Spatiotemporal Variability Of Small Mammal Population Abundance In The Ecosystems Of The Lower Amu Darya Delta

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Abstract
This paper analyzes the biotopic distribution, as well as certain population and demographic parameters of the community of murid rodents under different levels of population density of background (dominant) species.
Keywords: Amu Darya Delta, small mammals, population dynamics, population structure, rodent communities.

At present, the study of processes based on mechanisms that ensure adaptive regulation under sharply deteriorating environmental conditions continues to attract the attention of researchers, remaining a central issue in modern population ecology [1, 2, 3, 4, 5, 6, 7]. Small mammals, being an important component of natural ecosystems, are traditionally widely used as model organisms in zoological and ecological studies, including those addressing problems of anthropogenic landscape transformation [1, 2, 3]. This is a numerous group of animals which, due to their position in ecosystem trophic chains, directly experiences the pressure of various negative environmental factors over large areas and therefore can be used as indicators of environmental transformation [3, 5, 6, 7].

Under current conditions of intensive anthropogenic and technogenic impact on the natural complexes of the Southern Aral Sea region, the existence of many animal species is under the threat of extinction. The intensity of environmental factors, along with other indicators, has a significant influence on the population structure and population dynamics of small mammal fauna inhabiting the lower reaches of the Amu Darya delta.

Materials and Methods

The material of the study consisted of the results of field investigations conducted in 2009–2019 in natural and anthropogenic habitats of small mammals in the lower reaches of the Amu Darya Delta [8]. Well-known indices were used as measures of community biological diversity, including the biotopic affinity index, the Shannon diversity index (H), and the Simpson diversity (C) and dominance (D) indices [1, 3, 4]. The selection of biotopes in the natural group was linked to the main vegetation types of the zonal elements of the landscape [5, 6, 7].

Natural habitats included tugai forests and reed beds in the lower reaches of the Amu Darya Delta. In the anthropogenic group of biotopes, fallow lands, shelterbelts along highways, and agricultural fields of farming enterprises of the Republic of Karakalpakstan were surveyed.

Discussion of Results

In recent years, due to unfavorable directional climate changes and the associated alterations in vegetation, one of the most pressing issues has been the assessment of the stability of populations of sympatric animal species, as well as the preservation of the composition and structure of their communities [3, 5, 6, 7]. A detailed analysis of the biotopic affiliation of small mammal populations in the lower reaches of the Amu Darya makes it possible to evaluate their resistance to anthropogenic transformation of ecosystems and, to some extent, to predict trends in changes in their positions within communities during further economic development and land irrigation.

As is well known, any system of environmental control consists of ecological monitoring and analysis of the data obtained, on the basis of which decisions are made regarding the prospects for ecosystem functioning and practical use [1, 2, 3, 4, 5, 6, 7]. In this case, the humid ecosystems of the Aral Sea region—tugai biocenoses—under the influence of the general process of landscape transformation have undergone profound successional changes.

Analyzing the obtained assessments of the spatial structure of small mammal populations and their biotopic affiliation in the lower reaches of the Amu Darya, it should be noted that, according to all indicators, rodent populations differ significantly between areas with intensified anthropogenic impact and natural territories. Based on the distribution of mammal habitats, the lower Amu Darya region is divided into three biotopes: reed beds and water bodies, tugai forests, and agricultural lands.

As a result of the intensification of desertification processes, reduction of tugai and reed vegetation, intensification of land use, and other negative factors, the distribution area and abundance of mesophilic species have sharply declined. The analysis showed that 13 species inhabit the lower Amu Darya region, among which Mus musculus (13.6%), Nesokia indica (23.2%), Allactaga elater (14.5%), and Meriones tamariscinus (15.3%) are abundant, while Ondatra zibethica occurs in water bodies.

