Herald of Science of S.Seifullin Kazakh Agrotechnical Research University: Veterinary Sciences. – Astana: S. Seifullin Kazakh Agrotechnical Research University, 2025. – № 3 (011). – P.43-51. - ISSN 2958-5430, ISSN 2958-5449

doi.org/ 10.51452/kazatuvc.2025.3(011).2012
UDC 636.068;59.009; 591.135 **Research article**

The main helminths and protozoa of the digestive tract of domestic and wild ungulates in northern and central Kazakhstan

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Received: 08-07-2025 **Accepted:** 23-09-2025 **Published:** 30-09-2025

Abstract

Background and Aim. Parasitic infections in ungulates represent a major challenge to animal health, biodiversity conservation, and agriculture. This study aimed to investigate the diversity, prevalence, and intensity of gastrointestinal helminths and protozoa in domestic and wild ungulates in northern and central Kazakhstan, with a focus on species overlap and ecological implications.

Materials and Methods. Between January 2023 and July 2024, fecal samples (n = 559) from wild and domestic ungulates were collected from five regions. Standard flotation and centrifugation techniques (Fulleborn's method) were used for parasitological analysis. Parasites were identified morphologically, and their prevalence was statistically assessed using chi-square tests.

Results. A broad spectrum of parasites was found, including Strongyle-type eggs, *Eimeria, Trichuris, Nematodirus, Capillaria,* and *Dicrocoelium lanceolatum*. Horses, sheep, and cattle exhibited the highest prevalence and mean intensity of disease, suggesting increased risk due to anthropogenic factors. Wild ungulates had lower infection rates, although cross-species infections were documented.

Conclusion. This study highlights significant interspecies variation in gastrointestinal parasitism, with domestic animals serving as major reservoirs. Monitoring and targeted control are essential at the wildlife–livestock interface.

Keywords: gastrointestinal parasites; wild ungulates; domestic ungulates; helminths; protozoa; Kazakhstan.

Introduction

Ungulates represent a generalized group of mammals with significant economic, hunting, esthetic, and scientific value. Contemporary challenges in fields of veterinary medicine, ecology, epidemiology and biology can be addressed by studying the diversity of helminths and parasitic protozoa in these animals [1].

Parasitic infections of the gastrointestinal tract remains a complex problem for conservation, animal health and zoonotic risk management in ungulates, including domestic species as cattle, sheep, goats, and pigs, and wild ruminants like deer, moose. Main factors contributing to the morbidity and mortality rate among these animal populations are helminths and protozoan parasites. They affect productivity, ecological stability, reproduction and public health.

Substantial variations in the parasitic fauna have been documented by studies conducted in Europe and Asia. While investigating wild ungulates in northeastern Portugal, *Figueiredo* et al. (2020) found that 78.6% of them – particularly red deer, roe deer, and wild boar – were infected with at least one type of parasite, including zoonotic taxa such as Balantidium coli. The presence of *Strongylidae, Trichostrongylidae, Metastrongylus,* and protozoa like *Eimeria* and *Cystoisospora* underscores the diversity and ecological adaptability of endoparasites in these populations [2]. Similarly, *Swisłocka-Cutter* et al. (2024) used molecular diagnostics to detect high infection rates of *Ostertagia* spp. and other gastrointestinal nematodes in Polish deer [3].

In Russia, numerous studies have reported complex parasitic profiles among captive and free-ranging ungulates. *Tishkov* et al. (2018) documented the presence of gastrointestinal strongyles, Trichuris, and protozoa in maral populations, whereas studies from the Kazan Zoo (*Timerbaeva* et al., 2018) and Moscow zoological parks indicated persistent infections despite routine deworming. These studies confirmed widespread infestations of strongylid and Eimeria spp. among zoo-housed ungulates, highlighting the challenges of parasite control in semi-closed systems. In the Sumorokov Reserve, Russian researchers *Postevoy* and *Andreyanov* (2020) identified up to 17 helminth species in moose, including *Ostertagia, Trichuris, Moniezia,* and *Echinococcus granulosus* [4, 5, 6].

Several studies conducted across various geographic regions and ungulate species have detailed the diversity of helminth and protozoan infections. *Loginova* et al. (2024) examined 233 reindeer (Rangifer tarandus) housed in 50 Russian zoos and identified numerous parasites, including *Fasciola hepatica, Paramphistomum* spp., *Moniezia* spp., *Trichuris* spp., and *Dictyocaulus* spp., with an infection rate of 45%. The study revealed the unique risk posed by captivity, where deer coexist with species that are not normally encountered in the wild [7, 8].

