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Investigations of the nematode *Anguillicola crassus* (Nematoda, Dracunculoidea) in Lake Dringis, Lithuania

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Investigations of the occurrence and intensity of the nematode *Anguillicola crassus* (Nematoda, Dracunculoidea) infection in eels was carried out in Lake Dringis (Aukštaitija National Park) in summers of 2004 and 2005. Examination of the swim bladder of 28 different-aged eel individuals showed that 60.7% were infected with this parasite. The maximum infection intensity reached 14 parasites, their development stage varying from L4 larva to adult individuals. This parasite was recorded for the first time in Lithuanian inland waters. Based on the information on infection intensity and the distribution of the parasite among different eel age groups, it is possible to speculate that this parasite found its way to Lithuania in the same mode as to other European countries, i. e. it perhaps appeared in Lithuania in the 1980s when eel juveniles were intensively imported from other countries for the purposes of aquaculture and stocking.

Key words: eel, *Anguillicola crassus*, parasitic nematode, rate of infection, lakes of Lithuania

INTRODUCTION

The parasitic nematode *Anguillicola crassus* (Kuwahara, Niimi et Itagaki, 1974) found its way to Europe at the beginning of the 1980s. It was imported into Germany from Taiwan and New Zealand (Koops and Hartmann, 1989) together with infected eels for farming. It got into natural waters from a fish-breeding farm in 1982 (Koops and Hartmann, 1989), and since then it has been spreading fast not only on fish-rearing farms, but has also been posing threat to eel populations in natural waters. Later it was recorded in France, Spain, Belgium, Holland and other countries (Taraschewski et al., 1987). In Poland, it was first detected in 1988–1990 in eels imported for breeding from Portugal, Sweden and Germany. Later it was also found in eels released into lakes (Wlasow, 1991; Rolbiecki et al., 2000). Eel juveniles migrating from the sea to Polish rivers were also found to be infected with this parasite (Pilecka-Rapacz, 2001). The fast spreading of the parasite is preconditioned by its simple life cycle and the fact that in European waters it has paratenic hosts such as the ruff, roach, perch, bream (Rolbiecki, 2002) and also molluscs (Moravec, 1996). In European eels, the development of the parasite lasts 4 months (Haenen et. al., 1989; De Charleroy et al., 1990), under optimal conditions (20–21 °C) less than 2 months (Charleroy et al., 1990), whereas in Japanese eels its life cycle lasts approximately a year (Egusa, 1979). Eggs with L_2 larvae or L_2 larvae without egg membranes get out from the swim bladder via the pneumatic canal to the intestine from which they are expelled via defaecation. Larvae, which hatch out in water after some hours, attach to the substrate with the posterior part of their body and flutter in water, attracting intermediate hosts, lower-order crustaceans belonging to the Eucyclops, Copepoda, Ostracoda and Amphipoda (Haenen et al., 1989). In fresh waters infection may last up to 2 months (Kennedy and Fitch, 1990). Three weeks after ingestion by crustaceans, L_2 larvae develop into L_3 larvae which are infective to the definitive hosts (eels). From the eel intestine, larvae migrate to the body cavity from which they get into the swim bladder and attach to its walls. After 2–3 weeks of development, larvae reach the L_4 stage at which they switch to feeding on blood. Finally, they develop into L_5 larvae, maturate and proliferate producing an ordinary generation of larvae. Adult nematodes are comparatively large in size: the body length of females reaches up to 45 mm, that of males being slightly smaller. Their epidermis is tender, wrinkled and, as they feed on blood, dark brown in colour. That is a pathogenic nematode of the European eel's swim bladder. At a high infection intensity, the bladder deforms, increases in size, its walls becoming thinner. It bleeds and is filled with clear

liquid of blood and mucus (Køie, 1988). Age-growth comparisons of infected eels have shown that infected fish do not reach standard sizes specific to their age group (Orecka et al., 1995). Parasites impede growth, which exerts adverse effects on the host. Parasites harm the swim bladder, therefore infected silver eels are not capable of migrating to the sea to spawn (Køie, 1988). Naturally, this has a negative effect on the population abundance of this fish.

Because of the simple life cycle and the high rate of reproduction it is difficult to exterminate this parasite from the environment. It does not inflict so severe adverse effects on Japanese eels because of the long-term parasite–host co-evolution. Even at a high infection intensity, this disease displays moderate symptoms in the Japanese eels.

The aim of this study was to investigate the occurrence and intensity of infection of eels with the nematode *Anguillicola crassus* in Lake Dringis.

