Intestinal helminths of wild Canidae from the Kazakhstan steppe ecosystems

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Abstract

An epidemiological study of helminths in 39 wolves (*Canis lupus*), 15 foxes (*Vulpes vulpes*) and 13 corsacs (*Vulpes corsac*) collected from the steppes of the central, northern and western regions of Kazakhstan in 2018-2019, revealed 11 helminth species at autopsy, including pathogens of such zoonoses as echinococcosis, trichinellosis and toxocariasis. Species *Taenia taeniaformis* (prevalence 7.7%), *Dipylidium caninum* (2.6%), *Echinococcus multilocularis* (2.6%), *Toxocara canis* (10.3%) and *Dirofilaria immitis* (2.6%) were found only in wolves. Prevalence of *Alaria alata* in corsacs was 7.7% and in wolves 5.2%. *Taenia spp.* was found in 40% of foxes and 43.6% of wolves. Infection level with *Macracanthorynchus catulinus* among foxes was 26.7%, and in wolves 2.6%. *Trichinella spp. larvae* infected 6.7% of foxes and 17.9% of wolves. *Mesocestoides lineatus* were noted in all species of canine (*V. corsac, V. vulpes*, *C. lupus*) with the prevalence of 7.7%, 13.3% and 2.6%, and *Toxascaris leonina* infected 7.7%, 6.7% and 5.61% of these species of predators, respectively. Thus, populations of wild Canidae are forming natural foci of zoonotic invasions in the habitat regions.

Key words: helminths, wolf, fox, corsac, prevalence, Kazakhstan, zoonoses

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Introduction

Species of the Canidae family – grey wolf (*Canis lupus*), red fox (*Vulpes vulpes*) and steppe fox (*Vulpes corsac*)– are the typical inhabitants of the steppe ecosystems in Kazakhstan, and here, the numbers of these animals in 2018 were about 13, 200, 112,472 and 47,610, respectively. These predators play an important role in the biodiversity of the steppes. Therefore, the government supported a policy of density control of their populations up to certain values, and permitted officially the licensed shooting and hunting of Canidae (Sklyarenko, 2017; Decree of the Government of the Republic of Kazakhstan No. 901, 2017; Conclusion of the state environmental review, 2019).

Moreover, the infection with parasites, especially helminths, is considered a natural mechanism for regulating the wild canine populations. Furthermore, helminths of wild carnivores could be transmitted to domestic canine and productive animals, and some of these parasites are causative agents of dangerous zoonotic diseases. For example, both wild and domestic carnivores can act as the definitive hosts of the Taeniidae family cestodes, which can cause morbidity and mortality of intermediate hosts of *Taenia ovis*, *T. hydatigena* and *T. multiceps*, larvae of which cause cysticercoses in ruminants (Hoberg, 2002). *Echinococcus granulosus* and *E. multilocularis* are causative agents of cystic and alveolar echinococcosis – potentially fatal diseases of humans (Moro and Schantz, 2009). *Toxocara canis* causes an intractable human disease with the syndromes "visceral larva migrans" and "ocular larva migrans" (Strube et al., 2013). In addition, the larval stages of *A. alata* are found in the muscle and adipose tissues of many paratenic hosts, including humans (Möhl et al., 2009). Therefore, monitoring the dynamics of wild canine species' infestation with parasites is a relevant problem in modern parasitology (Bindke et al., 2019; Karamon et al., 2018; Al-Sabi et al., 2018).

