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Helminth Fauna of Eurasian Lynx (*Lynx lynx*) in Estonia

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ABSTRACT: Thirty-seven carcasses of Eurasian lynx (*Lynx lynx*) collected and examined in Estonia during 1999–2001 had helminths. Parasites identified and their prevalence included *Diphyllobothrium latum* (5%), *Taenia pisiformis* (100%), *Taenia laticollis* (41%), *Taenia hydatigena* (3%), *Taenia taeniaeformis* (3%), *Toxocara cati* (68%), and *Trichinella* spp. (22%). The only significant relationships ($P \leq 0.05$) between occurrence of helminths and host age and sex were a greater number of *T. pisiformis* and *T. laticollis* in older than in younger male lynx, and older males had a greater number of species of helminth than did younger lynx. Sixty-one fecal samples collected during snow tracking of nine lynx were examined; eggs of *T. cati* were identified in 38 samples, and *Capillaria* spp. were found in eight samples. This is the first systematic investigation of parasites of lynx in Estonia.

Key words: Estonia, Eurasian lynx, helminths, *Lynx lynx,* survey.

Parasites may play an important role in Eurasian lynx populations. Mange is the most common disease affecting lynx, and it is an important cause of death, especially in northern Europe (Ryser-Degiorgis, 2001). Intestinal worms, particularly helminths, are common in lynx. *Toxocara* sp. is one of the most common helminths, and it has been reported as a cause of death of juvenile lynx (Schmidt-Posthaus et al., 2002). Parasites of lynx have been studied in Lithuania (Kazlauskas and Prusaite, 1976; Kazlauskas and Matuzevicius, 1981) and are currently being investigated in Latvia (Bagrade et al., 2003). However, relatively little is known about parasites of lynx in the Baltic region, and no systematic investigations have been conducted in Estonia.

There are currently ~900 lynx in Estonia (Ministry of Environment, 2004), and ~100–200 animals are killed annually by hunters (Valdmann, 2000). The goals of the present work were to determine the species of helminths infecting lynx in Estonia, to estimate prevalence and intensity of helminth infections in relation to sex and age of the lynx, and to evaluate relationships between food habits of lynx and the role of lynx in transmission of helminths in Estonian forests.

Lynx were killed between 1 November and 28 February during the winters of 1999–2000 and 2000–01. Carcasses were obtained from hunters and originated in 12 of 15 Estonian counties. The sex of lynx was determined, and they were classified as young animals (body weight <15 kg and age <1.5 yr) and adults (body weight >15 kg and age >1.5 yr) according to the method of Schmidt et al. (1997). Eleven young females, 11 young males, nine adult females, and six adult males were examined.

Throrough necropsies were performed on 37 lynx. Carcasses were opened, and organs were removed and examined macroscopically. Liver, stomach, and intestines were opened, and the contents were washed with physiologic saline solution into beakers. The washings were allowed to settle, the fluid was decanted, and the procedure was repeated until the sediment became clean enough to detect and collect worms. Lungs, trachea, heart, and ureter were opened and washed with water into a tray. The gall bladder and urinary bladder were opened and examined, and the fluid was collected and examined as above. The esophagus was opened, and kidneys were cut into 1–1.5 cm strips. Both organs were examined macroscopically.

All worms were collected, counted, and preserved in Barbagallo standard solution (Parre, 1985). The generic identification of nematodes and eggs was done according to the method of Kozlov (1977).

The length of hooks on scolices was

TABLE 1. Results of the survey[a] of the prevalence of helminths in Eurasian lynx from Estonia.

Species of helminth	Source	Prevalence[b]	Intensity[c]
Diphyllobothrium latum	Small intestine	5 (2)	8.5 (4–13)
Taenia pisiformis	Small intestine	100 (37)	18.2 (1–49)
Taenia laticollis	Small intestine	41 (15)	1.8 (1–4)
Taenia hydatigena	Small intestine	3 (1)	9
Taenia taeniaeformis	Small intestine	3 (1)	1
Toxocara cati	Small intestine	68 (25)	17.1 (2–78)
	Eggs in feces	62 (38)[d]	
Capillaria spp.	Eggs in feces	13 (8)[d]	
Trichinella spp.	Larvae in muscles	30 (8)	

[a] Based on necropsy of 37 lynx, trichinelloscopy of 27 lynx, and fecal examination of 61 samples collected from nine free-ranging lynx.
[b] Percent (number) of lynx infected.
[c] Mean number of worms/infected host (range).
[d] More than one fecal sample may have been from the same lynx.

measured between the tips of the handle and the blade. To enable identification, proglottids of *Taenia* were cut with freezing microtome into 300-μm sections and stained with borcarmine. Sections were photographed at 90× magnification. Identifications were made by use of the genital sacs (after Verster, 1969). *Diphyllobothrium* worms were identified to species according to the method of Deljamure et al. (1985).

In addition, 61 fecal samples, collected from the wild during the snow tracking of nine lynx, were examined for parasite eggs by simple floatation. Muscle samples (anterior tibialis muscle, other limb muscles, and diaphragm) from 27 carcasses were examined for *Trichinella* larvae. Small subsamples were thoroughly pressed between compression slides and examined microscopically for *Trichinella* larvae. The samples were preserved at −20 C for further species identification.

Statistical analyses were performed using statistical software packet STATISTICA 5.0 (StatSoft Inc., Tulsa, Oklahoma, USA). Correlations among sex, age, and abundance and number of species of parasites were analyzed by nonparametric tests. Overall homogeneity was tested by Levine test and distribution by normal distribution test. Abundance of *Taenia pisiformis, Taenia laticollis,* and *Toxocara cati* and numbers of helminth species in different sex and age groups were compared by Kruskal-Wallis nonparametric and one-way analysis of variance tests.

