A C T A I C H T H Y O L O G I C A E T P I S C A T O R I A
Vol VI, Fasc. 1 Szczecin 1976

Jadwiga GRABDA

Parasitology

THE OCCURRENCE OF ANISAKID NEMATODE LARVAE IN BALTIC COD (*GADUS MORHUA CALLARIAS* L.) AND THE DYNAMICS OF THEIR INVASION

WYSTĘPOWANIE LARW NICIENI Z RODZINY *ANISAKIDAE* W DORSZU BAŁTYCKIM (*GADUS MORHUA CALLARIAS* L.) I DYNAMIKA ICH INWAZJI

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Larvae of two nematode species: *Anisakis simplex* (Rud.) and *Contracaecum aduncum* (Rud.) were found to occur in Baltic cod (*Gadus morhua callarias* L.). Their occurrence in various fish organs was analyzed; the investigations covered also the invasion incidence fish size relationship, the annual variability of infestation, and its occurrence in different regions of the Southern Baltic.

INTRODUCTION

Among many parasites found in fishes, nematodes are those of the greatest importance, their larvae living both in viscera and tissues of marine fishes. Some species bring about serious zoonoses in humans, in most cases a surgical treatment being required.

The *Anisakis simplex* larvae belong to this group of nematodes. For last twenty years they have been extensively and comprehensively studied, the investigations being primarily focused on developing some appropriate techniques preventing man from being infested.

The first identified *Anisakis* - caused case was noted in 1955 in Holland and from then on the anisakidosis was recorded both in Holland and other European countries; the

population of Japan, habitually consuming raw fish, is particularly vulnerable to the disease (Van Thiel et al., 1960; Yokogawa and Yoshimura, 1965, 1967; and others).

The other nematode species threatening man via marine fishes is *Terranova decipiens*. Recent reports give evidences of a pathogenic nature of this parasite. In 1972 some Japanese authors reported a human infestation by the *Terranova* larvae (Suzuki et al., 1972; Kagei et al., 1973), while in 1973 the first cases were noted in USA (Little and Most, 1973) and Canada (Kates, Wright and Wright, 1973). Those are the latest reports.

The necessity of studying the fishes with respect to their parasites is therefore undeniable not only from a purely academic point of view, but also as far as the human health is concerned (J. Grabda, 1974 b).

The issue is particularly vital whenever fresh fish, only slightly chilled with ice, containing live larvae capable of invading man are meant to be consumed.

Deep-sea catches reach their destination frozen down to very low temperatures (below -20°C) killing the larvae, thus preventing any damage to the human health. On the other hand, the Baltic fishes are landed fresh, the larvae contained in them fully maintain their viability and ability to invade so that the ***anisakidosis*** in man is likely to occur.

The question of the Baltic fish parasitization came into consideration after larval *Anisakis* had been found in Baltic herring (Rokicki, 1972, 1973; Lubieniecki, 1972; J. Grabda, 1974 a).

Apart from herring, cod is the other commercial species in the Baltic; it is a predatory fish feeding to a large extent on herring (Cięglewicz et al., 1972) and likely to become infested by the Anisakis larvae. According to the recent studies, spring herring entering the Baltic from the west to spawn here contain considerable numbers of these larvae (J. Grabda, 1974 a).

The occurrence of the *Anisakis* larvae in cod has been long known. They were found in the Atlantic, Pacific, North Sea, White, Norwegian, Barents and other adjacent seas (Rae, 1972; Wootten and Waddell, 1974; Šul'man and Šul'man-Al'bova, 1953; Berland, 1961; and others). No larvae in Baltic cod, however, were recorded either by the Polish workers (Markowski, 1933; Studnicka, 1965; Rokicki, 1975) or those from the neighbouring Baltic countries. Möller (1974) found only larval *Contracaecum aduncum* in cod from the Kiel Bay, no word on *Anisakis* being mentioned by him. In the North-Eastern Baltic the Soviet authors found only the *Contracaecum aduncum* larvae as well (Petruševskij and Šul'man, 1955; Gecevičjute, 1955; and others).

The present paper is aimed at studying Baltic cod in terms of their infestation by the Anisakids larvae, determining the extent of the invasion, and following its dynamics.

