ABS ACTA BIOLOGICA SIBIRICA
A journal on the biodiversity of Siberia and the adjacent lands

Acta Biologica Sibirica 11: 999–1013 (2025)
doi: 10.5281/zenodo.17174941
http://journal.asu.ru

RESEARCH ARTICLE

Helminth fauna of the Asian badger (*Meles leucurus* Hodgson, 1847) in the Southern Aral Sea region

Abat S. Berdibaev[1], Erkinjon B. Shakarboev[2,3], Sardorbek N. Turgunov[4], Shinbergen R. Bekbauliev[1], Oybek A. Abduganiyev[5], Ziroatkhon S. Abduqodirova[6]

1 *Nukus State Pedagogical Institute, P. Seytov St., u/h, Nukus, 230105, Uzbekistan*
2 *Institute of Zoology, Academy of Sciences of Uzbekistan, 232b Bogishamol St., Tashkent, 100053, Uzbekistan*
3 *Tashkent State Agrarian University, 2 University St., Tashkent, 111602, Uzbekistan*
4 *Andijan Institute of Agriculture and Agrotechnologies, 1 Oliygoh St., Andijan, 170600, Uzbekistan*
5 *Yangiyer branch of Tashkent Institute of Chemical Technology, 1b Tinchlik St., Yangiyer, Syrdarya region, 121001, Uzbekistan*
6 *Andijan State University, 129 University St., Andijan, 170100, Uzbekistan*

Corresponding author: Erkinjon B. Shakarboev (sh-erkinjon@mail.ru)

Academic editor: R. Yakovlev | Received 3 June 2025 | Accepted 14 August 2025 | Published 24 September 2025

http://zoobank.org/6F484D0D-9FE3-4F39-A84A-098687E76BC5

Citation: Berdibaev AS, Shakarboev EB, Turgunov SN, Bekbauliev ShR, Abduganiyev OA, Abduqodirova ZS (2025) Helminth fauna of the Asian badger (*Meles leucurus* Hodgson, 1847) in the Southern Aral Sea region. Acta Biologica Sibirica 11: 999–1013. https://doi.org/10.5281/zenodo.17174941

Abstract

Between 2017 and 2025, helminthological investigations were conducted on 32 wild badgers (*Meles leucurus*) across four natural geographic regions of Karakalpakstan. As a result, helminth infections were detected in 17 individuals, accounting for 53.1%. In total, 20 species of helminths were identified in the examined badgers, belonging to three phylum, four classes, nine orders, sixteen families, and eighteen genera. These included four species of cestodes, one species of trematode, three species of acanthocephalans, and twelve species of nematodes. Among the 20 helminth species, fifteen species were classified as helminths with indirect lifestyle and five species as helminths with direct lifestyle. The highest prevalence of infection was recorded for *Toxocara canis* (34.3%), followed by *Toxocara mystax* (25.0%). In terms of the intensity range, *T. canis* showed the highest range, with two to 77 specimens per host, while *T. mystax* ranged from three to 35 specimens. The intensity range of other helminth species varied between one and 33 specimens.

Keywords
Helminth fauna, badgers, parasitic worms, seasonal dynamics, Southern Aral Sea region, *Meles leucurus*

Introduction

Badgers (*Meles* Brisson, 1762) are burrowing animals that inhabit permanent territories, which provide them with essential resources such as food, shelter, and, most importantly, suitable conditions for constructing breeding dens. Currently, members of the genus *Meles* are widely distributed across Eurasia (Dvornikov and Chashchin 2008).

Based on morphological and genetic studies, the presence of two badger species has been confirmed in the territory of Uzbekistan: *Meles leucurus* (Hodgson, 1847) – the Asian badger, and *Meles meles canescens* Blanford, 1875 – the Common badger. The contact zone between these two species in Central Asia is located in the mountains of the Western Tien Shan. *Meles meles canescens* occurs in the foothills of the Karjantau, Ugam, Chatkal, Kuramin, and Turkestan mountain ranges. In the sympatric zone in southeastern Uzbekistan, the two forms exhibit distinct habitat preferences: *Meles meles canescens* inhabits mountainous areas, whereas *Meles leucurus* is found in plains and semi-deserts (Kashkarov et al. 2025).

Studies focused on the species composition, taxonomy, distribution, bioecological characteristics of dominant species, and epidemiological aspects of helminths in badgers remain relatively limited. Most existing research has primarily concentrated on helminths found in individual or a few host species, rather than providing comprehensive data specific to badgers (Shimalov 2007; Anisimova et al. 2008; Romashova et al. 2014; Ibragimova and Fataliyev 2015; Itin and Kravchenko 2016; Medvedev and Seredkin 2018; Suleymanov and Amanzhol 2020; Turgunov et al. 2024).

In the context of Uzbekistan, several studies have been conducted on the species composition, morphological and ecological characteristics, epizootology, and developmental biology of helminths infecting badgers, as well as domestic and wild carnivorous mammals (Koschanov 1971; Matchanov et al. 1973; Muminov et al. 1984; Shakarboev 2009; Akramova et al. 2019; Berdibaev 2021; Shakarboev et al. 2024). As a result of these studies, the species diversity of helminths in certain domestic and wild carnivores across various regions of Uzbekistan has been documented. The ecological and faunistic characteristics of carnivore helminths have been investigated, and bio-coenotic relationships between the hosts and their parasitic worms have been established (Shakarboev 2009; Berdibaev 2021; Shakarboev and Berdibaev 2023).

