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Species Composition of Rodents of the Genus Muridae Illiger and Their Parasitic Gamasoid Mites (Gamasoidea) in Southern Kyrgyzstan

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ABSTRACT

Rodents of the family Muridae are among the most widespread and ecologically adaptable mammals in Kyrgyzstan. They play important ecological roles in seed dispersal, insect regulation, and food chains, while also serving as reservoirs of dangerous zoonotic pathogens such as plague, tularemia, and leptospirosis. Understanding their species composition and distribution is therefore essential for both zoological and epidemiological research. This study aimed to investigate the diversity, distribution, and ectoparasite associations of Muridae in southern Kyrgyzstan. Field surveys were carried out in the foothill and mid-mountain zones between [insert years/seasons]. Small mammals were captured using live traps, identified by morphological features, and their relative abundance was estimated using standard density indices with statistical error (± SE). Parasitic mites were collected and identified with conventional parasitological methods. A total of 11 rodent species belonging to four genera were recorded. In the foothill zone, the dominant species were the grey rat (Rattus norvegicus, 21.1 ± 2.57%) and house mouse (Mus musculus, 19.1 ± 2.47%),

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while subdominants included the red-tailed gerbil (Meriones libycus) and the wood mouse (Apodemus sylvaticus). In the mid-mountain zone, A. sylvaticus (23.1 ± 2.96%) and the archaic vole (Microtus juldaschi, 21.2 ± 2.87%) prevailed. In total, 18 gamasid mite species from nine genera and four families were identified, with Lealaps agilis (31.42 ± 2.22%) as the predominant parasite. These findings clarify the composition, distribution, and host–parasite relationships of Muridae in southern Kyrgyzstan and provide a baseline for future ecological and sanitary-epidemiological monitoring.

Keywords: Dominant; Agrocenosis; Anthropogen; Trap; Craniology; Synanthropy; Landscape

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1. Introduction

1.1.Justification of the Study's Novelty

Existing literature on rodents and their parasites predominantly focuses on species composition and epidemiological significance, while the impact of anthropogenic landscape transformation on host–parasite relationships and rodent population structure remains insufficiently explored. Most studies are limited to either general descriptions of parasitic communities or analyses of individual rodent and parasite species, without considering changes in the ecological environment or the dynamics of their interactions.

The novelty of the present study lies in its integrative analysis of how anthropogenic landscape transformation influences the structure of rodent communities and the host specificity of their associated parasites. For the first time, we identify and systematize patterns of change in rodent populations and parasite associations in relation to the degree and nature of habitat transformation. This approach not only expands the current understanding of the biology and ecology of rodents and their parasites, but also provides insights into the adaptive responses of these systems under anthropogenic pressure. These findings are critical for assessing epidemiological risks, conserving biodiversity, and developing effective pest population management strategies [1].

Rodents are one of the most numerous and diverse groups of mammals, comprising over 2,200 species. They inhabit almost all natural zones, from Arctic tundras to tropical forests and urban areas. Due to their high fertility, adaptability, and rapid reproductive capacity, rodents play a significant role in ecosystems and often act as carriers of various parasites and disease pathogens, posing a threat to human and domestic animal health.

Rodents also possess strong and sharp teeth that grow continuously throughout their lives, forcing them to constantly gnaw on various materials to wear them down. This feature contributes to their high destructive potential, which manifests in several key aspects.

Rodents are capable of gnawing through a wide range of construction and utility materials, including wood, drywall, plastic, rubber, electrical wiring insulation, and even thin metal. Such activity often results in damage to structural elements (walls, floors, roofs) and infrastructure systems (plumbing and electrical), thereby increasing the risks of water leakage, fires, and electrical short circuits.

In agricultural settings, rodents can inflict extensive damage on crops and stored produce. They consume and contaminate grains, vegetables, and fruits both in the field and during post-harvest storage. According to various estimates, rodent-related crop losses may reach 10%–20% or higher, causing significant economic damage to farmers and agribusinesses.

Rodents pose a serious threat to food safety and hygiene in residential buildings, commercial facilities, and warehouses. Their droppings, urine, and fur can contaminate food products, rendering them unsuitable for consumption and increasing the risk of foodborne illnesses. This leads to considerable financial losses associated with the disposal of spoiled goods and the implementation of sanitary measures.

Rodents may damage or destroy various household items, including furniture, clothing, books, and personal belongings. Such activity results in material losses and often necessitates costly repairs or replacements.

Among the most well-known and widespread rodents are mice, rats, squirrels, hamsters, ground squirrels, beavers, and marmots. These species perform important ecological functions. They disperse plant seeds, aerate the soil, serve as prey for many predators, and help regulate populations of insects and other small animals.

However, due to their proximity to human habitation, rodents can become potential sources of infections. Mice and rats, in particular, prefer to inhabit areas near homes, warehouses, and garbage containers, which increases the likelihood of contact with humans [2].

Rodent parasites encompass a wide range of organisms—from microscopic protozoa and bacteria to arthropods and helminths. Many of these parasites serve as vectors of zoonotic infections, capable of causing diseases in humans.

Ectoparasites living on the surface of rodents include fleas, ticks, lice, and chewing lice.

Fleas are especially important epidemiologically, as they can transmit causative agents of plague (*Yersinia pestis*), tularemia, typhus, and other diseases. For example, the Oriental rat flea (*Xenopsylla cheopis*) is the primary vector of plague. Ticks transmit *Borrelia* species responsible for Lyme disease, as well as various rickettsiae and *Babesia* species. Ticks attach to the rodent's skin, feed on its blood, and can infect it with bacteria and viruses present in the host organism. Lice and chewing lice are less studied but can also carry pathogenic microorganisms.

Internal parasites of rodents include helminths (nematodes, cestodes, trematodes), protozoa, and bacteria. Helminths cause various diseases in rodents and weaken their bodies by reducing immunity. Some helminths are zoonotic and can infect humans, such as schistosomes and Toxocara species. Protozoa—such as amoebae, *Giardia*, and *Toxoplasma*—can cause intestinal and other diseases transmitted through rodent feces. Certain rodent species also serve as reservoirs for bacteria such as *Salmonella*, *Leptospira*, the causative agents of tularemia, and other zoonoses.

Parasitism is a type of relationship where the parasite lives at the expense of the host, causing it harm (weakening, disease). The parasite obtains food, shelter, and resources while reducing the host's viability.

Key features of parasitism:

- One-sided benefit: the parasite gains, the host suffers.
- Long-term contact between parasite and host.
- Specialization in specific hosts.
- Found in all groups of organisms.

The science studying parasites, their biology, interactions with hosts, and methods to control parasitic diseases is named parasitology. It is important for health, agriculture, and ecology.

Parasites affect ecosystem structure and dynamics by living at the host's expense and causing harm.

Role of parasitism in landscapes:

- Regulating host populations and maintaining ecosystem balance.
- Supporting biodiversity through evolutionary pressure.
- Transmitting infectious agents between animals and humans.
- Altering host behavior and condition, impacting food chains and ecological niches.

Rodents and their parasites play a crucial role in maintaining natural disease foci. This is particularly evident in urban and rural areas where rodent populations can reach high densities.