All intestinal tracts contained *T. pisiformis* and at least one helminth species. Eight helminth species were found (Table 1) with the number of species per lynx varying from one to five (mean = 2.4). *Taenia pisiformis* and *T. cati* were the most prevalent helminths and also had the highest mean intensities of infection (Table 1). *Toxocara cati* and *Trichinella* sp. were recovered at necropsy, but not *Capillaria* spp., despite the recovery of eggs of *Capillaria* from eight fecal samples collected from free-ranging lynx.

There were no statistically significant differences in the intensity of infection of helminths among sex or age groups, except that young male lynx had fewer *T. pisiformis* and *T. laticollis* than did older lynx ($P=0.004$ and 0.01 respectively). A significant correlation between host age and number of species of parasite per individual was observed only in males; old males had more species per host than young males (Kruskal-Wallis $H=6.45$; $P=0.01$).

The helminth fauna of lynx in Estonia was similar to that in neighboring regions. In Latvia, six helminth species were recorded found in lynx: *T. pisiformis, Toxocara mystax* (most common), *Thominx* *aerophilus, Capillaria felis-cati, Trichinella* sp., and one unidentified species (Bagrade et al., 2003). Six of 10 helminth species reported from lynx in Lithuania (Kazlauskas and Prusaite, 1976; Kazlauskas and Matuzevicius, 1981) were also recovered in our study, and three of six species of helminths reported from lynx in neighbouring northwestern Russia (Gepther and Sludski, 1972; Jushkov, 1995) were found in lynx in Estonia.

The similarity in helminth fauna in lynx among studies in this region is due to similar food habits. Lynx in Estonian and Latvia prey mainly on roe deer (*Capreolus capreolus*) and mountain hare (*Lepus timidus*) during winter (Valdmann et al., unpubl. data). Roedeer is an intermediate host of *Taenia hydatigena* in Estonia and Belorussia, although the prevalence is low (≤7%; Järvis, 1993; Schimalov and Schimalov, 2003); we found this parasite in only one lynx. Roedeer may act as a source of *T. hydatigena* for lynx.

Mountain hare is probaly the most important intermediate host of *T. pisiformis* and *T. laticollis* (Abuladze, 1964; Zyll de Yong, 1966; Smith et al., 1985; Jushkov, 1995), and these cestodes were common in our lynx. *Taenia pisiformis* is also common in Latvian lynx (Bagrade et al., 2003). *Toxocara cati* is the most ubiquitous nematode of domestic cats (Eckert, 2000), and it was very prevalent and had the highest intensity of infection in the present study. This is consistent with the results of other studies, where *T. cati* had the highest intensity of infection among lynx in Lithuania (Kazlauskas and Prusaite, 1976; Kazlauskas and Matusevicius, 1981), and *Toxocara* sp. was most prevalent in lynx in Switzerland (Schmidt-Posthaus et al., 2002).

Helminths not only reflect food habits of predators but, to some extent, also the extent of niche overlap among predators. In Belorussia *T. pisiformis, T. hydatigena,* and *Spirometra* larvae were the most common helminths in lynx, gray wolf (*Canis lupus*), fox (*Vulpes vulpes*), and raccoon dog (*Nyctereutes procyonoides*) (Karasev, 1975; Schimalov and Schimalov, 2002a, b, c). Similary, Estonian wolf and lynx share three cestodes (*D. latum, T. pisiformis, T. hydatigena*) (see Jõgisalu, 2002) and seven common food items (Valdmann et al., unpubl. data). This apparent high degree of overlap in main prey among predators in Estonia and Belorussia is in marked contrast to the situation in Canada, where lynx (*Lynx canadensis*) and canids harbor few common parasites (Smith et al., 1985).

Red fox may be a source of *Trichinella* infection (Kutzer, 1994; Pozio et al., 2001). Foxes are an important food item for lynx in Estonia (frequency of occurrence, 7%; Valdmann et al., unpubl. data), and they may be a main reservoir of *Trichinella* for this species. The prevalence of *Trichinella* in lynx in the present study (30%) is comparable to the results of earlier studies of *Trichinella* sp. in Estonian wildlife that found *T. nativa* and *T. britovi* in lynx with a prevalence of 38.5% (Järvis and Miller, 1999). The high prevalence (~50%) of *Trichinella* in lynx has been found in other European countries (Brglez, 1989; Oksanen et al., 1998; Ryser-Degiorgis, 2001).

Although the age of lynx was not correlated with worm burden, sex was important. *Taenia pisiformis* and *T. laticollis* were more numerous in adult males. Male lynx have significantly larger bodies than females, weighing 2.8–7.2 kg more (Pulliainen, 1981). The larger males presumably consume more roe deer and mountain hare and thus have a higher probability for acquiring these tapeworms. Similarly, male sex and increasing age were associated with *Trichinella* infection of lynx in Finland (Oksanen et al., 1998).

Capillaria spp. were not found in the carcasses, but eggs were identified in fecal samples. Rodents and lagomorphs are often infected with *Capillaria hepatica*; when they are eaten by a cat, eggs are shed in the feces (Anderson, 1992; Cross, 1998). Because hares are a frequent prey of lynx (Valdmann et al., unpubl. data), *Capillaria* eggs in their feces could be from infected hares.

As a rule, carnivores are seldom seriously affected by cestode and nematode infections. Clinical disease from helminth infections is rare in lynx populations (Ryser-Degiorgis, 2001). Only *T. cati* may threaten kittens under certain unfavorable conditions.

According to our survey, the helminth burden of lynx in Estonia is not high enough to affect health of the population. The potential presence of *Trichinella* spp. should be considered when consuming lynx meat.

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