Due to their natural lifestyle, badgers are considered important natural reservoirs of invasive parasitic diseases. Therefore, studying them holds significant scientific and practical importance.

The aim of this research is to study the species composition of helminths in wild badgers inhabiting the Southern Aral Sea region and to determine the degree of infection with parasitic worms.

Materials and methods

The research was carried out seasonally between 2017 and 2025 using both stationary and transect (route-based) methods across four natural-geographical regions of the Republic of Karakalpakstan. The geographical coordinates of the studied areas are as follows:

Northwest Kizilkum: **1.** 42°1'20.34"N – 61°13'1.21"E, **2.** 41°58'19.54"N – 60°25'27.26"E, **3.** 42°12'20.67"N – 60°12'41.06"E, **4.** 43°11'20.12"N – 60° 2'14.36"E;

Lower reaches of the Amu Darya: **5.** 42°43'4.67"N – 59°24'14.77"E, **6.** 42°59'58.52"N – 59°23'47.47"E, **7.** 43°13'21.32"N – 58°53'6.30"E, **8.** 43°34'6.98"N – 59°32'51.33"E;

Ustyurt Plateau: **9.** 42°46'15.54"N – 58°43'54.60"E, **10.** 42°58'52.76"N – 58°42'46.01"E; **11.** 43°43'19.40"N – 58°23'2.93"E;

Dried Seabed of the Aral Sea: **12.** 43°59'19.86"N – 59°54'45.24"E (Fig. 1).

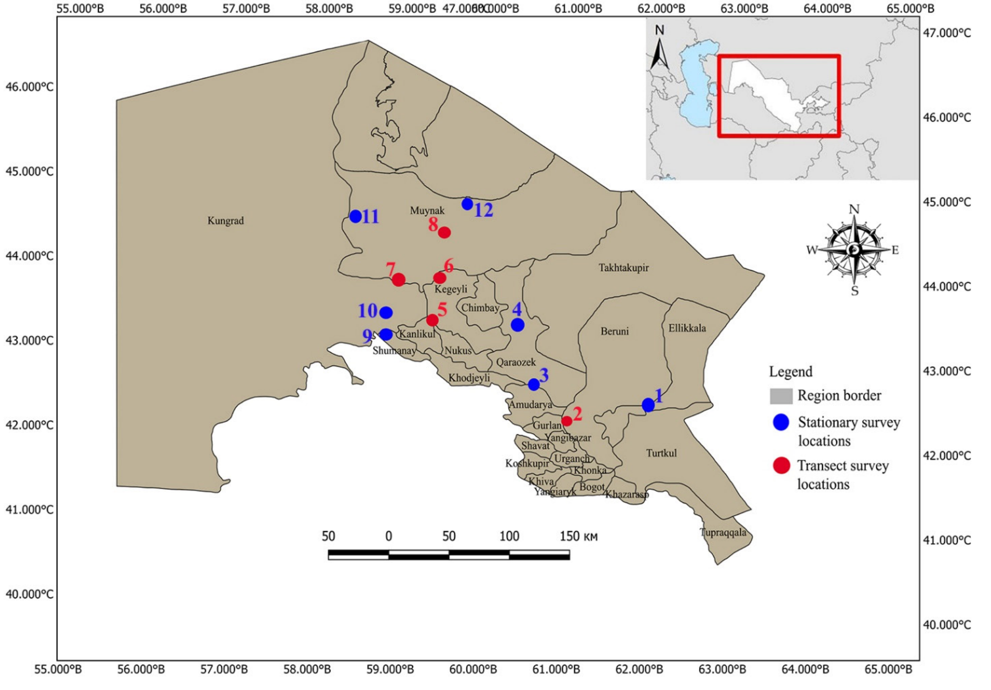

Figure 1. Map of the studied area.

In the research work, the methods of complete and incomplete helminthological dissection by Skrjabin (1928) were used. Helminths belonging to the classes Trematoda, Cestoda, and Acanthocephala were fixed in 70% ethanol, while nematodes were preserved in Barbagallo's solution, and all specimens were appropriately labeled (Kozlov 1977; Anderson 2000; Shakarboev 2009; Berdibaev 2021).

The identification of helminth species was carried out at the "General Parasitology" Laboratory of the Institute of Zoology, Academy of Sciences of the Republic of Uzbekistan, as well as the "Experimental Biological Research" Laboratory of Ajiniyaz Nukus State Pedagogical Institute. Identification was based on standard techniques and available scientific literature (Kozlov 1977; Anderson 2000; Shakarboev 2009; Berdibaev 2021).

Quantitative indicators of helminth infection in badgers, as well as the distribution of parasitic worms in the host organism, were calculated using standard parasitological indices such as the prevalence of infection (P, %), the intensity range (IR, specimens), and the mean abundance (MA, specimens) (Beklemishev 1970; Bush et al. 1997; Romashova et al. 2014).

