

**LARVAE OF *ANGUILLICOLA CRASSUS*
(NEMATODA, DRACUNCULOIDEA) IN STICKLEBACK
(*GASTEROSTEUS ACULEATUS*) AND SMELT
(*OSMERUS EPERLANUS*) FROM THE GULF
OF GDAŃSK AND THE VISTULA LAGOON**

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Abstract. *Anguillicola crassus* is an Asian nematode introduced in Europe, a parasite of the eel swim bladder. The parasite's life cycle involves crustaceans, mainly copepods, as intermediate hosts as well as paratenic hosts which, by accumulating the nematodes, increase the possibility of infection of the definitive host, the eel. The role of smelt and stickleback in the cycling of *A. crassus* in the Gulf of Gdańsk and the Vistula Lagoon was analysed. From May 2001 until November 2002, a total of 650 smelt specimens (306 from the Gulf of Gdańsk and 344 from the Vistula Lagoon) and 1523 stickleback specimens (1222 from the Gulf of Gdańsk and 301 from the Vistula Lagoon) were examined. The examination revealed the presence of the nematode's larval stages III (298 specimens) and IV (5 specimens). The infection levels in smelt and stickleback were 8.6%, 2.3 inds and 8.9%, 1.2 inds, respectively. This is the first Polish record of the nematode in smelt and stickleback. The study contributes to the knowledge of the biology of *A. crassus* and help follow pathways of the parasite transmission to other water bodies.

INTRODUCTION

The nematode *Anguillicola crassus* KUWAHARA, NIIMI et ITAGAKI, 1974 parasites the eel swim bladder. The parasite was introduced to Europe in the 1980s together with the eel imported for consumption and stocking. The nema-

tode had earlier been known from East Asia only (China and Japan) as a parasite of the Japanese eel (MORAVEC and TARASCHEWSKI, 1988). In Europe, the nematode was first recorded from northern Germany (NEUMANN, 1985). In a very short time, the nematode infected natural populations of the European eel *Anguilla anguilla*. At present, *A. crassus* is found almost throughout Europe (PAGGI et al., 1982; KENNEDY and FITCH, 1990; MORAVEC, 1994), including Poland (ROLBIECKI et al., 1996, 2000; WŁASOW, 1991).

The European eel proved more susceptible to infection than the Japanese eel, the hitherto principal host. In Japan, *A. crassus* affects 40% of *A. japonica* at most. Although it dwells in the swim bladder and feeds on blood, it does not produce any major damage to the host. Most probably, the Japanese eel evolved immunity to the parasite's harmful effects (EGUSA, 1979). On the other hand, the infection prevalence in the European eel may be as high as 90-100% at a very high intensity of 30 nematodes in a single fish (PETERS and HARTMANN, 1986; GARBACIK-WESOŁOWSKA, et al., 1994; MORAVEC, 1994; SURES and STREIT, 2001). Such a high infection level cannot remain harmless to fish condition; it produces symptoms in the form of anguilliosis.

Important in the *A. crassus* life cycle are paratenic hosts which, by accumulating the parasites, increase their chances for dispersal and infection of the definitive host, the eel. Paratenic hosts for the nematode in question are various fish species feeding on invertebrates (mainly crustaceans), the nematode's intermediate hosts (DE CHARLEROY et al., 1990; HAENEN and BANNING, 1990). The eel becomes infected with *A. crassus* by consuming crustaceans or paratenic hosts containing the invasive larval stage III. Occasionally, the larvae occur at stage IV, non-invasive for the definitive host. Paratenic hosts are particularly important for the large eel that feed primarily on fish.

The study described in this paper is a continuation of research, undertaken in mid-1990s, on the importance of paratenic hosts in the life cycle of *A. crassus* in the southern Baltic brackish waters (ROLBIECKI, 2002b, 2003a, b). This study focused on the role of smelt and stickleback in the nematode's life cycle.