MATERIAL AND METHODS

The fishes examined were obtained mainly from the Pomeranian Bay and adjacent fishing grounds exploited by the "Belona" Fisheries Cooperative, Dziwnów, because of a possible connection between invasions in cod and herring, the latter being particularly

Table 1

Specification of cod samples examined and extent of their infestation with nematode larvae on fishing grounds exploited by the "Belona" Marine Fisheries Cooperative, Dziwnów

No. of sample	Fishing ground	Date of catch	Cod length (cm)	Number of fish examined	*Anisakis* larvae				*Contracaecum* larvae			
					Incidence (%)	Intensity	Total amount of larvae	Mean intensity	Incidence (%)	Intensity	Total amount of larvae	Mean intensity
1.	C–3	30.IV.74	37–70	30	6.6	3–9	12	6	13.3	1–2	5	1.2
2.	E,F–5	20.V.74	34–67	50	22	1–43	201	18.3	8	1–2	6	1.2
3.	F–5	7.VI.74	38–62	34	20.6	3–64	146	20.7	14.7	1–24	64	10.6
4.	E–5	26.VI.74	34–64	44	15.9	6–54	139	19.8	4.5	3–6	9	4.5
5.	D–1	18.VII.74	34–65	50	4	10–14	24	12	4	1	2	1
6.	F–4	25.VII.74	37–67	50	8	1–12	19	4.7	6	1–7	13	4.3
7.	E–5	3.VIII.74	36–48	50	–	–	–	–	8	1	4	1
8.	B,E–5,7	28.VIII.74	33–66	50	8	1–28	41	10.2	6	1–6	9	3
9.	E–5,4	16.X.74	31–48	50	2	1	1	1	4	1–4	5	2.5
10.	C–3,4	8.XI.74	43–72	24	28.9	3–23	105	15	12.5	1	3	1
11.	E–4	3.XII.74	39–57	50	2	7	7	7	4	1	2	1
12.	F–3	9.I.75	36–77	48	4.1	4–8	12	6	6.2	1–3	5	1.6
13.	F–6	20.I.75	36–67	50	4	22–50	72	36	4	2–4	6	3
14.	C–3	4.IV.75	33–73	50	8	2–56	67	16.7	4	1	2	1
15.	D–3	15.V.75	39–63	50	4	1	2	1	10	1	5	1

Table 2

Specification of cod samples examined and extent of their infestation with nematode larvae on fishing grounds exploited by the "Kuter" Fisheries Company, Darłowo

No. of sample	Fishing ground	Date of catch	Cod length (cm)	Number of fish examined	*Anisakis* larvae				*Contracaecum* larvae			
					Incidence (%)	Intensity	Total amount of larvae	Mean intensity	Incidence (%)	Intensity	Total amount of larvae	Mean intensity
1	J–8	4.IX.74	44–95	50	2	3	3	3	26	1–32	91	6.5
2.	H–5	14.XII.74	46–83	34	20.6	1–35	69	9.8	32.3	1–34	81	7.3
3.	G–9	1.X.74	43–71	50	8	2–81	106	26.5	38	1–16	116	6
4.	J–9	26.X.74	31–82	38	5.2	1–24	25	12.5	13.1	1–53	59	11.8
5.	H–5	22.XI.74	36–64	50	–	–	–	–	6	1–13	15	5
6.	G–9	7.II.75	43–92	41	4.8	7–9	16	8	31.7	1–18	63	4.8
7.	G–6	20.II.75	44–87	50	8	2–8	16	4	34	1–10	55	3.2

Table 3

Specification of cod samples examined and extent of their infestation with nematode larvae on the eastern Baltic fishing grounds

"Rybmor" Marine Fisheries Cooperative, Łeba

No. of sample	Fishing ground	Date of catch	Cod length (cm)	Number of fish examined	*Anisakis* larvae				*Contracaecum* larvae			
					Incidence (%)	Intensity	Total amount of larvae	Mean intensity	Incidence (%)	Intensity	Total amount of larvae	Mean intensity
1.	N-7	22.IV.75	48-80	32	–	–	–	–	12.5	1-12	19	4.7
"Szkuner" Fisheries Company, Władysławowo												
2.	R.S-7,8	22.IV.75	37-65	50	–	–	–	–	24	1-14	28	2.3
3.	R-9,10	22.IV.75	46-90	40	–	–	–	–	55	1-73	204	9.2
4.	0-13	23.IV.75	39-83	50	–	–	–	–	32	1-106	215	13.4
"Koga" Fisheries Company, Hel.												
5.	R-11	23.IV.75	38-59	50	–	–	–	–	20	1-13	37	3.7

strongly infested in that area. The systematic sampling was carried out throughout the year; 15 cod samples derived from 680 specimens were examined.