All numerical data were processed using mathematical and statistical methods (Lakin 1990). For some statistical analysis, the Excell program and the OriginPro 7.5 software (OriginLab Corporation, USA) were used.

Results

According to the results of the conducted research, 32 wild badgers from four natural-geographical regions of Karakalpakstan were examined for helminthological infection, and 17 of them (53.1%) were found to be infected with helminths.

A total of 20 species of helminths were identified in badgers, belonging to three phyla, four classes, nine orders, 16 families, and 18 genera. (Table 1). Among these, four species of cestodes, one species of trematode, three species of acanthocephalans, and 12 species of nematodes were recorded (Kozlov 1977; Anderson 2000; Shakarboev 2009; Berdibaev 2021).

Table 1. Helminth infection rates of badgers in the Southern Aral Sea region

№	Helminth species	Site in host	The prevalence of infection (P, %)		The intensity range (IR, specimens)	
			Quantity	%	Min-Max	M±m
	Trematoda Rudolphi, 1808					
1	*Alaria alata* (Goeze, 1782) Krause, 1914	Small intestine	4	12.5	3–9	4.6±0.3
	Cestoda Rudolphi, 1808					
2	*Spirometra erinaceieuropei* (Rudolphi, 1819) Faust, Campbell & Kellogg, 1929	Small intestine	4	12.5	1–11	8.8±0.7

№	Helminth species	Site in host	The prevalence of infection (P, %)		The intensity range (IR, specimens)	
			Quantity	%	Min-Max	M±m
3	*Dipylidium caninum* (Linnaeus, 1758)	Small intestine	3	9.3	1–7	3.7±0.2
4	*Taenia pisiformis* (Bloch, 1780)	Small intestine	9	28.1	1–15	11.3±1.1
5	*Mesocestoides lineatus* (Goeze, 1782)	Small intestine	5	15.6	4–11	8.7±0.6
	Acanthocephala (Rudolphi, 1801)					
6	*Macracanthorhynchus hirudinaceus* (Pallas, 1781)	Small intestine	3	9.3	1–7	3.4±0.2
7	*Macracanthorhynchus catulinus* Kostylew, 1927	Small intestine	4	12.5	2–7	4.1±0.2
8	*Moniliformis moniliformis* (Bremser, 1811)	Small intestine	3	9.3	1–5	3.4±0.2
	Nematoda Rudolphi, 1808					
9	*Aonchotheca putorii* (Rudolphi, 1819)	Small intestine	4	12.5	1–17	11.4±1.1
10	*Eucoleus aerophilus* (Creplin, 1839)	Trachea and bronchi	2	6.2	1–5	3.6±0.2
11	*Dioctophyma renale* (Goeze, 1782)	Kidney	3	9.3	1–3	1.6±0.1
12	*Ancylostoma caninum* (Ercolani, 1859) Hall, 1913	Small and large intestine	2	6.2	2–5	4.2±0.2
13	*Uncinaria stenocephala* (Railliet, 1884)	Small and large intestine	4	12.5	2–15	10.5±11
14	*Crenosoma vulpis* (Dujardin, 1844)	Bronchi	3	9.3	1–5	3.5±0.2
15	*Toxascaris leonina* (Linstow, 1902) Leiper, 1907	Small intestine, stomach	6	18.7	1–23	13.3±1.3
16	*Toxocara canis* (Werner, 1782) Stiles, 1905	Stomach, abdomen, small and large intestine	11	34.3	2–77	22.7±2.0
17	*Toxocara mystax* (Zeder, 1800)	Small intestine, stomach and abdominal cavity	8	25.0	3–35	14.6±1.3
18	*Vigisospirura potekhini* Chabaud, 1959	Stomach	4	12.5	3–19	9.7±0.8
19	*Physaloptera sibirica* Petrow et Gorbunow, 1931	Small intestine	5	15.6	1–33	12.4±1.2

№	Helminth species	Site in host	The prevalence of infection (P, %)		The intensity range (IR, specimens)	
			Quantity	%	Min-Max	M±m
20	*Metathelazia capsulata* Gerichter, 1948	Bronchi	6	18.7	2–21	12.5±1.2

According to Table 1, out of the 20 helminth species identified, 15 belong to the group of helminths with indirect lifestyle, while five species are classified as soil-transmitted helminths. The highest prevalence of infection was observed in *T. canis* (34.3%), followed by *T. mystax* (25.0%). In terms of intensity range, the nematode *T. canis* ranked first, with a range of two to 77 specimens, followed by *T. mystax*, ranging from three to 35 specimens. For the remaining species, the infection intensity ranged from one to 33 specimens. All helminth species detected in badgers are considered specific parasites of domestic and wild carnivorous animals.

When analyzing the distribution of helminths found in badgers by order, Diphyllobothriidea was represented by one species (5.0% of the total species), Cyclophyllidea by three species (15.0%), Diplostomida by one species (5.0%), Oligacanthorhynchida by two species (10.0%), Moniliformida by one species (5.0%), Trichinellida by two species (10.0%), Dioctophymatida by one species (5.0%), and Rhabditida by nine species (45.0%) (Fig. 2) (Shakarboev and Berdibaev 2023).

