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Short notes

The helminthofauna of the garfish *Belone belone* (Linnaeus, 1760) from the southern Baltic Sea, including new data

Leszek Rolbiecki, Joanna N. Izdebska, Joanna Dzido

Department of Invertebrate Zoology and Parasitology, Faculty of Biology, University of Gdańsk, ul. Wita Stwosza 59, 80-308 Gdańsk, Poland

Corresponding Author: Leszek Rolbiecki; e-mail: leszek.rolbiecki@ug.edu.pl

ABSTRACT. The garfish *Belone belone* (Linnaeus, 1760) is a marine fish which can be found in the shallow waters of the Baltic Sea in the spring and summer spawning period. In 2010 and in 2016, 73 specimens of garfish collected in the Gulf of Gdansk (southern Baltic Sea) were examined for the presence of helminths. The fish were found to support the nematode *Anisakis simplex* (Rudolphi, 1809) L3, *Hysterothylacium aduncum* (Rudolphi, 1802) L4, ad., *Contracaecum* sp. L3 as well as the acanthocephalan *Echinorhynchus gadi* Zoega in Müller, 1776. For all garfish caught in 2010 and 2016, the overall prevalence of infection by all parasites was 38.4%, with a mean intensity of 2.9 (range 1–5). The dominant parasites were *H. aduncum* (20.5%, 1.8) and *E. gadi* (17.8%, 2.1). This study constitutes the first record of *Contracaecum* larvae in garfish in the Polish exclusive economic zone of the Baltic Sea.

Keywords: *Belone belone*, garfish, parasites, Baltic Sea

Introduction

The garfish *Belone belone* (Linnaeus, 1760) (Actinopterygii: Beloniformes: Belonidae) is a pelagic fish species inhabiting brackish and marine waters. It is distributed across a wide area that encompasses the north-east Atlantic Ocean (coasts of Europe and North Africa), North Sea, Baltic Sea, Mediterranean Sea and Black Sea [1,2]. Undoubtedly, it may well be this fact that favors the richness and diversity of garfish parasitofauna observed across its distribution. The nature of the parasitic communities in the garfish may well also be influenced by its behavioral traits, such as its predatory lifestyle, favoring parasite transmission between hosts, or its migratory tendencies. Its migratory pattern is comparable to that of the mackerel [3], being based around moving to shallow waters in spring (April, May), and returning to the open sea in autumn. Garfish spawn from eggs laid in shallow waters, and the juveniles remain there until they reach sexual maturity [4]. The garfish is often associated with the Baltic Sea, where it migrates to in spring to spawn, and remains there from April through July depending on the thermal conditions [5–7]. Being a predator, it hunts in the open sea, searching for schools of small fish or feeding on planktonic crustaceans; however, it can also feed near the shore, in natural or artificial coves [1,8].

Another element that may dictate the formation of garfish parasitofauna is its systematic diversity. Although the status of individual subspecies is not always unambiguous, three or four have been recognized by different sources: Collette and Parin [9] mention three, i.e. *B. belone belone* (Linnaeus, 1760) (north-east Atlantic), *B. b. euxini* Günther, 1866 (Black Sea and Sea of Azov), *B. b. acus* Risso, 1827 (Mediterranean Sea and the adjacent parts of the Atlantic, Madeira, Canary Islands, Azores and the south to Cape Verde). Later, Collette and Parin [10] supplemented that list with *B. b. gracilis* Lowe, 1839 (France, Canary Islands, Mediterranean Sea). However, Froese and Pauli [2] treats *B. b. euxini* as a distinct, endemic species *B. euxini* Günther, 1866.

The status of garfish parasitofauna research is very non-uniform. The greatest amount of data originates from the area of the Mediterranean Sea, or the Black Sea [e.g. 11–15]. However, the full picture of garfish communities and dynamics of distribution should include their regional and local

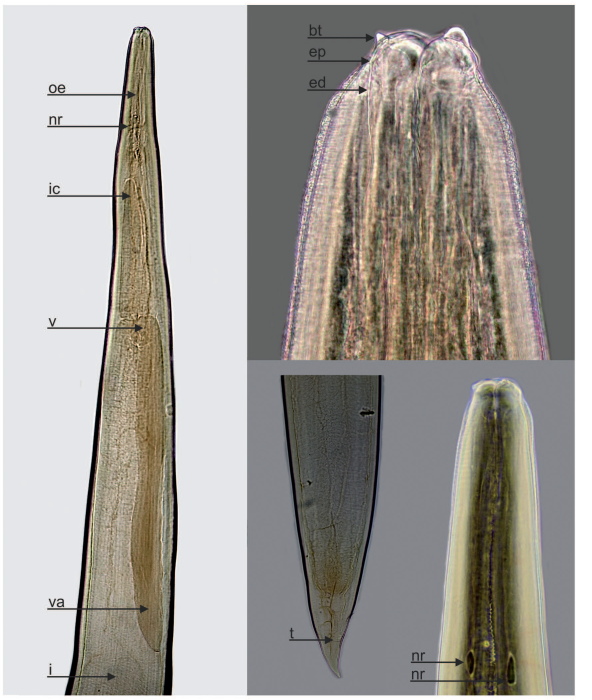

Figure 1. Third-stage larvae of *Contracaecum*; boring tooth (bt), excretory duct (ed), excretory pore (ep), intestine (i), intestinal caecum (ic), nerve ring (nr), oesophagus (oe), ventriculus (v), ventricular appendix (va), posterior end with tail (t).