Irrigated agriculture is among the most powerful transforming factors. On agricultural fields of various farming enterprises, a specific rodent assemblage is formed that differs substantially from the indigenous communities that existed prior to land development [1, 2, 3,4, 5]. As noted by specialists, not many animals are able to adapt to living on agricultural lands; however, there are rodent species for which habitation in fields has become a common phenomenon [3, 4, 5, 6, 7].

The applied informational indices of species diversity [1, 3, 4, 5] help to identify differences between habitats of various communities and to determine the biotope most favorable for murid rodents [5, 6, 7]. The species composition of small mammals in the studied plant communities is very similar in both quantitative and qualitative terms, with differences occurring mainly at the level of rare species [3, 4]. Consequently, the diversity indices of murid rodent communities in different habitats differ only slightly and, on average, show relatively low values (Table 1). The highest species diversity was recorded in agricultural habitats, where the diversity index (H) was higher than in other natural biotopes. In other natural habitats—tugai forests and reed beds—these indices were slightly lower.

Indices of Species Diversity of Small Mammals in Different Biotopes of the Lower Amu Darya Region

Biotope	Species Richness Index, C	Species Diversity Index, H	Simpson Dominance Index, D
Reed beds	1,24	1,26	0,36
Water bodies, drainage network	0,21	0,34	0,15
Tugai vegetation	0,75	1.12	0.21
Agricultural lands	1,18	1,56	0,23

Lower values of the indices obtained for reed beds and tugai ecosystems are likely related to the fact that their magnitudes can vary considerably during mass outbreaks of one or two background species [2, 3, 4, 6].

The conducted studies made it possible to establish that the lower level of overall abundance and spatial structure of mesophilic rodent species (*Ondatra zibethica*, *Microtus ilaeus*, etc.) is due to a reduction in the proportion of microhabitats suitable for animal habitation. It should be noted that these habitats become insularized, and the share of zonal territory with favorable living conditions decreases compared to the original natural zone, which is reflected in the population occupancy indicators of a given area. At the same time, the species persist in those habitat patches where the capacity of microhabitats allows the maintenance of normal vital activity [3, 4, 5, 6]. Among the elements of anthropogenic landscapes, the open collector–drainage network has the greatest ecological importance for rodents. These structures serve as the main habitats and refugia for rodent species such as *Mus musculus*, *Nesokia indica*, and *Meriones tamariscinus*. After the development and irrigation of agricultural lands in various farming enterprises of Karakalpakstan, populations of *Mus musculus* and *Nesokia indica* find favorable feeding and protective conditions on the slopes of the open collector–drainage network. Various embankments and constructed collector dams with loose soil are preferred burrowing sites for *Nesokia indica*. In settlements and farming enterprises, the dominant rodent species *Mus musculus* and *Nesokia indica* are established.

Thus, entirely new ecological conditions are formed in anthropogenic landscapes, to which ecologically plastic species are able to adapt. Landscape transformation has both direct and indirect effects on rodent fauna and populations, creating optimal conditions for the existence of some species and, conversely, unfavorable conditions for others. For the overwhelming majority of rodent species in anthropogenic landscapes, the feeding conditions of biotopes are limited [2, 4, 5, 6, 7].

As a result of anthropogenic landscape transformation, due to the preservation of biotope mosaicism, the abundance of certain rodent species (*Ondatra zibethica*, *Microtus ilaeus*, *Allactaga elater*) increases. At the same time, in anthropogenic landscapes, the species diversity of rodent food plants becomes simplified, trophic relationships are disrupted, and rodent population density decreases. Consequently, different rodent species exhibit unequal degrees of association with anthropogenic complexes. Thus, *Mus musculus* is less adapted than other species to inhabiting natural habitats and reaches high abundance in anthropogenic biotopes. In natural biotopes, the species appears only in years of high population density. *Meriones tamariscinus* inhabits natural biotopes mainly in tugai floodplain forests and reed beds, where it may occupy dominant positions; among anthropogenic biotopes, it uses intrazonal strips for permanent habitation.