Ecotones in which domestic and wild ungulates intersect further complicate parasite transmission. *Abdybekova* et al. (2020) reported co-infections of *Moniezia, Avitellina, Nematodirus, Marshallagia,* and *Skrjabinema* among sheep and saiga in Kazakhstan, suggesting the potential for parasite spillover. *Barone* et al. (2020) and *Remesar* et al. (2025) emphasized the need for genetic and ecological monitoring, noting the detection of parasite DNA associated with livestock in wild herbivores within conservation landscapes [9, 10].

Environmental contamination with eggs and larvae, particularly in the soils of enclosures and pastures, is also well documented. *Albery* et al. (2018) and *Polaz* (2022) highlighted seasonal fluctuations in larval abundance, peaking in spring and autumn, emphasizing the influence of climatic conditions on parasite life cycles. Given the expanding range of wild ungulates, anthropogenic landscape changes, and ongoing climate shifts, sustained parasitological surveillance is vital for the preservation of biodiversity and agricultural stability. *Panayotova-Pencheva* (2024) reviewed helminth control strategies for captive herbivores in zoos and reserves, focusing on the families *Bovidae, Cervidae*, and *Giraffidae* [11, 12, 13].

Notably, many studies have reported increased anthelmintic resistance among nematode populations. *Gałązka* et al. (2023) and *D'Amico* et al. (2025) documented reduced efficacy of fenbendazole, albendazole, and ivermectin, necessitating molecular surveillance and alternative control strategies. This calls for integrated management approaches that combine targeted therapy, pasture rotation, and biological control. Common challenges include reinfection, drug resistance, and difficulty in administering medications. Ivermectin and fenbendazole have shown variable efficacy, and copper oxide wire particles have also demonstrated potential against nematodes [14, 15].

Additional studies from France by *Verheyden* et al. (2020) established a positive correlation between roe deer helminth burden and livestock density, indicating the considerable potential for interspecies transmission in shared landscapes. *Jones* (2021) presented a geographic perspective on trichuriasis in deer (*Cervidae*), documenting the low but widespread prevalence of Trichuris spp. across the Neotropical and temperate zones. He emphasized the use of molecular tools over morphological methods for accurate species identification, particularly at the wildlife–livestock interface. *Remesar* et al. (2025) demonstrated the value of noninvasive eDNA-based diagnostics in endangered ungulates, confirming the presence of gastrointestinal nematodes in the saola (*Pseudoryx nghetinhensis*) [16, 17, 18].

Global trends confirm the ecological breadth of these parasites. For example, in Nepal, *Achhami* (2016) linked gastrointestinal helminths in blue sheep and Himalayan tahr to shared grazing zones with domestic yaks and goats. Genetic analysis is increasingly revealing host–parasite coevolution, highlighting the necessity of molecular diagnostics in surveillance programs [19].

Thus, the aim of this publication is to comprehensively analyze and summarize the diversity of gastrointestinal helminths and protozoa infecting domestic and wild ungulates, identify overlapping parasite species among host types, and highlight the ecological and veterinary significance of these interactions in the context of parasite control.

Materials and Methods

Sample Collection

Fecal samples from wild ruminants were collected between January 2023 and July 2024, either directly from the animals' rectums or from the ground. Collections were carried out in northern and central Kazakhstan, where the average temperature was 26.5 °C (ranging from −21 °C to 32 °C), and included the following five regions: Akmola, Karaganda, Kostanay, North Kazakhstan, and Pavlodar (Fig. 1). Samples were collected by local natural resource agencies, hunters, state veterinarians, and biologists. All sample collectors were provided with protocols and materials for sampling and shipping. Individual samples (10–20 g feces/animal) (n = 559) were obtained from wild and domestic ruminants of varying ages and species, including dappled deer (*Cervus nippon*, n = 23), Kazakhstan mountain sheep (*Ovis ammon collium*, n = 42), wapiti (*Cervus elaphus*, n = 90), moose (*Alces alces*, n = 53), Asian roe deer (*Capreolus pygargus*, n = 37), argali (*Ovis ammon*, n = 42), saiga antelope (*Saiga tatarica*, n = 126), red deer (*Cervus elaphus*, n = 3), European fallow deer (*Dama dama*, n = 3), bison (*Bison bison,* n = 3), wild yak (*Bos mutus*, n = 2), zubr (*Bison bonasus,* n = 1), mouflon (*Ovis gmelini*, n = 1). In addition, 133 samples were collected from domestic cattle (*Bos taurus*, n = 60), domestic sheep (*Ovis aries,* n = 32), and horses (*Equus ferus caballus*, n = 41). Fecal samples were stored in biological sample collection containers, which were numbered and shipped in cardboard boxes at ambient temperature (~18–22 °C) to the laboratory for further analysis.