Over the last two decades many cross-sectional epidemiological studies were conducted in Europe to assess the prevalence and intensity of intestinal parasites in wild carnivores (Franssen et al., 2014; Bruzinskaite-Schmidhalter et al., 2012; Saeed et al., 2006; Schuster and Shimalov, 2017; Jankovska et al., 2016). These studies had shown that here wild *Canidae* animals can be the reservoir for zoonotic *E. multilocularis*, *T. canis*, *A. alata*, hookworms and *Trichuris vulpis*. Some wild carnivores, for example foxes, usually inhabit natural landscapes and agricultural areas, and adaptation of this species to live in rural and urban areas has been documented. Thus, the invasive elements of zoonotic helminths could be distributed into the people's environment. Dogs and cats, as definitive hosts of the many wild Canidae's parasites, could also be invaded in natural conditions and become the closest source of parasite zoonoses for humans (Rajkovic-Janje et al., 2002; Vervaeke et al., 2005; Letkova et al., 2006; Gloor et al., 2001). In a few studies of the wild and domesticated canine helminths' fauna in the south of Kazakhstan established was that dogs, wolves and corsacs intensively infected with *E. granulosus* caused the emergent epidemiological situation of the cystic echinococcosis in the country (Torgerson, 2003; Abdybekova and Torgerson et al., 2012; Abdybekova, 2014).

However, it should be noted that parasites of wild carnivores in Northern, Central, and Western Kazakhstan have not been practically studied in the last ten years. The aim of this work was to identify the fauna of helminths of wild Canidae in the steppe ecosystems in the above mentioned regions.

Material and methods

The study was conducted using the wild Canidae carcasses of 39 wolves, 15 foxes and 13 corsacs obtained after officially licensed hunting in northern (Kostanay region: Turgay, Zangeldy districts), central (Karaganda region: Karkaraly, Zhezkazgan districts) and west (West-Kazakhstan region: Akzhayiyk district) parts of Kazakhstan (Figure 1). The geographical area of the surveillance lies between 41°8'11,162'' North Latitude and 41°49'11,682''East Longitude at the west part and 50°33'27,042'' North Latitude and 76°50'12,513682'' East Longitude at the north and central parts of the country. Much of the steppe landscapes where animals exist are considered to be semi-deserts and have a semi-arid, continental climate (Kazakh steppe, 2018).

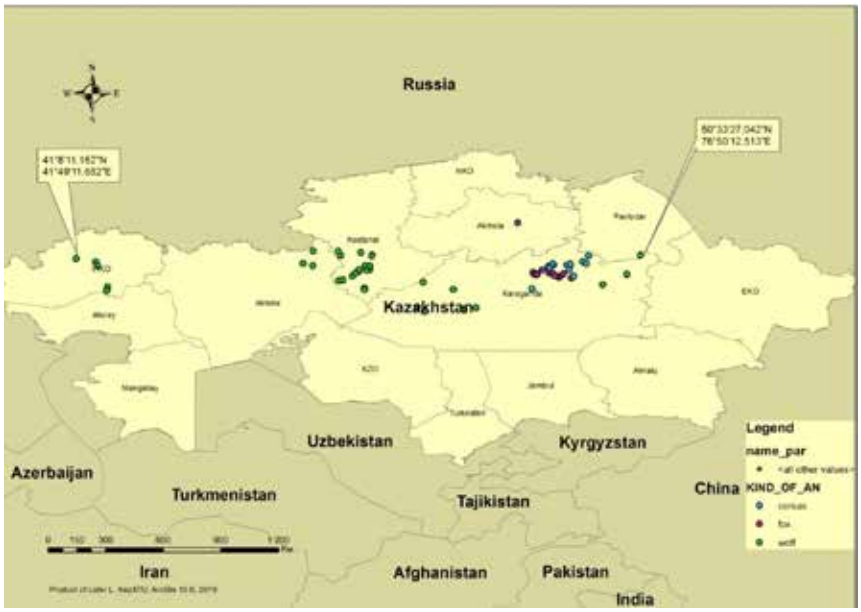

Figure 1. The specimens' study area

The parasitological study of the shot wild Canidae carcasses was approved by the Ethical Commission of the Faculty of Veterinary Medicine and Animal Husbandry Technology of S. Seifullin Kazakh Agro Technical University (Protocol No 5, 27th April, 2018).

The chilled and frozen corpses of hunted animals were delivered to Prof. N. T. Kadyrov Parasitology Laboratory in the limited period of one to three days after being shot. For the safety precautions, the carcasses were frozen at -20°C for more than two weeks prior to observation. Animals' sex, age, locality and date of death were recorded. The age was determined according to dental features (Yatusevich, 2010). Individuals up to six months of age were described by the term ''cubs'', animals of six to twelve months of age –''young'', and carnivores older than 12 months –''adult''.

