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III-STAGE *Anisakis simplex* (RUDOLPHI, 1809) (NEMATODA; ANISAKIDAE) LARVAE IN HERRING CAUGHT IN AUTUMN FROM THE POLISH PART OF THE VISTULA LAGOON

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Abstract. Of the 231 herring specimens caught in autumn from the Polish part of the Vistula Lagoon, 6.5% were found to contain III-stage *Anisakis simplex* larvae. The parasites were recorded in the fish longer than 23 cm. The presence of *Anisakis simplex* in autumn increases the risk of infection for accidental hosts, including humans.

Key words: *Anisakis simplex*, Baltic herring, *Clupea harengus membrans*, Vistula Lagoon, Poland

INTRODUCTION

Anisakis simplex is a common parasitic nematode species that occurs primarily in seas of the northern hemisphere. Its definitive hosts are marine mammals (cetaceans and pinnipeds). The first hosts are the Euphausiacea which become infected by the free-living II-stage larvae. Planktivorous fish, mainly the herring, serve as the second intermediate hosts, occasionally regarded as paratenic ones, housing III-stage larvae [Grabda 1973, Smith and Wootten 1978, Nagasava 1990]. Those larvae are present in numerous fish species all over the world, herring suffering usually the heaviest infection. By consuming fish products that contain live larvae, humans may become infected and serve as accidental hosts. Since the 1950s when the first incidence of the purported anisakiasis was described in humans [Ishikura et al. 1992], the parasite has become a subject of comprehensive research. In Poland, too, the parasite has been the focus of attention since the first record of *A. simplex* in herring [Lubieniecki 1972, Rokicki 1972, 1973].

MATERIALS AND METHODS

In September-October of 1995 and 1996, 101 and 130 specimens, respectively, of herring caught in the Polish part of the Vistula Lagoon were examined. The fish were obtained from fishermen operating from Tolkmicko near Elbląg. After measuring (to 1 mm)

and collecting otoliths for age determination, the fish were dissected and examined for the presence of parasites.

The parasites were looked for in the body cavity and internal organs. Muscles of 30 individuals were examined as well, individual myomeres being separated with laboratory needles.

Some of the nematodes were mounted in glycerin-gelatin, as described by Rolbiecki [2002]. The remaining parasites after fixation were preserved in 70% ethanol. In addition, metric characteristics were determined on 30 larvae. To this end, in order to straighten the parasites (live and dead stage 3 larvae of *A. simplex* are characteristically arch-like curved), they were placed in lactophenol in a groove (0.7 mm diameter) formed by two slides glued to a larger glass plate.

RESULTS

The *Anisakis simplex* stage 3 larvae were recorded in viscera of 6.5% of all the individuals examined; no parasites were found in muscles. The mean infection intensity was 5.3 ind., the intensity varying from 3 to 11 ind. In 1995, the infection indices were higher (9.9%; 5.3 ind.) than in 1996 (3.8%; 5.2 ind.). The parasites were present only in the fish longer than 23 cm. Herring females were found to be more heavily infected (7.5%; 5.9 ind.) than males (5.1%; 4 ind.) (Table 1). The ranges of metric characteristics are given in Table 2.

Table 1. Morphometric characteristics of the herring caught in autumn infected with *Anisakis simplex* III-stage larvae

Tabela 1. Dane morfometryczne odłowionych jesienią śledzi zarażonych larwami III-stadium *Anisakis simplex*

No. L.p.	Length, cm Długość, cm	Age Wiek	Sex – Płeć	No. of nematodes Liczba nicieni	Location in host – Lokalizacja
				1995	
1	23.3	3	female – samica	3	on stomach – na żołądku
2	24.6	3	female – samica	4	on pyloric caeca – na wyrostkach pylorycznych
3	25.5	3	male – samiec	4	on pyloric caeca – na wyrostkach pylorycznych
4	26.0	3	female – samica	5	on/in gonads – na/w gonadach*
5	26.4	4	male – samiec	5	on gonads – na gonadach
6	27.4	4	male – samiec	4	on parietal peritoneum – na otrzewnej ściennej
7	28.0	4	female – samica	7	on mesentery – na krezce
8	28.2	4	female – samica	8	on mesentery – na krezce
9	28.3	4	female – samica	8	on pyloric caeca – na wyrostkach pylorycznych
10	28.4	4	female – samica	5	on pyloric caeca – na wyrostkach pylorycznych
				1996	
1	25.0	3	male – samiec	3	on parietal peritoneum – na otrzewnej ściennej
2	26.0	4	male – samiec	4	on parietal peritoneum – na otrzewnej ściennej
3	27.3	4	female – samica	5	on gonads – na gonadach
4	27.3	4	female – samica	6	on stomach – na żołądku
5	27.8	4	female – samica	8	on pyloric caeca – na wyrostkach pylorycznych

* two unencapsulated nematodes found in gonads – dwa wolne nicienie znaleziono w gonadzie

Table.2. Measurements data, in mm, of III-stage larvae of *Anisakis simplex* from the Baltic herring from the Vistula Lagoon

Tabela 2. Dane pomiarowe, w mm, larw III-stadium *Anisakis simplex* z bałtyckich śledzi z Zalewu Wiślanego

Specification - Wyszczególnienie	30 specimens
Total length –Długość ciała	21.890-23.010
Maximum width – Maksymalna szerokość ciała	0.390-0.514
Distanse from anterior end to nerve ring – Odległość obrączki nerwowej do przedniego końca ciała	0.278-0.295
Oesophagus length – Długość gardzieli	1.555-1.625
Oesophagus maximum width – Maksymalna szerokość gardzieli	0.128-0.138
Ventriculus length – Długość żołądeczka	0.797-1.141
Ventriculus width – Szerokość żołądeczka	0.118-0.224
Tail length – Długość ogona	0.095-0.174
Mucron length – Długość mukrona	0.011-0.025