Sample Preparation

Fulleborn's method consisted of the following: 3 g of excrement was pre-soaked in a saturated salt solution and centrifuged at 3000 rpm for 15 min. The surface of the film was examined using a parasitological loop with a diameter of 5 mm. Three loops were taken from each sample, and the average number of helminth eggs in each sample was calculated. The morphology of the eggs and larvae obtained from the feces was studied by light microscopy (LM) using an Axio Scope.A1 optical microscope (Zeiss, Germany) equipped with objectives with ×5 (for navigation on the slide), ×10, ×20, ×40, and ×100 magnification (the latter with oil immersion) [20].

Statistical Analysis

The frequency of gastrointestinal parasite isolates detected in fecal samples was statistically compared using the chi-square test, with a 95% confidence interval. The p-value was calculated, and statistical significance was established at $p < 0.05$. (https://www.statskingdom.com).

Results and Discussion

From January 2023 to July 2024, fecal samples were collected from wild and domestic ruminants in the northern and central regions of Kazakhstan. The materials were collected directly from the rectums of the animals and from the soil surface in places where the individuals had recently been present. The study area covers five administrative regions: Akmola, Karaganda, Kostanay, North Kazakhstan, and Pavlodar (Figure 1).

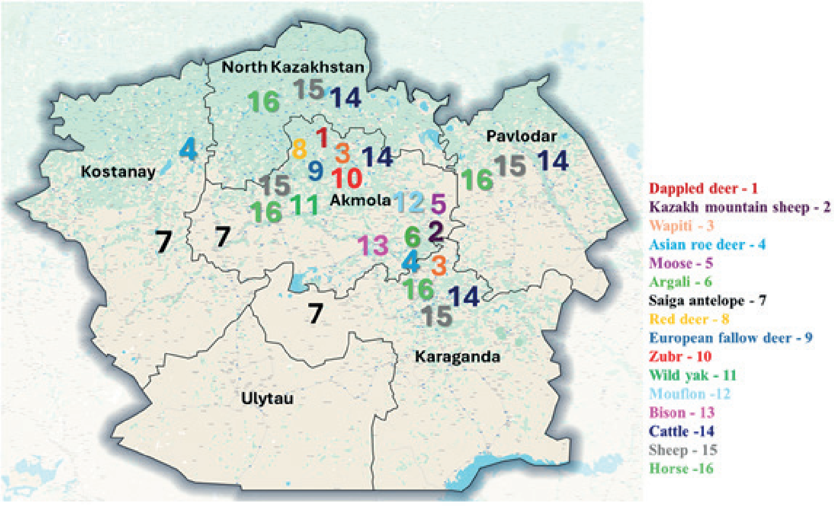

Figure 1 – Map of the regions of northern and central Kazakhstan showing the marked locations of samples collected from domestic and wild ungulates

Figure 1 presents the geolocation data for fecal samples collected from both wild and domestic ungulates across various regions. A noteworthy observation was that many of the samples were from the Akmola region, as this region is notable for its diverse ungulate population. Additionally, a substantial number of samples were collected from the Karaganda region, underscoring its ecological significance. Samples were also obtained from the Kostanay region, where they primarily came from Asian roe deer and saiga antelope, indicating their presence and habitat in this area. On the contrary, the Pavlodar and North Kazakhstan regions obtained feces samples only from domestic farm animals, which shows the difference in ungulate species representation between these regions.

Table 1 presents comparative information on the prevalence and intensity of helminth infections found in domestic and wild ungulates. The data included the number of infected animals, infection prevalence (with 95% confidence intervals), the range of helminth intensity, and the mean intensity with standard deviation.