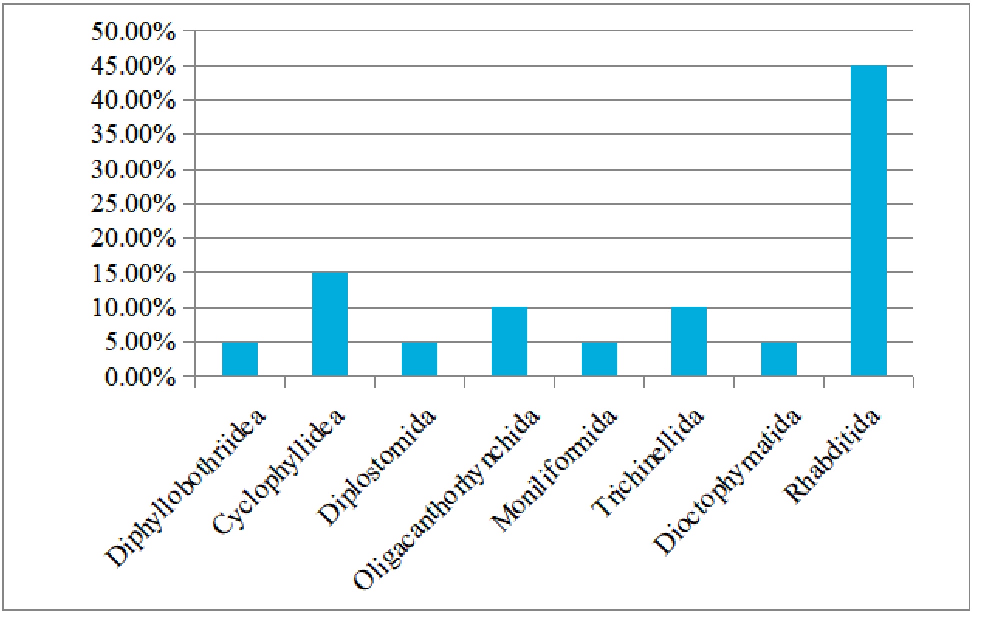

Figure 2. Distribution of badger helminths by orders.

The class Trematoda is represented by one species, accounting for 5.0% of the total number of helminth species. The class Cestoda includes four species, comprising 20.0% of the total species diversity. The class Acanthocephala unites three species, making up 15.0% of the overall species count. Meanwhile, helminths of the class Nematoda are the most diverse, represented by 12 species, which constitutes 60.0% of the total number of recorded helminth species (Fig. 3).

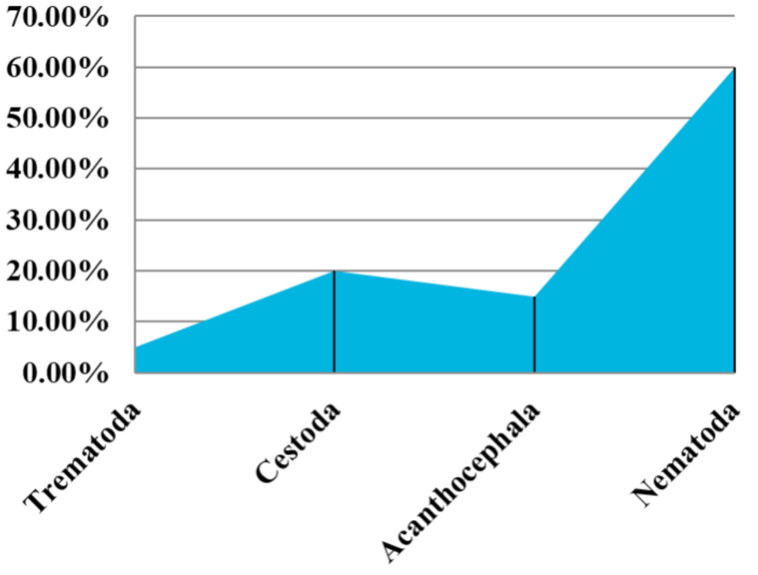

Figure 3. Distribution of the helminths of badgers of the Southern Aral Sea region by classes.

According to the data presented above, out of the 32 badgers examined through helminthological analysis, 17 individuals (53.1%) were found to be infected with parasitic worms. The species composition in helminth infracommunities in the badgers was as follows: two species of helminths were recorded in three badgers (9.3%), three species in four badgers (12.5%), four species in two badgers (6.2%), five species in five badgers (15.6%), and six species in six badgers (18.7%). Specifically, trematodes were detected in four badgers (12.5%), cestodes in four badgers (12.5%), and acanthocephalans in three badgers (9.3%), while helminths belonging to the class Nematoda were found in six badgers (18.8%). Thus, among helminth infections in badgers, nematodoses were dominant, followed by cestodoses and trematodoses, with acanthocephalan infections comprising 9.3%.

