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ENDOPARASITES OF CARNIVORES IN NON-GOVERNMENTAL ORGANIZATION “FELDMAN ECO-PARK” (KHARKIV, UKRAINE)

156 feces samples from predators that belong to the Non-Governmental organization “Feldman Eco-park” (Kharkiv, Ukraine) were investigated for four years (2016–2019). Eggs/oocysts of various gastrointestinal parasites were found in 46 feces samples that made up 29.5%. There were 13 positive samples in Caniformia (28.3%) and 33 in Feliformia (71.7%). All diagnosed parasitoses were caused by monoxenic (single-host) geohelminths and protozoa with a direct development cycle. The most common parasite species was Toxascaris leonina (60.9%) followed by nematodes of the Ancylostomatidae family (19.6%), protozoa genus Isospora (8.7%), Toxocara cati (6.5%) and the least common parasite was Toxocara canis (4.3%).

Keywords: helminths, protozoa, coproscopy, predators, zoo.

Introduction. Non-Governmental organization “Feldman Eco-park” is the most visited park of the region. The number of visitors exceeds 1 million people per year.

The basis of the park is a zoo with more than 3,000 animals. Among such a variety of species mammals make up 45.8%. The fauna of carnivores consists of representatives of different families: *Canidae*, *Ursidae*, *Procyonidae*, *Mephitidae*, *Mustelidae*, *Felidae*, *Hyaenidae*, *Herpestidae*. Carnivores that belong to *Canidae* and *Felidae* families are fully represented in the zoo.

The parasitofauna of carnivores in wild life is diverse and includes more than 400 species of helminths [1].

According to researchers from different countries, the most common parasites among carnivores both in wild life and in captivity are helminthiases of the gastrointestinal tract [2–6].

In Ukraine according to recent data, 30 species of nematodes among wild carnivores have been recorded, including 18 intestinal ones. In wild life predators are usually infested with several species of parasites. The most diverse helminth fauna was recorded in red foxes (27 species) and wolves (17 species). The extension of invasion among different representatives of *Caniformia* and *Feliformia* ranged from 46.1% to 100% [7].

The goal of the work was to carry out coproscopic studies for the diagnosis of intestinal helminths in wild carnivores of the “Feldman Eco-park”.

Materials and methods. To detect helminth eggs standardized sedimentation-flotation method with the application of zinc sulfate solution – 450 g per 1 liter of water (density 1.2 g/cm³) according to A. Vishnyauskas was used.

The research technique was the following: 1 g of feces was thoroughly mixed with 40–50 ml of water in the mortar. The mixture was filtered through a strainer into another dish, and the mortar was rinsed with 50–60 ml of water for several times. Fecal matter was washed with the same water through a strainer. The obtained filtrate (100 ml) was sedimented for 5 minutes and drained. The washing procedure was repeated twice. The sediment with 10 ml of liquid was transferred to a centrifuge tube and was centrifuged for 1 min at 1500 rpm. The supernatant of the liquid was drained, and a solution of zinc sulfate was added to the sediment to the top with the formation of a meniscus of liquid above the edges of the centrifuge tube. The tube was covered with a cover glass so that the surface of the liquid could hold the glass. It was centrifuged for 0.5 min. at 1500 rpm. At that time helminth eggs were rising and fixing to the surface of the glass. Then it was removed and transferred to a glass slide. Parasite eggs were counted at a small (×100) magnification of the light microscope.

Differentiation of eggs and protozoa was determined according to their morphological features [8–11]. At the same time, the invasion intensity was calculated – the number of eggs in 1g of feces. The invasiveness was calculated as well – the percentage of positive samples out of the total examined number.

Results of research and discussion. From 2016 to 2019 one hundred fifty six feces samples from different species of predators of two suborders: *Caniformia* – 74 samples and *Feliformia* – 82 samples from “Feldman Eco-park” (Kharkiv, Ukraine) were examined (Table 1).