MATERIALS AND METHODS

Lake Dringis is one of the largest lakes in Aukštaitija National Park: it covers an area of 717.8 ha, it is 4.3 km long, its greatest width is 3 km, the maximum depth being 24.0 m and the average depth measuring 8.4 m. The lake has a complicated configuration (Fig. 1). It has many different-sized bays, peninsulas, capes. The meandering shoreline measures 31.5 km in length. The basin of the lake is diverse, formed by several different glaciers. There are five islands and several shoals in the lake. The eastern part of the lake is the deepest. The lake is surrounded by sandy 20–25 m long shallows with abundant aquatic vegetation. The shores are overgrown all-over. In places the overgrowth is patchy, with reed and bulrush stands predominating. Dringis is an on-line lake: the Rivers Švogina and Juodupis flow into it from the north, a nameless brook and the stream Palaukinis from the east, the River Dumblė outflowing from it into Lake Dringykštis in the south. The lake is surrounded by a forest and its shores are swampy in places.

Investigations of ichthyofauna in the lake are carried out annually at two stations using selective and vendace bottom multimesh gill nets, while eels are fished in the littoral zone of the lake with a long line (equipped with 100 hooks). The species composition and abundance of fish were investigated using selective nets of different mesh size, whose one section measured 5 m in length, 3 m in height and mesh size range was 17–22–25–30–40–50–60 mm (Thoresson, 1993).

A comprehensive ichthyological analysis of the caught fish was carried out using universally applied methods (Pravdin, 1966; Thoresson, 1993). L. Ložys (2004) identified the age structure of eels in Lake Dringis. Immediately upon catching, fish were measured (to 0.1 cm) and weighed (to 0.1 g). The swim bladder and the intestine were opened, parasites were macroscopically searched for and counted. Nematodes were removed from the swim bladder and intestine, rinsed in a 0.9% physiological salt solution and fixed in 70% ethanol mixed with 5% glycerin. Their development stage was established using a microscope.

RESULTS AND DISCUSSION

According to the generalized data of previous investigations, 22 fish species had been recorded in Lake Drin-

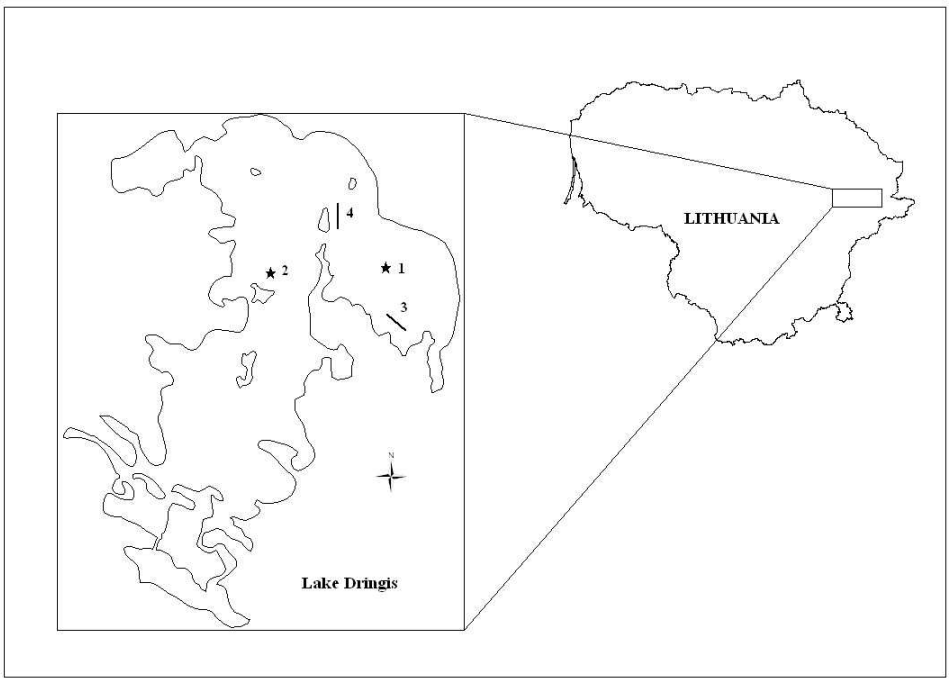

Fig. 1. Fish study stations at Lake Dringis.
1, 2 – fish monitoring stations, 3, 4 – eel fishing sites