MATERIALS AND METHODS

Within March 2001 - November 2002, a total of 1523 stickleback specimens (2.5-7.2 cm; 1.3-4.5 g) were examined; 1222 of them were caught in the Gulf of Gdańsk and 301 in the Vistula Lagoon. Simultaneously, a total of 650 smelt specimens (12-28 cm, 19.5-42g) were examined; 306 were obtained from the Gulf of Gdańsk and 344 from the Vistula Lagoon.

The nematodes were looked for in temporary mounts prepared, with the aid of a compressor, from the gut walls, liver, spleen, kidney, swim bladder, and gonads of the fish. The parasites collected were fixed in 70% ethanol or 95:5 glacial acetic acid-formaldehyde; some of the parasites were mounted in semi-permanent glycerol-gelatine mounts following the procedure described by ROLBIECKI (2002a). The remaining nematodes were stored in 70% ethanol.

RESULTS

The study revealed the presence of *Anguillicola crassus* larval stages III (298 inds) and IV (5 inds), L4 being found in smelt only. The smelt infection prevalence was 8.6%; the mean intensity and intensity range were 2.3 and 1-5 inds, respectively. The corresponding parameters of stickleback infection were: 8.9%, 1.2 inds, and 1-4 inds. The Vistula Lagoon fish were more heavily infected than those from the Gulf of Gdańsk (smelt: prevalence of 9.6 vs 7.5%, mean infection intensity of 2.8 vs 1.7 inds; stickleback: prevalence of 11.9 vs 8.1%, mean intensity of 1.3 vs 1.2 inds).

The parasites were located in the swim bladder wall (67.4%), gut wall (29%), and liver (3.6%); the L4 larvae were found in the swim bladder wall only.

Females proved to be more heavily infected than males (smelt: 10.1 vs 4.2%, 2.3 vs 2.1 inds; stickleback 10.1 vs 7.1%, 1.3 vs 1.2 inds).

DISCUSSION

As shown by the present study, both smelt and stickleback from the Gulf of Gdańsk and the Vistula Lagoon can be paratenic hosts for *Anguillicola crassus*. Larval stage III of *A. crassus* had been earlier recorded in the Gulf of Gdańsk from nine-spined stickleback (ROLBIECKI, 2003a) and eel (BYSTYDZIŃSKA et al., 2003); in the Vistula Lagoon, they had been found in ruffe, European perch, zander, carp bream, ziege, and eel (ROLBIECKI et al. 1996, ROLBIECKI 2002b, 2003a, b, WŁASOW et al. 1996, 1997, 1998, BYSTYDZIŃSKA et al. 2003). Stage IV larvae had been previously recorded from eel only, both in the Gulf and the Lagoon (WŁASOW et al., 1996, 1997; BYSTYDZIŃSKA et al., 2003). It was the ruffe only (infection parameters: 11.8%, 8.2 inds) that could be considered to be involved in the *A. crassus* life cycle. In the remaining species, the parasites occurred very sporadically, usually in large specimens which, on account of their size, could not be preyed upon by eel. Stage III larvae found in eel had been acquired by the hosts during their feeding on intermediate hosts and other fish species, including the small eel.

In addition to ruffe, smelt and - occasionally - stickleback have been referred to as paratenic hosts of *A. crassus*. Smelt usually showed a heavier infection (more than 80%) than stickleback (more than 45%) (HAENEN and BANNING 1990, THOMAS and OLLEVIER 1992). The infection parameters recorded in this study could have been a result of a slower rate of infection in the mixohaline environments of the Gulf of Gdańsk and Vistula Lagoon, compared to freshwater European water bodies. Water salinity seems to play a significant part in the occurrence of *A. crassus*. This conclusion is supported by the values of infection parameters, recorded in this study in smelt and stickleback from more saline Gulf of Gdańsk (7.5%, 1.7 inds and 8.1%, 1.2 inds, respectively) lower than those observed in the Vistula Lagoon (9.6%, 2.8 inds. and 11.9%, 1.3 inds, respectively). The Gulf of Gdańsk and the Vistula Lagoon are brackish

water bodies of mean annual salinity of 7.1 and 2.5‰, respectively (according to the Institute of Meteorology and Water Management in Gdynia and CYBERSKA, 1998) while the salinity in freshwater basins does not exceed 0.5‰ (ŻMUDZIŃSKI et al., 2002).