Therefore, the stability of small mammal populations in areas with high anthropogenic pressure is apparently determined by individual adaptive responses leading to increased intensity of physiological processes in the organism. From the perspective of the evolutionary–ecological approach, this mechanism represents the first stage of adaptive changes (the most primitive and energy-intensive), yet it is precisely through this mechanism that the existence and integrity of population systems of small mammals are maintained in areas subjected to intensified anthropogenic impact.

The amplitude of population abundance dynamics in transformed territories is increased compared to natural ones (except for *Microtus ilaeus*), which emphasizes the imbalance of living conditions for most mesophilic species. This effect is particularly pronounced during population depressions and leads to an increase in fluctuation amplitude. Population structure is characterized by a significant contribution of synanthropic species (*Mus musculus*, *Nesokia indica*). The abundance of animals in areas of anthropogenic successions in the lower Amu Darya is comparable to, and in some habitats significantly exceeds, that in undisturbed natural landscapes.

Our data confirm the well-known concept that in the ecological optimum of a species' range, population density is not only higher but also more stable, whereas at the periphery it fluctuates over a wider range [1, 3, 4]. Under pessimal conditions, populations are highly sparse, lack effective population control, and their abundance is mainly limited by external factors.

An analysis of the demographic, sex, and age structure of populations of background species shows that the main population parameters are stable and correspond to species-specific norms. Similarities in reproductive processes are noted for *Mus musculus*. A high reproductive potential allows populations to increase their density within one or two reproductive seasons, while the high carrying capacity of the habitat helps maintain it at a high level.
Demographic structure shows little dependence on population abundance level, anthropogenic impact, biotopic affiliation, or external environmental factors. The ratio of males to females in all age groups is nearly equal, which also indicates population stability. In the bank vole, a high reproductive intensity is observed, and variability in litter size by years and seasons is not a factor regulating population numbers. *Meriones tamariscinus* is characterized by the presence of intrapopulation mechanisms regulating abundance; in years of high density, males of different age groups predominate in the population. *Mus musculus* is capable of intensive reproduction and rapid population growth, has a high litter size, and exhibits an approximately equal sex ratio.
At present, a balance between environmental resources and the density of their inhabitants has been achieved in this territory. The coexistence of species is apparently determined not by competitive interactions, but by the partitioning of living space in accordance with the biological characteristics of each species.

References

Карасева Е.В., Телицина А.Ю. Методы изучения грызунов в полевых условиях: Учеты численности и мечение.- М.: Наука, 1996.- 228 с.
Котенкова Е.В. Синантропные и дикоживущие мыши надвидового комплекса Mus musculus s.l.: Систематика, распространение, образ жизни, механизмы изоляции и эволюция //Автореф. дис. … д-ра биол. наук.-М.- 2000.- 55 с.
Мамбетуллаева С.М., Тлегенов М. Т., Динамика численности и популяционные показатели мелких млекопитающих в низовьях дельты Амударьи// Финляндия FARS International Journal of edication social science humanities №12 (15.12.) 2023.с. 115
Реймов Р.Р. Грызуны Южного Приаралья.- Нукус, 1987.- 125 с.
Тлегенов М.Т., Экологические особенности популяции meriones tamariscinus в низовьях Амударьи Медж. Журн. Россия -2022.- Universum химия и биология №3-1 (93)с. 7-11.
Тлегенов М.Т., Популяционные показатели мелких млекопитающих в низовьях дельты Амударьи «Российская наука в современном мире» XXXVI Международная научно-практическая конференция 28 февраля 2021 Научно-издательский центр «Актуальность.РФ» СБОРНИК СТАТЕЙ. Moscow – 2021 с. 27-29
Тлегенов М.Т., Оценка биотопической приуроченности популяций грызунов в низовьях Амударьи Научно-технический прогресс и инновационные технологии Сборник статей по итогам Международной научно-практической конференции 29 декабря 2021 г. Стерлитамак, Российская Федерация Агентство международных исследований Agency of international research 2021.