

Annotation

Of the dissertation work of Zakanova Assel Naurizbayevna on the theme «Fauna and ecology of small mammals in North-Eastern Kazakhstan under anthropogenic impact», presented for the degree of Doctor of Philosophy (PhD) in the specialty 8D05101 – «Biology»

General characteristics of the work: The dissertation explores the fauna and ecology of small mammals inhabiting the areas surrounding territories subjected to anthropogenic pressures. The research delves into the issues of anthropogenic influence at both the population and organismal levels, as well as cranial asymmetry.

Relevance of the research topic: The ever-growing human population (Fraser E.D.G., 2020) is increasing the anthropogenic pressure on ecosystems. Contaminated air, soil, and surface and groundwater often have adverse effects on living organisms (Masindi V., et al., 2018). Questions regarding the anthropogenic impact on the environment are most pressing in regions with rapidly developing industrial production. The non-ferrous metallurgy industry, particularly the aluminum sector, significantly contributes to environmental pollution due to the specific technological processes that release elements like fluorine compounds and benz(a)pyrene into the air (Zaporozhets A., et al., 2020). The heavy industry in Northeastern Kazakhstan, as exemplified by Pavlodar region, began active development in the mid-20th century (Ахметова З.Б. и др., 2019). Coal mining, ferroalloy production, aluminum manufacturing, and electricity generation (Сагинтаев Б., 2009) provided an economic impetus for the region's growth and the country as a whole.

The group of micro-mammals is of special interest in ecological predictions and research because it is characterized by a high metabolism (d'Havé H. et al., 2005). This explains their high demand for habitat quality. High species diversity is indicative of the stability and ecological well-being of the studied area (Sall M.L., et al., 2020). Therefore, the monitoring of small animals, especially mammals, is crucial in areas subject to anthropogenic pressure.

Emissions from industrial activities that enter the biotic component of ecosystems primarily induce physiological and biochemical disturbances at the cellular, tissue, and organ levels (Zarrintab M., et al., 2017). We hypothesize that changes in the population size or the disappearance of individual species will be an ecological response to stress in the form of industrial pollution.

Individual components may respond differently to the effects of pollutants, resulting in varying productivity among individuals living in different areas, including differences in the number of females and males and age composition (Koerner S.E., et al., 2017), as well as the manifestation of cranial structural asymmetry.

In their natural habitats, animals with territories near industrial facilities are exposed to chronic low-level doses of heavy metals over an extended period (Hamers T., et al., 2006). Chronic exposure negatively affects populations, communities, and biodiversity. Research (Veltman K., et al., 2007) has shown that

as one approaches the source of anthropogenic stress, the biodiversity index decreases. Persistent anthropogenic influence can alter community structure, ecosystem dynamics, population distribution and abundance, and may also have an impact at the organismal level.

In our study, we took into account the gender, age group, registered animal species, and the trophic level of organisms. Research (Wijnhoven S. et al., 2007) demonstrates a correlation between the heavy metal content and the type of food consumed by animals. Pollutants can be transferred among invertebrates, moving from one trophic level to another and eventually reaching small mammals.

The age criterion of the population can be one of the factors influencing the extent of the impact of heavy industry. Studies demonstrate an increase in the accumulation of toxic substances with the animal's age (Kar I., et al., 2018). According to Tifarouine, L., Aziz, F., et al., adult European mice (*Apodemus sylvaticus*, Linnaeus, 1758) accumulated twice as much Pb and Cu in the liver, kidneys, and heart tissues compared to young individuals (Tifarouine L., et al., 2019).

According to a study by scientists (Lazarus M., et al., 2017), in addition to diet and the age of the animal, gender is also a significant factor. This is linked to differences in the metabolism and ecology of male and female mammals (daily activity, reproductive involvement, habitat size), which consequently affects the amount of food consumed.

Therefore, deviations in the expression of cranial structural symmetry, biodiversity indices, species richness, age, and gender composition of communities will indicate adaptive responses of animals to changes in the environment, driven by anthropogenic influence (Вольперт Я.Л., 2020). Small mammals can serve as model subjects for studying the impact of anthropogenic influence on human health. The results of this study may be useful in addressing the issue of the impact of chronic anthropogenic influence on public health.