It is worthwhile to focus on the problem of identifying a paratenic host species most important in the life cycle of *A. crassus* in the Gulf of Gdańsk and the Vistula Lagoon. The high - compared to that in other fish species - level of infection, observed earlier in ruffe (ROLBIECKI, 2002b, 2003b) may warrant a conclusion that ruffe is an important paratenic host. However, the lower infection levels found in this study in smelt and stickleback cannot rule them out as links in the *A. crassus* cycle. An important criterion in evaluation of the importance of paratenic hosts should be, in addition to the infection level, also the fish size which may limit the definitive host's ability to swallow a potential paratenic host. Then, stickleback, as the smallest species, should be the most important in the nematode cycle, while smelt - the largest fish - would be least important. However, as opposed to stickleback and percids, smelt does not have sharp fin rays and spines which may prevent the eel from swallowing a fish thus armed. Although smelt is larger than stickleback and percids, it should be a more accessible prey for eel. In addition to the infection level and fish size, eel feeding selectivity is an important factor as well. For example, the major paratenic host of *A. crassus* in Lake Balaton is bleak that accounts for more than 90% of the eel's food there (PAULOVITAS and BIRÓ, 1987; SZEKELY, 1994). With respect to the Gulf of Gdańsk and the Vistula Lagoon, composition of the eel's diet is known from the Lagoon only (May - September): among the fish in the diet, as much as 37.8% is accounted for by smelt, ruffe supplying 30.8%; no stickleback was found (ŻELEPIEŃ and WILKOŃSKA, 1995). The authors mentioned quoted also herring larvae as an important dietary item. Probability of their infection, however, is very low because larvae at that stage do not usually feed yet. It should be also borne in mind that the composition of eel diet may change from season to season, hence pathways of infection, and its level, may vary as well.

In summary, it should be concluded that smelt and stickleback are new paratenic hosts for *A. crassus* in Poland, smelt seeming more important in the nematode's life cycle in the Gulf of Gdańsk and the Vistula Lagoon. On the other hand, as the parasite has relatively recently appeared in the southern Baltic area, it is expected that paratenic hosts will be infected at an increasing rate, for which reason the proportion of infected eel will increase as well. It should be added that paratenic hosts can transport the parasite to other water bodies connected with the Vistula Lagoon and the Gulf of Gdańsk, and thus facilitate the nematode's dispersal.

LARWY *ANGUILLICOLA CRASSUS* (NEMATODA, DRACUNCULOIDEA)
U CIERNIKA (*GASTEROSTEUS ACULEATUS*) I STYNKI (*OSMERUS
EPERLANUS*) Z ZATOKI GDAŃSKIEJ I ZALEWU WIŚLANEGO

STRESZCZENIE

Anguillicola crassus jest azjatyckim nicieniem introdukowanym do Europy i pasożytuje w pęcherzu pławnym węgorzy. W cyklu życiowym pasożyta występują skorupiaki - głównie widłonogi - pełniące rolę żywicieli pośrednich oraz żywicieli parateniczni, które akumulując nicienie zwiększają możliwość zarażenia żywiciela ostatecznego - węgorza. Przeanalizowano rolę stynek i cierników w krążeniu nicienia *Anguillicola crassus* w Zatoce Gdańskiej i Zalewie Wiślanym. W okresie od maja 2001 do listopada 2002 roku przebadano 650 stynek (306 z Zatoki Gdańskiej i 344 z Zalewu Wiślanego) i 1523 cierników (1222 z Zatoki Gdańskiej i 301 z Zalewu Wiślanego). Stwierdzono larwy III (298 egz.) oraz IV stadium (5 egz.); poziom zarażenia stynek i cierników wyniósł odpowiednio - 8,6%, 2,3 egz. i 8,9%, 1,2 egz. Jest to pierwsze stwierdzenie tego nicienia u stynek i cierników w Polsce. Przeprowadzone badania poszerzają wiedzę na temat biologii *A. crassus* i mogą być pomocne w określaniu dróg transmisji pasożyta do innych akwenów.

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