Outbreaks of plague, typhus, tularemia, leishmaniasis, and other serious diseases are associated with human contact with rodents or their ectoparasites. Rodent parasites such as fleas and ticks act as a kind of "bridge" for transmitting pathogens between wild animals and humans.

To reduce the risk of infection, comprehensive measures must be implemented to control rodent populations and their parasites:

- Elimination of food sources and shelter for rodents in residential and agricultural areas.
- Use of mechanical traps and toxic baits.
- Regular deratization (rodent extermination) and disinsection (insect vector control).
- Sanitary control of the territory and timely removal of waste.
- Educating the population on hygiene rules and safety measures when in contact with potentially infected animals [3].

The study of rodents and their parasites holds significant economic importance for several reasons:

Rodents cause considerable harm to agriculture, industry, and the domestic sector. They destroy crops, spoil stored grain, damage products in warehouses, and degrade building structures and engineering systems. Understanding the biology and behavior of rodents enables the development of effective control methods, which helps minimize economic losses.

Rodents and their parasites are vectors of numerous zoonotic infections that can spread to humans and animals. Diseases associated with rodents (such as plague, tularemia, and typhus) require expensive treatment and can lead to epidemics. Research facilitates timely identification of infection foci and prevention of outbreaks, thereby reducing healthcare expenses and social consequences.

Monitoring rodent populations and their parasites contributes to improving sanitary conditions at industrial facilities, warehouses, and residential areas. This enhances product quality, decreases the risk of spoilage, and strengthens consumer confidence, which is crucial for the economy and business.

Scientific data on the biology and ecology of rodents allow for the development of effective and economically justified strategies for controlling rodents and their parasites. This minimizes the use of poisons and resources, reducing costs and adverse environmental impacts.

Thus, research on rodents and their parasites is an essential tool for economic security, public health preservation, and protection of material assets.

1.2. Characteristics in Different Landscape Types

- Forest landscapes are characterized by high species diversity and complex parasitic interactions, contributing to ecosystem stability.
- Agricultural landscapes experience reduced biodiversity and parasite concentration on a limited number of hosts, necessitating disease control measures.
- Urban landscapes create unique conditions for parasites adapted to synanthropic hosts (e.g., rats, pigeons), thereby increasing epidemiological risks.

Studying host–parasite relationships is essential for understanding ecosystem processes, maintaining biodiversity, and preventing disease spread. Effective management of these interactions supports the health of both natural and anthropogenically altered ecosystems.

Anthropogenic landscape changes (deforestation, urbanization, agriculture) affect ecosystem structure and functions as well as the interactions between parasites and their hosts.

Anthropogenic landscape transformation is the process of changing natural environments due to human activities, including agriculture, urbanization, industrial development, resource extraction, and construction.

Main forms of transformation:

- Agriculture: deforestation, wetland drainage, and plowing reduce biodiversity, degrade soils, and pollute water bodies.
- Urbanization: replacement of natural landscapes with artificial surfaces reduces natural habitats and alters the microclimate.
- Industrial development: ecosystem destruction and environmental pollution.
- Hydrotechnical structures: changes in water regimes affecting flora and fauna.
- Road construction: impacts natural areas, especially in mountainous and residential zones.

Consequences:

- Loss of biodiversity and natural habitats.
- Soil degradation and reduced fertility.
- Increased erosion and risk of natural disasters.
- Disruption of essential ecosystem services (air purification, climate regulation).

Understanding human impacts on landscapes is crucial for developing sustainable land-use and environmental protection strategies, which help minimize negative effects and ensure balanced territorial development.

Landscape transformation often reduces populations of some species while increasing others, particularly synanthropic ones. This alters host availability: specialist parasites may lose their typical hosts, whereas generalists gain an advantage by exploiting new host species.

The division of natural areas into isolated patches limits host and parasite migration, potentially reshaping parasite communities and promoting adaptation to new hosts or conditions. This often results in reduced host specificity.

Human activity creates novel habitats (e.g., landfills, greenhouses, residential zones), enabling new host-parasite interactions to form—typically with lower specificity.

Pollution, noise, and microclimate changes compromise host immunity, increasing vulnerability to parasitic infections and facilitating host-switching events.

The link between anthropogenic landscape transformation and host-parasite specificity lies in environmental changes that alter host diversity and ecological conditions. These shifts drive parasite adaptation, broaden host ranges, and foster new interaction patterns. Ultimately, it is landscape change that shapes parasitic systems—not the reverse [4].

Human impact on host–parasite systems

Human activities—such as construction, deforestation, agriculture, urbanization, and pollution—directly alter natural habitats, reduce biodiversity, and fragment species' ranges. These changes lead to the decline or disappearance of some species (often specialists), while others, including synanthropic and invasive species, increase in abundance. As a result, previously stable host–parasite associations are disrupted.

Parasites that lose their typical hosts must either adapt by switching to new, available hosts or face extinction. This shift is often accompanied by a reduction in host specificity, with a trend from specialization toward generalism [5].

Anthropogenic landscape transformation drives adaptive changes in parasite systems, notably a shift in host specificity.

Types of influence:

– *Direct:* habitat destruction → loss of specific hosts → extinction or host-switching by parasites.
– *Indirect:* changes in climate, microclimate, humidity, and vegetation → altered host behavior and population structure → reorganization of parasite–host interactions.

1.3.Landscape of Kyrgyzstan

Kyrgyzstan is a country with extremely diverse terrain, including mountain ranges and intermountain hollows and valleys. This diverse landscape creates a variety of natural conditions and significant biodiversity. The animal world of the country's mountain ecosystems is formed in accordance with two main principles. First, there are significant differences in the species composition and abundance of animals distributed horizontally from northeast to southwest. Second, faunistic complexes change vertically, forming clearly defined landscape-altitude bands [6].

Special attention in this paper is paid to the distribution of rodents (Muridae) across these landscape belts. The main object of the study is the Alai Range, an integral and important component of the Pamir-Alai mountain system, which is formed together with the Turkestan Range and is part of the Southern Tien Shan. The average height of the Alai Range exceeds 5000 meters above sea level. Compared to the Zaalai Range, it is 1.5–2 km lower. The southern slope, which faces the Alai Valley, is short, steep, and sparsely dissected. It is about 10–15 km long (up to 4–5 km in the central part) and has a slope of 28–30°. The northern slopes are gentler and more dissected, with well-defined longitudinal valleys and numerous glaciers in the western part. Transverse valleys are often represented by deep gorges with turbulent mountain rivers. As a rule, the southern slopes are barren and precipitous, descending sharply into the Alai Valley without a pronounced foothill zone [7].

To analyze the distribution of rodents by altitude belts, we use the strip classification of landscapes proposed by A. I. Yanushevich (1968). According to Yanushevich, three altitude-landscape zones are distinguished:

1. The foothill belt, which ranges from 500 to 1800 meters above sea level.
2. The mid-mountain belt is between 1800 and 2800 meters above sea level.
3. High Mountain belt: 2800–3500 meters above sea level and higher [8].