gis: smelt, vendace, peled whitefish, pike, bream, roach, tench, rudd, silver bream, asp, ide, bleak, crucian carp, gudgeon, carp, burbot, perch, pikeperch, ruff, three-spined stickleback and eel (Balkuvienė, Kesminas, Virbickas, 2003). However, fish species diversity is usually less, ranging from 8 to 11 species. According to fishery development gradation, Lake Dringis belongs to grade II lakes which are characterized by "vendace" fishery. The core of fish community in this type of lakes is dominated by vendace, bleak and roach. The roach makes up 41.9%, vendace 19.6%, perch 11.9%, bream 13.3%, eel 0.9% of the total amount of all fish caught in the lake (Balkuvienė, Kesminas, Virbickas, 2003). Vendace, pike and eel individuals were released into the lake, attempts were made to introduce pikeperch, peled whitefish, crucian carp and carp. However, because of unfavourable ecological conditions the latter species did not acclimatize to the lake. Conditions in the lake are favourable for eels. Their population abundance in the lake varies depending on fishery intensity, fish stocking efficiency and peculiarities of natural migration of eels. In 2003, there were 140.1 thousand eel juveniles with the body weight of 50–100 g introduced into Lake Dringis. According to the 2005 investigation data, eel abundance in the lake after the introduction increased by 3% and their biomass even by 15%. In 2004, investigations of eel age-size structure were carried out. The examination of 43 eel individuals showed that their age varied from 3 to 12 years, their weight ranging from 84 to 882 g (Ložys, 2004). The investigation results demonstrated that the eel population in the lake comprised not only the juveniles introduced into the lake in 2003 (whose present age is within the range of 3 to 6 years), but also individuals of older age groups that had immigrated to Lake Dringis from other lakes. It should be noted that eels had not been introduced into Lake Dringis earlier, but they were constantly released into other lakes of Aukštaitija National Park, the last eel introduction dating back to 1996. It is important to note that eels of different age groups are distinguished for vast differences in growth rate. Therefore, the length L (cm) and weight Q (g) values of some individuals vary within a very wide range. For instance, the body length L of 11-year-old eels may reach 85 cm and weight 882 g, but they also may be considerably smaller, reaching the body length L of 55.8 cm and the weight of 311 g. It is known that the growth rates of eel males and females differ significantly. But in this case we deal only with the growth rate of females which is usually considerably faster than that of males. One of the reasons causing growth disorders in eels may be infection of this fish with parasites, the nematode *Anguillicola crassus* in particular (Fig. 2).

Parasitological investigations of the swim bladder of 28 eel individuals performed in Lake Dringis in summers of 2004 and 2005 demonstrated that 17 eel individuals were infected with this parasite, the infection intensity in some of them being very high (Table). The maximum intensity of infection reached 14 nematodes per fish. We recorded the larval stage L_4 and adult nematodes.

Anguillicola crassus was found in eel caught in the Lithuanian coastal zone in 1998 (Bacevicius, 2004). The overal prevalence of infection was 60.7% (Table). This is within the range of the overal prevalence of infection recorded in other countries, e. g., 76.7–83.6% in the River Rhine, Germany (Sures et al.,1999), the River Elba, Germany 52–75.6% (Möller et al., 1991), the Pomeranian rivers, Poland 41.7–65.6% (Pilecka-Rapacz, Sobecka, 2004), but it was significantly lower than in some rivers in Germany (97.5%, Tarachewski et al.,1987), the Gulf Puck (74.4%) and the Vistula Lagoon (76.2%, Bystydzieńska et al., 2003).