No cases of monoinfection were observed among the infected badgers. All exhibited associative infection, in which each animal harbored between two and five helminth species. Associative infection gives rise to interspecies and intraspecies interactions (Krotov 1973).

An analysis of the quantitative parameters within the composition of the helminthofauna of badgers revealed heterogeneous distribution patterns among individual helminth species. In line with ecological approaches to species classification based on prevalence and abundance (Hanski 1982), the helminths were divided into two categories: primary and secondary species. The primary species group includes dominants, subdominants, and associated intermediate species, while the secondary species group comprises rare, incidental, and peripheral species (Romashova et al. 2014; Hanski 1982).

Within the helminthofauna of badgers, three species were identified as dominant, four as subdominant, 11 as associated intermediate species, and two as rare species. Dominant and subdominant species together accounted for 35.0% of the total composition (Table 2).

Table 2. Distribution of badger helminths in the Southern Aral Sea region according to dominance degree

№	Category of helminths	Helminth species	Infection Indicators	
			The prevalence of infection (P, %)	Mean abundance, specimens
1	Dominant species	*T. canis*	34.3	22.7±2.0
2		*T. pisiformis*	28.1	11.3±1.1
3		*T. mystax*	25.0	14.6±1.3
4	Subdominant species	*T. leonina*	18.7	13.3±1.3
5		*P. capsulata*	18.7	12.5±1.2
6		*P. sibirica*	15.6	12.4±1.2
7		*M. lineatus*	15.6	8.7±0.6
8	Adjacent intermediate species	*A. alata*	12.5	4.6±0.3
9		*S. erinacei-europei*	12.5	8.8±0.7
10		*M. catulinus*	12.5	4.1±0.2
11		*C. putorii*	12.5	11.4±1.1
12		*U. stenocephala*	12.5	10.5±1.1
13		*V. potekhini*	12.5	9.7±0.8
14		*D. caninum*	9.3	3.7±0.2
15		*M. hirudinaceus*	9.3	3.4±0.2
16		*M. moniliformis*	9.3	3.4±02
17		*D. renale*	9.3	1.6±0.1
18		*C. vulpis*	9.3	3.5±0.2
19	Rare species	T. aerophilus	6.2	3.6±0.2
20		A. caninum	6.2	4.2±0.2

Helminths detected in badgers were also recorded in the bodies of domestic and wild predatory mammals. The helminths identified in badgers were observed across four natural-geographical regions of Karakalpakstan.

The highest rate of helminth infection in badgers was recorded in the Lower Amudarya region at 31.2%, while the lowest was observed in the Northwestern Kyzylkum (3.2%). In the Ustyurt Plateau, the infection rate was 12.5%, and in the dried seabed of the Aral Sea, it was 6.2%.

Seasonal changes have a significant impact on the formation of the helminth fauna in badgers. The seasonal dynamics, especially in regions with sharply continental climates such as the Ustyurt Plateau, Northwestern Kyzylkum, the dried seabed of the Aral Sea, and the Lower Amudarya, strongly influence soil-transmitted helminths and, to a slightly lesser extent, helminths with indirect lifestyle. The territory of Karakalpakstan is characterized by extremely dry and cold winters and very hot, arid summers.

In spring, as air and soil temperatures rise and soil moisture increases, ephemeral vegetation rapidly covers foothill, desert, and semi-desert areas. These conditions create favorable environments for the development of invasive helminth eggs. During this period, a noticeable increase in the activity of insects and other invertebrates is also observed (Berdibaev 2021).

In summer, air and soil temperatures average 35–40°C and often exceed these values, while soil and air humidity decrease significantly. Such unfavorable summer conditions negatively affect the viability of helminth eggs and the life cycles of intermediate hosts.

In autumn, the weather becomes cooler, occasionally cold, precipitation increases, and soil moisture rises. As a result, the number of intermediate hosts grows following the summer season.

Thus, the climatic characteristics of each season exert a considerable influence on the helminth fauna of badgers. The seasonal changes in the helminth fauna composition of badgers were reflected in the data presented in Table 3. The data in Table 3 indicate that under the conditions of Karakalpakstan, the infection of badgers with helminths occurs throughout the year.

Table 3. Seasonal dynamics of helminth infection in badgers under the conditions of the Southern Aral Sea region

Animal species	Examined	Infected (specimens)	%	Spring		Summer		Autumn		Winter	
				Examined	Infected	Examined	Infected	Examined	Infected	Examined	Infected
M. leucurus	32	17	53.1	6	2 (6.2%)	9	4 (12.5%)	12	8 (25.0%)	5	3 (9.4%)

Note: The data are derived from the total number of badgers examined.

The highest infection rate was recorded in autumn at 66.6%, followed by winter at 60.0%, summer at 44.4%, and spring at 33.3%. It can be seen that the level of helminth infection in badgers increased by two to three times in autumn compared to spring. The seasonal dynamics of individual species were studied using the examples of *T. pisiformis* and *T. canis* helminths.