The central part of the Baltic, exploited by the "Kuter" Fishing Company, Darłowo as well as the eastern part operated on by the "Rymbor" Fisheries Cooperative Łeba, "Szkuner" Fishing Company, Władysławowo and the "Koga" Fishing Company, Hel yielded 7 samples out of 313 and 5 samples out of 222 fish individuals, respectively.

Total amount of 27 cod samples out of 1215 individuals of the total length range 31–95 cm were examined (Tables 1, 2, 3).

As a rule, the fishes to be examined were collected directly from the vessels operating on the pre-determined quadrats of the fishing ground preferably twice a month from 30 April 1974 till 15 May 1975.

A single sample contained 50 individuals. Only in a few cases a full-size sample could not be obtained due to some reasons beyond out our control.

Additionally, in order to interrelate the *Anisakis* invasion in both species, 3 herring samples 100 individuals each were examined, the fishes being caught at the same time and place (Table 4).

The body cavity, mesentery, liver, serum membrane covering the digestive tract,pyloric processes, intestine, gonads and skeletal muscles were all scrupulously surveyed.

The Pomeranian Bay fishes were examined at the Institute of Ichthyology laboratory in Szczecin except for 2 samples surveyed on the spot in Dziwnów (the "Belona" Fisheries Cooperative). When studying cod caught off Darłowo, the laboratory facilities at the Experimental Station of the Faculty of Marine Fisheries and Food Technology, Darłowo were used, while for fish caught off Łeba, Władysławowo and Hel the facilities provided by the "Szkuner" Fishing Company, Władysławowo were taken advantage of. The results obtained are presented in tables and graphs.

RESULTS OF INVESTIGATIONS

The larvae of 2 nematode species of the family *Anisakidae,* viz., *Anisakis simplex* (Rud.) and *Contracaecum aduncum* (Rud.) were found in cod examined. The larvae occurring were in the 3rd developmental stage, encysted in various fish organs. Mean incidence and intensity of the invasion by the two species are presented in Tables 1, 2 and 3.

The *Anisakis simplex* invasion incidence ranged from sample to sample within 0–28.9%, the intensity range amounting to 1–81 larvae per fish.

The *Contracaecum aduncum* larvae were much more frequent; they were found in every sample examined. Their invasion incidence ranged within 4–55%, the intensity reaching 106 larvae per cod specimen.

Location of larvae in cod viscera

Larval *Anisakis* occurred in each organ examined in the fish visceral cavity. They were found within the liver capsule, among pyloric processes, on the serum membrane covering the intestine, on the stomach, gonads, mesentery, external peritoneal membrane as well as

