

Parasites of carnivorous mammals in Białowieża Primeval Forest

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ABSTRACT. Background. Although the parasitofauna of wild carnivorous mammals in Poland is quite well recognized, there has been only one research carried on this issue so far in Białowieża Forest — the last lowland primeval forest of temperate zone in Europe. **Material and methods.** Twelve wild and two domestic species of carnivorous mammals are living in Białowieża Forest. In our work faeces or intestines of all of them except ermine (*Mustela erminea*) have been examined and parasites or their eggs (or oocysts) recorded. In total 222 faecal probes from 13 species and 11 intestines of weasels have been investigated. **Results.** All species of examined carnivorous mammals were infected with parasites. The most infected species has occurred red fox *Vulpes vulpes* (over 70% infected with parasites) meanwhile only about 30% of otters *Lutra lutra* were infected. We found at least three protozoan species, one trematode, one tapeworm and nine species of nematodes. Except trematode *Alaria alata*, all of them are reported for the first time from Białowieża Primeval Forest. Oocysts of coccidia have been found in faeces of nine host species, with the highest prevalence (29.4%) in badger. Six species of carnivorous mammals have been occurred infected with trematodes (highest prevalence 42.1% in wolves) and two with tapeworms (*Diphyllobothrium latum* with the prevalence 2.6% in otter and 31.6% in wolves). All examined host species were infected with nematodes (with prevalence from 14.7% in lynx to 72.7% in red fox). Results of our work should be treated as preliminary researches on the species composition of parasitic fauna invading carnivorous mammals in Białowieża Primeval Forest.

Key words: Białowieża Primeval Forest, carnivorous mammals, parasites.

Introduction

Parasites of wild carnivorous mammals have been investigated in Poland from about 80 years. First data about parasites found during necropsy of mammals from this order have been published by Ruskowski [1] and Łukasiak [2]. Since that time much more data concerning species composition of parasites invading wild predatory mammals have appeared. Usually researchers investigated one or two host species, like wolf [3-5], polecat [6], fur minks and foxes kept in captivity [7, 8] and first of all red fox [9-16]. The last species is important host for hydatid tapeworm *Echinococcus multilocularis* — a parasite very dangerous for man [15, 16].

Actually red foxes are becoming more and more common in Poland and their importance as a reservoir of dangerous parasitic and viral zoonoses is increasing.

Białowieża Forest is the last lowland primeval forest of temperate zone in Europe, so all aspects of environmental ecology have been investigated intensively. Also parasites of wild animals living in Białowieża Forest were examined, but almost only in herbivorous and insectivorous mammals. However, some larval stages of parasites maturing in predatory mammals have been found in tissues of herbivorous species. Larvae of tapeworms: *Taenia crassiceps*, *T. polyacantha* and *T. teaniaeformis* have been found in rodents (*Microtus arvalis* and

Clethrionomys glareolus), in turn larvae of *Taenia hydatigena* have been observed in ruminants like European bison, red deer and roe deer [17]. Larvae of hydatid tapeworm *Echinococcus granulosus* found in tissues of red deer have been reported from Bielorussian part of Białowieża Forest [18]. The only studies on parasitic fauna of wild carnivorous mammals from Białowieża Primeval Forest were undertaken in 1996 [19] when faeces of eight wolves, four lynxes and four red foxes were examined. All investigated animals were infected with 100% prevalence. Parasites found in these studies were coccidia from genus *Isoospora*, trematodes (*Alaria alata*), tapeworms (*Mesocestoides* sp.) and nematodes (*Aelurostrongylus abstrusus*, *Thominx* sp., *Toxocara* sp. and hookworms from family *Ancylostomatidae*). The aim of our study was to conduct a preliminary recognition of species composition of parasites invading all species of carnivorous mammals.

Material and methods

Thirteen species of wild and domestic carnivorous mammals from fourteen living in Białowieża Primeval Forest have been examined. Their faeces were collected from spring 2003 to autumn 2004, both in the National Park and in timber forest. Probes were collected by experienced workers of the Mammal Research Institute. Only faeces determined without doubt (species of mammal) were collected and then examined. Faecal samples of domestic dog and cat have been collected in Białowieża village. Probes were kept frozen until examination.