The distribution of rodents across these zones is closely related to vegetation type, climate, soil moisture, and food availability. Each altitude-landscape zone forms a unique ecological niche in which certain rodent species find optimal habitat and reproductive conditions. Specifically, species adapted to dry steppe and semi-desert conditions predominate in the foothill belts. In contrast, the mid-mountain and high-mountain areas are inhabited by more cold-resistant and specialized forms that live in subalpine and alpine landscapes.

The study of not only rodents themselves but also the parasitic organisms associated with them is of particular interest. Gamasid mites (Gamasoidea) are among the most numerous, ecologically flexible, and taxonomically diverse groups of ectoparasites closely associated with rodents. These mites live in the burrows and nests of their hosts, as well as on their bodies. They play an important role in transmitting various pathogens, including rickettsiae, borreliae, and viruses. The distribution and species composition of Gamasoidea depend on the range and density of rodent populations as well as on microclimatic conditions, soil moisture, soil-vegetation structure, and anthropogenic impact.

Studying these rodents is important for zoogeography, parasitology, and assessing the epidemiological situation, especially in areas with natural foci of zoonotic infections. Monitoring rodents and their ectoparasites enables the timely identification of potential public health threats and the prediction of disease outbreak risks.

Although data on the rodent fauna and their ectoparasites in the region are presented in several scientific publications, they remain fragmentary and incomplete. This is particularly true of hard-to-reach, poorly studied areas of mountainous terrain. The present study aims to systematize the available data, identify new faunistic data, and analyze the distribution patterns of rodents and gamasid mites in the landscape belts of southern Kyrgyzstan. The results may provide a foundation for future research in zoology, epidemiology, and the conservation of biodiversity in mountain ecosystems in the region.

2. Materials and Methods

2.1.Study Area and Sampling Design

Fieldwork was conducted from 2021 to 2024 in the Alai Range. Sampling was carried out across various altitudinal and landscape zones, including the foothill zone (500–1800 m a.s.l.), the mid-mountain zone (1800–2800 m a.s.l.), and the high mountain zone (above 2800 m a.s.l.), following the classification proposed by A.I. Yanushevich (1968). Sampling sites were selected to represent typical biotopes of each elevation belt, such as steppe habitats, shrublands, and valley systems with varying moisture levels (**Figure 1**).

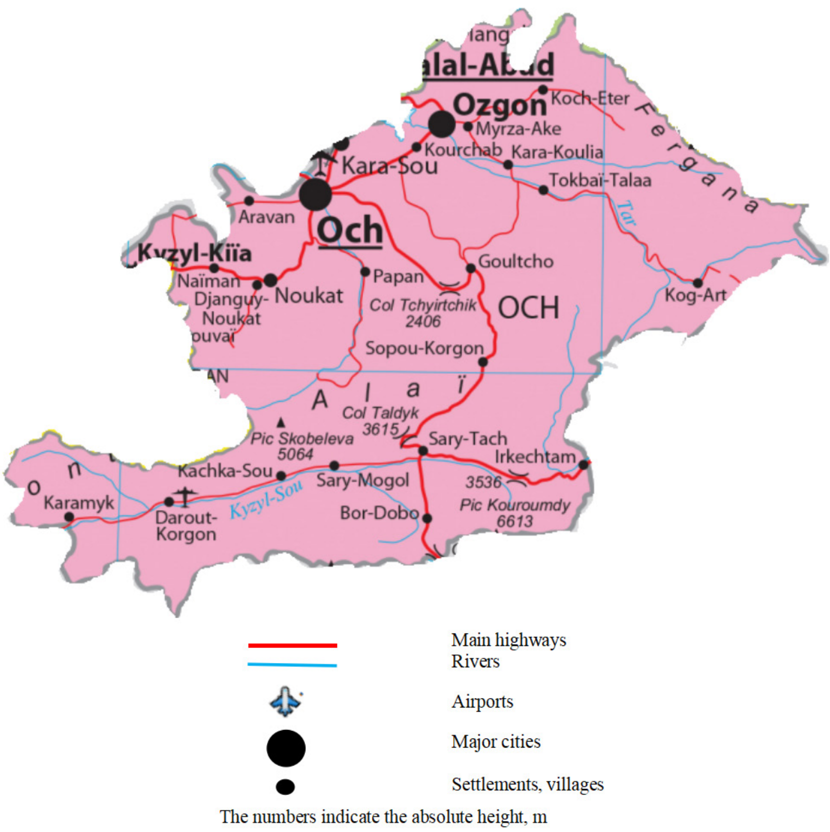

Figure 1. Study area map.

2.2. Trapping and Field Collection

The ecological and biological characteristics of small rodents were studied using a comprehensive approach, including assessments of species composition, abundance, and patterns of horizontal and vertical (zonal and landscape) distribution. Small mammals were captured using the line-trapping method, which is widely applied in zoological and ecological research. Traps used in the study were compact "Hero" snap traps, according to the protocol of V.V. Kucheryuk (1952), which ensures preservation of key morphological features of the specimens. Over the course of the study, a total of 3700 trap-nights were recorded, resulting in the capture of 455 individuals belonging to 15 species and 4 genera of small rodents (**Table 1**) [9].

Table 1. Conservation status of selected rodent species recorded in southern Kyrgyzstan.

№	Species Name	Common Name	IUCN Status	National Red List (Kyrgyzstan)	Endemic Status	Threats	Legal Protection
1.	*Dryomys nitedula*	Forest dormouse	Least Concern (LC)	Vulnerable (VU)	No	Habitat fragmentation, deforestation, fires	Bern Convention (Appendix II)
2.	*Alticola argentatus*	Silver vole	Not Evaluated (NE)	Rare / Insufficiently studied	Central Asian endemic	Climate change, degradation of alpine ecosystems	National protection recommended

Notes:
- **IUCN Status**: based on the IUCN Red List (https://www.iucnredlist.org/).
- **National Red List**: status according to the Red Data Book of the Kyrgyz Republic (3rd edition, 2006).
- **Endemic Status**: indicates whether the species' distribution is restricted to Central Asia.
- **Legal Protection**: refers to international and national conservation regulations and agreements.

2.3. Specimen Identification and Data Processing

All collected specimens were processed using standard zoological procedures, including morphological identification, estimation of population density, and analysis of spatial distribution. Identification was conducted based on external morphological characteristics, with species determination cross-verified against established regional taxonomic keys.

2.4. Sampling Design and Trap Placement

The traps were placed along linear transects (trap lines), a standard method in ecological and zoological studies. Each transect consisted of 25–50 traps spaced at intervals of 5–10 meters, depending on habitat type and terrain accessibility. Trap lines were positioned within representative microhabitats of each altitudinal zone to ensure coverage of ecological variability.

Transects were placed in key biotopes such as dry steppe slopes, shrublands, alpine meadows, and moist valley floors. In each habitat type, at least two to three replicate trap lines were deployed to account for spatial heterogeneity. The total trapping effort was standardized in trap-nights (trap × nights of operation), with a cumulative effort of 3,700 trap-nights across all sites.

Traps were checked daily, and their positions were georeferenced using handheld GPS devices to allow for spatial analysis of species distribution and abundance.