Table 1

**Fauna of examined carnivores in Non-Governmental organization
“Feldman Eco-park” (n = 156)**

Common name	Number of samples	Scientific name (Species or Subspecies)
Suborder Caniformia (Kretzoi, 1943)		
Family Canidae		
Alaska Wolf	10	<i>Canis lupus pambasileus</i> (Elliot, 1905)
European Grey Wolf	10	<i>Canis lupus lupus</i> (Linnaeus, 1758)
Alaskan Tundra Wolf	10	<i>Canis lupus tundrarum</i> (Miller, 1912)
Red Fox (silver-black suit)	3	<i>Vulpes vulpes</i> (Linnaeus, 1758)
Family Ursidae		
Brown Bear	4	<i>Ursus arctos</i> (Linnaeus, 1758)
Asiatic Black Bear	2	<i>Ursus thibetanus</i> (G. Cuvier, 1823)
Family Procyonidae		
Brown-nosed Coati	7	<i>Nasua nasua</i> (Linnaeus, 1766)
Northern Raccoon	9	<i>Procyon lotor</i> (Linnaeus, 1758)
Raccoon Dog	6	<i>Nyctereutes procyonoides</i> (Gray, 1834)
Ussuri Raccoon Dog	1	<i>Nyctereutes procyonoides ussuriensis</i> (Matschie, 1907)
Family Mephitidae		
Striped Skunk	2	<i>Mephitis mephitis</i> (Schreber, 1776)
Family Mustelidae		
Steppe Polecat	8	<i>Mustela eversmanni</i> (Lesson, 1827)
Eurasian Badger	2	<i>Meles meles</i> (Linnaeus, 1758)
Suborder Feliformia (Kretzoi, 1945)		
Family Felidae		
Bengal Tiger	2	<i>Panthera tigris bengalensis</i> (Linnaeus, 1758)
Amur Leopard	10	<i>Panthera pardus orientalis</i> (Schlegel, 1857)
Siberian Tiger	6	<i>Panthera tigris altaica</i> (Temminck, 1844)
Cheetah	16	<i>Acinonyx jubatus</i> (Schreber, 1775)
Lion	6	<i>Panthera leo</i> (Linnaeus, 1758)
Jaguar	5	<i>Panthera onca</i> (Linnaeus, 1758)
South African Lion	4	<i>Panthera leo krugeri</i> var. <i>alba</i> (Roberts 1929)
Puma	9	<i>Puma concolor</i> (Linnaeus, 1771)
Eurasian Lynx	2	<i>Lynx lynx</i> (Linnaeus, 1758)
Ocelot	2	<i>Leopardus pardalis</i> (Linnaeus, 1758)
Caracal	4	<i>Caracal caracal</i> (Schreber, 1776)
Wildcat	3	<i>Felis silvestris</i> (Schreber, 1777)
Leopard Cat	3	<i>Prionailurus bengalensis</i> (Kerr, 1792)
Family Hyaenidae		
Striped Hyena	3	<i>Hyaena hyaena</i> (Linnaeus, 1758)
Family Herpestidae		
Meerkat	6	<i>Suricata suricatta</i> (Schreber, 1776)
Banded Mongoose	1	<i>Mungos mungo</i> (Gmelin, 1788)

The results of coproscopic studies are presented in Table 2.

Table 2

Prevalence of gastrointestinal parasites in predators of Non-Governmental organization “Feldman Eco-park”

Scientific name	Number of samples	<i>Toxocara cati</i>	<i>Toxocara canis</i>	<i>Toxascaris leonina</i>	Family Ancylostomatidae	Genus <i>Isospora</i>
Suborder Caniformia						
Family Canidae						
<i>Canis lupus</i>	30		2 (6.7%)	2 (6.7%)	8 (26.7%)	-
Family Procyonidae						
<i>Nasua nasua</i>	7		-	-	1 (14.3%)	-
Suborder Feliformia						
Family Felidae						
<i>Acinonyx jubatus</i>	16	3 (18.8%)		11 (68.8%)	-	-
<i>Pantera leo</i>	6	-		4 (66.7%)	-	-
<i>Panthera leo krugeri</i> <i>var. alba</i>	4	-		3 (75.0%)	-	-
<i>Panthera pardus orientalis</i>	10	-		2 (20.0%)	-	2 (20.0%)
<i>Lynx lynx</i>	2	-		2 (100.0%)	-	-
<i>Puma concolor</i>	9	-		4 (44.4%)	-	-
<i>Panthera onca</i>	5	-		-	-	1 (20.0%)
<i>Caracal caracal</i>	4	-		-	-	1 (25.0%)
Total	93	3	2	28	9	4