The intestines and associated organs of carcasses were removed after thawing overnight. The small and large parts of intestinal tract were opened, examined and investigated by the Skrjabin helminthological autopsy method (Ibrayev et al., 2017). All visible helminths were removed and examined microscopically. The intestinal sedimentation counting technique was used for the recovery of *Echinococcus* and other small helminths (Eckert et al., 2001). The abundance of helminths was counted in each animal and the parasite's genus and species were identified according to morphological features, using the manual for identification of hunting mammals' helminths. Before microscopy, nematodes and acanthocephalans were cleared in lactophenol (Yatusevich, 2010; Sepulveda and Kinsella, 2013). *E. multilocularis* was identified according to Eckert and Deplazes, 2004.

In order to determine *Trichinella* spp. larvae, the gastrocnemius, diaphragm and forelimb (m. triceps brachii, m. biceps brachii) muscles were investigated by the compression method, and samples of the above muscles of 20 g weight were studied with the artificial pepsin–HCl digestion technique (Malakauskas et al., 2007). *Trichinella* spp. larvae were not identified at the species level.

The specimens are deposited at Prof. N. T. Kadyrov Parasitology Laboratory, Veterinary Medicine Department, S.Seifullin Kazakh Agro Technical University, Kazakhstan.

Mapping of data was performed in ArcGIS.

Results

There was established that the fauna of wild canine helminths in the Kazakhstan steppe ecosystems were represented by the Trematoda species *Alaria alata* (Goeze, 1782; Krause, 1914); cestodes of four species *Taenia taenia formis* (Batsch, 1786), *Mesocestoides lineatus* (Goeze, 1782; Railliet, 1893), *Dipylidium caninum* (L., 1758), *Echinococcus multilocularis* (Leuckart, 1863) and *Taenia* (L., 1758) spp.; nematodes of four species *Toxocara canis* (Werner, 1782), *Toxascaris leonina* (Linstow, 1902), *Dirofilaria immitis* (Leidy, 1856) and *Trichinella* (Railliet, 1895) spp. *larvae*, and the acantocephalus species *Macracanthorynchus catulinus* (Kostylev, 1927) (Table 1, Figure 2).

Only in wolves found were *T. taeniaformis* (with the prevalence of 7.7%/ intensity 2-8 helminths), *D. caninum* (2.6%/6), *E. multilocularis* (2.6%/351), *T. canis* (10.3%/3-28) as well as *D. immitis* (2.6%/1) (Table 2).

Prevalence of *A. alata* infection among corsacs was 7.7% with an intensity of 13 parasites, in wolves – 5.2% and 15-28 trematodes, respectively. *Taenia* spp. was observed in 40% of foxes with infection intensity of 2-5 cestodes as well as in 43.6% of wolves with intensity 2-15 parasites. Infection level of *M. catulinus* among foxes was 26.7% with intensity of 9-32 worms, and among wolves – 2.6% and 19 parasites, respectively. An average of 6.7% of foxes and 17.9% of wolves were infected with *Trichinella* spp. *larvae* (Table 2).

In observed corsacs, foxes and wolves, the prevalence of *M. lineatus* was 7.7%, 13.3% and 2.6% and intensity was 4, 3-6, and 3 parasites, and infection rate of *T. leonina* was 7%, 6.7% and 5.6% and intensity was 3, 5 and 4-9 helminths, respectively to Canidae species (Table 2).