We used standard flotation and sedimentation methods. In total faeces of 222 animals from thirteen species have been examined. It could happen that in some cases that more than one faecal probe from one host specimen has been collected. No samples of ermine's (*Mustela erminea*) faeces have been examined because of rarity of this mammal species.

Intestines from eleven weasels *Mustela nivalis* stored frozen at low temperature in the Mammal Research Institute for several years have been dissected and examined. Unfortunately only one specimen of worm was found because of a decay of the material. Also one specimen of nematode found in the body cavity of pine marten killed by lynx, has been investigated. All helminths found were placed into vials containing fixative agents, processed according to the species and specifically identified on the basis of previous descriptions.

Results

All species of examined carnivorous mammals have appeared to be infected with parasites. Because of very small probe available, we have not determined the prevalence of any invasions for domestic cat *Felis catus* and racoon dog *Nyctereutes procyonoides* (only 4 and 5 faecal samples have been found respectively). Also weasel *Mustela nivalis* remains very poor examined because of autolysis of dissected intestines (only one specimen of *Capillaria putori* has been found). Results of the examination of all host species are shown in Table 1 and the parasitic species found are listed in Table 2.

Table 1. Results of coproscopic examination of carnivorous mammals from Białowieża Primeval Forest

Host species	Number of examined probes	Prevalence of parasitic invasions				
		Coccidia	Digenea	Cestoda	Nematoda	not identified
<i>Canis lupus</i>	19	15.8%	42.1%	31.6%	21.0%	–
<i>Canis familiaris</i>	24	16.7%	–	–	33.3%	–
<i>Vulpes vulpes</i>	22	4.5%	13.6%	4.5%	72.7%	–
<i>Nyctereutes procyonoides</i>	5	20.0%	40.0%	–	60.0%	–
<i>Felis catus</i>	4	–	–	–	25.0%	–
<i>Lynx lynx</i>	7	14.7%	14.7%	–	14.7%	–
<i>Lutra lutra</i>	38	7.9%	23.7%	2.6%	–	–
<i>Meles meles</i>	17	29.4%	17.6%	5.9%	17.6%	–
<i>Martes martes</i>	38 (in one case a parasite found in dead body)	5.3%	2.6%	–	52.6%	–
<i>Martes foina</i>	24	–	–	–	25.0%	16.7%
<i>Mustela putorius</i>	8	12.5%	–	–	37.5%	–
<i>Mustela nivalis</i>	11 (examinations of small intestine)	–	–	–	9.1%	–
<i>Mustela vison</i>	16	–	37.5%	–	31.3%	–

Table 2. Parasites found in faeces or intestines of carnivorous mammals from Białowieża Primeval Forest