Note. In numerator – number of infected animals, and in denominator – number of infected animals expressed in percentage in relation to a number of investigated samples from the present species (subspecies) of animals.

Parasite eggs were found in 46 samples (29.5%) out of 156 fecal samples. Among them 13 samples from *Caniformia* (28.3%) and 33 samples from *Feliformia* (71.7%) were positive. In general, the invasiveness of *Caniformia* was 17.6% and *Feliformia* – 40.2%. Oocysts of protozoa genus *Isospora* were detected in 4 samples (2.6%) out of all positive samples.

Eggs/oocysts of various gastrointestinal parasites in 46 samples of feces of various carnivores were microscopically found. The most common parasite species

was *Toxascaris leonina* (60.9%) followed by nematodes of the *Ancylostomatidae* family (19.6%), protozoa genus *Isospora* (8.7%), *Toxocara cati* (6.5%) and the least common parasite was *Toxocara canis* (4.3%) (Fig. 1).

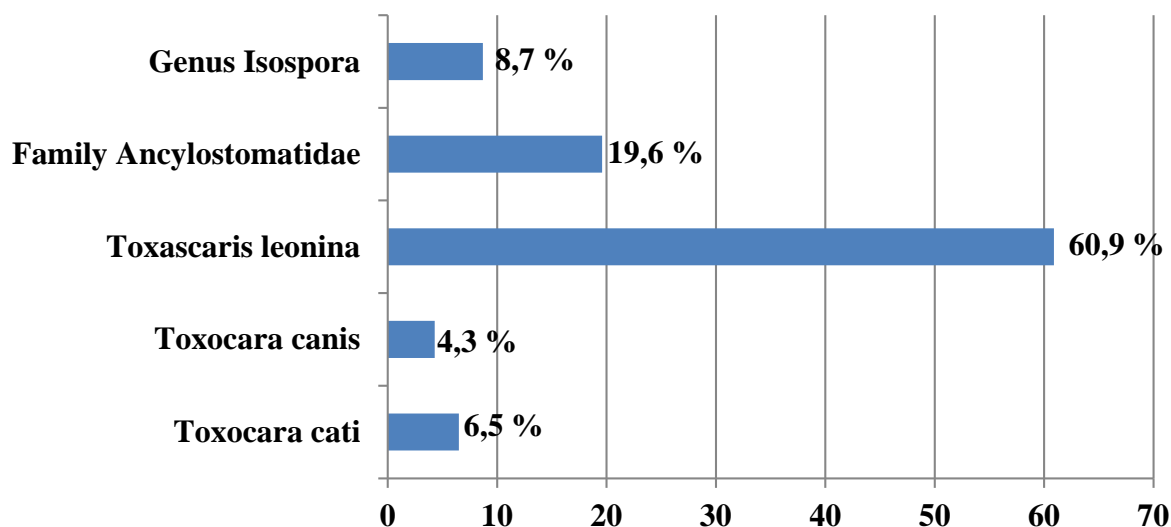


Fig. 1. Prevalence of gastro-intestinal parasites in various carnivores of Non-Governmental organization "Feldman Eco-park".

Among *Caniformia* only wolves and coatis were infested with nematodes. *Strongilata* eggs, family *Ancylostomatidae* were detected in 14.3% of the samples from *Nasua nasua*, while in wolves the number of samples infested with helminths of this family was 26.7%. In addition, *Toxocara canis* eggs were found in 6.7% of wolves, and *Toxascaris leonina* eggs were detected in 6.7% of wolves.

