

Parasite fauna of the eel, *Anguilla anguilla* (Linnaeus, 1758), from the Polish part of the Vistula Lagoon*

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ABSTRACT. **Introduction**. Eel is one of the most valuable commercial fish species of the Vistula Lagoon. For this reason its infection by non-indigenous species of parasites is the subject of the interest of sciencists. **Material and methods**. A total of 90 eel specimens caught in the Polish part of the Vistula Lagoon were examined over the period of May-August 2005. The fish were subjected to standard procedures of parasitological examination and parasite identification. The fish were divided into two length classes: smaller and larger than 50 cm. To assess the effects of parasites on fish condition, the Fulton coefficient, expressed with the formula: $WF = G \cdot L^{-3} \times 100$, was calculated. **Results**. The fish were found to be hosts to 17 parasite taxa. The Ciliophora were represented by *Trichodinella epizootica* (Raabe, 1950); the Myxozoa by *Myxidium giardi* Cépede, 1906; the Digenea by *Bunodera luciopercae* (Müller, 1784), *Deropristis inflata* (Molin, 1859), *Diplostomum* spp., and *Ichthyocotylurus platycephalus* (Creplin, 1852); the Cestoda by *Bothriocephalus claviceps* (Goeze, 1782), *Proteocephalus macrocephalus* (Creplin, 1815), and *Proteocephalus* sp.; the Nematoda by *Anguillicola crassus* Kuwahara, Niimi et Itagaki, 1974, *Camallanus lacustris* (Zoega, 1776), *C. truncatus* (Rudolphi, 1814), and *Hysterothylacium aduncum* (Rudolphi, 1802); the Acanthocephala by *Acanthocephalus lucii* (Müller, 1776) and *Corynosoma strumosum* (Rudolphi, 1802); the Hirudinea by *Piscicola geometra* (Linnaeus, 1761); and the Copepoda by *Ergasilus sieboldi* Nordmann, 1832. All fishes were infected, and the mean intensity of all parasites was 4.8 inds. The nematode *Anguillicola crassus* was the most frequent parasite (67.8%, 4.2 inds), represented by all developmental stages, but mostly by adult specimens. The fish condition coefficient was somewhat higher in the eel larger than 50 cm (0.1746) than in those smaller than 50 cm (0.1734); in addition, only *Anguillicola crassus*-free fish showed a higher condition coefficient (0.1861), compared to the infected specimens (0.1715).

Key words: *Anguilla anguilla*, eel, parasites, Poland, Vistula Lagoon.

Introduction

The Vistula Lagoon is one of the largest coastal water bodies of the Baltic Sea. It is an elongated brackish water lagoon 90.7 km long and 13 km wide. The lagoon connects with the Baltic Sea *via* the Pilava Strait near Baltiysk. The lagoon and adjacent territory is intersected by the state border between Poland and Russia [1, 2]. The lagoon supports 42 fish species, the eel population being most valuable from the standpoint of fisheries management [3–5]. After a new type of large fish traps was introduced in the late 1970s, the fish resources of the Lagoon, including the eel, were rapidly reduced. The reduction was additionally augmented by the lack of systematic stocking operations [4], increasing pressure of the black cormorant from the nearby breeding site at Kąty Rybackie [6], and by the spread of *Anguillicola crassus*, a new eel parasite. The total eel catches in 1980 were about 400 and as little as 90.4 tons, respectively in 1995 [4].

The knowledge on the Vistula Lagoon eel parasites is incomplete; very often only some selected parasite taxa were examined, that is the nematode

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Anguillicola crassus [7-9] and copepods [10-12], but also Microsporea and Myxozoa [7] were found in the occasion of other investigations. On the other hand, more comprehensive studies were carried out in the Russian part of the Lagoon; those studies covered all the parasite taxa [13–16], the non-indigenous helminths [17], the Myxozoa being studied as well [18].

The present study, constituting a continuation of the research commenced in 2001–2002 [19], supplies new data on the eel parasites in the Vistula Lagoon.