differences, undoubtedly stemming not only from the diverse composition of local factors and climatic and biological conditions, but also the discrete nature of the garfish systematics at the subspecies, or perhaps the species, level [e.g. 14,16–18]. At the same time, the parasitofauna of garfish in the Baltic Sea, where the nominal species occurs, is poorly understood and only based on individual studies from Germany, Scandinavia and Poland [16,17, 19–21]. These include data from the Polish area of the Baltic, based on isolated works concerning the Gulf of Gdańsk and the Gulf of Pomerania [16,21].

It should be added, that the importance of parasitological studies on the garfish does not only stem from the necessity to understand its role as a link in the cycle of parasites in the environment or their transmission during migration. In addition, it is a fish species of economic significance, fished both commercially and for sport for its palatable meat: according to ICES [22], the 2017 catch statistics were close to 840 tonnes in the north-east Atlantic, and 76 tonnes for Poland. Therefore, it is important to understand the possible health hazards associated with garfish consumption, including its parasitology.

Materials and Methods

The study included 73 *B. belone* specimens (45.8–78.3 cm, 221.4–532.4 g, 29 ♀♀, 44 ♂♂) collected in the Gulf of Gdańsk (Baltic Sea, Poland, ICES Subdivision 26) in June 2010 (n=32 fish) and in June 2016 (n=41 fish). The collected garfish were frozen. In order to detect parasites, the skin, fins, oral cavity and gills were analyzed, followed by the body cavity and internal organs (digestive tract, liver, spleen, gall bladder and gonads). In addition, from 16 garfish specimens selected at random (eight from each year), and fillets were prepared from the muscles (maximum width 1–1.5 cm), which were then observed under a stereoscopic microscope in transmitted light.

The collected parasites were fixed and preserved in 70% ethanol solution. For the purpose of species identification, the nematodes were cleared in lactophenol, the acanthocephalans were stained in alcohol-borax carmine, differentiated (i.e. excess pigment rinsed) in acidified ethanol, dehydrated in alcohol series (80, 90, 2×99%) and cleared in benzyl alcohol [23,24]. The parasites were identified in a droplet of lactophenol (nematodes) and benzyl alcohol (acanthocephalans) before being submerged in glycerogelatine or Canada balsam. The specimens were deposited in scientific collections within the framework of the Collection of Extant Invertebrates in Department of Invertebrate Zoology and Parasitology, University of Gdańsk, Poland (UGDIZP).

Results and Discussion

The overall prevalence of infection of all garfish collected in 2010 and 2016 by all parasites was 38.4%, with a mean intensity of 2.9 and intensity range of 1–5. A total of 82 parasites were collected; these included Nematoda and Acanthocephala. Nematodes were represented by *Anisakis simplex* (Anisakidae; nine L3 on the peritoneal wall, 11 on the intestinal, five on the liver), *Contracaecum* sp. (Anisakidae; three L3 on the liver), and *Hysterothylacium aduncum* (Raphidascarididae; 14 L4 in the intestinal lumen, seven adult males, and six adult females in the intestinal lumen). Acanthocephalans were represented by *Echinorhynchus gadi* (12 females, 15 males in the intestinal lumen). The dominant species were *H. aduncum* and *E. gadi*.

Since this was the first identification of *Contracaecum* larvae in garfish from Poland, their

Table 1. Prevalence (%), mean intensity and range of intensity of parasites of *Belone belone* from the Gulf of Gdańsk in the 2010 and 2016 years

Parasites	2010 (n=32)	2016 (n=41)	Total 2010 and 2016 (n=73)
Nematoda			
Anisakis simplex (Rudolphi, 1809), L3	15.6/2.4/1–4	9.8/3.3/2–4	12.3/2.8/1–4
Contracaecum sp., L3	–	4.9/1.5/1–2	2.7/1.5/1–2
Hysterothylacium aduncum (Rudolphi, 1802), L4, ad	28.1/1.8/1–3	14.6/1.8/1–3	20.5/1.8/1–3
Acanthocephala			
Echinorhynchus gadi Zoega in Müller, 1776	25.0/2.3/1–5	12.2/1.8/1–3	17.8/2.1/1–5
Total	46.9/3.1/1–5	31.7/2.8/1–5	38.4/2.9/1–5

measurements (in mm) are presented (Fig. 1).