Table 1 – Prevalence and intensity of helminths in domestic and wild ungulates

№	Host	N infected/N examined	% prevalence (95% CI)	Range of the intensity	Mean (SD) intensity	Helminth species
1	Dappled deer (*Dama dama*)	23/9	39.1 (19.7–61.4)	3-14	8.2 (3.6)	*Strongyle-type egg*
2	Kazakh mountain sheep (*Ovis ammon collium*)	42/13	31.0 (17.6–47.1)	2-7	4.1 (1.9)	*Strongyle-type egg*
3	Wapiti (*Cervus elaphus*)	90/17	18.9 (11.4–28.5)	4-9	6.2 (1.8)	*Strongyle-type egg* *Eimeria sp.* *Trichuris sp.* *Capillaria sp.*
4	Asian roe deer (*Capreolus pygargus*)	37/5	13.5 (4.5–28.7)	3-8	5.0 (1.8)	*Strongyle-type egg* *Eimeria sp.* *Trichuris sp.*
5	Moose (*Alces alces*)	53/5	9.4 (3.1–20.6)	2-6	4.0 (1.6)	*Strongyle-type egg* *Eimeria sp.*

Continuation of Table 1

6	Argali (*Ovis ammon*)	42/4	9.5 (2.6–22.6)	1-8	4.5 (2.6)	*Strongyle-type egg* *Eimeria sp.* *Naematodirus sp* *Dicrocoelium lanceolatum*
7	Saiga antelope (*Saiga tatarica*)	126/20	15.9 (10.0–23.4)	6-26	14.1 (5.8)	*Strongyle-type egg* *Eimeria sp.* *Trichuris sp.* *Naematodirus sp.*
8	Red deer (*Cervus elaphus*)	3	-	-	-	-
9	European fallow deer (*Dama dama*)	3/2	66.6 (9.4–99.1)	2-3	2.5 (0.7)	*Eimeria sp.*
10	Zubr (*Bison bonasus*)	1	-	-	-	-
11	Wild yak (*Bos mutus*)	2/1	-	3	3.0 (0.0)	*Eimeria sp.*
12	Mouflon (*Ovis gmelina*)	1/1	-	3	3.0 (0.0)	*Eimeria sp.*
13	Bison (*Bison bison*)	3	-	-	-	-
14	Cattle (*Bos taurus*)	60/20	33.3 (21.7–46.7)	4-26	13.2 (6.2)	*Strongyle-type egg* *Naematodirus sp.* *Eimeria sp.*
15	Sheep (*Ovis aries*)	32/15	46.9 (29.1–65.2)	6-24	12.7 (5.7)	*Naematodirus sp.* *Eimeria sp.* *Trichuris sp.*
16	Horse (*Equus ferus caballus*)	41/20	48.8 (32.9–64.9)	5-58	18.6 (11.7)	*Strongyle-type egg* *Eimeria sp.* *Trichuris sp.*

95% CI: 95% confidence interval; SD: standard deviation

Among all species examined, European fallow deer (66.6%), horses (48.8%), and sheep (46.9%) showed the highest infection prevalence, indicating that these animals are particularly susceptible to helminth infections. Horses also recorded the highest mean intensity of infection (18.6 ± 11.7 helminths), followed by saiga antelope (14.1 ± 5.8) and cattle (13.2 ± 6.2), reflecting a substantial parasite burden in these hosts. In contrast, species such as moose, argali, and Asian roe deer exhibited relatively low prevalence rates (below 15%) and moderate intensities (approximately 4–5 helminths per infected individual).

Some species, including red deer, zubr, and bison, had incomplete data – either due to a very small sample size or unreported intensity metrics – limiting conclusions about their infection status. Despite this, the data highlight clear interspecies variation in helminth load, with domestic animals tending to have both higher prevalence and intensity than most wild ungulates.

Nematode, trematode, protozoan eggs. The parasites were preliminarily identified based on their morphology and morphometric data (Fig. 2).