Materials and methods

Within May-August 2005, a total of 90 eel specimens (37.5–84.1 cm, 25.4–1635.6 g) caught in the Polish part of the Vistula Lagoon were examined. After delivery to the laboratory, the fish were subjected to standard procedures of parasitological examination and parasite identification. Ciliates were impregnated with 2% silver nitrate. The Myxozoa were fixed with 70% ethanol and embedded in glycerol-gelatine. The remaining parasites were fixed with 19:1 glacial acetic acid-formalin; digeneans, cestodes, and acanthocephalans were stained in Borax carmine, dehydrated in ethyl alcohol series, and cleared with benzyl alcohol; nematodes and copepods were cleared in lactophenol and embedded in glycerol-gelatine.

The fish were divided into two length classes: smaller and larger than 50 cm (marketable size).

To assess the effects of parasites on fish condition, the Fulton coefficient, expressed with the formula: $WF = G \cdot L^{-3} \times 100$, where G is fish weight (g) and L is fish length (mm), was calculated.

Results

The Vistula Lagoon eel examined were found to host 15 parasite species as well as metacercariae of *Diplostomum* spp. and the juvenile tapeworm *Proteocephalus* sp. (most probably *P. macrocephalus*) (Table 1). The overall prevalence (with all parasites species) was 100%, the mean intensity and intensity range amounting to 4.8 and 1–42 inds., respectively. The calculated intensity values doe not include, due to quantification problems, cysts of *Myxidium giardi*.

The specimens of *Bunodera luciopercae*, *Deropristis inflata*, *Bothriocephalus claviceps*, *Proteocephalus macrocephalus*, and *Acanthocephalus lucii* were at the reproductive stage (they contained eggs). In addition, among *Anguillicola crassus* there were eggs containing L2 larvae, (very abundant), 7 L3 larvae, 32 L4 ones (21 females and 11 males), and 216 adults (165 egg-bearing females and 51 males). *Camallanus lacustris* was represented by 3 females (including 1 ovigerous one) and 1 male; *C. truncatus* was represented by 4 females (including 2 ovigerous ones) and 2 males, while *Hysterothylacium aduncum* was represented by 2 females (including 1 ovigerous one) and 1 male.

The levels of infection with *Bothriocephalus claviceps*, *Proteocephalus macrocephalus*, and *Anguillicola crassus* were found to differ between the two length classes distinguished: the respective levels of infection with the species mentioned in the fish smaller than and larger than 50 cm were as follows: 12%, 1 ind. and 27.5%, 1.4 inds; 22%, 1.6 inds and 42.5%, 3 inds; 72%, 5.1 inds and 62.5%, 2.8 inds.

The fish condition index was somewhat higher in the eel larger than 50 cm (0.1746) than in those smaller than 50 cm (0.1734). Moreover, the condition coefficient in the eel hosting less than 5 and more than 5 parasites per specimens were different as well: the overall values were 0.1812 and 0.1641, respectively; among the eel smaller than 50 cm — 0.1781 and 0.1521, respectively; and among the eel larger than 50 cm — 0.1786 and 0.1588, respectively. It is worth mentioning that only *Anguillicola crassus*-free eel showed a higher condition coefficient (0.1861) than the infected individuals did (0.1715).

Discussion

This study revealed the presence of a number of species (*Trichodinella epizootica*, *Bunodera luciopercae*, *Diplostomum* spp., *Ichthyocotylurus platycephalus*, *Camallanus truncatus*, *Corynosoma strumosum*, and *Piscicola geometra*) which had not been recorded earlier in the Vistula Lagoon eel [19]. This is the most likely cause of the increased prevalence, compared to that in the previous period of study, from 88.7% to 100%. However, despite the much higher number of species, the increased prevalence was accompanied by a reduction in the infection intensity, from 9.8 to 4.8 inds.

Of the 17 parasite taxa recorded, 5 are species-specific for eel: *Myxidium giardi*, *Deropristis inflata*, *Bothriocephalus claviceps*, *Proteocephalus macrocephalus*, and *Anguillicola crassus* [20–24].