Among *Feliformia* the invasiveness with toxascaris prevailed. Their eggs were found in 26 out of 82 samples, which made up 31.7%. *Toxascaris leonina* eggs were found in 100% samples from *Lynx lynx*, 75.0% from *Panthera leo krugeri var. alba*, 68.8% – from *Acinonyx jubatus*, 66.7% – from *Panthera leo*, 44.4% – from *Puma concolor* and 20% of samples from *Panthera pardus orientalis*. In three samples (18.8%) from *Acinonyx jubatus* eggs genus *Toxocara*, *Toxocara cati* species were detected.

Monospecific invasions prevailed in indicated parasitoses and made up 76.9% among invasive *Caniformia* (13 samples) and 6.1% among *Feliformia* (33 samples).

Out of 30 samples from *Canis lupus* the eggs of two helminths were simultaneously detected in three samples: two samples (6.7%) had nematodes eggs of the family *Ancylostomatidae* and *Toxascaris leonina*, and one sample (3.3%) had nematodes eggs of the family *Ancylostomatidae* and *Toxocara canis*.

Out of 10 samples from *Panthera pardus orientalis* two samples had simultaneously *Toxascaris leonina* eggs and genus *Isospora* oocysts, that made up 20%.

The intensity of invasions was different and made up 37.20 ± 17.75 eggs in 1g of feces (3–101) in wolves with monoinvasion, and with mixed ones – 7.67 ± 6.17 (1–20). In *Nasua nasua* the intensity of invasion with *Ancylostomatidae* family nematodes was 0.7 eggs per gram of feces. *Toxocara canis* eggs were detected at a low level of invasion intensity in the amount of 0.3–1 per 1g of feces, and *Toxascaris leonina* eggs – 1.50 ± 0.50 (1–2).

In *Acinonyx jubatus* the invasion intensity of *Toxocara cati* was low – 2.00 ± 0.58 , and *Toxascaris leonina* – 23.45 ± 5.36 eggs per gram of feces.

In *Panthera leo* the invasion intensity of *Toxascaris leonina* was 25.75 ± 4.97 , in *Panthera leo krugeri* var. *alba* – 25.67 ± 8.09 , in *Panthera pardus orientalis* – 13.00 ± 0.00 , in *Lynx lynx* – 14.00 ± 1.00 , and in *Puma concolor* – 16.75 ± 11.21 eggs per 1g of feces.

Among animals infested with isospores only invasion intensity of *Panthera onca* made up 15 oocysts per gram of feces, while other animals had 1–3 oocysts per gram of feces.

Discussion. Zoos play an important role in preserving wildlife biodiversity under conditions of urbanization, reducing of the habitat of the animals [12] and climate change [13].

In wild life animal populations are regulated by biotic and abiotic factors. Parasites, as biotic factors affect hosts and in combination with other conditions can cause a decrease in resistance, reproductive function, and can even lead to death of an animal [14, 15].

This work is devoted to the study of the parasitofauna of the gastrointestinal tract of *Caniformia* and *Feliformia* at the “Feldman Eco-Park”.

According to the results of these studies, among 15 species and subspecies of the caniform suborder representatives of 2 species – wolves (*Canis lupus*) and coatis (*Nasua nasua*) were invaded by nematodes. In wolves (subspecies *Canis lupus pambasileus*, *Canis lupus lupus*, *Canis lupus tundrarum*) two species of geohelminths of the suborder *Ascaridata* (*Toxocara canis*, *Toxascaris leonina*) and one representative of the *Strongylata* suborder of the *Ancylostomatidae* family were recorded. In coatis one helminthiasis caused by a parasite from the *Ancylostomatidae* family was diagnosed. The extension of invasion of *Caniformia* by different helminths ranged from 6.7% to 26.7%.

The obtained data on the distribution of pathogens of *Toxocara canis*, *Toxascaris leonina* and strongylates of the *Ancylostomatidae* family among wolves coincide with the data of other researchers [16].

Among 16 species and subspecies of the feliform suborder eight ones had nematodoses and protozoos.