Only one helminth species was found in 47.3% of wolves (from 19 infected animals). In three individuals (15.7%) observed was a mixed invasion with two parasite species (*Taenia* spp. + *M. catulinus*; *Taenia* spp. + *E multilocularis*; *Taenia* spp. + *Trichinella* spp.), in five animals (26,3%) three species' associations (*Taenia* spp + *T. taeniaformis* + *T. canis*; *Taenia* spp. + *D.caninum* + *Trichinella* spp.; *Taenia* spp + *T. canis* + *Trichinella* spp.;

Table 1. Systematic position of parasites' species

Phylum	Class	Order	Family	Genus/Species	Host
Plathyhelmintes	Cestoda	Cyclophilidea	Taeniidae	*Alaria alata*	Canis lupus, Vulpes corsac
				Taenia taeniaformis	C.lupus
				Taenia spp.	C.lupus, Vulpes vulpes
				Echinococcus multilocularis	C.lupus
			Mesocestoididae	*Mesocestoides lineatus*	C.lupus, V.corsac, V.vulpes
			Dipyliidae	*Dipylidium caninum*	C.lupus
Nematoda	Secernentea	Ascaridida	Ascarididae	*Toxocara canis*	C.lupus
				Toxascaris leonina	C.lupus, V.corsac, V.vulpes
		Trichurida	Trichurida	*Dirofilaria immitis*	C.lupus
				Trichinella spp. larvae	C.lupus, V.vulpes
Acanthocephales	Acanthocephala	Oligacanthorhynchida	Oligacanthorhynchidae	*Macracanthorynchus catulinus*	C.lupus, V.vulpes

