results of an analysis of the accumulation of microelements in the body of small mammals in the conditions of exploited ecosystems of the Aral Sea region. The level of content of various toxic elements in the body of small mammals is associated with the characteristics of their biology, primarily with the food specialization of the species. A high level of pollution is typical for both technogenic and adjacent territories in the Southern Aral Sea region.

KEY WORDS: *micromammals, technogenic territories, microelements, pollutants, monitoring, nature conservation.*

In modern conditions of social development, one of the most difficult problems is environmental protection and rational use of natural resources. Systematic research into the impact of global technogenic environmental pollution on living organisms is one of the most important tasks of modern ecology, since microelement pollution of the environment inevitably leaves its mark on them. In connection with the increase in environmental pollution by emissions from industrial enterprises, there is a need to conduct accelerated diagnostics of the state of natural systems near them and assess the impact of industrial pollutants on these systems.

Without knowledge of the peculiarities of the biology of mammals in the technogenic environment, it is impossible to comprehensively solve the problems of monitoring and nature conservation. In recent years, a large arsenal of methods has been developed to identify the effect of various impacts on the environment. Adaptation of rodent populations to anthropogenic transformation of the landscape occurs mainly at the community level due to changes in species composition, the ratio of species with different food specializations [3,4,6,12,14].

And, if high concentrations of a pollutant lead to clearly defined effects, then low concentrations cause chronic damage, which often remains hidden and can only be detected through physiological and biochemical studies [6]. Therefore, new knowledge of the compensatory and adaptive capabilities of the body in conditions of industrial pollution of the environment is important both for solving problems of environmental protection and for urgent measures to diagnose and prevent the development of pathological, irreversible processes in the body [4,11].

The Southern Aral Sea region is a unique region in natural terms and is of great interest in studying the characteristics of the distribution of animals across biotopes. The total area of the Southern Aral Sea region (about 1 million sq. km) covers the northwestern parts of Uzbekistan (eastern part of the Ustyurt plateau, northwestern part of the Kyzylkum, middle and lower reaches of the Amu Darya) and Turkmenistan (Zaunguz Karakum, southern Ustyurt) [5]

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Fig. 1. Transformation of the ecosystem in the territory of the KSP (2024)

Kungrad Soda Plant (KSP) is the only large manufacturing enterprise in Central Asia producing soda ash. The work is based on the results of studies conducted in 2018–2023. on the technogenic territory of the sanitary protection zone of the Kungrad Soda Plant (KSP) and control (background) areas located in the Kungrad district of the Republic of Karakalpakstan. Relative counts of small mammals were carried out in several areas remote from the territory of the KSP: at a distance of 1 and 2 km southeast of the KSP; at a distance of 2 and 4 km northwest of KSP [1].

The distribution of species in the communities of micromammals within the village boundaries was radically different from those in the desert. Inside settlements, *Mus musculus dominated* in all areas, making up about 57% in the general community, and about 80% in the "green" zones. The second most abundant species in the demutating ecosystem was the population of *Rhombomys opimus,* (just over 18%), followed by *Citellus fulvus* (about 11%).

Dominance in desert and semi-desert ecosystems in terms of species composition and values occupied an intermediate position between desert and intra-village communities. On the first transects, closest to the development, *Mus musculus* dominated everywhere. The different nature of the response to the consequences of natural catastrophic impacts indicates a decrease in the population size of *Meriones erythrourus* and *Citellus fulvus* during the middle stages of restoration succession and, on the contrary, an increase in the abundance of *Mus musculus* and *Allactaga elator* populations.

To study the patterns of microelements accumulation in the body of small mammals, we studied the composition and concentration of heavy metals in the body of natural populations of micromammals living on the territory of the Kungrad soda plant of the Southern Aral Sea region.

Samples were taken from 11 samples of organs and tissues of small mammals: the great gerbil (*Rhombomys opimus*) and the yellow ground squirrel (*Citellus fulvus*). The content of elements in organs and tissues was determined by performing ICP-MS spectral analysis in the physicochemical laboratory of the Karakalpak Research Institute of Natural Sciences. As a result, the average content of 21 chemical elements was determined: Al, Si, P, S, Cl, K, Ca, Cr, Mn, Fe, Ni, Cu, Zn, As, Br, Rb, Sr, Mo, Ag, Se, Nb.
Analysis of communities of small mammals in technogenic and background territories shows that the species composition and number of individuals of individual species in the compared territories differ. The analysis of the average content of elements in the body of the studied species of small mammals in technogenic and natural areas showed the species-specific nature of their accumulation, regardless of territorial zones (Fig. 1-4).