Taenia pisiformis is a helminths with indirect lifestyle, and it was found that badgers are infected with this cestode throughout all seasons of the year. This species is considered one of the specific parasites of badgers. The highest infection rate with this cestode in badgers was recorded in autumn at 44.5%, while the lowest was observed in spring at 11.1%. In winter and summer, the infection rate remained the same at 22.2%. (Fig. 4). The intermediate hosts of this species include domestic and wild rabbits, and in some cases, rodents may also participate in its life cycle (Kozlov 1977).

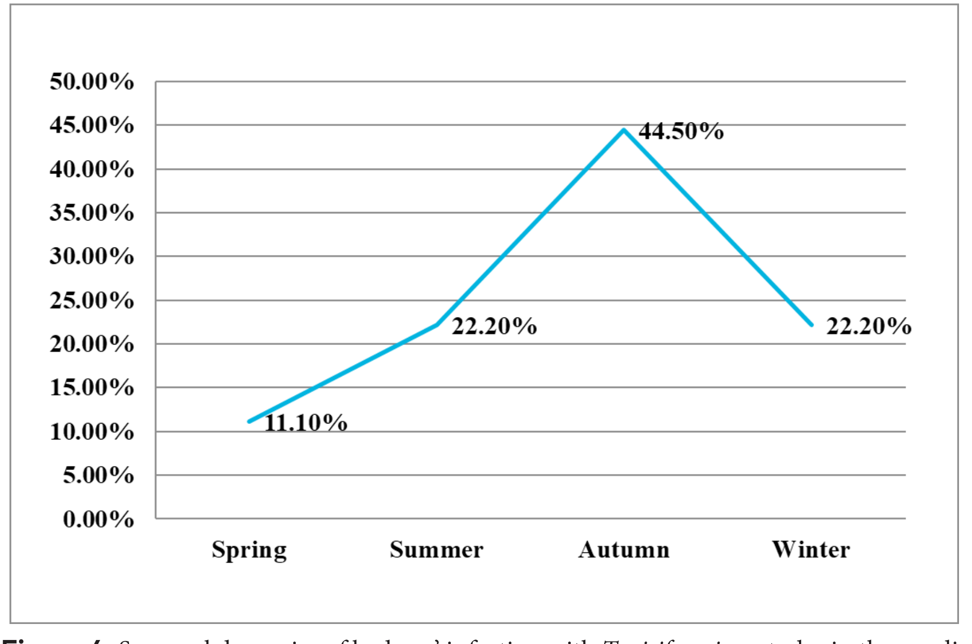

Figure 4. Seasonal dynamics of badgers' infection with *T. pisiformis* cestodes in the conditions of the Southern Aral Sea region.

Toxocara canis is a geohelminth and is considered one of the most widespread helminths among badgers and other carnivorous animals. Infection of badgers with this nematode was observed in all seasons of the year, with the highest infection rate recorded in the summer months (36.3%). It was found that the infection rates in autumn and winter were identical, at 27.3%. In the spring season, a decrease in infection was noted, reaching as low as 9.1% (Fig. 5).

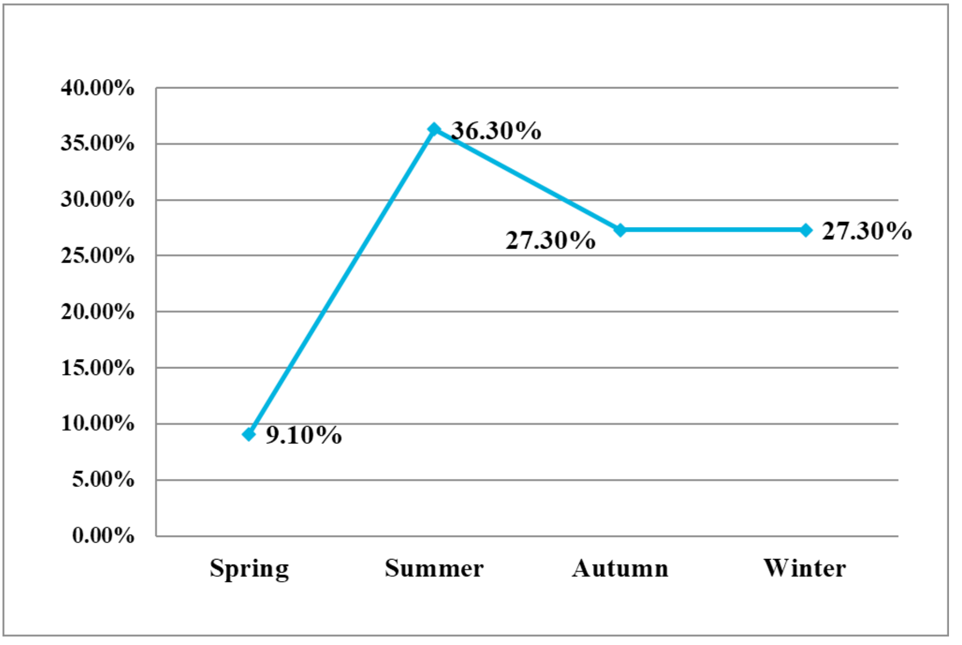

Figure 5. Seasonal dynamics of badgers' infection with *T. canis* nematodes in the conditions of the Southern Aral Sea region.