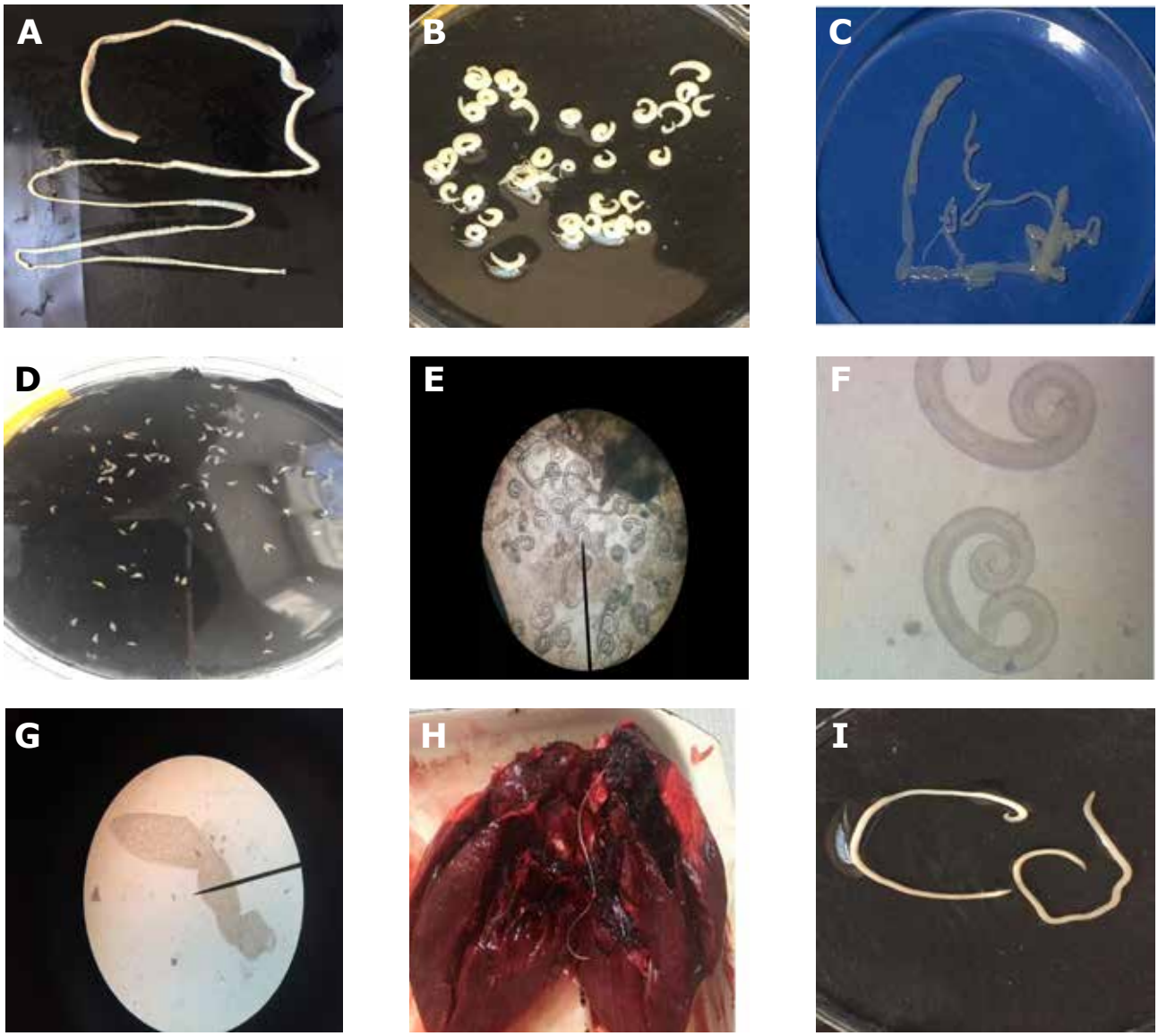

Figure 2. Species of helminths. A) fragment of *Taenia spp.* (from *C. lupus*); B) *Macracanthorynchus catulinus* (*V. vulpes*); C) *Dipylidium caninum* (*C. lupus*); D) *Alaria alata* (*V. corsac*); E) *Trichinella* spp.(*V. vulpes*) x 10; F) *Trichinella spp.* (*C. lupus*) x 100; G) *Echinococcus multilocularis* (*C. lupus*) x 10; H) *Dirofilaria immitis* (*C. lupus*); I) *Toxocara canis* & *Toxascaris leonina* (*C. lupus*).

Taenia spp. + T. canis + D. immitis, Taenia spp. + T taeniaformis+ Trichinella spp.) were found, and two wolves (10,5%) had associated infections with four parasite species *(Taenia spp.+ A. alata + T. canis + Trichinella spp.*; *Taenia spp.+M. lineatus + T. canis + Trichinella spp.*). Thus, species of the genus *Taenia* dominated in mixed invasions.

We found two species of helminths in young corsacs, one in adult corsacs, two and four in foxes, six and nine in wolves, respectively to ages of animals. Only two wolf cubs were investigated in the study, and one of them was infested with *T. canis*. In relation to the age of wolves and foxes, more helminth species were observed among the adults than young animals, but the prevalence of parasites in the latter age group was higher (Table 3).

The geography of distribution of established parasite species was covered in all studied areas of Kazakhstan. The spatial distribution of species of wild canine parasites in the central, western and northern regions of the country was relatively uniform.

Table 2. Helminths of wild Canidae in Kazakhstan

Species	*Vulpes corsac (n=13)*		*Vulpes vulpes (n=15)*		*Canis lupus (n=39)*	
	Prevalence*	**Intensity, parasite No**	**Prevalence***	**Intensity, parasite No**	**Prevalence***	**Intensity, parasite No**
			Trematodes			
Alaria alata	1 (7,7)	13			2(5,2)	15-28
			Cestodes			
Taenia spp.			6(40)	2-5	17(43,6)	2-15
Taenia taeniaformis					3(7,7)	2-8
Mesocestoides lineatus	1 (7,7)	4	2 (13,3)	3-6	1(2,6)	3
Dipylidium caninum					1(2,6)	6
Echinococcus multilocularis					1(2,6)	351
			Nematodes			
Toxocara canis					4(10,3)	3-28
Toxascaris leonina	1 (7,7)	3	1(6,7)	5	2(5,1)	4-9
Dirofilaria immitis					1(2,6)	1
*Trichinella spp. larvae***			1 (6,7)	+	7(17,9)	+++
			Acanthocephalans			
Macracanthorynchus catulinus			4(26,7)	9-32	1(2,6)	19

Notes: * – an absolute value, in brackets – %;
** + – < 10 larvae in the vision of the microscope field, magnification x 100;
+++ –>10 larvae in the vision of the microscope field, magnification x 100

