

The state of health of the river lamprey *Lampetra fluviatilis* (L.) from Lake Dąbie compared to the pathogens hitherto found in this host

Ewa Sobecka[1], Jerzy Moskal[1], Beata Więcaszek[2]

[1]Division of Fish Diseases, West Pomeranian University of Technology, K. Królewicza 4, 71-550 Szczecin, Poland
[2]Division of Fish Systematics, West Pomeranian University of Technology, K. Królewicza 4, 71-550 Szczecin, Poland

Corresponding author: Ewa Sobecka; E-mail: ewa.sobecka@zut.edu.pl

ABSTRACT. The objective of the study was to check the health status of the anadromic river lamprey *Lampetra fluviatilis* (L.), the most frequently recorded lamprey species in Poland caught in Lake Dąbie, connected with the Odra river estuary. The species composition of parasitofauna of the river lamprey from the Polish waters was compared to the pathogens of this host noted so far. The skin and fins, eyes, oral cavity and nasal mucus of 36 lamprey specimens were examined. After decapitation the brains and gills were analysed. A single gonad, liver and the kidney wet microscopic preparations were made and examined. Examination was also made of the contents of the straight alimentary tract, the body cavity and muscles from the dorsal area. The pathogens known of the river lamprey are mostly the parasites of a very low extensity. No monogeneans were found among the parasites recorded. The reasons of such species composition of the parasitic fauna are discussed against the background of the anatomy, physiology and biology of the host. In the alimentary tract of one lamprey single larva of the nematode *Anisakis simplex* (Rudolphi, 1809) was found, not noted yet in this host in Poland and Europe. The parasite was noted in any of the lamprey species occurring in neither fresh nor saline waters in Europe. Such a low prevalence and intensity of the infection pointed that this nematode as many other species of parasites was swallowed accidentally.

Key words: *Lampetra fluviatilis*, pathogens, *Anisakis simplex*, Poland

Introduction

The European river lamprey *Lampetra fluviatilis* (L. 1758) is an anadromous amphihaline species. The adult migrate to the sea and return to rivers to spawn. *L. fluviatilis* is noted in the Baltic Sea and North Sea basins as well as in the rivers all over the country. Along the Southern Baltic, important river systems for this species were the Neman, Vistula and Oder [1–4].

The objective of the study was to check the health status of the anadromous river lamprey *L. fluviatilis*, most abundantly represented in Poland, against the background of the pathogens recorded in this host.

Material and methods

The river lampreys for the study were collected from the fishing nets set in the Lake Dąbie (connected with the Odra River estuary) for industrial fish catchment. The specimens collected were either studied directly after collection or frozen and analyzed later. The lampreys studied were caught during the autumn spawning migration in October and November 2001 (29 individuals) and in the same months in 2005 (11 individuals). Their length varied from 35 to 50 cm (mean value of 42 cm), while their weight varied from 90 to 240 g (mean value of 164 g). The individuals were beginning their spawning season as indicated by the empty (and not fused) alimentary tracts.

The analysis of parasites was performed using the anatomic descriptions by Jasiński [5] and our

own experience in parasitic study of fish. At first a careful examination of the skin and fins, eyes, oral cavity and nasal mucus was performed. After decapitation the brains and gills were analyzed. The gills in the form of 7 pairs of branchial bags were prepared and observed under a binocular in glycerol. The majority of the lamprey body was filled with a single gonad of which wet microscopic preparations were made and examined, similar preparations were also made of the liver and the kidney. Examination was also made of the contents of the straight alimentary tract, the body cavity and muscles from the dorsal area.

Results and discussion

Only a few studies on the health status of *L. fluviatilis* have been published. Most examinations were performed on the adult lampreys caught in the sea and during their spawning season migrations. According to Jääskeläinen [6], the typical freshwater parasites can exist together with marine ones, which managed to adapt the freshwater conditions. Larval stages of the most parasites (cestodes, nematodes, acanthocephalans) inhabit the lamprey together with the food. The bacteria *Bartonella pavlowskii* Epstejn, 1935, found in the erythrocytes and digenean metacercariae *Diplostomum petromyzifluviatilis* Diesing, 1850 found in the central nervous system are specific pathogens for the river lamprey [7,8]. The occurrence of both pathogens is not dependent on a food composition of the host.

The most numerously and most often recorded are digeneans and cestodes [9]. The metacercariae of digenean *Diplostomum petromyzifluviatilis* Diesing, 1850 were found in the mesencephalic duct of lampreys [10–13]. In the cerebral structures of lampreys from Kŭrsiu-Marios Lagoon (Baltic Sea), metacercariae of digenean determined as *D. petromyzifluviatilis* were noted [14]. However, the author suggests that it could be *Diplostomum phoxini* Faust, 1918. Metacercariae of *D. phoxini* occur in the brain of *Phoxinus phoxinus* (Cyprinidae, Teleostei) and their occurrence in the river lamprey has not been confirmed till now.