2.5. Endangered Species (*Dryomys nitedula* and *Alticola argentatus*)

Among the species recorded during the study, particular attention should be given to endangered and rare mammals such as *Dryomys nitedula* and the *Alticola argentatus*, which have significant conservation value (**Table 2**).

Table 2. The species composition of mouse-like rodents inhabiting the foothills and mid-mountain altitude zones of southern Kyrgyzstan.

No.	Name in Latin	Common Name
1.	*Gliridae*	Silver Dormice
2.	*Dryomys nitedula*	Forest Dormouse
3.	*Cricetidae*	Common vole
4.	*Alticola argentatus*	Silver Vole
5.	*Microtus juldasci*	Juldas Microtus
6.	*Microtus arvalis*	Tamarisk vole
7.	*Ellobius tancrei*	Tancrei Mole Vole
8.	*Gerbilidae*	Gerbils
9.	*Meriones tamariscinus*	Tamarisk Jird
10.	*Meriones libycus*	Libyan Jird
11.	*Muridae Illiger*	True Mice and Rats
12.	*Apodemus sylvaticus*	Wood Mouse
13.	*Mus musculus*	House Mouse
14.	*Rattus turkestanicus*	Turkestan Rat
15.	*Rattus norvegicus*	Brown Rat (Norway Rat)

Dryomys nitedula

The forest dormouse is a rare arboreal rodent, inhabiting primarily forest and shrub biotopes with a well-developed undergrowth layer. In southern Kyrgyzstan, the species occurs locally, mainly in foothill areas with remnant patches of deciduous forests and shrub thickets. The dormouse is listed in the Red Data Book of the Kyrgyz Republic (3rd edition, 2006) with the status of a Vulnerable species (VU), and is also included in Appendix II of the Bern Convention as a species requiring protection. The main threats to forest dormouse populations are habitat fragmentation, degradation of natural forest areas, fires, and human economic activities.

Alticola argentatus

The silver vole is a mountain rodent inhabiting the highlands of the Tien Shan and Pamir, primarily in rocky habitats, talus slopes, and alpine meadows at elevations above 2800 m a.s.l. The species is considered endemic to Central Asia, with a limited and patchy distribution. *Alticola argentatus* is included in the Red Data Book of the Kyrgyz Republic as a rare and insufficiently studied species. It is characterized by low population density and high sensitivity to climate change and the degradation of alpine ecosystems. Conservation of this species requires further study of its range, population status, and ecological preferences, as well as the establishment of protected areas in regions of stable occurrence.

During the research, all traps were used to count the number of rodents, and rodents were caught and examined for ectoparasite infestation. A total of 749 gamazid mites were collected from them. During the research, generally accepted zoological and parasitological research methods were used [10].

On the transformed landscapes of the valley and foothill zone of the Alay Range, part of the Pamir-Alay, 12 species of gamazid mites, which are obligate and facultative haematophages, were found on house mice (*Musculus*). Nine species of mites were recorded on this host for the first time in the region. Since the Alay natural plague focus functions in the studied territory, active exchange of ectoparasites with other rodents contributes to an increase in the epizootological and epidemiological danger of the house mouse as a synanthropic species that is in constant contact with humans [11].

In southern Kyrgyzstan, it is usually found in fields, forests, along the banks of rivers, lakes, canals, and reservoirs, and in thickets of shrubs. The house mouse is of significant epidemiological and epizootological importance as a reservoir for pathogens of diseases such as tsutsugamushi fever, Q fever, tick-borne rickettsiosis, brucellosis, salmonellosis, anthrax, plague, pseudotuberculosis, listeriosis, erysipelas, leptospirosis, toxoplasmosis, spirochaetosis, and tick-borne encephalitis [12]. In natural foci of infection, the house mouse acts mainly as a secondary carrier of infection and becomes infected through contact with the main carriers – marmots, ground squirrels, gerbils, voles, as well as through transmission by blood-sucking insects and ticks (**Figure 2**) [13].

Figure 2. Traps prepared for installation using the trap-line method.

As a numerous intrazonal species, the house mouse feeds on a wide range of ectoparasites – fleas, lice, ixodid ticks, gamazid ticks, red mites, hair mites, and scabies mites. The most representative group, diverse in ecological terms, is gamazid ticks (*Gamasina*). Systematic studies of the gamazid fauna in Kyrgyzstan began in the middle of the last century. At that time, the faunal complex of gamazid mites in southern Kyrgyzstan consisted of seven species: *Hupoaspis (G) murinus Strandt. et Menz. (=H. (G.)) lubrica Oud. et Voights), Androlaelaps angustiscutis Breg., Eulaelaps stabularis (Koch), Hirsionyssus musculi (John.), Allodermanyssus sanguineus (Hirst), Laelaps algericus Hirst,* and *Laelaps agilis Kosh.*

Seventeen species of blood-sucking gamazid mites parasitise the nine species of mouse-like rodents surveyed in the Alay Range. Among them, the dominant species is *Lealaps agilis*, a specific parasite of the forest mouse. Some species of gamazids have a wide range of hosts, parasitising various species of rodents.

To determine the species of gamazid mites, the USSR fauna identifier '*Gamasoidea* gamazid mites was used [14]. The accuracy of the identification of ectoparasites was verified by Doctor of Biological Sciences, Professor B. K. Kulanazarov and Candidate of Biological Sciences, Senior Researcher at the Biological and Soil Institute of the National Academy of Sciences of the Kyrgyz Republic S. Zh. Fedorova.

During the research, generally accepted zoological and parasitological research methods were used. The obtained materials underwent generally accepted statistical calculations (**Figures 3,** and **4**) [15].

Figure 3. Mouse-like rodents used in office research.

Figure 4. Conducting laboratory research in field conditions on rodents.

3. Results

Today, the natural plains, valleys and fields located in the foothills have been completely transformed by anthropogenic factors. The former natural landscapes have been replaced by secondary modified landscapes – agrocenoses, villages, towns, roads, reservoirs, and main and irrigation canals, etc. Of course, these anthropogenic factors have a direct quantitative and qualitative impact on the animals and plants that live there, altering the former natural landscapes. That is why today the study of the animal world inhabiting the altered landscapes of the foothill belt is one of the most pressing issues [16–18].

Our long-term studies of rodents have identified eight species of rodents belonging to four genera that occur in the altered landscapes of the foothills (**Table 3**). As shown in the table, the most numerous rodents are the grey rat and the house mouse, accounting for 21.1 ± 2.57% and 19.1 ± 2.47% of the mice caught, respectively. Of these mice, the house mouse and grey rat were dominant, while the red-tailed sand rat occupied a subdominant position with 13.1 ± 2.12% (**Table 4**) [19].

Table 3. The species composition of mouse-like rodents inhabiting the foothill highlands of southern Kyrgyzstan.