The purpose of the dissertation research: is to describe the fauna and ecology of small mammals in the Northeast of Kazakhstan, particularly in the Pavlodar region, under the influence of anthropogenic factors.

Research objectives:

1. Describe the fauna of small mammals inhabiting areas at varying distances from the Pavlodar Aluminum Plant (PAP).
2. Determine the gender and age distribution of organisms, assess the impact of anthropogenic activity on the fertility of small mammals recorded in the research areas.
3. Analyze changes in external and internal parameters in small mammals whose habitat includes anthropogenic areas.
4. Identify cranial morphometric characteristics of dominant species within the orders Rodentia and Eulipotyphla.
5. Investigate the expression of fluctuating asymmetry in dominant species.
6. Describe the survival strategies of small mammals recorded in industrial areas.

7. Determine the responses of small mammal communities to anthropogenic influences, focusing on biodiversity indicators.

Object of research. Populations of small mammals, focusing on dominant species, residing at varying distances from the emission source.

Methods of research. Methods for the enumeration and capture of small mammals, morphometric analysis, cranial morphometrics, phenetic analysis, and statistical data processing methods.

Novelty of the study:

For the first time, the study examined the fertility of female small mammals on anthropogenic territories in Northeastern Kazakhstan. High fertility rates were identified, especially among dominant species of the Rodent order, which may lead to an increase in the populations of these species and competition with others.

For the first time, interior indices were calculated for small mammals in the region. The heart index of voles (*Arvicolinae* Gray, 1821) and shrews (*Soricidae* G. Fischer, 1817) showed an increase in organ size, indicating increased activity and metabolic processes. The increase in kidney index, liver and lung mass suggests increased energy requirements in anthropogenic environments.

It has been revealed that rodents adapting to anthropogenic conditions exhibit smaller cranial morphometric facial dimensions but larger cranial brain regions, indicating the necessity to rapidly adapt to new environmental conditions.

It has been determined that the narrow-skulled vole, in anthropogenic territories, exhibits cranial asymmetry, particularly in the Foramen suprainfraorbitalis posterior and anterior, Foramen basis processus zygomaticum. The lower jaw is more susceptible to asymmetry and displays greater variability, which may suggest the sensitivity of this area to anthropogenic factors.

For the first time, a stability index for the narrow-skulled vole in the studied region has been calculated. Moderate adverse factors were detected in the buffer zone, which may require active environmental control.

Theoretical Significance of the Research:

This study helps us understand how human activities impact small mammals. Analyzing changes in the fauna and population of animals based on their proximity to anthropogenic sources enriches theoretical knowledge about how human activities affect ecosystems.

The research provides information about the age group structure of small mammals in anthropogenic areas. These data can be crucial for understanding how small mammal populations respond to environmental changes and can serve as a basis for the development of conservation and management strategies for these species.

The study of biometric characteristics, such as the reduction in body size (*Rodents* on anthropogenic territories), can serve as an indicator of human influence on the evolution and physical traits of mammals.

Calculations of stability based on cranial morphometric data help determine the level of stress that narrow-skulled voles face in different zones. This information can be valuable in understanding which environmental factors may pose a threat to the population of this species.

The research provides essential data on the impact of human activities on small mammals and their habitat, which can be valuable for the development of conservation and natural resource management strategies in the Northeastern Kazakhstan region.

Practical relevance of the results. The results can be used by environmental and natural resource management authorities to develop strategies for conserving and managing the impact of industrial enterprises on small mammals. This may include regulating emissions and implementing measures to minimize the negative impact on the environment.

The research findings can be utilized for educational purposes. They can serve as a foundation for creating educational courses and programs for students specializing in the fields of ecology, biology, and wildlife management. The work can serve as a source of data and examples for students and researchers.

The information presented in the dissertation can be used to create a regional database on small mammals and other wildlife. This is important for monitoring changes in populations and biodiversity in the region. This data can serve as a basis for the development and implementation of biodiversity conservation and nature protection programs.