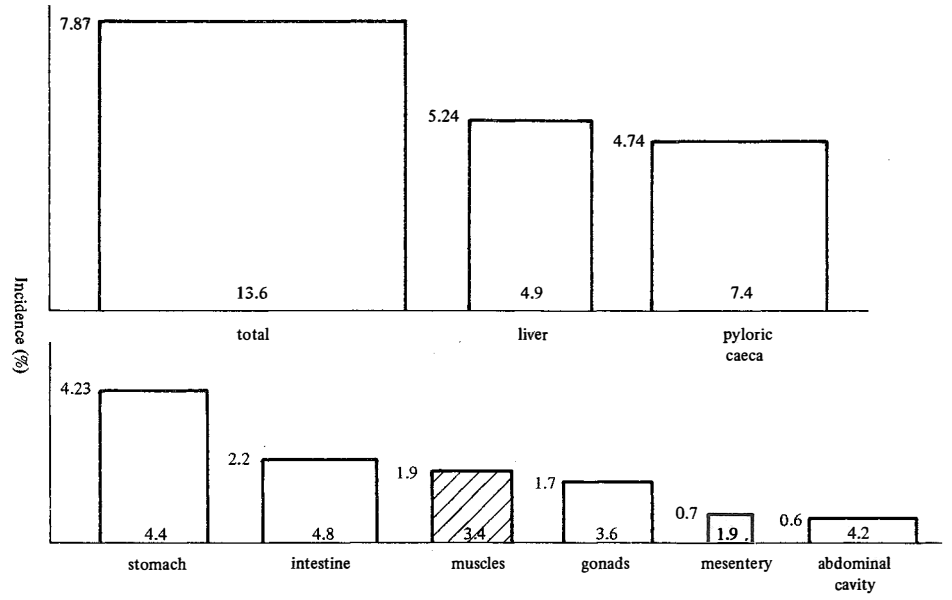

Fig. 1. Localisation of the *Anisakis simplex* larvae in cod viscera
Numbers at the basis of the columns signified mean number of larvae per fish

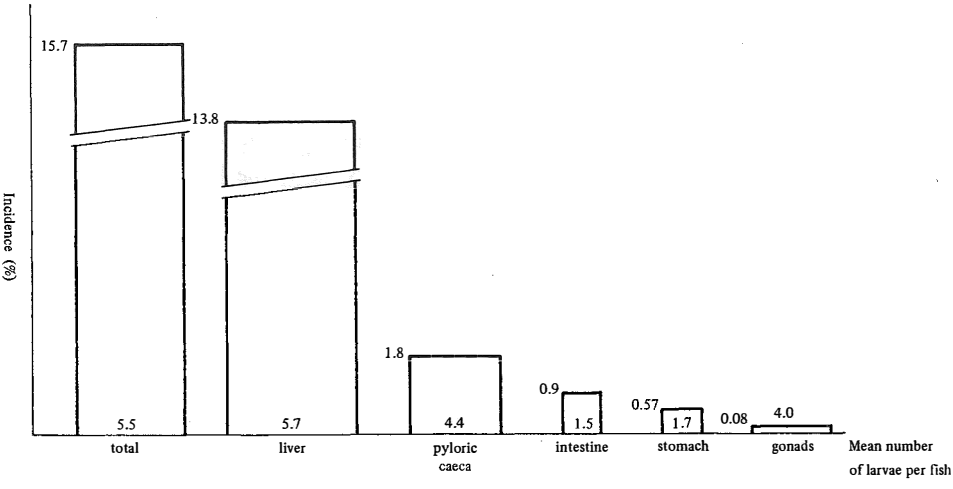

Fig. 2. Localisation of the *Contracaecum aduncum* larvae in cod viscera
Numbers at the basis of the columns signified mean number of larvae per fish

in ventral skeletal muscles. The larvae were most often encountered in the liver, between pyloric processes and on the stomach. The maximum invasion intensity in the liver and

muscles reached 17 and 10 larvae per fish, respectively, whereas gonads revealed single larvae in all but one case when 27 larvae were found (Fig. 1).

The *Contracaecum* larvae were most frequent in cod livers and between pyloric processes. The remaining organs were parasitized to a minimum degree (Fig. 2).

In contrary to the *Anisakis* larvae living well-visible under the liver capsule, *Contracaecum* occurred always in the liver parenchyma, sometimes immediately below its surface, only partly visible, thus likely to be overlooked on tentative examination. The greatest invasion intensity was ascribed to the eastern Baltic fishing grounds where the maximum liver parasitization reached 106 larvae per fish, the liver so affected having a loose texture.

Conversely to larval *Anisakis,* the *Contracaecum* larvae were never found in muscles of cod even when the invasion was generally strong.

Larval *Anisakis* occurring in muscles, liver and gonads of cod are a serious problem in fish processing. The parasitized fishes have to be thoroughly examined and sorted, the fillets carefully cleared off nematodes. Also liver and gonads to be processed should be strictly controlled; even when sparsely parasitized they cannot be used in consumption.

Similar is the procedure with liver infested by the *Contracaecum* larvae in spite of their harmlessness to man; the sanitary regulations do not permit to process such livers. Ganowiak (1968) pointed out a particularly strong parasitization of Baltic cod liver. He found from several to tens *Contracaecum* larvae in ca 50% of cod individuals caught in early spring.