No.	Name in Latin	Common Name
№ I	*Gliridae*	Dormice
1.	*Dryomys nitedula*	Forest Dormouse
№ II	*Cricetidae*	Common vole
2.	*Microtus arvalis*	Tamarisk vole
№ III	*Gerbilidae*	Gerbils
3.	*Meriones tamariscinus*	Tamarisk Jird
4.	*Meriones libycus*	Libyan Jird
№ IV	*Muridae Illiger*	True Mice and Rats
5.	*Apodemus sylvaticus*	Wood Mouse
6.	*Mus musculus*	House mouse
7.	*Rattus turkestanicus*	Turkestan rat
8.	*Rattus norvegicus*	Brown Rat (Norway Rat)

Table 4. Quantitative ratios of mouse-like rodents inhabiting the foothill altitude zone.

No.	Types	Absolute Number	Relative Abundance (%)
1.	Forest dormouse	21	8.33 ± 1.74
2.	Common vole	18	7.14 ± 1.62
3.	Tamarisk vole	24	9.52 ± 1.84
4.	Tancrei Mole Vole	33	13.1 ± 2.12
5.	Wood Mouse	28	11.1 ± 7.10
6.	House mouse	48	19.1 ± 2.47
7.	Turkestan rat	27	10.7 ± 1.95
8.	Brown Rat (Norway Rat)	53	21.1 ± 2.57
	Total:	252	

We discovered nine species of rodents in the Alay Range. All of them had previously been described as common species in southern Kyrgyzstan. The only exception is the narrow-skulled vole, which is relatively rare in the Pamir-Alay region, as confirmed by our data. Among the rodents inhabiting the Alay Range, the predominant species are the silver vole, the forest mouse and the archa vole, which account for 24.4 ± 1.08%, 18.8 ± 0.98% and 16.2 ± 0.93% of the rodents caught, respectively.

We identified a total of 28 species of gamazid mites, 17 of which were blood-sucking. Of the 17 species of gamazid mites found on rodents, the dominant species is Lealaps agilis (13.4 ± 1.24%), a specific parasite of the forest mouse (**Table 5**). Haemogamasus nidi ranks second in terms of numbers, accounting for 12.6 ± 1.21% of the mites collected.

Table 5. Species composition of blood-sucking gamazid mites of rodents in the Alay Range.

№	Taxon	Number of Ticks Collected	
		Absolute Number	Relative Abundance (%)
1.	*Haemolealaps glasgovi*	72	9.61 ± 1.07
2.	*Haemolaelaps casalis*	20	2.67 ± 0.58
3.	*Eulealaps stabularis*	83	11.0 ± 1.14
4.	*Lealaps turkestanicus*	52	6.94 ± 0.92
5.	*Laelaps algericus*	31	4.13 ± 0.72
6.	*Lealaps jettmari*	15	2.00 ± 0.51
7.	*Lealaps agilis*	101	13.4 ± 1.24
8.	*Huperlaelaps arvalis*	34	4.53 ± 0.76
9.	*Haemogamasus nidi*	95	12.6 ± 1.21
10.	*Haemogamasus hirsutus*	43	5.74 ± 0.85
11.	*Haemogamasus ivanovi*	54	7.20 ± 0.94
12.	*Haemogamasus bifurcatus*	6	0.80 ± 0.32
13.	*Haemogamasus dudius*	7	0.93 ± 0.35
14.	*Haemogamasus spirius*	5	0.66 ± 0.29
15.	*Hirstionyssus transiliensis*	54	7.20 ± 0.94
16.	*Hirstionyssus isabellinus*	70	9.34 ± 1.06
17.	*Hirstionyssus criceti*	7	0.93 ± 0.35
	Total:	749	

Among blood-sucking arthropods parasitising rodents in the Alay Range, gamazid mites are highly diverse. In addition to free-living gamazid mites, 19 species of parasitic mites have been found in this area. Among them, the red marmot parasite *Androlealaps karawaiewi* is particularly numerous.

Gamasoidea mites represent the extensive superfamily *Gamasoidea*, which belongs to the order *Parasitiformes*. This superfamily includes about 20 families of parasitic and free-living mites distributed in various natural zones worldwide. A smaller part of them are parasitic forms. They live on the bodies of mammalian and bird hosts, in their nests, in streams, and in accumulations of organic substrates. More than 150 parasitic species of gamazoid mites have been identified in the fauna of the CIS [20].

Most parasitic mites of medical significance belong to five families: *Laelaptidae*, *Haemogamasidae*, *Hirstionyssidae*, *Macronyssidae*, and *Dermanyssidae*.

They are associated with reptiles, birds, and small mammals. Some species (the red mite *Ornithonyssus bacoti*, the mouse mite *Allodermanussus sanguineus*, and the chicken mite *Dermanussus gallinae*), which live near humans, are capable of attacking them. Massive tick bites cause dermatitis [21,22]. Parasitic gamazid mites are widespread in southern Kyrgyzstan, in various landscape zones and vertical belts, from foothill valleys to high mountains.

Gamasid mites are the most numerous and species-rich group of arthropods inhabiting the Alay Range, diverse in their feeding habits and relationships with host animals. We found a total of 26 species of gamasid mites, 19 of which are blood-sucking. In general, blood-sucking gamazid mites account for 27.9% of the arthropods found on rodents in the Alay Range.

Of the 19 species of blood-sucking gamazid mites found on rodents, the dominant parasites are *Androlealaps karawaiewi* and *Haemogamasus dauricus*, which account for 13.7 ± 1.10 and 12.8 ± 1.07% of the collected mites, respectively. *Haemogamasus nidi* and *Eulealaps stabularis* are in second place in terms of abundance (9.58 ± 0.94 and 8.34 ± 0.89%) (**Table 6**). The latter two parasites are most commonly found on red marmots, forest mice and archaic voles [23].

Table 6. Species composition of blood-sucking gamasid ticks of rodents of the Alai ridge.

No.	Types of Ticks	Number of Ticks Collected	
		Absolute Number	Relative Abundance (%)
1.	*Androlealaps karawaiwei*	133	13.7 ± 1.10
2.	*Haemolealaps glasgowi*	70	7.21 ± 0.83
3.	*Haemolealaps casalis*	18	1.85 ± 0.43
4.	*Eulealaps stabularis*	81	8.34 ± 0.89
5.	*Lealaps turkestanicus*	50	5.15 ± 0.71
6.	*Lealaps algericus*	29	2.98 ± 0.54
7.	*Lealaps jettmari*	13	1.34 ± 0.37
8.	*Lealaps agilis*	98	10.1 ± 0.96
9.	*Huperlaelaps arvalis*	32	3.29 ± 0.57
10.	*Haemogamasus dauricus*	124	12.8 ± 1.07
11.	*Haemogamasus Nidi*	93	9.58 ± 0.94
12.	*Haemogamasus Hirsutus*	41	4.22 ± 0.64
13.	*Haemogamasus ivanovi*	52	5.35 ± 0.72
14.	*Haemogamasus Bifurcates*	4	0.41 ± 0.20
15.	*Haemogamasus Dubius*	5	0.51 ± 0.23
16.	*Haemogamasus Spirius*	3	0.31 ± 0.18
17.	*Hirstionyssus transiliensis*	52	5.35 ± 0.72
18.	*Hirstionyssus Isabellinus*	68	7.00 ± 0.82
19.	*Hirstionyssus criceti*	5	0.51 ± 0.23
	Total:	971	

The differences between the proportions of dominant and subdominant species of gamazid mites in the collections are statistically significant (t = 2.8 and 3.2, respectively). There are no statistically significant differences between the proportions of dominant and subdominant species of gamazid mites in the collections (t = 0.6 and 0.8, respectively). In general, the range of hosts of blood-sucking gamazoid mites is quite wide and includes almost all species of rodents. The largest number of gamazid mites was found on red squirrels, forest mice, and archaic voles (abundance index (AI) respectively: 3.95 ± 0.87; 2.80 ± 2.21 and 3.94 ± 1.27 conventional units). The occurrence index of mites is highest on red squirrels. However, as evidenced by the abundance and occurrence indices of mites, calculated taking into account the number of hosts, the main hosts of blood-sucking gamazid mites are mouse-like rodents: forest mice, archaic voles, and silver voles.

