Ascarids infestation of captive big cats (Felidae) in zoos

O A Panova¹ and A V Khrustalev

Federal State Budget Scientific Institution “Federal Scientific Centre VIEV”, st. B. Cheryomushkinskaya, 28, Moscow, 117218, Russia

¹E-mail panova@vniigis.ru

Abstract. Parasitological studies are an important part of veterinary control when keeping wild and endangered species of animals in captive breeding. For three years we watched felines (Felidae) in zoos. In 49.2% of feces samples, nematodes were found: *Toxascaris leonina* and *Toxocara cati*. Infection with toxascaris in half of the snow leopard (*Uncia uncia*), all cheetahs (*Acinonyx jubatus*) and one puma (*Puma concolor*) was recorded regularly during 3 years of research. *T. leonina* eggs were found in the soil of the enclosures of these animals. This allows to talk about a stable area of invasion. The most probable way of introducing *T. cati* nematode into the animal population of the zoo with an animal brought from the wild was noted. Measures for the complete rescue of the territory of zoos and animals from ascaridids require an integrated approach and further improvement.

1. Introduction

Currently, due to the extinction of many species of wild animals under the influence of human activity, the problem of preserving biological diversity in integral ecosystems is becoming increasingly acute [1]. In the framework of the Nagoya Protocol, collectors of genetic resources have been identified in Russia, which include zoos in terms of their functions [2]. In zoos, research is being conducted on the study, maintenance, conservation and breeding of rare species of animals in captivity, the features of their behaviour, physiology and possible pathologies are being studied [3, 4].

Wild feline (representatives of Felidae) attracts special attention. The Russian Federation is internationally responsible for the conservation of the Amur tiger, Far Eastern leopard, snow leopard.

The Far Eastern leopard (*Panthera pardus orientalis*) is currently over-exposed species. It is listed in the IUCN Red Book, the Red Book of Russia, the IUCN Red List and in Appendix I to the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). This subspecies is widespread in the mountain coniferous-deciduous and oak forests of the Far East, in the border area of three countries - Russia, China and North Korea [5]. According to 2017 data, 87 individuals survived in the wild in Russia in the territory of the Leopard Land National Park and from 8 to 12 in China (data from the WWF official website in Russia). Leopard hunting has been banned since 1956.

The snow leopard (*Panthera uncia*) is included in the IUCN Red List and has the status of a rare or endangered species in all 12 countries where it lives. The species is listed in the Red Book of the Russian Federation as being endangered; According to the results of 2018, 61 individuals were registered in Russia. Snow leopard remains one of the least studied feline species in the world. Very little is known about the biology and ecology of this rare predator, and its number within their habit area is determined very conditionally [6].
An important issue is parasitological monitoring. The causative agents of invasive diseases have a pathogenic effect on the body, contribute to a decrease in resistance and, as a consequence, increase the susceptibility of animals to other diseases, mainly infectious. Together, these factors negatively affect the reproduction of animals [7]. In zoos, an exchange of pathogens may occur among different felines. An important role in the spread of helminthiases is played by the external environment, in which the development of geohelminths to the invasive stage and their preservation takes place [8, 9]. Therefore, in the conditions of zoos, regular monitoring of the epizootic situation relating to parasitic diseases is necessary.

The aim of our work was to study helminthiases in large felines in zoos and to determine the role of environmental objects in the formation of stationary isolated area of animal re-excretion in confined spaces.

2. Materials and methods

For 3 years (from 2016 to 2018) 120 samples of feces from 25 individuals of eight species of animals of this family were studied. Felidae: snow leopard Panthera uncia, cheetah Acinonyx jubatus, Asian lion Panthera leo persica, puma Puma concolor, lynx, tiger Panthera tigris, manul Otocolobus manul, leopard Panthera pardus. Samples for research were obtained from stationary zoos in Moscow and the Moscow region. Feces were investigated within 24 hours after collection by formalin-ether deposition and flotation using a saturated solution of sodium nitrate (NaNO3, density 1.38) [10].