At the same time, mixed two-component invasion represented by the *Toxocara cati* and *Toxascaris leonina* helminths was found in the cheetah (*Acinonyx jubatus*), and the *Toxascaris leonina* helminths and protozoa *Isospora* were detected in the Far Eastern leopard (*Panthera pardus orientalis*).

Monoinvasion caused by *Toxascaris leonina* helminth was registered in the African lion (*Panthera leo*), white lion (*Panthera leo krugeri* var. *Alba*), lynx (*Lynx lynx*) and puma (*Puma concolor*).

Monoinvasion caused by protozoa of *Isospora* genus was found in the jaguar (*Panthera onca*) and caracal (*Caracal caracal*).

The extension of invasion of *Feliformia* by helminths and protozoa ranged from 18.8% to 100%.

According to the results of our research, mostly monoinvasions were recorded in predators, less often they had mixed two-component parasitoses.

Among carnivores (brown bears, lions, tigers, coatis) helminths of the suborder *Ascaridata* (*Baylisascaris* sp., *Toxocara* spp., *Toxascaris leonina*), *Strongylata* (*Ancylostoma* sp.) and *Rhabditata* (*Strongyloides* sp.) [17] were previously detected in the zoos of Dnipropetrovsk and Zaporizhzhya regions of Ukraine that mainly coincides with the data of the conducted studies.

Helminths of the *Strongylata* suborder are widespread in nature and are common for domestic and wild carnivores [18].

Nematodes of the *Ascaridata* suborder are also widespread. In this case, the species *Toxocara canis* is common for wild and domestic *Caniformia*, *Toxocara cati* – for *Feliformia*, and the species *Toxascaris leonina* is common for wild and domestic *Caniformia* and *Feliformia* [18].

According to the results of these studies, infestation with *Toxascaris leonina* species that was recorded more often among *Caniformia* and *Feliformia* reached 100%.

Taking into account the results of the study and the data of other scientists, it was established that wild *Caniformia* and *Feliformia* can play an important role in the spread of parasitoses (helminthiases, protozoos) among domestic cats and dogs that can be infected from them [19, 20] and also become a source of zoonotic invasions [21–23].

The transmission of pathogens can be made among predators of the zoo, and among domestic and homeless carnivores. Therefore, it is necessary to carry out diagnostic studies and treatments with antiparasitic drugs systematically.

Conclusions and prospects for further research. The results of our studies showed that helminths eggs and protozoa oocysts were found in 46 samples, that is – 29.5% in samples of feces from predators kept in Non-Governmental organization “Feldman Eco-park”. All diagnosed parasitoses were caused by monoxenic (single-

host) geohelminths and protozoa with a direct development cycle. The reasons of the circulation of these pathogens in the zoo are the following: keeping of animals on a limited area, high resistance of invasive eggs and protozoa oocysts to the external medium, the difficulties of disinvasion of the places for keeping predators, their dehelmintization, and mechanical transfer of pathogen eggs and oocysts on shoes, clothing and inventory by zoo employees.

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ЭНДОПАРАЗИТЫ ПЛОТОЯДНЫХ В ОБЩЕСТВЕННОЙ ОРГАНИЗАЦИИ «ФЕЛЬДМАН ЭКО-ПАРК» (ХАРЬКОВ, УКРАИНА) / Приходько Ю.А., Мазанный А.В., Федорова Е.В., Люлин П.В., Никифорова О.В.

За 4 года (2016–2019 гг.) происследовано 156 проб фекалий от разных видов хищников, которые принадлежали общественной организации «Фельдман Эко-парк» (Харьков, Украина). Яйца/ооцисты различных желудочно-кишечных паразитов были обнаружены в 46 пробах фекалий, что составило 29,5%. Среди проб от собакообразных положительных оказалось 13 (28,3%), а от кошкообразных – 33 (71,7%). Все диагностированные паразиты были вызваны моноксенными (однохозяйными) геогельминтами и простейшими с прямым циклом развития. Наиболее распространенным паразитом был *Toxascaris leonina* (60,9%), за ним следуют нематоды семейства

Ancylostomatidae (19,6%), простейшіе рода *Isospora* (8,7%), *Toxocara cati* (6,5%), а наименее распространенным паразитом был *Toxocara canis* (4,3%).