The results of the research indicate that, under the conditions of Karakalpakstan, the seasonal factor has a certain influence on the helminth fauna of badgers. These findings are consistent with the works of other researchers who have studied helminths in predatory animals (Trunova and Nurmagomedova 2017; Koschanov 1971).

Thus, according to the results of our research conducted during 2017–2025, 20 species of helminths were recorded in badgers in the territory of Karakalpakstan. Among the identified species, there are several of significant epidemiological and epizootological importance. These include *T. canis*, *T. pisiformis*, *T. mystax*, *T. leonina*, *A. alata*, *M. catulinus*, *U. stenocephala*, *M. moniliformis*, *D. renale*, and *A. caninum*. These species may pose a serious threat to the health of both livestock and humans. Furthermore, badgers serve as a key link in the active transmission and exchange of helminths between domestic and wild animals.

Conclusions

During our research, 20 species of helminths were identified parasitizing badgers under the conditions of the Southern Aral Sea region. Most of these species parasitize in the digestive system and are found as mixed infections.

Compared to other mustelids, badgers are more frequently infected with helminths typical of canids – such as *Dipylidium caninum*, *Ancylostoma caninum*, *Toxocara canis*, and others – likely due to the shared use of badger burrows by members of the Canidae family. At the same time, they lack certain parasites characteristic of mustelids, such as nematodes of the genus *Skrjabingylus*.

According to Tokobaev (1976), a total of 17 species of helminths have been recorded in badgers across the territories of Central Asia, including three species of cestodes, two species of acanthocephalans, and 12 species of nematodes. Six of the recorded helminth species have been identified as widespread and commonly occurring: *Mesocestoides lineatus*, *Moniliformis moniliformis*, *Macracanthorhynchus catulinus*, *Rictularia affinis*, *Uncinaria stenocephala*, and *Crenosoma vulpis*. With the exception of *Rictularia affinis*, all of these species were also detected in our study. Overall, nine helminth species identified in our research were also reported in the works of Tokobaev (1976). The presence of nematode species such as *Taenia martis* and *Filaria martis* in other regions of Uzbekistan was reported by Safarov (2024). According to recent studies (Safarov 2024), a total of 19 helminth species have been recorded in badgers from various regions of Uzbekistan, including five cestodes, one trematode, two acanthocephalans, and 11 nematodes. In our study, 20 helminth species were identified in badgers, which is a result comparable to that reported by Safarov (2024). However, four helminth species found in Safarov's study – *Taenia crassiceps*, *Taenia martis*, *Gnathostoma spinigerum*, and *Filaria martis* – were not detected in badgers from the territory of the Republic of Karakalpakstan. This is considered a natural phenomenon, as the physical and geographical characteristics of Karakalpakstan are unique and differ significantly from other regions of Uzbekistan. Certain species of spirurids and taeniids are absent under the environmental conditions specific to Karakalpakstan.

Therefore, in the territory of Karakalpakstan, badgers contribute to the formation and maintenance of natural foci of alariosis, taeniosis, ancylostomiasis, toxocariasis, and other helminthiases of epizootic significance, which necessitates ongoing monitoring and further study.

The species diversity of the badger's helminthocenosis is determined by the structure of trophic–epizootic chains, as well as the quantity and availability of key food sources involved in the circulation of the life stages of most helminth species parasitizing badgers, thereby supporting a high level of helminth species richness.

Intermediate hosts, which form the basis of the badgers' diet, play a significant role in the formation of the helminth fauna in badgers and are also crucial in the transmission of helminths within ecosystems among animals. Today, the development of measures to prevent and control the spread of intermediate hosts, as well as the creation of effective treatments against helminth infections, remains one of the most important tasks.

Acknowledgements

The work was carried out within the framework of the program "Ways of the Development of Helminth Fauna in Vertebrates, Taxonomy and Improvement of Control Measures" implemented by the Academy of Sciences of the Republic of Uzbekistan. We express our gratitude to Academician D.A. Azimov and Professor F.D. Akramova for their help in the morphological identification of helminth species.

References

Akramova FD, Azimov DA, Shakarboev EB, Shakarbaev UA, Mirzaev AU, Safarova FE, Arepbaev IM, Toremuratov MSh (2019) Ecological and faunistic analysis of nematodes of the Spirurida order – parasites of animals of Uzbekistan. Russian Journal of Parasitology 13(3): 11–25. [In Russian]

Anderson RC (2000) Nematoda parasites of vertebrates: their development and transmission. CAB International, New York, 650 pp.