73 soil samples from aviaries were also selected and investigated. The selection was carried out in accordance with MUK 4.2.2661-10 "Methods of sanitary-parasitological studies" by the method of an envelope of 10-point samples weighing 30-40 g. Samples were taken at 5 × 5 m sites, at a depth of 5-10 cm. During the study of samples, the method of Santarém V.A. et al. (2009) was used [11]. We took a soil sample weighing 15 g. As a surfactant, 0.2% Tween-80 was used, in which the sample was preliminarily held for one hour. A saturated solution of sodium nitrate (NaNO3, density 1.38) was used as a flotation solution.

Microscopy and micrometry were conducted on a Motic BA410 biological microscope (PRC).

3. Findings

Of 120 fecal samples examined, nematode eggs were found in 59 (49.2%) (table 1).

| Animal species | Total number of samples | Pathogens detected in studies by year | Contagion, % | The average number of eggs in 1 g of feces |
|----------------|-------------------------|--------------------------------------|--------------|------------------------------------------|
| Snow leopard Panthera uncia | 24 | T. leonina | T. leonina | T. leonina | 12 | 50 | 341.2 |
| Cheetah Acinonyx jubatus | 16 | - | T. leonina | T. leonina | 16 | 100 | 464 |
| Asian lion Panthera leo persica | 12 | - | T. leonina | T. leonina | - | - | 0.25 |
| Puma Puma concolor | 12 | T. leonina | T. leonina | T. leonina | 6 | 50 | 240 |
| Common lynx Lyynx | 26 | T. leonina | T. leonina | T. leonina | 12 | - | 152.3 |
| - | - | - | T. cati | 3 | 11.5 | 0.75 |
| - | - | - | - | 1 | 16.6 | 0.25 |
| - | - | - | - | 2 | 7.7 | 110 |
| Tiger | 10 | T. leonina | - | - | 4 | 40 | 795 |
Panthera tigris - - T. cati 2 20 386
Manul Otocolobus manul 5 - - - 0 0 0
Leopard Panthera pardus 15 - - - - 0 0
General data 120 59 49.2

The eggs of *Toxascaris leonina* nematodes were found in half of individuals of the snow leopard, all cheetahs, one cougar and three common lynx (figure 1). Infection with toxaskaris in these animals was recorded regularly during 3 years of research, which suggests the presence of a stable isolated area of invasion.

![Figure 1. Eggs of Toxoascaris leonina. Enlarged x400.](image)

Grown up *T. leonina* nematodes, appeared after dehelmintization, were also found in feces of cheetah, tigers and lynx in an amount of 4 to 14 specimens.

*Toxocara cati* eggs were first discovered in one of the zoos in a young lynx, which was imported from the wild in 2018. Re-examination of this animal after 6 months also showed the presence of helminth eggs in feces. In other felines from this zoo, helminths were not recorded during examinations in 2016 and 2017. Coprological studies carried out in 2018 revealed toxocara infection in one adult lynx and two tigers as well. After dehelmintization, 5 specimens were found in the feces of one tiger nematodes *T. cati*.

In feces samples from manul and leopard, parasitosis pathogens were not found.

In the study of 73 soil samples from aviaries, *T. leonina* eggs were found in 24 of them (32.9%) (table 2). The number of eggs in a sample weighing 15 g varied from 1 to 8 specimens. The eggs found were at different stages of development (figure 2).

**Table 2.** The results of a parasitological study of the soil of aviaries of various feline species

| Animal species                  | The number of test samples | Pathogens       | Number of positive samples | Share of positive samples, % |
|---------------------------------|---------------------------|-----------------|----------------------------|-----------------------------|
| Snow leopard Panthera uncia    | 12                        | T. leonina      | 4                          | 33.3                        |
| Cheetah Acinonyx jubatus       | 15                        | T. leonina      | 11                         | 73.3                        |
| Puma Puma concolor             | 10                        | T. leonina      | 4                          | 40                          |
| Manul Otocolobus manul         | 12                        | -               | 0                          | 0                           |
| Leopard                        | 24                        | T. leonina      | 5                          | 20.8                        |
Panthera pardus

| General data | 73 | 24 | 32.9 |

![A) Stage of two blastomeres; B) Stage of 8 blastomeres; C) Larva in the egg.](image)

**Figure 2.** Eggs of *Toxoascaris leonina* at different stages of development, found in the soil of feline enclosures in zoos. Enlarged x400: A) stage of two blastomeres; B) stage of 8 blastomeres; C) the larva in the egg.