Ключевые слова: гельминты, простейшие, копроскопия, хищники, зоопарк.

ЕНДОПАРАЗИТИ М'ЯСОЇДНИХ В ГРОМАДСЬКІЙ ОРГАНІЗАЦІЇ «ФЕЛЬДМАН ЕКО-ПАРК» (ХАРКІВ, УКРАЇНА) / Приходько Ю.О., Мазанний О.В., Федорова О.В., Люлін П.В., Нікіфорова О.В.

Вступ. Фауна хижих тварин ГО «Еко-парк Фельдмана» складається з представників родин: *Canidae*, *Ursidae*, *Procyonidae*, *Mephitidae*, *Mustelidae*, *Felidae*, *Nyctenidae*, *Herpestidae*. Паразитофауна хижих тварин у дикій природі включає понад 400 видів гельмінтів. Найпоширенішими серед них є гельмінти шлунково-кишкового тракту.

Метою роботи було проведення копроскопічних досліджень для діагностики кишкових гельмінтів у диких хижих тварин «Еко-парку Фельдмана».

Матеріали і методи досліджень. За 4 роки (2016–2019 рр.) досліджено 156 зразків фекалій від різних видів хижаків, які належать ГО «Еко-парк Фельдмана» (Харків, Україна). Копроскопічний матеріал отриманий від тварин, які відносяться до двох підрядів: собакоподібних – 74 проби і кішкоподібних – 82. Для виявлення яєць гельмінтів застосовували стандартизований седиментаційно-флотаційний метод із застосуванням розчину сульфату цинку – 450 г на 1 літр води (щільність 1,2 г/см³) за А. Вишняускасом. Диференціацію яєць та найпростіших визначали за їх морфологічними ознаками.

Результати досліджень та їх обговорення. Яйця та ооцисти паразитів були виявлені в 46 зразках фекалій, що склало 29,5%. Серед проб від собакоподібних позитивних виявилось 13 (28,3%), а від кішкоподібних – 33 (71,7%). В цілому інвазованість собакоподібних склала 17,6%, а кішкоподібних – 40,2%. В 4 пробах (2,6%) були виявлені ооцисти роду *Isospora*. З собакоподібних в 14,3% проб від *Nasua nasua* виявлені яйця стронгілят родини *Ancylostomatidae*, а серед вовків кількість інвазованих гельмінтами даної родини склала 26,7%. Крім цього у 6,7% вовків виявлені яйця *Toxocara canis*, а ще у 6,7% – яйця *Toxascaris leonina*. Яйця токскарисів виявлені в 26 з 82 проб від котятих, що склало 31,7%. У трьох пробах (18,8%) виявлені яйця *Toxocara mystax*. Моноінвазії переважали серед зазначених паразитозів і становили 76,9%.

Інтенсивність інвазій була різною і становила у вовків при моноінвазії гельмінтами родини *Ancylostomatidae* від 3 до 101 яйця в 1 г фекалій, в середньому $37,20 \pm 17,75$, а при змішаних – $7,67 \pm 6,17$. У *Nasua nasua* інтенсивність інвазування анкілостоматидами склала 0,7 яєць в 1 г фекалій. Яйця *Toxocara canis* виявлені у вигляді низького (0,3-1 яйце в 1 г фекалій) ступеня інтенсивності інвазії, а яйця *Toxascaris leonina* – $1,50 \pm 0,50$. У кішкоподібних інтенсивність інвазування *Toxocara mystax* була низькою $2,00 \pm 0,58$ яйця в 1 г фекалій, а *Toxascaris leonina* – від $13,00 \pm 0,00$ до $25,75 \pm 4,97$ яйця в 1 г фекалій.

Ключові слова: гельмінти, найпростіші, копроскопія, хижаки, зоопарк.

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