DISCUSSION

The herring (*Clupea harengus*) inhabits boreal and subarctic Atlantic. The Baltic is inhabited by its sub-species *Clupea harengus membrans*, called the Baltic herring. Herring is one of the dominants of fisheries worldwide [FAO yearbook 2000], including the Baltic Sea and the Vistula Lagoon [Borowski 1996, Wyszyński 1996]. The species forms numerous local populations. The Baltic Sea houses three populations: the spring coastal herring, the spring open sea herring, and the autumn herring. The three stocks differ, i.a., in their vertebrae, keel scale, fin ray, and gill raker counts as well as in the otolith structure, growth rate, and fecundity [Kompowski 1971, Kosior and Strzyżewska 1979, Elwertowski 1982]. Individual populations begin spawning in different seasons. The spring coastal herring spawn within March-May off the southern and eastern Baltic coast; once spawning is completed, most of those herring migrate to the Danish straits and into the North Sea. The spring open sea herring spawn along the coasts of Sweden, Lithuania, Latvia and Estonia; after spawning, they migrate to feeding grouns located in the open sea of the Southern Baltic. The autumn herring spawn within August-October farther offshore; after spawning, similarly to the spring open sea herring, they remaining in the Baltic [Kompowski 1971, Elwertowski 1982]. According to numerous authors, the herring caught in the Baltic have been infected beyond the boundaries of that sea (in the North Sea, Danish strait) while feeding on the Euphasiacea. For this reason, the heaviest infection is usually encountered in the herring caught in the western Baltic fishing grounds, the level of infection decreasing eastwards [Lang et al. 1990, Potajałło et al. 1992, Myjak et al.1995].

The III-stage *A. simplex* larvae in the Baltic herring have been dealt with in numerous papers, the nematodes being found mainly in the spring coastal herring with as much as 80% of the population being infected. In contrast, the remaining two populations have been regarded as infected to a minimum degree only (about 1%) [Potajałło et al. 1992, Myjak et al. 1995, 1996a, b, Podolska 1996, Rokicki et al. 1997, Rodjuk and Shuhgalter 1999]. On the other hand, in the Vistula Lagoon, the larvae in question were found in the herring only in spring, with even more than 50% of the population being infected [Potajałło et al. 1992, Myjak et al. 1995, 1996a, b, Rokicki et al. 1997, Rodjuk and Shuhgalter 1999, Szostakowska and Sulgostowska 2001]. As shown by the

present study, the parasites are present in the lagoon also in autumn, although the autumn infection (6.5%, mean intensity of 2.6 ind.) is less heavy than that in spring. It is worth mentioning that the *A. simplex* III-stage larvae have been recorded in the Vistula Lagoon not only in herring, but also in zander [Rolbiecki and Rokicki 2000], infected via herring. The presence of *A. simplex* in zander of the Polish Baltic waters (River Odra mouth area) was reported also by Piasecki and Sobecka [1987].

It should be mentioned that individual herring populations may containing fish belonging to other stocks [Kompowski 1971]. One cannot thus be certain if the fish infected were representing the autumn herring or if they belonged to the spring coastal herring, most often subjected to infection, which remained in the Baltic/Vistula Lagoon after spawning. It is therefore safer to discuss the parasitic invasion in the herring caught in autumn than in fish belonging to the autumn herring. A possibility that *Anisakis simplex* developmental cycle proceeds in the Baltic, albeit to a limited degree, cannot be ruled out; such a possibility was mentioned by Grabda [1973] and by Rolbiecki et al. [2001]. Perhaps the Euphausiaces, the first intermediate host, is substituted here by other crustaceans acting as paratenic hosts. Probably the importance role in the life cycle of *A. simplex* play also copepods and other small crustaceans (infected with II-stage larvae), which mays serve as transmission hosts and a source of infection for larger crustaceans, in which parasites develop into L_3 [Smith 1983, Koie 2001].

Although nematodes were not found in muscles of the fish examined, and thus a potential source of human infection was not present, it should be remembered that they had been recorded in the Baltic herring muscles before, even in as many as 10% of the infected herring [Wierzbicka et al. 1991, Myjak et al. 1995]. Herring gonads are consumed by humans as well; in addition to muscles, gonads are another source of infection for man. In this study, 13 nematodes were found on and 2 in gonads. Besides, nematode survival as a result of inappropriate smoking or salting of whole fish (carcasses with viscera) poses additional risk of a potential infection.

That *A. simplex* were found in the herring caught in autumn demonstrates that the parasites occur in the Polish Baltic waters, including the Vistula Lagoon, for a period longer than previously thought. Because of that, the risk of infecting accidental hosts, including man, is increased.

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LARWY III-STADIUM *Anisakis simplex* (RUDOLPHI, 1809) (NEMATODA; ANISAKIDAE) U ŚLEDZI ODŁOWIONYCH JESIENIĄ Z POLSKIEJ STREFY ZALEWU WIŚLANEGO

Streszczenie. Spośród 231 zbadanych śledzi odłowionych jesienią z polskiej strefy Zalewu Wiślanego, u 6.5% stwierdzono larwy III-stadium *Anisakis, simplex*. Pasożyty odnotowano u ryb powyżej 23 centymetrów długości. Występowanie *Anisakis simplex* u śledzi w okresie jesiennym zwiększa prawdopodobieństwo zarażenia żywicieli przypadkowych, w tym człowieka.

Słowa kluczowe: *Anisakis simplex*, śledź Bałtycki, *Clupea harengus membrans*, Zalew Wiślany, Polska

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