Parasite	Host (prevalence)
Coccidia	
<i>Isospora melis</i>	<i>Meles meles</i> (29.4%)
<i>Isospora putori</i>	<i>Mustela putorius</i> (12.5%)
<i>Isospora rivolta</i>	<i>Canis familiaris</i> (16.7%), <i>Canis lupus</i> (15.8%), <i>Nyctereutes procyonoides</i> (20%), <i>Lynx lynx</i> (14.7%)
<i>Isospora canis</i> (probably)	<i>Canis familiaris</i> (12.5%)
<i>Isospora vulpis</i> or <i>I. canivelocis</i>	<i>Vulpes vulpes</i> (4.5%)
Not identified coccidia	<i>Lutra lutra</i> (7.9%), <i>Martes martes</i> (5.3%)
Trematoda	
<i>Opisthorchis</i> sp. or <i>Metorchis</i> sp.	<i>Meles meles</i> (11.8%), <i>Lutra lutra</i> (15.8%)
<i>Alaria alata</i>	<i>Canis lupus</i> (26.3%), <i>Vulpes vulpes</i> (13.6%), <i>Lutra lutra</i> (2.6%), <i>Mustela vison</i> (12.5%)
Not identified trematodes	<i>Canis lupus</i> (15.8%), <i>Nyctereutes procyonoides</i> (40%), <i>Lynx lynx</i> (14.7%), <i>Meles meles</i> (5.9%), <i>Lutra lutra</i> (5.3%), <i>Martes martes</i> (2.6%), <i>Mustela vison</i> (25%),
Cestoda	
<i>Diphyllobothrium latum</i>	<i>Canis lupus</i> (31.6%), <i>Lutra lutra</i> (2.6%)
Taenidae	<i>Vulpes vulpes</i> (4.5%), <i>Meles meles</i> (5.9%)
Nematoda	
<i>Toxocara canis</i>	<i>Canis familiaris</i> (16.7%), <i>Vulpes vulpes</i> (13.6%)
<i>Toxocara cati</i>	<i>Lynx lynx</i> (14.7%), <i>Martes martes</i> (2.6%)
<i>Toxascaris leonina</i>	<i>Canis familiaris</i> (12.5%), <i>Felis catus</i> (25%)
<i>Trichuris vulpis</i>	<i>Canis lupus</i> (15.8%), <i>Vulpes vulpes</i> (27.3%), <i>Nyctereutes procyonoides</i> (20%)
<i>Trichuris nitzschii</i>	<i>Martes martes</i> (5.3%)
<i>Uncinaria stenocephala</i>	<i>Canis familiaris</i> (12.5%), <i>Vulpes vulpes</i> (27.3%)
<i>Uncinaria criniformis</i>	<i>Martes martes</i> (5.3%), <i>Mustela putorius</i> (12.5%)
<i>Uncinaria</i> sp.	<i>Meles meles</i> (5.9%)
<i>Capillaria aerophila</i>	<i>Canis lupus</i> (5.2%), <i>Vulpes vulpes</i> (22.7%)
<i>Capillaria putori</i>	<i>Mustela nivalis</i> (9.1%)
<i>Capillaria putori</i> or <i>C. mustelae</i>	<i>Meles meles</i> (11.8%), <i>Martes martes</i> (34.2%), <i>Martes foina</i> (25%), <i>Mustela putorius</i> (25%), <i>Mustela vison</i> (31.3%)

1. Coccidia

Oocysts of these protozoans have been found in faeces of nine species with the lowest prevalence in red foxes, and the highest in badgers. We have identified three species (*Isospora melis*, *I. putori*, and *I. rivolta*). In some cases we could not recognize the species of coccidium, so parasites from this group infecting otters and pine martens were not identified. Also the species of coccidia infecting domestic dog and red fox were not identified without doubt.

2. Trematodes

Six species of examined mammals were infected with digenans. We identified only one species — *Alaria alata*. We have found eggs of *A. alata* in faecal samples of wolf, red fox, lynx, otter and mink. Eggs of *Opisthorchis* sp. or *Metorchis* sp. (the proper identifications is difficult) have been found in faecal probes of badger and otter. Eggs of trematodes found in faeces of raccoon dog and pine marten remain not identified.

3. Cestodes

The only identified species of tapeworm was *Diphyllobothrium latum*. Eggs of this helminth have been found in faeces of wolf and otter. Eggs of tapeworms from family *Taenidae* have been found in faecal samples of badger and red fox, but identification of particular species of tapeworm was impossible because of similarity of the eggs from several closely related species.

4. Nematodes

We found eggs of roundworms in faecal samples (or in the intestine) of all examined host species. Eggs of *Toxocara canis* have been found in faeces of dogs and foxes, eggs of closely related *Toxocara cati* in faeces of lynx. One adult specimen of *T. cati* (!) was found in abdominal cavity of pine marten killed and abandoned by lynx. Domestic dogs and cats were infected with *Toxascaris leonina*. Eggs of whipworms from genus *Trichuris* have been found in faecal samples of domestic dog, red fox and rac-

coon dog (*Trichuris vulpis*), and also in the those pine marten (*T. nitzschi*). Eggs of hookworms from genus *Uncinaria* have been found in faeces of domestic dog and red fox (*U. stenocephala*) and mustelids: badger, pine marten and polecat (probably *U. criniformis*). Domestic dogs and red foxes were infected with *Capillaria aerophila*, whereas badgers, pine and stone martens, polecats and american minks with *C. putori* or *C. mustelae* (proper identification difficult). A specimen found in the intestine of weasel was identified as *Capillaria putori*.