The species composition of gamazid mites parasitising red marmots and forest mice, despite their almost identical abundance indices, differs quite significantly. Only 5 species of gamazid mites were found on red marmots. A relatively numerous species of mites on this animal is *And. Karawaiewi* (abundance index (AI) – 1.48 ± 0.18, occurrence index (OI) – 48.8 ± 4.76 conventional units). Seven and eight species of gamazid mites were found on silver and archaic voles, respectively. A relatively numerous species of mite on the archaic vole is *And. Karawaiwei*, found in single specimens on the silver vole, with an abundance index of 1.02 ± 0.18; occurrence index of 38.0 ± 3.70 and 0.02 ± 0.01; 3.70 ± 0.92 conventional units, respectively. The basis of the gamazid mite collections found on the silver vole is *Hi. Trahsiliensis* (abundance index (AI)–1.13 ± 0.08 at occurrence index (OI)–44.3 ± 4.81 conventional units) (**Table 7**).

Table 7. The number of blood-sucking gamasid mites of background rodent species.

No.	Types of Ticks	Types of Animals							
		Red Marmot		Silver Vole		Juldas Microtus		Wood Mouse	
		Abundance Index	Occurrence Rate	Abundance Index	Occurrence Rate	Abundance Index	Occurrence Rate	Abundance Index	Occurrence Rate
1.	*Androlealaps karawaiewi*	1.48 ± 0.18	48.8 ± 4.76	0.02 ± 0.01	3.70 ± 0.92	1.02 ± 0.18	38.0 ± 3.70		
2.	*Haemolealaps glasgowi*			0.001 ± 0.001	0.40 ± 0.39	0.47 ± 0.08	25.0 ± 3.07	1.40 ± 0.16	41.1 ± 2.15
3.	*Haemolealaps Casalis*							0.003 ± 0.003	0.40 ± 0.39
4.	*Eulealaps stabularis*	0.35 ± 0.06	16.5 ± 2.48			0.07 ± 0.01	1.54 ± 0.71	0.08 ± 0.02	1.65 ± 0.86
5.	*Lealaps algericus*							0.28 ± 0.12	4.53 ± 1.52
6.	*Lealaps agilis*							2.43 ± 0.07	58.8 ± 3.59
7.	*Hyperlaelaps arvalis*							0.28 ± 0.12	4.53 ± 1.52
8.	*Haemogamasus dauricus*	0.63 ± 0.16	11.3 ± 1.81	0.84 ± 0.05	34.5 ± 3.70	0.23 ± 0.12	4.53 ± 1.41	0.80 ± 0.03	27.2 ± 3.12
9.	*Haemogamasus nidi*	0.007 ± 0.001	1.54 ± 0.72	0.03 ± 0.03	2.69 ± 0.88	0.63 ± 0.16	11.3 ± 1.81	0.06 ± 0.01	8.46 ± 1.83
10.	*Haemogamasus ivanovi*	0.01 ± 0.01	0.84 ± 0.56	0.04 ± 0.01	1.70 ± 0.75	0.35 ± 0.04	8.46 ± 1.83		
11.	*Hirstionyssus transiliensis*			1.13 ± 0.08	44.3 ± 4.81	0.04 ± 0.03	2.69 ± 0.98	0.004 ± 0.03	0.84 ± 0.56
12.	*Hirstionyssus isabellinus*			0.93 ± 0.07	33.5 ± 3.60	0.04 ± 0.01	0.84 ± 0.56		

Unlike the silver and archaic voles, nine species of gamazid mites were found on the forest mouse as a host. Among them, the specific parasite of the forest mouse, *Lealaps agilis*, is absolutely dominant. Its abundance is AI–2.43 ± 0.07 and OI–58.8 ± 3.59 conventional units. Also, among blood-sucking gamazid mites, the highest numbers are found on this animal for *Haemolealaps glasgowi* and *Haemogamasus dauricus* (respectively, AI–1.40 ± 0.16; 0.80 ± 0.03 at OI–41.1 ± 2.15; 27.2 ± 3.12 conventional units). According to specialised literature, these species are typical and widespread parasites of the red marmot, archaic and silver voles, and forest mice. On other host species, they are found in isolated individuals, although their range of hosts is quite large, which coincides with our data. The species of gamazid mites found on rodents indicate the richness of the parasitocenosis of the studied territory, which may create a certain epidemiological and epizootological situation with regard to transmissible infectious diseases in this territory (**Table 8**).

Table 8. Gamasid mites of transformed landscapes of the valley-foothill zone of the Alai ridge of the Pamir-Alai.

No.	Types of Ticks	Occurrence Index	Abundance Index	Dominance Index
1.	*Androlealaps glasgowi*	2.95	0.060	5.82
2.	*Haemolealaps Casalis*	0.53	0.010	0.93
3.	*Androlealaps Androgynous*	0.53	0.005	0.46
4.	*Androlealaps longipes*	0.53	0.005	0.46
5.	*Androlealaps ellobii*	0.53	0.016	0.40
6.	*Eulaelaps stabularis*	2.95	0.083	7.22
7.	*Lealaps algericus*	8.33	0.884	76.69
8.	*Ornithonyssus bacoti*	0.26	0.002	0.23
9.	*Hirstionyssus meridianus*	0.26	0.008	0.70
10.	*Hirstionyssus isabellinus*	1.07	0.029	2.56
11.	*Hirstionyssus eusoricis*	0.26	0.002	0.23
12.	*Hirstionyssus muscudi*	0.80	0.030	3.26

The dominant species is, naturally, *Laelaps algericus* (Dominance Index (DI) = 76.69), which is specific to the house mouse and is also the most numerous on this host (Abundance Index (AI) = 0.88). Subdominants are the nest-dwelling ectoparasites of rodents *Eulaelaps stabularis* (Dominance Index (DI) = 7.22, Abundance Index (AI) = 0.083) and *Androlaelaps glasgowi* (Dominance Index (DI) = 5.82, Abundance Index (AI) = 0.060); common ones are *Androlaelaps casalis*, *Androlaelaps longipes*, *Androlaelaps ellobii*, *Hirstionyssus meridianus*, *Hirstionyssus isabellinus*; rare – *Androlaelaps androgynus*, *Ornithonyssus bacoti*, *Hirstionyssus eusoricis* – are specific species of other rodents.