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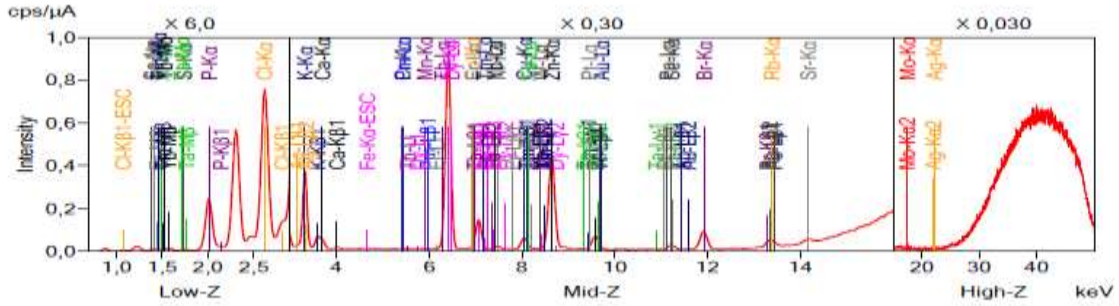

Fig.1. Spectral analysis of the content of microelements in the body of Rhombomys opimus (KSP)

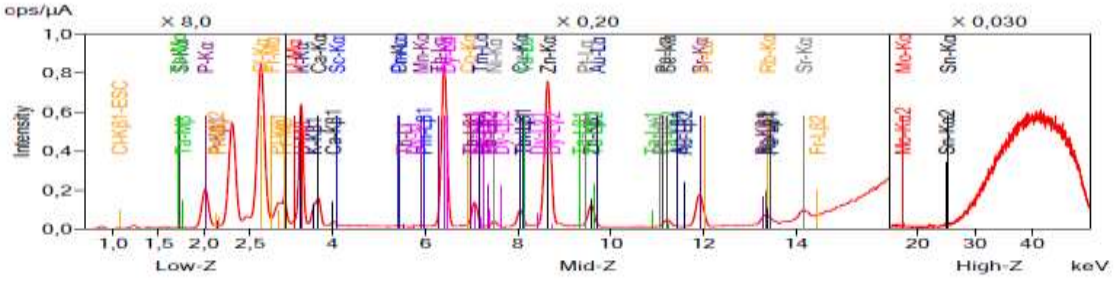

Fig.2. Spectral analysis of the content of trace elements in the body of Rhombomys opimus (control)

Spectrum

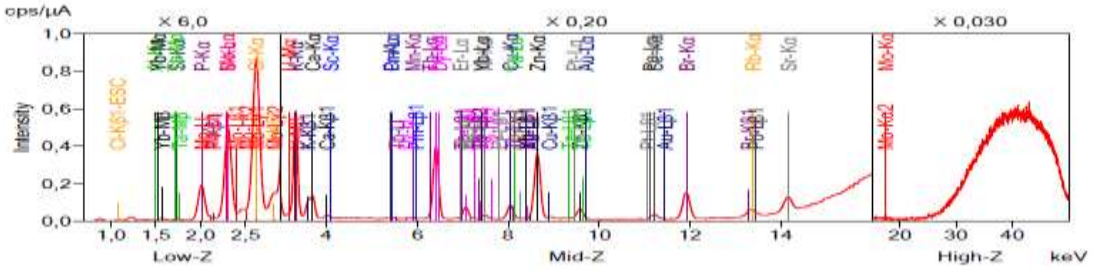

Fig.3. Spectral analysis of the content of microelements in the body of Citellus fulvus (CSZ)

Spectrum

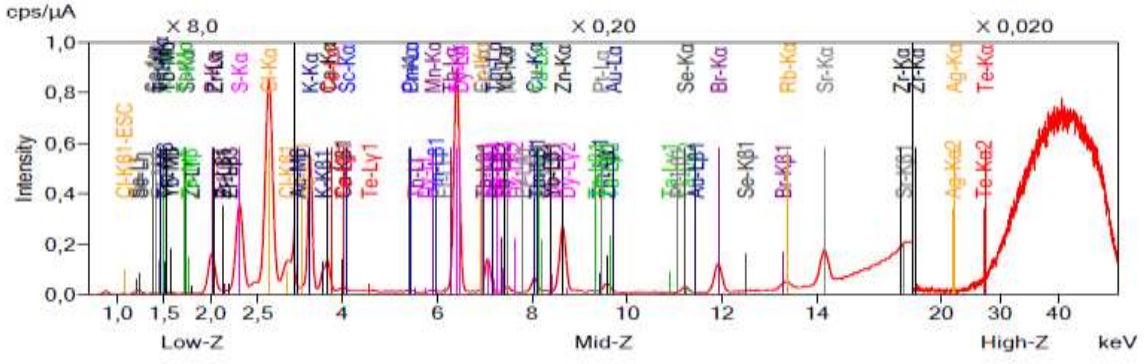

Fig.4. Spectral analysis of the content of microelements in the body of Citellus fulvus (control)

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As a result of the analysis of the data obtained, *Rhombomys opimus* has an excess of 5 elements in the control and 6 elements in the experiment, while Al, S, As, Ag, Nb are absent in the control, and S, As, Nb are absent in the experiment.

