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Endoparasites of the European beaver (*Castor fiber* L. 1758) in north-eastern Poland

Aleksander W. Demiaszkiewicz[1], Jacek Lachowicz[1], Izabela Kuligowska[1], Anna M. Pyziel[1], Grzegorz Bełżecki[2], Renata Miltko[2], Barbara Kowalik[2], Wojciech Gogola[2], Zygmunt Giżejewski[3]

[1]Institute of Parasitology of the Polish Academy of Sciences, 00-818 Warsaw, Poland
[2]Institute of Animal Physiology and Nutrition of the Polish Academy of Sciences, 05-110 Jablonna, Poland
[3]Institute of Animal Reproduction and Food Research of the Polish Academy of Sciences, 10-747 Olsztyn, Poland
aldem@twarda.pan.pl

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Abstract

Parasitological examination after necropsies of 48 European beavers from Podlaskie and Warmisko-Mazurskie provinces were performed between April 2011 and November 2012. All helminthes were isolated from the contents of the gastro-intestinal tract and their species were determined. In addition, blood samples and faeces were examined. All beavers were infected with six species of parasites. *Stichorchis subtriqetrus* trematodes were found in 93.7% of animals. They were localized mainly in the caecum, less in the colon, and single juvenile parasites were found in the small intestine. The intensity of infection ranged from two to 893 parasites. *Travassosius rufus* nematodes (10-4336 specimens) were present in the stomach of 68.7% of the beavers. In the small intestine of four (8.3%) beavers, two-six specimens of *Psilotrema castoris* were found. This is the first record of this species in Poland and the third of its discovery in the world. Furthermore, in the small intestine of one beaver, two *Trichostrongylus capricola* nematodes were detected. In the liver of one beaver, pathological changes caused by hydatid cestode *Echinococus granulosus* occurred. Inflammatory changes of the gastric mucosa caused by *Travassosius rufus* and of caecum caused by *Stichorchis subtriquertus*, were observed. Coproscopy was performed with the use of Baermann, flotation, and decantation methods. All results of Baermann method were negative. Examinations with flotation and decantation methods confirmed necropsy findings. Using the flotation method, single oocysts of *Eimeria sprehni* in one beaver were detected. A blood test conducted by Kingston and Morton method did not reveal the presence of protozoa or microfilariae.

Key words: European beaver, endoparasites, Poland.

Introduction

European beaver (*Castor fiber* L., 1758) is the largest rodent in Eurasia. In the middle ages beavers occupied the entire territory of Poland. In the XIX century, European beaver was almost completely eradicated in our country. After the II World War, small populations of beavers remained. Artificial reintroduction and natural migration from Lithuania and Belarus led to the increase in their population; however, it was still low and did not exceed several hundred. Inclusion of beaver to the list of endangered species, as well as the "Active Protection of Beavers Programme" initiated by the Research Station of the Polish Academy of Sciences in Popielno and Polish Hunting Association, resulted in significant enlargement of population, and currently beaver has become a common animal. The Beaver Research Farm in Popielno played a significant role in beaver restoration in Poland. A total of 300 animals born at the farm were introduced into a new territory of the country. Restoration of the beaver population was so significant that endangered species status of these animals was changed from an absolute to a partial one. Currently, the estimated beaver population in Poland is about 50,000 individuals. The places of localisation of this species are mainly in north-eastern part of the country. Large concentration of beavers in that area forces the animals to migrate and leads to their self-dispersal. An increase in the number of beavers and the damage to plough caused by them are the reasons why they are being captured and relocated to other regions

of the country, such as the areas of Warta and Notec rivers, Bieszczady and Beskid Niski Mountains, and Bory Dolnoslaskie districts (10, 11). Sparse data on the state of beavers' infection with the parasites was the reason to undertake the present studies. Their main goal was to determine the species composition as well as the prevalence and intensity of beavers' infection with parasites in north-eastern Poland.