Studies show that the faunal complex of house mouse gamazids has undergone significant changes. For the first time in the region, *Androlaelaps glasgowi*, *Androlaelaps casalis*, *Androlaelaps andro*gynus, *Androlaelaps longipes*, *Androlaelaps ellobii*, *Ornithonyssus bacoti*, *Hirstionyssus meridianus*, *Hirstionyssus isabellinus*, *Hirstionyssus eusoricis* have been recorded on this host. *Androlaelaps lubrica*, *Androlaelaps angusticutis*, and *Androlaelaps sanguineus* have not been found at present. This means that the microcommunity of ectoparasites of the house mouse in southern Kyrgyzstan has been replenished with new species, and therefore the epidemiological danger of this species has increased due to active contact with other rodents (**Table 9**).

Table 9. Species composition of mouse-like rodents inhabiting the mid-mountain altitude zone of Southern Kyrgyzstan.

No.	Name in Latin	Common Name
1.	*Dryomys nitedula*	Forest dormouse
No. I.	*Cricetidae*	Common vole
2.	*Alticola argentatus*	Silver vole
3.	*Microtus juldasci*	Juldas Microtus
4.	*Microtus arvalis*	Tamarisk vole
No. II.	*Muridae Illiger*	True Mice and Rats
5.	*Apodemus sylvaticus*	Wood Mouse
6.	*Mus musculus*	House mouse
7.	*Rattus turkestanicus*	Turkestan rat
8.	*Rattus norvegicus*	Brown Rat (Norway Rat)

Another feature was that a complete change in the quantitative indicators of the mouse-like rodent fauna under the direct influence of anthropogenic factors was proven. For example, from a theoretical point of view, in a comparative analysis of natural and altered landscapes, the forest mouse dominated in earlier or ancient natural landscapes in the foothill altitude zone. However, as our research shows, in secondarily altered landscapes, synanthropic mice (grey rats, house mice) are almost as dominant in terms of numbers as other mice. If we extrapolate these data to other animals, we can conclude that, as a result of anthropogenic factors, the animal world in foothill landscapes is undergoing a complete quantitative, qualitative, and population-structural transformation (**Table 10**) [24].

Here it is shown that among mouse-like rodents, the forest mouse, the archaic vole and the house mouse have higher quantitative indicators.

Among mice with higher numbers in the mid-mountain belt, the forest mouse and Pamir vole are considered dominant, with indices of 23.1 ± 2.96% and 21.2 ± 2.87%, respectively, while the subdominant or second most numerous species is the house mouse, with a percentage of 12.3 ± 2.31% (**Table 11**).

Table 10. Quantitative distribution of rodents in the foothills by landscape type.

No.	Landscapes	No.	Types of Rodents	Relative Abundance (%)
1.	Agrocenoses	1.	Common vole	26.4 ± 0.69
		2.	Forest mouse	
		3.	House mouse	
		4.	Turkestan rat	
2.	Anthropogenic settlement landscapes	1.	Forest dormouse	27.9 ± 0.70
		2.	House mouse	
		3.	Turkestan rat	
		4.	Grey rat	
3.	Artificial coastal ecotones	1.	Red-tailed sand rat	13.4 ± 0.53
		2.	House mouse	
		3.	Turkestan rat	
		4.	Grey rat	
4.	Natural semi-altered coastal ecotones	1.	Forest dormouse	15.1 ± 0.56
		2.	Common vole	
		3.	Forest mouse	
5.	Urbanised cultural landscapes	1.	Forest dormouse	3.25 ± 0.28
		2.	House mouse	
		3.	Turkestan rat	
6.	Abandoned buildings	1.	House mouse	1.30 ± 1.30
		2.	Turkestan rat	
		3.	Tamarisk vole	
		4.	Red-tailed sand rat	

Table 11. Quantitative ratio of mouse-like rodents living in the mid-mountain altitudinal zone.

No.	Species	Absolute Number	Relative Abundance (%)
1.	Forest dormouse	22	9.85 ± 2.03
2.	Silver vole	23	12.3 ± 2.30
3.	Juldas Microtus	43	21.2 ± 2.87
4.	Common vole	24	11.8 ± 2.27
5.	Forest mouse	47	23.1 ± 2.96
6.	House mouse	25	12.3 ± 2.31
7.	Turkestan rat	14	6.10 ± 1.78
8.	Brown Rat (Norway Rat)	19	9.36 ± 2.04
	Total:	203	

The species composition and quantitative indicators of rodents in the mid-mountain altitude zone are the same as in previous literature data. However, changes in the faunistic characteristics of rodents can be observed. For example, it can be said that a new species, the grey rat, is expanding its range to the mid- mountain altitude zone. Also, in this zone, as in the foothill zone, the quantitative indicators of rodents are increasing in cultural landscapes (agrocenoses, anthropogenic-settlement landscapes). For example, these mice include the house mouse and the grey rat. The abundance of these synanthropic species in agrocenoses accounts for 12.8% of all mouse-like rodents in the mid-mountain altitude zones, and in anthropogenic-settlement landscapes — 9.94%. Naturally, changes in the faunal composition of mouse-like rodents (the appearance of the grey rat, the growth in the number of synanthropic mice), an increase in the quantitative indicators of rodents, the spread of various infectious and invasive diseases (epizootological), and an increase in the likelihood of transmission of these diseases to humans (epidemic) lead to a number of pressing problems.

When studying mid-mountain landscapes, we divided them into eight types (**Table 12**).

Table 12. Quantitative distribution of rodents in mid-mountain belts across landscapes.

No.	Landscapes	No.	Types of Mouse-like Rodents	Relative Abundance (%)
1.	Pine forests	1.	Silver vole	7.56 ± 0.49
		2.	Pamir vole	
		3	Forest mouse	
		4.	Turkestan rat	
2.	Juniper forests	1.	Forest dormouse	22.8 ± 0.78
		2.	Silver vole	
		3.	Pamir vole	
		4.	Forest mouse	
3.	Rocky gravel slopes	1.	Forest dormouse	11.8 ± 0.78
		2.	Common vole	
		3.	Pamir vole	
		4.	Forest mouse	
4.	Shrub forests	1.	Forest mouse	2.30 ± 0.28
		2.	House mouse	
		3.	Turkestan rat	
5.	Natural coastal ecotones	1.	Forest dormouse	15.8 ± 0.68
		2.	Common vole	
		3.	Forest mouse	
		4.	Turkestan rat	
6.	Anthropogenic settlement landscapes	1.	House mouse	13.9 ± 0.64
		2.	Turkestan rat	
		3.	Grey rat	
7.	Agrocenoses	1.	House mouse	3.74 ± 0.35
		2.	Turkestan rat	
8.	Nut and fruit forests	1.	Forest dormouse	33.9 ± 0.88
		2.	House mouse	
		3.	House mouse	
		4.	Turkestan rat	
		5.	Grey rat	

An analysis of the distribution of mouse-like rodents in these landscapes showed that all landscapes have a higher diversity of mice. However, the mid-mountain altitude zone also includes landscapes that have been secondarily altered by human activity. For example, agrocenoses (arable land) and anthropogenic settlements (warehouses, sheds and other structures). In the landscapes of the mid-mountain altitude zone, the species composition of mice consists of four species. Of the landscapes in the mid-mountain zone, the nut-bearing forest landscape is considered the most favourable for the habitation and reproduction of mice. This is because mice caught in nut-bearing forest and archaic forest landscapes accounted for 33.9 ± 0.88% of the total number of mouse-like rodents caught in other landscapes of the mid-mountain belt, 22.8 ± 0.78%.