Citellus fulvus has an excess of 5 elements in the control and 12 elements in the experiment, while there are no elements such as Mo, Nb (in the control), Ag, Nb (in the experiment) (Table 1).

Table 1

Average content of microelements in the body of the studied species of small mammals, mass%

Elements	Microelements content, mass%			
	Rhombomys opimus *(n=5)*		***Citellus fulvus*** *(6)*	
	опыт	контроль	опыт	контроль
Al	5,96	-	4,26	3,76
Si	0,651	1,39	1,49	0,745
P	20,7	18,5	12,8	12,5
S	-	-	15,3	13,7
Cl	17,5	21,8	27,6	21,7
K	40,2	41,0	38,3	34,2
Ca	4,83	10,7	8,21	7,54
Cr	0,0441	0,0317	0,0359	0,0416
Mn	0,0373	0,0333	0,0412	0,0351
Fe	8,41	4,89	5,08	4,16
Ni	0,0645	0,0715	0,0485	0,0458
Cu	0,203	0,189	0,135	0,0914
Zn	1,16	1,20	0,462	0,318
As	-	-	-	-
Br	0,0780	0,0916	0,0630	0,0468
Rb	0,0226	0,0154	0,0100	0,0052
Sr	0,0151	0,0197	0,0271	0,0370
Mo	0,0094	0,0082	0,0063	-
Ag	0,0049	-	-	0,0034
Se	0,0199	0,0217	0,0110	0,0087
Nb	-	-	-	-

The yellow ground squirrel usually avoids large tracts of sand and vast areas with monotonous landscape conditions, but inhabits them along the edges, reaching the highest numbers in areas with a mosaic combination of various biotopes of desert and semi-desert zones. The main food of the yellow gopher is the succulent aboveground and underground parts of herbaceous plants. The yellow gopher (*Citellus fulvus*), which predominantly feeds on underground parts of plants that accumulate toxic substances, demonstrates the highest levels of microelements with maximum accumulation doses in the organs and tissues of the body.

In spring, the main food of *Rhombomys opimus* consists of ephemeral and ephemeroid plants: bluegrass, desert and sandy sedges, succulent shoots and branches of herbaceous plants and shrubs. In autumn and winter, the food of the great gerbil mainly (up to 95%) consists of above-ground shoots and seeds of ephemeral and ephemeral plants, branches of saxaul and kandym. Accumulation rates in the body of the great gerbil (*Rhombomys opimus*) are also high because In the summer, she digs up succulent bulbs and rhizomes of bluegrass, onions, and ebelek and uses assimilating shoots - wormwood, seline, solyanka, cherkes, boyalych, sand acacia and saxaul, which also accumulate toxic substances.

According to the literature, it is noted that the level of accumulation of toxic elements and heavy metals in the body is mainly associated with the food specialization of species [6, 8, 9]. The sources of high concentrations of microelements in natural areas, where, in addition to the highway, passing near the territories of the KSZ, require additional study. Toxic elements and heavy metals found in the body of the studied species of small mammals are a consequence of contamination of soil, water, air and vegetation in the study areas in the territory of an ecological extreme situation in the Southern Aral Sea region.

Thus, in the conditions of the technogenic landscape of the sanitary protection zone of the KZZ, communities of small mammals are characterized by a decrease in the abundance of species by an average of 18%. Under the conditions of technogenic pressure, monodominant communities are formed with a predominance of a single species – *Mus musculus*, which has the greatest plasticity and resistance to technogenic factors. The ecotone conditions of the "green" zone created additional conditions for greater species

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diversity of the lower layers of vegetation and, accordingly, communities of small mammals, which is consistent with the general provisions on ecotones.

The level of content of various toxic elements in the body of small mammals is associated with the characteristics of their biology, primarily with the food specialization of the species. A high level of pollution is typical for both technogenic and adjacent territories in the Southern Aral Sea region. At the same time, the features of the accumulation of heavy metals in the body of small mammals depend on a number of factors related both to the biology of the animals themselves and to the patterns of transmission of trace elements from the source of pollution with subsequent accumulation in various substrates, including biological ones.
The results of complex studies of model rodent species (*Rhombomys opimus and,Citellus fulvus*) showed that they can be used not only for the purpose of bioindication of environmental pollution at the local, regional levels and to justify ecotoxicological regulation, but also for long-term environmental forecasting tasks.

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