Material and Methods

Between April 2011 and November 2012, parasitological examination after necropsies of 48 European beavers from Podlaskie and Warmisko-Mazurskie provinces were performed. The majority of the beavers originated from the Suwalki district. Among the animals necropsied, 13 were young up to two years old (I age group) and 35 were adults (II age group). They were subjected to entire parasitological examination. The gastrointestinal tract was divided into following parts: oesophagus, stomach, small intestine, caecum, and large intestine. Their contents and mucosal scrapes were decanted several times, and finally fixed in 2% formalin. Then they were placed in small portions into Petri dishes and examined using a stereomicroscope. All parasites observed were collected and preserved. Trematodes were preserved in 75% ethyl alcohol. Some specimens were later stained in aluminium carmine and mounted in Canada balsam on microscope slides. Nematodes were preserved in a mixture of 75% ethyl alcohol and 5% glycerol. After evaporating of the alcohol, temporary slides of nematodes in glycerol were made. The specimens were then observed under a microscope and species were identified on the basis of morphometric characteristics. Additionally, samples of faeces collected from the rectum were examined. These examinations were performed with the following methods: Willis' flotation method to detect eggs of nematodes and oocysts of coccidia, Baermann method to detect larvae of lungworms, and decantation method to detect eggs of flukes (14). For the subsequent methods, 3 g of faecal sample were used. A blood test (13) was also performed to detect infection with trypanosomes and microfilariae.

Beaver *Castor fiber* is the species under particular protection in Poland, which resulted in difficulties in obtaining the materials for parasitological studies from these animals. The authorisation of the Regional Direction of Environment Protection for captured beaver gave us the possibility of parasitological examination of this species.

Results

All examined beavers were infected with six species of endoparasites. Autopsy of the animals revealed the infection with *Stichorchis subtriquetrus* (Fig. 1) and *Travassosius rufus* (Figs 2-4).



Fig. 1. Trematodes *S. subtriquertus* from the caecum of beaver



Fig. 2. Anterior end of nematode *T. rufus* (50×)



Fig. 3. Posterior end of male of *T. rufus* (50×)



Fig. 4. Posterior end of female *T. rufus* (50×)

S. subtriqetrus was found in 93.7% of beavers. The parasites were localised mainly in the caecum, less often in the colon, and single juvenile nematodes were found in the small intestine. The intensity of infection ranged from 2 to 893 specimens. In 68.7% of beavers, the nematodes *T. rufus*, in the number of 10 to 4336 specimens, were present in the stomach. In the small intestine of four young beavers (8.3%), a few (2-6) specimens of *Psilotrema castoris* were found. Furthermore, two nematodes belonging to the species *Trichostrongylus capricola* were detected in the small intestine of one adult beaver. Pathological changes caused by three larval forms of *Echinococus granulosus* occurred in the liver of one adult beaver. Observed cysts were of different size, with thick walls, and were infertile as no rostellar hooks were seen in the cyst cavities. Moreover, none of the cysts contained live or dead protoscoleces. Inflammatory changes of the gastric mucosa caused by nematodes *T. rufus* and in the caecum caused by trematodes *S. subtriquertus* were also observed.

All results of coproscopy, using Baermann method, were negative. Examination with flotation and decantation methods agreed with necropsy findings. Single oocysts of *Eimeria sprehni* (Fig. 5; Table 4) were detected in the faeces of one young beaver using the flotation method. A blood test did not reveal the presence of protozoa or microfilariae.



Fig. 5. Sporulating oocyst of *E. sprehni*

Detailed data concerning the beavers' infection with parasites is presented in the Tables 1-3.

The prevalence of infection with *S. subtriquetus* and *T. rufus*, which is lower in young beavers, increased with age of animals. In the case of trematodes this increase was small, and in the case of nematodes the intensity increased almost four times.

Table 1. Infection of beavers with parasites in north-eastern Poland (n = 48); autopsy examination

Species of parasites	Number of infected	Prevalence (%)	Intensity range	Intensity mean
Stichorchis subtriquetrus	45	93.7	2-893	119
Travassosius rufus	33	68.7	10-4336	818
Psilotrema castoris	4	8.3	2-6	3.5
Echinococcus granulosus	1	2	3	3
Trichostrongylus capricola	1	2	2	2

Table 2. Infection of two age groups of beavers with the most important parasites; autopsy examination

Age group	*Stichorchis subtriquetrus*				*Travassosius rufus*			
	Number of infected	Prevalence (%)	Intensity Range	Mean	Number of infected	Prevalence (%)	Intensity Range	Mean
I (n = 13)	11	84.6	5-479	201	3	23.0	12-1055	362
II (n = 35)	34	97.1	2-893	93	30	85.7	10-4336	865

Table 3. Infection of beavers with the most important parasites in different seasons; autopsy examination