5. Eggs not identified

In 16.7% of faecal probes of stone martens we found eggs, which did not resemble any known helminth eggs. Probably they were the eggs of saprophagic acarids or other arthropods.

Discussion

All examined species of carnivorous mammals living in Białowieża Primeval Forest appeared to be infected with parasites. It is common that the prevalence of parasitic infections is high in wild animals. These animals are not treated and they have much more possibilities to acquire the infection with parasites than domestic pets. The half of investigated dogs have been found to be infected with parasites, what is rather high prevalence, but dogs living in villages like Białowieża are usually not treated with antihelmintics. They can also spend a lot of time in forests surrounding Białowieża and to pick up invasive eggs, larvae or intermediate hosts of parasites. Red fox appeared to be the most infected (prevalence over 70% and seven species of parasites found), what is typical for this animal [11-14]. Red fox is a species which can adopt to various environmental conditions so it has more possibilities to infect with different species of parasites.

In contrast, eggs of only one genus of nematode with two possible species (*Capillaria putori* or *C. mustelae*) have been found in faeces of stone marten. Closely related pine martens were infected with at least six parasitic species. The reasons of this difference are probably feeding habits of two marten species. Stone marten is more herbivorous [20], so it has less possibilities to eat a potential intermediate host for trematodes and tapeworms.

Coccidia are usually specific to one host species, but some of them can infect more host species and

we observed it for *Isospora rivolta* (four species of *Canidae* and *Felidae*).

Trematodes from genus *Opisthorchis* and *Metorchis* need two intermediate hosts, the second of which is the fish. So it is not strange that we found eggs of those parasites in faeces of otter. Also badgers were infected with this trematode. The prevalence was surprisingly high, as fish constitute only about 0.7% of badger's food [21]. The only identified species of trematode — *Alaria alata* infects the final host with the intermediate of frog or other amphibian, which are component of food of all species of carnivorous mammals living in Białowieża Forest [20, 21].

Invasions of tapeworm *Diphyllobothrium latum* are not typical for wolves, but we have found eggs of this species in 31.6% of wolf's faecal samples. *D. latum* needs a fish as a second intermediate host and there is a possibility that wolves from Białowieża Forest fed on fish in 2002. In that year river Narewka was poisoned with insecticides in Bielorussian part of the forest, and thousands of dead fish were laying on the riverbank also in Polish part of the forest.

Eggs of hookworm from genus *Uncinaria* have been found in faeces of three species of *Mustelidae* (badger, pine marten and polecat), and two species of *Canidae* (domestic dog and red fox). Canids are usually invaded with *U. stenocephala* and mustelids with *U. criniformis*, but there have been reports on *U. stenocephala* isolated from the intestines of badger [22-24], so in this case the eggs from badger's faeces could only be identified as belonging to genus *Uncinaria*.

Similar problem we had with *Capillaria putori* and *C. mustelae*. Both species live in the intestines of mustelids and it is the reason why we cannot be sure which one's eggs we found in faeces. One specimen of *C. putori* was found in the intestine of weasel, so in this case there was no problem with identification of the species.

Thirteen species of parasites found and identified in our studies have not been so far reported from Białowieża Primeval Forest. These are three protozoan species: *Isospora melis*, *I. putori* and *I. rivolta*, one tapeworm: *Diphyllobothrium latum*, and nine species of nematodes: *Toxocara canis*, *T. cati*, *Toxascaris leonina*, *Trichuris vulpis*, *T. nitzschi*, *Uncinaria stenocephala*, *U. criniformis*, *Capillaria aerophila* and *C. putori*. *Mesocestoides* sp., *Aelurostrongylus abstrusus* and *Thominx* sp. previously reported from this area [19] have not been found in our

studies.

The results of our work shows that investigation (particularly dissections of hosts) of parasites of carnivorous mammals from Białowieża Primeval Forest should be continued and perhaps much more species of parasites from different groups could be found.

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