Anisimova EI, Kekshina AM, Poloz SV (2008) Borse (*Meles meles*) helminth infection and organization of its settlements. Works of the VI International Scientific-Practical Conference, Vitebsk, 256–260 p. [In Russian]

Beklemishev VN (1970) Biocenotic Foundations of Comparative Parasitology. Tashkent, 504 pp. [In Russian]

Berdibaev AS (2021) Helminths of predatory mammals (Mammalia: Carnivora) of Karakalpakstan. PhD Dissertation. Nukus, 156 pp. [In Uzbek]

Bush AO, Lafferty KD, Lotz JM, Shostak AW (1997) Parasitology meets ecology on its own terms: Margolis et al. revisited. Journal of Parasitology 83(4): 575–583. https://doi.org/10.2307/3284227

Dvornikov MG, Chashchin PV (2008) Biogeographic features of the Badger (*Meles* Brisson, 1762) ecology. Proceedings of the Samara Scientific Center of the Russian Academy of Sciences 10(2): 464–472. [In Russian]

Hanski I (1982) Dynamics of regional distribution: The core and satellite species hypothesis. Oikos 38(2): 210–221. https://doi.org/10.2307/3544021

Ibragimova RSh, Fataliyev GG (2015) The current state of canine (*Canidae*) helminth fauna in Azerbaijan. NANA News. Biological and medical sciences 70(1): 35–39. https://doi.org/10.5281/zenodo.8298839 [In Azerbaijani]

Itin GS, Kravchenko VM (2016) Species structure of the helminthocenoses of wild predatory mammals in the landscape-geographical zones of the Northwest Caucasus. Theory and Practice of Combating Parasitic Diseases 17: 194–198. [In Russian]

Kashkarov RD, Mitropolskaya YO, Ten AG, Azimov NN, Jumayev FK, Ganiyev BN (2025) Fauna and Monitoring System of Vertebrate Animals in the Syrdarya and Jizzakh Regions. Fan, Tashkent, 464 pp. [In Russian]

Koschanov EK (1971) Helminths of wild mammals of Uzbekistan. Doctoral Dissertation. Tashkent, 232 pp. [In Russian]

Kozlov DP (1977) Determinant of helminths of predatory mammals of the USSR. Nauka, Moscow, 277 pp. [In Russian]

Krotov AI (1973) Fundamentals of Experimental Therapy of Helminthiases. Medicine, Moscow, 272 pp. [In Russian]

Lakin GF (1990) Biometry. Vysshaya Shkola, Moscow, 352 pp. [In Russian]

Matchanov NM, Sadykov VM, Bekirov RE (1973) Helmintofauna of some wild animals of Uzbekistan. Proceedings of Uzbek Research Veterinary Institute 20: 87–92. [In Russian]

Medvedev SG, Seredkin IV (2018) Fleas (Siphonaptera) of predatory mammals (Mammalia, Carnivora) of the Far East of Russia. Parasitology 52(4): 57–62. [In Russian]

Muminov PA, Sultanov MA, Elbusinova M, Siddiqov BKh, Mavlyanova RD (1984) Helminths of domestic carnivorous animals. Ecology of animal parasites of northeastern Uzbekistan. Tashkent, 55–57 p. [In Russian]

Romashova EN, Rogov MV, Romashov BV, Nikulin PI (2014) Wild carnivorous helminths of the Voronezh region: ecological and faunal analysis. Russian Journal of Parasitology 1: 23–33. [In Russian]

Safarov AA (2024) Parasite fauna of Carnivorous mammals (Mammalia: Carnivora) of Animals of Uzbekistan. Abstract of the dissertation for the degree of Doctor of Biological Sciences. Tashkent, 58 pp. [In Russian]

Shakarboev EB, Berdibaev AS (2023) Ecological and Faunistic Analysis of Helminths of Wild Mammals from the Order Carnivora in Karakalpakstan. Advances in Animal and Veterinary Sciences 11(11): 1801–1809. https://dx.doi.org/10.17582/journal.aavs/2023/11.11.1801.1809

Shakarboev EB, Jumamuratov JE, Khosilova GA (2024) Overview of Trematodes (Trematoda) of mammals in Uzbekistan. Acta Biologica Sibirica 10: 677–692. https://doi.org/10.5281/zenodo.12672756

Shakarboev EB (2009) Vertebrate trematodes of Uzbekistan (species composition, circulation routes and ecological-biological features). Abstract of the dissertation for the degree of Doctor of Biological Sciences. Tashkent, 42 pp. [In Russian]

Shimalov VV (2007) Contamination of meliorated territories with excrement of predatory mammals containing helminth eggs and larvae. Parasitology 41(2): 137–144. [In Russian]

Skryabin KI (1928) Methods of complete helminthological dissection of vertebrates, including humans. Publishing House of 1st Moscow State University, Moscow, 45 pp. [In Russian]

Suleymanov MJ, Amanzhol RA (2020) Species composition of jackal (*Canis aureus*) helminths in the western region of Kazakhstan. Theory and Practice of Combating Parasitic Diseases. Moscow, 420–423 p. [In Russian]

Tokobaev MM (1976) Helminths of Wild Mammals of Central Asia. Ilim, Frunze, 180 pp. [In Russian]

Trunova SA, Nurmagomedova SG (2017) Seasonal dynamics of dog helminth infection in the plain belt of Dagestan. Russian Journal of Parasitology 42(4): 358–360. [In Russian]

Turgunov SN, Amirov OO, Shakarboev EB, Kuchboev AE (2024) Morphological and Molecular Studies Nematode of the Species *Parascaris equorum* (Ascaridida). Advances in

Animal and Veterinary Sciences 12(8): 1450–1455. https://dx.doi.org/10.17582/journal.aavs/2024/12.8.1450.1455