Season	*Stichorchis subtriquetrus*				*Travassosius rufus*			
	Number of infected	Prevalence (%)	Intensity		Number of infected	Prevalence (%)	Intensity	
			Range	Mean			Range	Mean
Spring (April) (n = 16)	15	93.7	2-893	73	14	87.5	15-4305	893
Summer (July) (n = 16)	14	87.5	5-130	51	12	75.0	10-2811	895
Autumn (November) (n = 16)	16	100	6-484	222	7	43.7	12-1984	533

Table 4. Infection of beavers with parasites in north-eastern Poland (n = 48); coproscopic examination

Species of parasites	Number of infected	Prevalence (%)	Number of eggs/oocysts	
			Range	Mean
Stichorchis subtriquetrus	40	83.3	1-154	26
Travassosius rufus	29	60.4	1-32	4
Eimeria sprehni	1	2	2	2

The mean intensity of infection with *S. subtriquetus* was twice as high in young animals, and in adult ones it decreased. The state of beaver infection with the most important species of parasites also showed seasonality. In the spring season, the prevalence of infection and the mean intensity of infection with *S. subtriquetus* was lower and increased in autumn, because beavers were infected successively during the entire growing season. However, in the case of infection with *T. rufus* in spring season, the prevalence and intensity of infection were the highest. It is so called "spring rise" and is characteristic for nematodes from the family *Trichostrongylidae*. This occur when larvae of IV and V stages are inhibited in the development and reside in the mucosa during the winter (1). Then in the autumn, the prevalence and intensity of infection with *T. rufus* was shown to be the lowest (Table 3).

Discussion

The first studies on beaver parasites in Poland were conducted at a beaver research farm in Popielno. At that time, one to 11 specimens of *S. subtriquetrus* were found in three beavers, single specimens of *Ascaris castoris* in two animals, and seven *T. capricola* in one beaver. Additionally, one cestode was found, unfortunately, its species was not determined (12). Subsequent studies conducted between 1998 and 2000 on a large material concerning 43 beavers captured in Suwałki region, Mazury, and the vicinity of Białystok showed a presence of five species of parasites: *S. subtriquetrus, E. granulosus* cestode larvae, *T. axei*, *T. rufus*, and *E. sprehni* coccidia oocysts (3, 7-9). Species adherence of *E. granulosus* larvae was then confirmed by molecular study (17). The prevalence of infection with *S. subtriqetrus* presented in the aforementioned studies was exactly the same as in the studies conducted earlier (9), the mean and the maximal intensity also was similar. However, the prevalence of infection and the maximal intensity of infection with *T. rufus* were slightly higher in our study, and the mean intensity was about two times higher. The mean intensity of infection with *T. rufus* in adult beavers demonstrates a more than twofold increase. It is influenced by a significant activity of these animals and the penetration of the larger area on land where they have contact with invasive larvae of the nematodes (Table 2). Inflammatory changes of the gastric mucosa caused by *T. rufus*, and in the caecum caused by *S. subtriquertus* confirm the results of our previous studies indicating that these species are the most dangerous parasites of beavers in Poland. Higher levels of infection with *T. rufus* observed several years after the previous studies can be caused by an increase in beaver population and its density. A decrease in prevalence and intensity of infection in adult animals may be caused by the formation of immune mechanisms. The autumn decrease in *T. rufus* infection is caused by the expulsion of the adult nematodes and by inhibiting the development of the nematode larvae, which infect the animals during the vegetation season.

The detection of *T. capricola* in the intestines of one beaver, and the earlier recognition of this nematode (12) as well as *T. axei* (9) in beavers, parasites, which were formerly recognised as typical for free living (4-6) and domestic ruminants, means that the direct exchange of these helminthes between wild and domestic ruminants and beavers is possible.

The confirmation of *P. castoris* in our study is the first registration of this species in Poland and the third in the world (15). In beavers' blood no parasites were found, similarly as it was described in the studies of 27 beavers in Norway, where the result was also negative (2). All helminthes observed in our studies were also found on the territory of the former Soviet Union, mainly in Woronezh Reserve (16).

As a result of current and previous (9, 12) studies, in total nine species of parasites were detected in beavers on the territory of Poland. These are two species of trematodes: *S. subtriquetrus* and *P. castoris*, two species of cestodes: *E. granulosus* larvae and not matured cestode which was not classified, four species of nematodes: *A. castoris*, *T. rufus*, *T. capricola*, and *T. axei*, and *E. sprehni* oocysts. The introduction of beavers into the new territories requires new studies in order to determine their parasitofauna and the influence of parasites on the condition and the state of health of these animals.

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