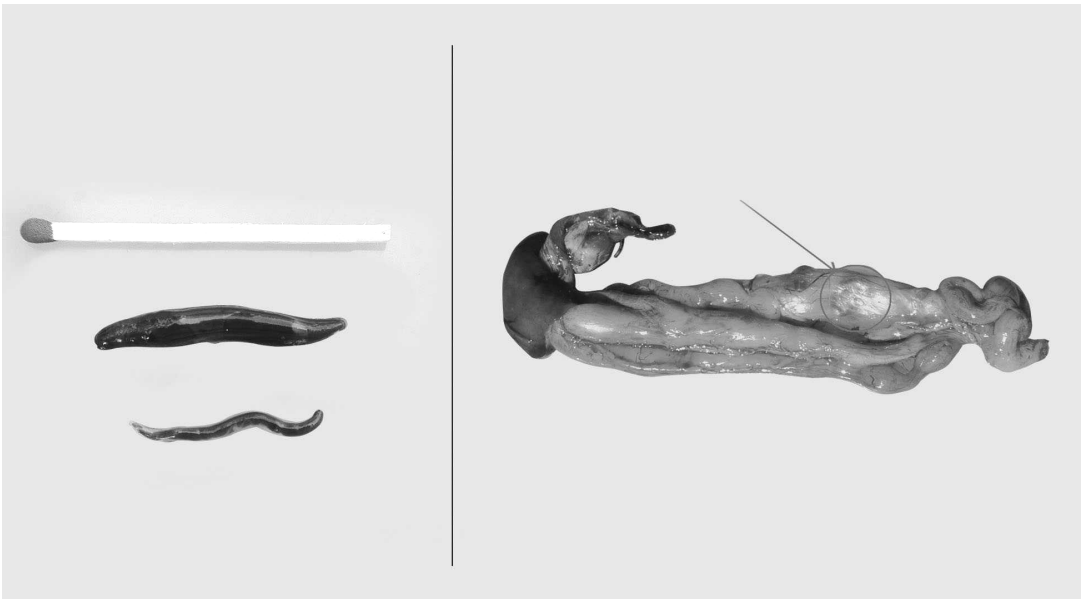

Fig. 2. The nematode *Angullicola crassus*:
A – an adult nematode; B – the parasite (arrow) in the eel swim bladder

Table. **Intensity of eel infection with the nematode *Anguillicola crassus* in Lake Dringis**

Ell no.	Date of eel catching	Length of eel (cm)	Weight of eel (g)	Number of parasites	Adult nematode	Larval stage L5	Larval stage L4
1	28.07.2004	45.5	186	2			2
2	÷	45	180	10	2	7	1
3	÷	56	366	3			3
4	÷	50	225	3			3
5	÷	54	311	2			2
6	÷	44.7	128	n.e.			
7	÷	42.6	112	n.e.			
8	÷	45	141	14	2	3	9
9		44	152	1			1
10	13.09.2004	57.8	335	n.e.			
11	÷	54.5	276	2		1	1
12	÷	53.2	257	4		1	3
13	÷	56.2	296	4	1	2	1
14	÷	56.5	310	3		2	1
15	÷	52,3	268	3	2	1	
16	÷	47.2	198	5		1	4
17	02.07.2005	56.5	342	n.e.			
18	÷	47.5	120	1			1
19	÷	53.0	308	4	1	2	3
20	÷	620	390	n.e.			
21	÷	39.5	100	n.e.			
22	÷	45.0	150	n.e.			
23	÷	60.0	376	5	1	1	3
24	÷	45.3	144	n.e.			
25	÷	55.0	262	n.e.			
26	÷	54.0	308	n.e.			
27	÷	59.0	339	n.e.			
28	÷	54.0	232	1			1
	Total			67	9	21	39

Note. AD – adult individuals, L4 and L5 – mature larvae, n.e. – not established.

It should be noted that this is the first record of the nematode *Angullicola crassus* in Lithuanian waters. Based on information on the intensity of eel infection and the distribution of the parasite in various eel age groups, it is possible to speculate that this parasite found its way to Lithuania in the 1980s, when eels from other countries were imported for aquacultural and stocking purposes. It seems probable that the migration routes of this parasite to Lithuania and to other European countries are similar.

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NEMATODO *ANGUILLICOLA CRASSUS* (NEMATODA, DRACUNCULOIDEA) TYRIMAI DRINGIO EŽERE, LIETUVA

S a n t r a u k a

Tyrimai buvo atliekami 2004–2005 m. vasarą Dringio ežere, Aukštaitijos nacionaliniame parke. Tyrinėtas ungurių plaukiojimo pūslės užsikrėtimo nematodu *Anguillicola crassus* (Nematoda, Dracunculoidea) intensyvumas. Ištyrus įvairaus amžiaus 28 ungurių plaukiojimo pūsles nustatyta, kad 60,7% yra apsikrėtę parazitu. Užsikrėtimo intensyvumas siekia 1–14 individų, o vystymosi stadija nuo lervutės L4 iki suaugusio individo. Lietuvos vidaus vandenyse šis parazitas nustatytas pirmą kartą. Sprendžiant pagal ungurių užsikrėtimo intensyvumą ir parazito paplitimą įvairiose ungurių amžiaus grupėse, galima daryti prielaidą, kad jis į Lietuvą, panašiai kaip ir kitose Europos šalyse, atkeliavo XX a. 9 dešimtmetyje, intensyviai įvežant ungurių jauniklius ir išleidžiant juos į ežerus.

Raktažodžiai: ungurys, *Anguillicola crassus*, parazitinis nematodas, užsikrėtimo intensyvumas, Lietuvos ežerai