Table 3. Distribution of parasites according to wild carnivores'age

Species	**Prevalence of helminths, absolute number (%)**						
	corsacs (n=13)		**Foxes (n=15)**		**wolves (n=39)**		
	young (n=4)	**adult (n=9)**	**young (n=7)**	**adult (n=8)**	**cub (n=2)**	**young (n=12)**	**adult (n=25)**
Alaria alata	1(25)						2(8)
Taenia spp.			3 (42.8)	3(37.5)		7(58.3)	10(40)
Taenia taeniaformis							3(12)
Mesocestoides lineatus	1(25)			2(25)		1(8.3)	2(8)
Dipylidium caninum						1(8.3)	
Echinococcus multilocularis							1(4)
Toxocara canis					1(50)	3(25)	
Toxascaris leonina		1(11.1)		1(12.5)		1(8.3)	1(4)
Dirofilaria immitis							1(4)
Trichinella spp.			1(14,3)			3(25)	4(16)
Macracanthorynchus catulinus				4(50)			1(4)

Discussion and conclusion

In the steppe ecosystems of the northern, central and western regions of Kazakhstan, the fauna of wild canine (corsac, fox and wolf) helminths was represented by trematodes of one species; cestodes of four species and the genus *Taenia* L., 1758; nematodes of four species and the genus *Trichinella* Railliet, 1895, as well as a species of acantocephalans. The study showed that helminths of wild animals were detected as co-infections with two, three and four species similar to the studies conducted in other countries (Franssen et al., 2014; Karamon et al., 2016).

V. corsac is a relatively poorly surveyed species with respect to helminth infections in Kazakhstan and bordering countries. In the 1970s, 26 species of helminths were established in this predator in seven regions of Kazakhstan, including two species of trematodes, seven cestodes, 16 nematodes and an acantocephalan species (Taziyeva, 1970). According to the recent data, autopsy of 39 corsacs in the southern regions of Kazakhstan identified seven species of helminths: *E. multilocularis*, *Taenia crassiceps*, *D. caninum*, *M. lineatus*, *T. canis*, *M. catulinus* and *Trichiuris vulpis* (Abdybekova, 2014). Our research in the central regions of Kazakhstan detected species *A. alata*, *M. lineatus*, and *T. leonina* among 23.1% of corsacs (n=13) with relatively low rates of prevalence and intensity.

Steppe foxes (n=5) from the Omsk region in Russia, neighboured to the specimens' collecting area of this study, were infected with 11 species, including *A. alata*, three cestodes (*Taenia crassiceps*, *Taenia polyacantha*, *E. multilocularis*) and seven nematodes: *T. canis*, *Toxocara mystax, T. leonina*, *Uncinaria stenocephala*, *Physaloptera sibirica, Spirocerca lupi and Spirocerca arctica*. Here, the prevalence of *A. alata* was 20%, tapeworms – 80% and nematodes – 100% (Strelchik et al., 2016). Among five corsacs investigated in Samarkand region of Uzbekistan, species *A. alata*, *T. hydatigena*, *T. leonina*, *U. stenocephala* and *D. caninum* were found with similar levels of the infection (Young et al., 2019).

Thus, the literature and our own results allow us to suggest that in Central Kazakhstan Eurasian species of helminths typical for corsacs – *A. alata*, *T. leonina*, *M. lineatus*, have apparently stable ecological conditions for maintenance of these parasites' area in the investigated territory.

As the number of the red fox populations have tended to increase in European countries, the intensive monitoring study of *E. multilocularis* in this definitive host has been carried out here (Franssen et al., 2014; Jankovska et al, 2016; Magi et al., 2015). This has contributed to define the helminth fauna of the predator in a European part of the northern hemisphere. For example, in different regions of central Poland, helminths were found in 98.9% of foxes, prevalence of which of *E. multilocularis*, *A. alata*, *Toxocara*/*Toxascaris*, *Mesocestoides* spp., hookworms, *Taenia* spp. and *Eucoleus aerophilus* was relatively high, and infection level with *Trichuris vulpis* was lower (Karamon et al., 2018).