Metacercariae of *Diplostomum* sp. were recorded in the lens of eye and determined by Dogiel and Petruševskij [15] and Šulman [8] as *D. spathaceum* Rudolphi, 1819. The authors cited as the second localization indicated the brain. However, hitherto made studies confirmed such a localization in the lamprey body only for *D. petromyzifluviatilis*. The mature digeneans *Hemiurus appendiculatus* Rudolphi, 1802 are restricted to clupeids of the genus *Alosa* [16]. Dawes [17] mentioned the river lamprey among the hosts as well, however neither precise location nor geographical distribution was given in his paper. Up to present this is the only notice on the occurrence of this digenean in the river lamprey, thus this record is most likely based on a misidentification.

Sphaerostomum bramae is the next mature digenean species, which was noted in the digestive tract of one lamprey from the Neva river [8]. This is a parasite of the gut of many cyprinids [18].

In the intestine lumen of lampreys from the West Dvina, Lake Ladoga and Kŭrsiu-Marios Lagoon the cestode *Eubothrium crassum* (Bloch, 1779) Nybelin, 1922 was found [6,8,14]. *Eubothrium* sp. was recorded in the lampreys from Daugava river [12]. The first intermediate host of this parasite is a copepod *Cyclops* or *Eucyclops,* the second one – *Perca fluviatilis*, while the salmonids serve as definitive hosts. Migrations of the river lamprey in the Baltic Sea are not extensively distant off the coastline. Usually the migrations are finished in the brackish lagoons, inhabited by both freshwater and marine fish species [19]. Therefore the lampreys food may include both the intermediate and definitive hosts of cestodes.

The similar cycle shows the cestode *Bothriocephalus* sp., found in the larval stage on mesentery in the lamprey from the Lake Ladoga [6]. This is the only stated case of this cestode occurrence in the river lamprey.

In the body cavity, gut and kidney of lampreys from the Lake Ladoga and Kŭrsiu-Marios Lagoon, the plerocercoids of *Diphyllobothrium* sp. were observed. Plerocercoids can be transferred through predation of one fish on another [13].

Plerocercoids *Triaenophorus nodulosus* Forel, 1868 are recorded in many fish species as well as in Petromyzontidae, who are the second intermediate hosts [20]. In the body cavity of *L. fluviatilis* from the Lake Ladoga it was noted only once [6]. However, the cestode *Proteocephalus* sp. was found in the lamprey several times. For the first time a juvenile individual of *P. percae* Müller, 1780 was noted in the lamprey from Lake Ladoga [6]. In the study of lampreys caught in the river Neva mouth, in the intestine the heads of *Proteocephalus* sp. were found [16]. In the intestine of lampreys from the west Dvina, from 1 to 9 individuals of

Proteocephalus sp. were recorded [8]. They were found also in the lampreys from the Daugava river [12]. In the intestine of lampreys from the Lake Onega *P. longicollis* Zeder, 1800 was noted (prevalence over 50%) [13].

Five nematode species were recorded in the river lampreys up to present. A single larva of *Raphidascaris acus* (Bloch, 1779) Ralliet et Henry, 1915 and *Hysterothylacium aduncum* Rudolphi, 1802 were observed in the intestinal lumen [13,21].

Larva of *Cystidicola farionis* Fischer, 1798 is reported in the gut of *L. fluviatilis* [21]. The common definitive hosts of *C. farionis* are fishes of the families Salmonidae and Osmeridae. *Lampetra fluviatilis* apparently are only facultative hosts, acquiring accidental infections by ingesting small salmonids or amphipod intermediate hosts [21].

Truttaedacnitis truttae (Fabricius, 1794) is the only nematode, who is noted in the river lamprey in larval and adult stages. Encysted larvae are most often visible in the intestinal walls, whereas mature larvae in the intestinal lumen. Gecevičiute [14] reports the nematodes occurrence only in the gut lumen while the empty cysts are present in the intestinal walls of the migrating lamprey from the sea in the autumn. The lampreys migrating back from the sea to the river to spawn stop to feed, thus they have no opportunity to infect with new parasites. Only parasites that tolerate the changes of environment can survive and remain in the lamprey body.

In the southern Sweden larval lampreys were infected by preinfective *Gordius aquaticus* Linnaeus, 1766 larvae. Less than 10 gordiid larvae per host were observed, but occasionally as many as 62. Encysted preinfective larvae have been frequently recorded from several fish species. It may be concluded that the *G. aquaticus* seems to be next parasite of river lamprey [23].

Four acanthocephalan species were recorded in the river lamprey. *Echinorhynchus gadi* Zoega in Müller, 1776 was noted sporadically in the intestine of lamprey migrating from the Gulf of Gdańsk into the lower Vistula as well as in the individual from the Daugava River, entering from the Gulf of Riga [10,24]. In the intestines of lampreys from the Lakes Ladoga and Onega *Metechinorhynchus salmonis* (Müller, 1784) Petročenko, 1956 was found [6,13]. Juvenile forms of *Corynosoma strumosum* (Rudolphi, 1802) Lühe, 1904 and *C. semerme* Forsell, 1904, for the first time were recorded in *L. fluviatilis* from the Ladoga Lake by Jääskeläinen [6]. The next individuals were observed in the intestine and the body cavity of lampreys entering the Daugava near Riga Gulf and Daugava river near Ogre [12].