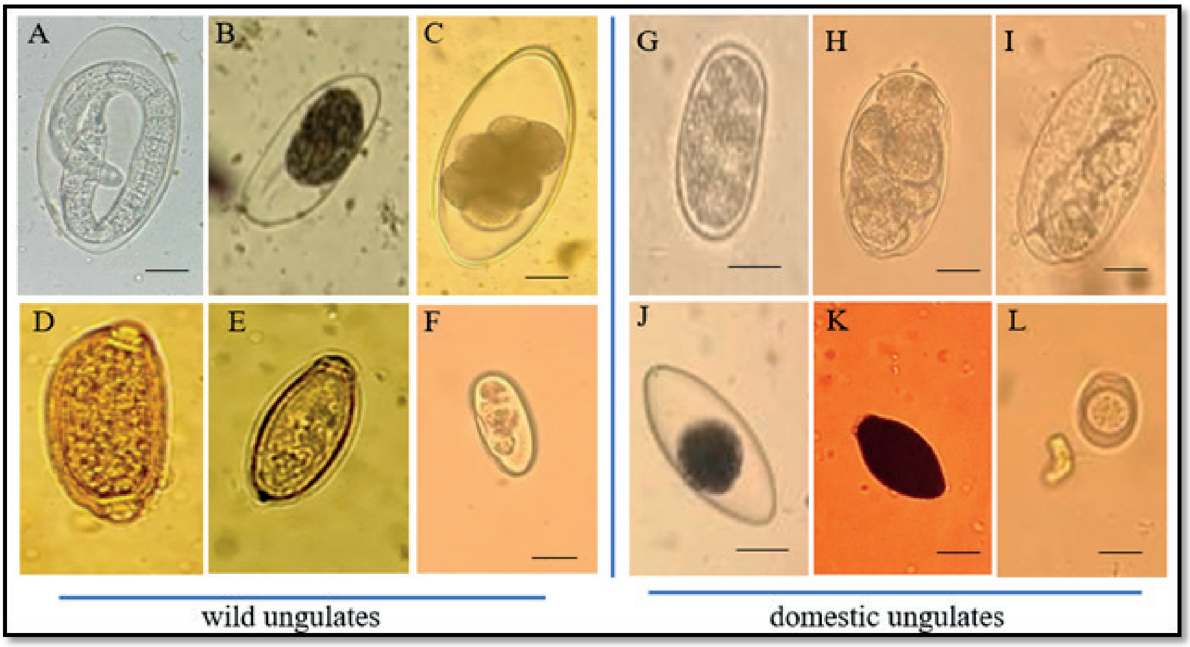

Figure 1 – Diagnostic stages of helminths isolated from wild feces (A-B. Strongyle-type eggs; C. *Naematodirus* sp.; D. *Capillaria* sp.; E. *Dicrocoelium lanceolatum*; F. Eimeria sp.) and domestic ungulates (G, H, I. Strongyle-type eggs; J. *Naematodirus* sp.; K. *Trichuris* sp. L. *Eimeria* sp.)

Bright field microscopy, ×40 objective lens magnification. Scale bar equals 50 µm.

All samples exhibited low parasite intensity. We found 1–5 trematode eggs per 1 g of feces, 1–26 nematode eggs per 1 g of feces, and 1–8 protozoan coccidia. Only one sample from argali (*Ovis ammon*) contained nematodes, trematodes, and protozoa – up to 8 specimens per 1 g. The rest are interpreted as medium intensity or its absence.

Based on the results of the study of fecal samples from wild ungulates (n = 426) and domestic ungulates (n = 133) collected from five regions of northern and central Kazakhstan, these results are consistent with earlier studies showing a higher prevalence of parasites among domesticated ungulates [21, 22]. The ecological plasticity of parasites such as Eimeria and Strongyle-type nematodes was reflected in the results from Portugal, Poland, and Russia (*Figueiredo* et al., 2020; *Swisłocka-Cutter* et al., 2024; *Tishkov* et al., 2018).

In the conducted study, the prevalence and intensity of helminthiasis varied significantly among the examined ungulates. Domestic animals (horses, sheep and cattle) demonstrated higher prevalence and mean intensity values compared to wild ungulates, indicating an increased susceptibility or vulnerability due to housing and environmental conditions. Notably, horses had the highest mean intensity (18.6±11.7), highlighting their potential role as major helminth reservoirs. Whereas, wild species such as elk, argali and Asian roe deer demonstrated lower prevalence and intensity of infection, which may indicate differences in habitat, diet and transmission dynamics of the parasite in the population. These interspecific differences among ungulates highlight the need to develop individual parasite control strategies, especially among domestic animals with a high degree of infection.

Conclusion

This study revealed substantial variation in the prevalence and intensity of gastrointestinal parasites among wild and domestic ungulates in Kazakhstan. The domestic species displayed significantly higher infection burdens, emphasizing their role as key reservoirs. Evidence of parasite overlap between wild and domestic species highlights the importance of controlling cross-transmission, especially in areas where ecotones and shared grazing sites exist. Continued monitoring, species-specific treatment regimes, and coordinated wildlife–livestock health strategies are essential for sustainable parasite control.

Authors' Contributions

Conceptualization, VK; methodology, VK and RU; validation, AS, RU, AN, and LL; formal analysis, VK, RU, and AS; investigation, VK; resources, VK; data curation, AS; writing–original draft preparation, AS, RU, VK; writing–review and editing, VK and RU; visualization, AS, LL and A.N; project administration, VK; funding acquisition, VK. All authors have read and agreed to the publication of the final version of the manuscript.

Acknowledgments

The research was carried out with financial support from the Committee of Science of the Ministry of Science and Higher Education of the Republic of Kazakhstan within the framework of project AP19576421 for 2023–2025.

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