In terms of the biodiversity of mouse-like rodents, natural coastal ecotones ranked second after nut- bearing and archaic forests. The quantitative indicators of mouse-like rodents in these landscapes accounted for 15.8 ± 0.68% of the total number of mouse-like rodents caught in all landscapes, respectively.

4. Discussion

We divided the altered landscapes located in the foothills into eight types. The species composition of rodents in the landscapes belonging to these eight types was found to be diverse. In general, the greater or lesser distribution of rodents is directly related to the ecological conditions of the landscapes, the sufficiency or insufficiency of food resources, disturbance factors, the greater or lesser number of predators (birds of prey, mammals) or the stability of the landscapes (sometimes certain agricultural landscapes, land ploughed by tractors, dug up, and other types of activities, floods, and other factors). During the research, it was proven that, of the foothill landscapes, anthropogenic residential agrocenoses are the most favourable for the life of mouse-like rodents [25].

If we analyse the number of species of rodents, there are four species of mice living in these landscapes. In the other altered landscapes, there are two to three species.

According to the station distribution in the valley-foothill belt, the biotone richest in species diversity of mites is artificial coastal ecotones (hydraulic structures, irrigation canals). Almost all species of gamazid mites of forest mice are found here. The percentage of gamazids found at this station is 38.27 ± 2.32% of the total number collected.

It is known from the literature that spontaneous infection of forest mice with the causative agents of the following naturally occurring diseases has been recorded in Kyrgyzstan leptospirosis (Kichatov, Tynalinov, Genis, 1964), fever (R.I. Fedorova, 1968), necrobacillosis (S. Galiev, A.A. Volkova, B.M. Aizin, 1965), listeriosis (A.M. Kadycheva, 1966), and erysipeloid (A.M. Kadycheva, 1966). In 1966, A.M. Kadycheva isolated pathogens of paratyphoid, diplococcal, and streptococcal infections from forest mice and found streptostaphylococci and staphylococci [26,27].

It is important to note that blood-sucking gamazoid mites are an important link in the transmission of the following naturally occurring diseases: *Haemolaelaps glasgowi* – tick-borne typhus (Lonzinger, 1961), tularemia (Popova, 1966); *Eulaelaps stabularis* – tick-borne typhus (Lonzinger, 1961); *Laelaps algericus* – tularemia (Popova, 1966); *Laelaps agilis* – lymphocytic choriomeningitis (Solovyova, 1959); *L. Jetmari* – endemic haemorrhagic fever (Solovyova, 1959); tularemia (Popova, 1966); *Hirstionyssus meridianus* – brucellosis (Rementsova et al., 1963); *H. musculi* – tularemia (Popova, 1966); *Ornithonyssus bacoti* – endemic rat typhus (Somova, 1961); *Allodermanyssus sanguineus* – rickettsial pox (Kulagin, Zemskaya, 1953); *Allodermanysus sanguienus* and *Ornithonyssus bacoti* may be of epidemiological significance, as they inhabit human dwellings and readily attack humans. Their relatively low specialisation in host selection and potential polyphagia lead to an expanded range of hosts. In our materials, *Allodermanysus sansuienus* was found in secondary archaic forests of the Nookatsky district and degraded shrub forests of the Chon-Alai district, with the latter accounting for 2.70 ± 2.66 and 6.45 ± 4.41% of the number collected, respectively. *Ornithonyssus bacoti* was found in a single specimen in the secondary archaic forests of the Nookat district. All other species of blood-sucking gamazids found on forest mice inhabiting southern Kyrgyzstan are of epizootic significance. According to our data, almost all of these species of gamazids are found in artificial coastal ecotones [28–30].

The data presented indicate that the large genus of gamazid mites found on forest mice are carriers of various infectious diseases from rodents to rodents. However, additional facts are needed to draw a definitive conclusion about the significance of gamazid mites parasitising forest mice in the epizootic spread of zoonoses. Interest in the study of gamazid mites remains high in light of the hypothesis about the mechanism of the plague epizootic, put forward by L.I. Klassovsky and others (1981), who attach great importance to the preservation of the plague microbe in the L-form precisely in the body of mites [31].

In summary, it can be said that the formation of mouse-like rodents in altered foothill landscapes occurs from the fauna of mice that inhabited ancient natural landscapes.

Natural landscapes predominate in the landscapes of the middle mountain belt. However, even in the middle mountain belt, some landscapes have undergone changes under the influence of anthropogenic factors, as described above. For example, agrocenoses, anthropogenic settlements and other altered anthropogenic landscapes have appeared in the middle mountain belt. In summary, it can be said that natural landscapes predominate in the mid-mountain altitude zone. However, in recent years, these natural landscapes have also undergone changes. As a result of the clearing of primary forests, the formation of new forests, the wider use of land for grazing, hunting, the destruction of animals, the construction of livestock barns and other human activities, various landscape changes are taking place. As a result of many years of research, it has been confirmed that eight species of rodents inhabit the mid-mountain altitude zone.

Thus, it was proven that rodents in landscapes common within the mid-mountain altitude zone have a higher species composition and quantitative indicators. In this altitude zone with high biodiversity and abundance of mouse-like rodents, the landscapes of nut forests, archaic forests, and natural coastal ecotones are found. The main difference between the landscapes of the mid-mountain zone and the foothills is that the ecological balance in the mid-mountains is not disturbed, or if it is, then to a lesser extent.

5. Conclusions

As a result of the study conducted in southern Kyrgyzstan, 11 species of rodents belonging to four genera were identified. The greatest species diversity is represented by the families *Muridae* (71.5%) and *Cricetidae* (28.5%). It was established that the dominant species in the foothill altitude zone is the grey rat (*Rattus norvegicus*) 21.1%, and the subdominant species is the house mouse (*Mus musculus*) — 19.1%. In the middle mountain belt, the forest mouse (*Apodemus sylvaticus*) predominates — 23.1% — and the Pamir vole (*Microtus juldaschi*) — 21.2%.

The most favourable landscapes for the habitation and reproduction of rodents in the foothills were anthropogenic settlement areas (26.4%) and agrocenoses (22.8%). In the mid-mountain zone, rodents were most numerous in nut-bearing forests (33.9%) and archaea forests (22.8%). The data obtained emphasise the importance of landscape characteristics in shaping the structure of rodent populations in different altitude zones of the region.

Author Contributions

All authors made significant contributions to this study. A.S. developed the study concept; U.A. and B.A. developed the methodology; K.k.Z. contributed to data collection and resources; T.K. supervised the data; M.M. prepared the initial draft, and A.K. reviewed and edited the manuscript; A.S. supervised the study. All authors read and approved the final manuscript.

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Conflict of Interest

All the authors declare that there is no conflict of interest in relation to the research, authorship, and publication of this study.

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