In Poland the river lamprey parasites were studied and only the presence of *D. petromyzi-fluviatilis*, *Echinorhynchus gadi* and Unionidae larvae [10] were stated.

In this study a single larva L3 of the nematode *Anisakis simplex* (Rudolphi, 1809) was recorded, found in the lamprey alimentary tract (prevalence – 2.68%). With any doubt the nematode was swallowed with a food by the adult lamprey. *A. simplex* does not belong to the group of specialists, therefore nearly each fish species could be its host, both from the marine and brackish waters in the latter part of the Pomeranian Bay.

As in the case of *A. simplex*, most parasites of the river lamprey demonstrate the sporadic or even accidental character of occurrence. The majority of them were found at single sites, often at very low intensity and prevalence. This phenomenon is connected with the different mode of lampreys feeding in the marine and brackish waters. In the larval stage (ammocoetes) lampreys show static way of life. The structure of the feeding and breathing apparatus is different compared to the adults. The blind ammocoetes larvae are filter feeders of remnants of plants, algae and by chance desmids and diatoms [25,26]. Most of parasites of ammocoetes occur in the form of larvae and live in the host in the form of small invasive forms [9,21]. As the size of the food of ammocoetes is limited, they rarely swallow water crustaceans and arthropods, therefore they rarely are infected with parasites that need an intermediate host from these groups. Adult river lamprey are believed to spend most of their feeding phase in estuarine or costal waters, following the movements of the host fishes [27]. Adults feed on the big fishes by sucking their system fluids and afterwards consuming the tissues, uniquely feed on the small fishes, exceptionally on the benthic crustaceans and other invertebrates [28]. The most common hosts are clupeids and gadoids, in the estuaries– cyprinids and flatfishes [29,1]. Lamprey suction marks have been seen on sprat (*Sprattus sprattus*), smelt (*Osmerus eperlanus*), vendace (*Coregonus albula*) [30,31]. These species are at the same time the intermediate or parathenic hosts of digeneans *Hemiurus appendiculatus*, cestodes *Bothriocephalus* sp. and *Diphyllobothrium*

sp., nematodes *Raphidascaris acus*, *Hysterothylacium aduncum* and *Anisakis simplex* (found in this study) and acanthocephalans *Echinorhynchus gadi*, *Corynosoma strumosum* and *C. semerme.* These parasites are noted in the river lamprey very seldom. Such a low specialized diet as well as marginal importance in the diet of invertebrates and small fishes who may be swallowed as the whole item [27], explain the low number of these non-specific parasites.

Mode of living of ammocoetes in deep mud and double changes of the environment are not favourable for the parasites occurrence. However, the lampreys entering the Lake Onega to spawn, were infected with *Chilodonella hexasticha*, *Trichodina tenuidens*, *Trichodinella epizootica* [13]. On the gills of lamprey from the Kuršű-Mares Lagoon and Gulf of Riga *Ergasilus sieboldi* and *Argulus foliaceus* were observed [14,24]. Unionidae larvae were noted on the gills of lamprey from the lower Vistula and Kuršű-Mares Lagoon [10,14]. The leech *Piscicola geometra* parasitized on the skin of lampreys from the Gulf of Riga [24].

Gyrodactylid monogeneans are considered to be the most invasive fish parasites and less narrowly specific than other parasites [32]. They are omnipresent on teleost fishes. Known from anadromous salmonids, viviparous gyrodactylids infect all of the more advanced fishes from the Anguilliformes. Anadromous Gasterosteidae were also experimentally infected by *Gyrodactylus salaris* [33]. However, as so far no gyrodactylids were recorded in the river lamprey. The monogeneans nor from this group neither from other groups were noted in other lamprey species. Monogeneans are indeed sensitive to host skin components. Fish mucous cells release a number of mucopolysaccharides carrying galactose, lactose, mannose and fucose epitopes and carbohydrate/lectin associations could make up a sensitive recognition system between host and parasite [34,35]. The lamprey mucous cells are different from the typical epidermal mucous cells of teleosts. Also the elongated gill chamber and pharynx is floored by a so-called endostyl, which is glandular and produced a mucoid secretion [36]. Also the composition and structure of hemoglobin and methemoglobin of lamprey is different and its pH is lower than in fishes [37]. The ancestral globin of the lamprey represents the earlier stage in the evolution of the present day of the vertebrate hemoglobin. As fossil records reveal little change in the morphology of the lampreys, the properties of the hemoglobin of modern-day sea lampreys may be representative of those of the ancestral globin [38]. It is probably question of time, prior to the evolutional border crossing for monogeneans imposed by the morphology and physiology of lampreys.

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