Table 1. Parasites of eels from the Vistula Lagoon

Parasite	Prevalence (%)	Mean intensity	Range of intensity
Ciliophora			
Trichodinella epizootica	3.3	2.5	1–4
Myxozoa			
Myxidium giardi	21.1	numerous – very numerous	numerous – very numerous
Digenea			
Bunodera luciopercae	1.1	2	2
Deropristis inflata	2.2	3	2–6
Diplostomum spp. (met.)	8.9	1–4	1–2
Ichthyocotylurus platycephalus (met.)	2.2	3	3
Cestoda			
Bothriocephalus claviceps	18.9	1.3	1–3
Proteocephalus macrocephalus	31.1	2.5	1–5
Proteocephalus sp.	16.7	2.2	1–6
Nematoda			
Anguillicola crassus (L3, L4, ad)	67.8	4.2	1–37
Camallanus lacustris	2.2	2	2
C. truncatus	2.2	3	2–4
Hysterothylacium aduncum	2.2	1.5	1–2
Acanthocephala			
Acanthocephalus lucii	1.1	1	1
Corynosoma strumosum (cystacanth)	1.1	1	1
Hirudinea			
Piscicola geometra	1.1	1	1
Copepoda			
Ergasilus sieboldi	9	2.3	1–4
Total	100	4.8*	1–42*

*the values do not include *M. giardi*

The dominant among them was the nematode *A. crassus*, brought to Europe in the early 1980s from Asia [25, 26], present in almost 68% of the specimens examined. Fairly frequent were also *P. macrocephalus*, *B. claviceps*, and *M. giardi*. The remaining species, except for the tapeworms of the genus *Proteocephalus* (16.7%, 2.2 inds.), not identified to the species level, were found in fewer than 10% of the fish. Compared to the earlier data [19], a decreased infection with *A. crassus* and a distinct increase in prevalence of *B. claviceps* and *P. macrocephalus* at a slight reduction in intensity were noted. However, according to different authors [7–9], the extent of the Vistula Lagoon eel's infection with *A. crassus* tended to fluctuate from 63.3 to 100% and from 2 to 12 inds, the data most often concerning the adults only. It is therefore difficult to predict that the reduced level of infection, observed at present, will be a constant trend.

The remaining parasites (*Diplostomum* spp., *Ichthyocotylurus platycephalus*, *Bunodera luciopercae*, *Camallanus lacustris*, *C. truncatus*, *Hysterothylacium aduncum*, *Acanthocephalus lucii*, *Corynosoma strumosum*, *Piscicola geometra*, and *Ergasilus sieboldi*) show a varying degree of host specificity; their infection parameters were low and oscillated between 1.1% and 8.9% and between 1 and 3 inds.

Because of the estuarine nature of the Vistula Lagoon, the area supports typically freshwater, typically marine, and brackish water species. Among the parasites recorded, three only (*Deropristis inflata*, *Hysterothylacium aduncum*, and *Corynosoma strumosum*) are typically marine, occasionally introduced to brackish, and even fresh, waters. The remaining parasites are considered to be freshwater

species which may also be introduced to brackish water bodies. While there, species such as *A. crassus*, characterised by high infection parameters and represented by reproductive females, can be regarded as highly salinity-tolerant. This has already been reported by, i.a., Reimer et al. [27] and Kirk et al. [28, 29].

The correlation between eel length and extent infection shows that the large eel was more frequently infected by the tapeworms *Bothriocephalus claviceps* and *Proteocephalus macrocephalus*, the smaller eel being more frequently the host of the nematode *Anguillicola crassus*. The presence of cestodes in large fish may be related to the type of food they ingest. The eel becomes infected with the cestodes mentioned *via* copepods of the order Cyclopoida [30-33] which host procercoids, infective for fish. Most probably, the large eel more frequently fed on the crustaceans, although it might seem that the large fish would feed mainly on large food items, e.g., other fish species. The lower *A. crassus* infection parameters recorded in the large eel could have been a result of, on the one hand, their higher immunity, and from increased anguillicolosis-related mortality in the smaller fish on the other.

As shown by the data obtained, the parasites are likely to adversely affect the fish host, although it was not possible to compare the condition between infected and parasite-free fish, as all the fish were infected. However, the condition coefficient proved to reflect the intensity of infection (the number of parasites per fish): those fish showing a better condition (both smaller and larger than 50 cm) supported fewer parasites. In addition, the condition of the eel infected with the new, hence more pathogenic, nematode *Anguillicola crassus* proved worse than that of the nematode-free specimens. It is worth adding that, generally, the better condition of the large eel is more desirable from the fisheries management standpoint.

To summarise, it should be concluded that the Vistula Lagoon eel parasite fauna is diverse; the parasites are highly prevalent, but the intensity of their infection is relatively low. The nematode *Anguillicola crassus* is a dominant and constant parasite of the Vistula Lagoon eel.

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