A strong infestation of Baltic cod by larval *Contracaecum aduncum* is often mentioned in the Soviet literature. According to Gecevičjute (1955), the invasion incidence and intensity in cod liver off Klaipeda and in the Gotland Deep reached 72% and above 100 larvae per fish, respectively.

The parasitologic examination of cod is undoubtedly very difficult to carry on in fishing companies and does increase the production costs, none the less it is a necessary procedure.

Even the most thorough scrutiny can omit some nematodes in fish, deep in flesh. Because of that, having found the *Anisakis* larvae invasion, cod should be immediately deep-frozen after capture, the process being lethal to the larvae so that an infestation of a future consumer is avoided.

The Soviet authors (Dogiel, Petrushevskij and Polyanski, 1958) find no *Contracacum aduncum* larvae – caused decrease in the liver vitamine A content; infested liver can thus be used in the fish oil production.

Nematode invasion incidence – cod length relationship

In order to follow this relationship all the fishes were divided into 5 cm length classes for which the incidences of invasion by the both species were calculated. No notice was paid to the fishes over 75 cm length since they were too few for any significant class to be made up. 968 cod specimens from the western and central parts of the Baltic where both the nematode species occurred were examined in this way. The relationship is shown on a graph (Fig. 3).

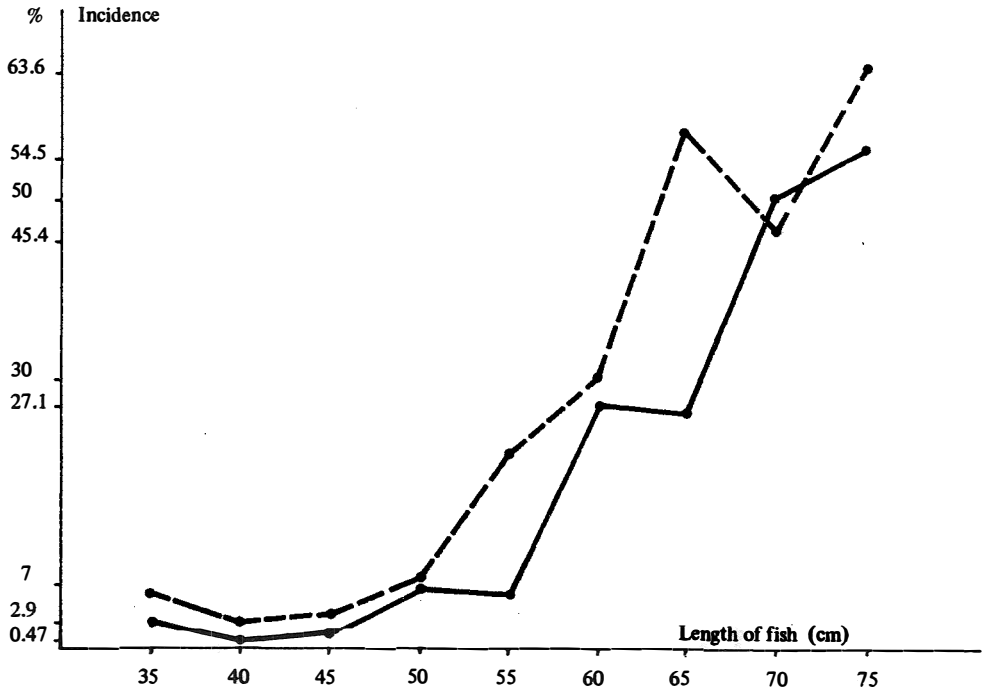

Fig. 3. The larval nematode invasion incidence – cod size relationship
Solid line – incidence of invasion by the *Anisakis* larvae
Dotted line – incidence of invasion by the *Contracaecum* larvae

In either case the incidence increased with fish length. Such a relationship could be explained by the proportion of fish in the cod food increasing with growth (Cięglewicz et al., 1972). Herring and sprat are the principal species fed upon by cod in the Baltic, small flounder, greater sand eel, garfish, small cod and others being consumed as well. Occasionally we could find also eel pout.