In the research area's bordering Russian territory (Omsk ant Altay regions) foxes were infected with 27 species of helminths, and demonstrated was the high prevalence of trematodes, nematodes and cestodes (70%, 100 and 80%, respectively) in this predator. Here, helminth fauna of red foxes was represented by such zoonotic pathogens such as *Opistorchis felineus*, *E.multilocularis*, *T.canis*, *Trichinella spiralis*, and potentially zoonotic species such as *A. alata*, *Ancylostoma caninum*, *D. caninum and Dirofilaria repens* (Strelchik et al., 2016; Kostyukov, 2012; Ponamarev et al., 2011). In the neighbouring to Southern Kazakhstan Naryn District of Kyrgyzstan, 151 foxes were autopsied and 64% of them were infected by *E. multilocularis* with an average intensity of 8,669 parasites. Foxes were infected with *T. leonina* and *Acanthocephala* spp. at a lower level (6 and 1%, respectively), but the prevalence of *Mesocestoides* spp., *D. caninum*, *Taenia* spp., *T. canis* and *Capillaria* spp. in this carnivore was relatively high – 23-66% (Ziadinov et al., 2010).

Our study demonstrated that in Central and Northern Kazakhstan 80% of dissected red foxes (n=15) were infected by helminths, species such as *Taenia* spp. (40%), *M. lineatus* (13.3%), *T. leonina* (6.7%) and *M. catulinus* (26.6%). *Trichinella* spp. was observed in one fox, which indicates the role of this predator in maintaining the biotic potential of trichinosis pathogen in the studied region's wildlife. In general, helminths in foxes were observed as monoinvasions, and the mixed infection with *Taenia* spp. and *M. catulinus* was observed in 13.3% of infected animals. Some species such as *E. multilocularis* or hookworms, which were typical for foxes in other geographical zones, were not found in our study of these predators. This could be explained by the small size of sampling. Therefore, a research with a more representative number of animals in different parts of Kazakhstan steppe would be done as the next step of the wildlife parasitological investigations.

Thus, Eurasian and our own studies indicate that red foxes are the main natural carriers of *E. multilocularis* and other zoonotic helminth species such as *O. felineus*, *T. canis*, *Trichinella* spp. and *A. alata*. It was also demonstrated that the abundance and prevalence of zoonotic parasitical diseases' pathogens in foxes were likely to be high in some geographic regions.

Studies of the wolf helminths fauna was actively presented all over the world, for the predator plays a significant role in spreading *E. granulosus* in wildlife environment globally (Bindke et al., 2019; Guerra et al., 2012; Solaiman et al, 2018; Bryan et al., 2012).

Wolves were infested with nine species of helminths in different geographical zones of regions of Russia bordering with Northern Kazakhstan. So, it was established that in Altay Region the maximal prevalence of *A. alata* in this carnivore was: 88.8%, *E.granulosus* – 44.4%, *Multiceps multiceps* – 33.3%, *Taenia hydatigena* – 66,6%, *Dirofilaria repens* – 33,3%, *U.stenocephala* – 100%, *Spirocerca lupi* – 44,4% and *Trichinella native* – 22,2%. Three species – *A. alata, Taenia krabbei and T. hydatigena* were found in the

wolf from Omsk Region (Ponamarev et al., 2011; Strelchik et al., 2016). In Southern Kazakhstan, revealed were *E. granulosus*, *Taenia* spp., *D. caninum*, *M. lineatus*, *T. canis*, *T. leonina*, *T. vulpis*, *M. catulinus* and *Moniliformis moniliformis* in dissected 41 wolves (Abdybekova and Torgerson, 2012). As a result of our surveillance, it was found that in the steppe regions of Central, Northern and Western Kazakhstan 48.7% of wolves (n=39) were infected with helminths. In these areas, *M. moniliformis* was not found, but *E. multilocularis*, *T. taeniaformis*, *A. alata*, and *D. immitis* were described in addition to the above mentioned species of wolves in the south of the country.

Thus, our data indicate that wild canine populations in Central, Northern and West Kazakhstan have the intestinal helminth fauna common with that of the wild carnivores' populations in different Eurasian geographical zones. Moreover, it should be noted that in the studied regions the biodiversity of intestinal parasites of corsacs was poorer than among wolves and foxes. However, taking into account that the sampling of animals was relatively scanty, it should be assumed that the variety of canine parasites in the wildlife is represented by a greater number of species, the refinement of which requires future research.