The body (the maximum length and maximum width) of the first, second, and third specimens respectively 16.1×0.72, 18.2×0.50, 20.0×0.53 (mean 18.1× 0.58); excretory pore situated at base of lips; larval tooth small; oesophagus 0.90×0.12, 0.95×0.10, 1.07×0.10 (mean 0.97×0.11); distance of the nerve ring from the anterior extremity 0.25, 0.27, 0.30 (mean 0.27); ventriculus appendix 1.05×0.14, 1.10×0.12, 1.20×0.15 (mean 1.12×0.14); intestinal caecum 0.55×0.11, 0.70×0.14, 0.92×0.15 (mean 0.72×0.13); length ratio of ventricular appendix and oesophagus 1:1.0, 1:1.2, 1:1.3 (mean 1:1.1); length ratio of ventricular appendix and intestinal caecum 1:1.1, 1:1.6, 1:2.2 (mean 1:1.5); ventriculus 0.08×0.07, 0.08×0.06, 0.12×0.10 (mean 0.09×0.08); tail conical, 0.13, 0.15, 0.16 (mean 0.15), sharp point.

Of the four species of parasite identified in the garfish from the south Baltic Sea, three have been recorded in earlier studies of the area [16,21]. However, the observation of the unidentified to the species *Contracaecum* larvae is the first for this host in this study area. In previous studies of the garfish from the Baltic Sea, this parasite (identified as *Contracaecum rudolphii* (Rudolphi, 1802)) was recorded only once, in the west Baltic Sea (German zone); in that case, the species was defined as rare for the host, as only singular specimens were found [20].

Despite the new record, the diversity of parasites in the garfish appears to be lower than shown in the previous studies of this area; in 70 specimens of the species studied over the period of 1966–1967, a comparable sample to the present study, Rynkiewicz [21] demonstrated seven parasite species, including *Diplostomum spathaceum* (Rudolphi, 1819) and *Tylodelphy*s sp., *Cucullanus truttae* Fabricius, 1794, *H. aduncum* (=*Contracaecum aduncum* Rudolphi, 1802), *Neoechinorhynchus rutili* (Müller, 1780) and *Pomphorhynchus laevis* (Zoega in Müller, 1776), as well as tapeworm larvae *Scolex pleuronectis* Müller, 1788. In turn, during the period 1978–80, Grabda [16] analyzed a total number of 103 garfish, for which six parasite species were found, including *Lecistorhynchus tenuis* (van Beneden 1858), *A. simplex*, *H. aduncum* (=*Thynascaris adunca* (Rudolphi, 1802)), *N. rutili*, *E. gadi* and *P. laevis*. In contrast, higher infection level with nine parasite species were detected among 35 garfish specimens collected along the German coast of the Baltic Sea in May 2012 that in during comparable period of study, including *Lecithaster confusus* Odhner, 1905; *Axine belones* Abildgaard, 1794; *Bothriocephalus scorpii* (Müller, 1776); *Proteocephalus* sp., *A. simplex*, *C. rudolphii*, *H. aduncum*, *E. gadi* and *P. laevis* [20].

In total, 21 records of parasite species have been identified in garfish taken from different Baltic Sea regions [16,17,19–21]; however, both the species composition and the dynamics of occurrence are highly diverse. It should be added that the parasites recorded in the present study (*A. simplex*, *H. aduncum*, *E. gadi*) belong to common species, which have been recorded in the area of the south Baltic Sea for various fish species in numerous studies [e.g. 25–33]. *Hysterothylacium aduncum* is one of the most common parasite species in fish collected in the Baltic Sea and the adjacent North Sea, and it also occurs in fish collected from freshwater and brackish habitats [e.g. 25,33–37]. Its wide distribution is probably linked to its strong adaptability in terms of the selection of intermediate and final hosts; this might be the reason why this nematode was the most commonly-identified parasite in the studied material, even though its mean intensity was relatively low, being only one to three specimens. *Echinorhynchus gadi* is another frequent parasite of numerous fish species, such as Atlantic cod *Gadus morhua* Linnaeus, 1758, saithe *Pollachius virens* (Linnaeus, 1758), Atlantic herring *Clupea harengus* Linnaeus, 1758, lumpsucker *Cyclopterus lumpus* Linnaeus, 1758 or European flounder *Platichthys flesus* (Linnaeus, 1758) [e.g. 25–30,38,39].

While *H. aduncum* and *E. gadi* are parasites, whose life cycle is closed within the Baltic Sea, the closure of *A. simplex* life cycle is associated with host migration to the North Sea [32,40,41]. Thus, the garfish likely becomes infected with this nematode outside of the Baltic Sea, and similarly to the herring, this may indicate the migration patterns of this parasite.

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