In the enclosures of Asian lions, tigers and common lynxes, the soil was not investigated.

4. Discussion

There are many reports in the literature about the pathogenic effect of parasites on the animal organism in zoos [12, 13]. Invasions become a predisposing factor for the development of secondary immunodeficiency, reduction or loss of productivity, and with high infection rates, animal death is possible [7, 8, 9, 14, 15].

According to some authors, the most common helminths are nematodes. Most often, toxocars, toxascaris and hookworms are recorded [13, 14, 17].

Harchenko and Marunchin (1992) conducted research at the Kiev Zoo: helminth infection in felines was 52%, of which *T. leonina* - 40%, *Strongylida sp.* - 8.7%, *T. catt* - 8.7%, *Trichuris sp.* - 4.3% и *Diphyllobothrium sp.* - 4.3% [8].

Bortsova M.S. and Konyaev S.V. (2013) found parasites in 72% of the examined samples when studying feline feces in zoos. *T. catt* was recorded in 58.8% of animals, *T. leonina* in 43.1%, *Trichuris sp.* in 33.3%. *Strongyloides sp.* larvae were found in the serval, which were recorded with an invasion rate of 3.9% [18].

On the territory of the zoo “Feldman Ecopark” in Kharkov region Ponomarenko V.Ya., Fedorova E.V. et al. (2017) found *T. catt* in an African lion, Bengal tiger, Far Eastern leopard and lynx. *T. leonina* was found in Amur and Persian tigers, Far Eastern leopard, cougar and lion [13].

In the Kazan Zoo Timerbaev R.R. et al. (2018) recorded *T. leonina* in the serval and lynx, and *T. catt* in the lion [19]. Nematode of Capillaria was discovered by Domatsky V.N., Badryzlova A.A. 2019 in felines at the zoo in Yekaterinburg, the invasion rate was 28.6% [15].
The results of the above studies show that most of the established nematodes are geo-helminths. The ways of parasites getting into zoos are different - with food, with intermediate and paratenic hosts, with imported animals, care items, zoo employees and visitors [8, 9]. In our case, *T. cati* was most likely introduced into the animal population of the zoo with a lynx caught from the wild.

For the treatment of carnivorous ascariasis, a number of drugs based on such nematicidal active substances as albendazole, fenbendazole, mebendazole, flubendazole, levamisole, products of the macrocyclic lactone group, etc., have been recommended [20].

To treat predatory animals Ponomarenko V.Ya. and others used the drug Cestal Plus individually at a dosage of one tablet per 10 kg of body weight twice with an interval of 14 days. The effectiveness at toxocariasis and toxascarosis was 100% [13].

The animals that were observed in our experiment were dehelmintized with Cestal (Seva) containing febantela pomoat, twice with an interval of 14 days. However, as the results of our studies show, quarterly dehelmintization alone was not a sufficient measure to free animals from invasion.

The insufficiency of conducting a quarterly dehelmintization of a feline zoo is associated with the development cycle of *T. leonina*, restrictions on grooming and veterinary work with wild animals, and the difficulties of disinvasing places of detention. *T. leonina* nematodes are geo-helminths and have a short egg maturation period: 8–9 days at 27 ° C and 3 days at 30 ° C [21]. In this case, regular dehelmintization is a restrictive measure for the further spread of invasion among susceptible animals of the zoo, but cannot be the only way to free the territory of the zoo and the animals themselves from the pathogen.

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