Most of the helminths found in the populations of wild carnivores in Kazakhstan were observed in alternative definitive hosts such as dogs, and some of these parasites pose a potential direct or indirect health risk to humans. For example, the prevalence of gastrointestinal parasites is usually high in shelter dogs (Raza et al., 2018). So, 43% of stray dogs housed at the shelter of Nur-Sultan City in the central Kazakhstan were infected by different species of helminths, including zoonotic pathogens (Bauer et al., 2019). Similar data were demonstrated in dogs from many other regions of the world, such as Russia (Yastreb and Shaitanov, 2017), Jordan (El-Shehabi et al., 1999), Spain (Gracenea et al., 2009), Japan (Kimura et al., 2009) and Mexico (Canto et al., 2011).

In observance of this information, it should be noted that, according to official medical reports, the isolated incidences of alveococcosis, dirofilariasis, toxocariasis and trichinosis were annually recorded among the human population of Kazakhstan (The epidemiological situation for 8 months of 2017 in the Republic of Kazakhstan, 2018). In addition, southern and western parts of the country are considered emergent for cystic echinococcosis (Torgerson et al., 2003). Besides, there were described isolated regional endemic outbreaks of trichinosis among people in the south and north of the country, while the source of invasion was dogs', badgers', wild boars' and wolves' meat (Shabdarbaeva et al., 2012).

Therefore, the results of the study confirm that wild and domesticated Canidae species play a definite role in the circulation of parasitic zoonoses pathogens in the steppe regions of Kazakhstan.

Wild Canidae (*Canis lupus*, *Vulpes vulpes* and *Vulpes corsac*) in the steppe ecosystems of the central, northern and west regions of Kazakhstan are infected by 11 species and genera of helminths of different classes, some of which are common to domestic animals and humans. The research results suggest that in all habitat steppe regions the wild Canidae populations form natural foci of zoonotic infestations.

Conflicts of interest

Authors declare no conflict of interest.

Acknowledgements

We would like to thank the Prof. N.T. Kadyrov Parasitology Laboratory's staff for help in this research.

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Intestinalni paraziti divljih kanida iz stepskih ekosistema Kazahstana

Sažetak

Epidemiološko istraživanje helminata kod 39 sivih vukova (*Canis lupus*), 15 lisica (*Vulpes vulpes*) i 13 stepskih lisica (*Vulpes corsac*) prikupljenih u stepama centralnog, sjevernog i zapadnog Kazahstana u periodu između 2018. i 2019. godine na obdukcijama je otkrilo prisustvo 11 vrsta helminata, uključujući patogene zoonoze kao što su ehinokokoza, trihineloza i toksokarijaza. Vrste *Taenia taeniaformis* (prevalenca 7.7%), *Dipylidium caninum* (2.6%), *Echinococcus multilocularis* (2.6%), *Toxocara canis* (10.3%) and *Dirofilaria immitis* (2.6%) su pronađene samo kod vukova. Prevalenca *Alaria alata* kod stepskih lisica je iznosila 7.7%, a kod vukova 5.2%. *Taenia spp.* je pronađena kod 40% lisica i 43.6% vukova. Stupanj infekcije sa *Macracanthorynchu scatulinus* među lisicama je iznosio 26.7%, a među vukovima 2.6%. *Trichinella spp. larvae* su infestirale 6.7% lisica i 17.9% vukova. *Mesocestoides lineatus* je zabilježen kod svih vrsta kanida (*V. corsac, V. vulpes*, *C. lupus*) sa prevalencom od 7.7%, 13.3% i 2.6%, dok je *Toxascaris leonina* infestirala 7.7%, 6.7% i 5.61% ovih vrsta predatora. Na ovaj način populacije divljih kanida formiraju prirodne fokuse za invazije zoonoza u staništima.

Ključne riječi: helminti, vuk, stepska lisica, Kazahstan, zoonoze