The results provide information for predicting changes in small mammal populations. This can help in developing more effective measures to reduce the negative impact of human activities on the environment.

The main provisions of the dissertation to be defended are as follows:

- It is essential to consider a combination of factors, including gender, age, physiological and morphological characteristics, nutritional status, and sampling locations in ecological and faunal studies of small mammals inhabiting anthropogenic areas;
- The number of small mammal species decreases, leading to a simplification of community structure and reduced biodiversity as anthropogenic influence intensifies;
- The Northeastern Kazakhstan region is home to 16 species of small mammals, *Rodents* being the predominant order. *Insectivores* have smaller numbers.
- The total number of individuals on control sites is significantly higher compared to anthropogenic areas.
- The composition ratio of *Insectivores* to *Rodents* in anthropogenic territories and control areas differs. Near the plants, there is a predominance of herbivorous animals compared to the control area, indicating the accumulation of harmful elements with an increase in the trophic level in the food chain and higher accumulation in organisms of higher-order consumers.
- The dominance index shows that the impact and buffer areas of the industrial zone tend to exhibit monodominance, with two species being more abundant: narrow-skulled vole (*Microtus gregalis* Pall., 1779) and subtle birch mouse (*Sicista subtilis* Pall., 1773).
- Cranial measurements reveal that rodents in anthropogenic conditions have smaller sizes of facial cranial parameters but larger brain sizes, indicating

physiological adaptation to living alongside humans and the need for rapid adaptation to new environmental conditions.

➤ Narrow-skulled voles in anthropogenic areas display significant asymmetry in cranial features, differing from control zones. Asymmetry in various cranial features includes foramen basis processus zygomaticum, foramen supraorbitalis posterior and foramen supraorbitalis anterior. The lower jaw of narrow-skulled voles exhibits higher asymmetry and variability, suggesting increased sensitivity to anthropogenic factors. Fluctuating asymmetry in the lower jaw of mammals can be a result of the complex interplay between genetic and environmental factors. Research in this area helps understand the factors influencing asymmetry and its potential impact on species survival and reproduction.

➤ The impact zone indicates moderate negative effects, while the buffer zone points to more significant adverse factors, necessitating active control. The background and control zones are characterized by favorable habitat conditions without serious negative factors.

➤ Small mammals in anthropogenic areas exhibit traits of r-strategists, showing a propensity for rapid reproduction and increasing offspring numbers in a short season.

Author's personal contribution to the work: analysis of literature data on the research topic, defining the research goals and objectives, conducting experimental research, statistical data processing and analysis of results, writing the dissertation, and manuscript formatting were performed with the author's direct involvement.

Compliance with the directions of development of science or state programs. The research is an individually conducted work by the author and is not affiliated with any funded research projects.

Approbation of the results of the dissertation: the results of the dissertation have been presented and discussed at international conferences:

1. Materials of the International Scientific and Practical Conference: I International Scientific and Practical Conference «World Science Priorities», December 15-16, 2022, Vienna, Austria. Article on the topic: «The Number of Insectivores and Rodents in the Industrial Production Areas of Northern Kazakhstan».

2. Materials of the International Scientific and Practical Conference: «Zoological Research in Kazakhstan in the 21st Century: Results, Problems, and Perspectives», April 15-16, 2023, Almaty, Kazakhstan. Article on the topic: «Species Composition and Characteristics of Small Mammal Fauna in Northeastern Kazakhstan with Different Anthropogenic Impact».

Publications. On the researched topic, 10 articles were published, including 4 articles in journals recommended by the CQASHE MSHE RK, 1 article in a journal indexed by SCOPUS (Q4), 2 articles in the proceedings of international scientific-practical conferences, and 3 articles in Kazakhstan scientific periodicals.

Scope and structure of the dissertation: The dissertation consists of an introduction, five chapters, a conclusion, findings, and a list of references. The total

volume of the manuscript is 162 pages, including 29 tables and 69 figures. The list of references includes 194 Kazakh and foreign sources.