As it is well known, the Southern Baltic spawning grounds, mainly in the western part of the area, are frequented by strongly *Anisakis* – parasitized western herring staying there throughout the winter and spring months (J. Grabda, 1974a). This herring is obviously the source of invasion for cod. 24–25 cm long herring individuals, some containing larval *Anisakis,* were found in January in snouts and stomachs of examined cod.

First intermediate hosts in the *Anisakis simplex* life cycle are *Euphausiacea,* those of the genus *Thysanoessa* in particular, which – along with fish – form an important component in the Atlantic cod's food hence being the other source of invasion.

Euphausids do not occur in the Baltic and their presence has not been found in the Baltic cod's food (Cięglewicz et al., 1972) so this path of invasion here can be excluded. Besides, Baltic cod compared to the Atlantic ones are rather sluggish, migrating only within the Baltic where they form a separate population (or a group of populations) not encountered elsewhere (Mulicki, 1959) (Fig. 5).

Table 4

Incidence and intensity of invasion of *Anisakis simplex* larvae in herring and cod from the same Baltic fishing grounds

Baltic herring						Baltic cod					
No. of sample	Fishing ground	Date of catch	Fish length (cm)	Incidence of invasion (%)	Intensity of invasion	No. of sample	Fishing ground	Date of catch	Fish length (cm)	Incidence of invasion (%)	Intensity of invasion
1.	E–3	9.I.75	22–30	57	1–42	1.	E–3	9.I.75	36–77	4	4–8
2.	E–5	16.I.75	20–33	87	1–115	2.	E–6	20.I.75	36–67	4	22–50
3.	D–3,4	13.V.75	24–30	34	1–53	3.	D–3	15.V.75	39–63	4	1

In spite of a direct contact with parasitized herring, Baltic cod are relatively poorly parasitized by larval *Anisakis.* The invasion incidence over the period studied did not exceed 28.9% in a sample.

In order to check the parasitization of herring over the period studied, 3 herring samples 100 individuals each were collected concurrently with the cod ones from the same or adjacent fishing grounds. The results are summarized in Table 4.

Herring were found to be strongly parasitized, particularly so in January 1975. The invasion incidence and intensity amounted to 57–87% and 115 larvae per fish, respectively. On the other hand, cod feeding at that time showed only 4% invasion and the number of larvae not exceeding 50 per fish. Thus there is no direct relationship. Presumably most larvae are digested in cod's stomachs and only a fraction of parasites can gen into the body cavity.

In contrary to *Anisakis simplex,* the life cycle of *Contracaecum aduncum* takes place entirely within the Baltic. First intermediate hosts are planktonic crustaceans: *Acartia bifilosa* and *Eurytemora affinis* had been experimentally found to be susceptible to parasitization (Markowski, 1937). Various fishes are second intermediate hosts, whereas the predatory fishes, cod included, are the definite ones. The principal host both for the larval and adult nematodes is eel pout, described as a reservoir of this nematode in the Baltic.

Herring only occasionally contains the *Contracaecum* larvae, more often they can be found in sprat, smelt, gobies, serpent blenny, flounder and many other species (Markowski, 1933; Janiszewska, 1938; Rokicki, 1975). Thus the cods are exposed to parasitization throughout the year and over the whole Baltic area which probably explains the larger degree of infestation by larval *Contracaecum* than by *Anisakis.*

Annual cycle of nematode invasion

The annual variability of invasion of larval *Anisakis* and *Contracaecum* was being followed from April 1974 till May 1975 (a two-month break in the investigations occurring from February till April 1975) in the Pomeranian Bay and adjacent areas (Fig. 4).

The curves obtained show no seasonal changes in larval occurrences, month-to-month irregular variations being found only. A clear seasonality of the western herring's *Anisakis* invasion found in this part of the Baltic is not reflected in cod in spite of the species' feeding on herring. The seasonal occurrence of the *Anisakis* larvae was connected with herring's extensive westward migrations outside the Baltic and the species' vanishing from the fishing grounds of this sea.

Conversely, cod restrict their life history to the Baltic, undertaking only small-scale migrations from the spawning to the feeding grounds and vice versa (Fig. 5). Besides, both the *Anisakis* and *Contracaecum* larvae live at least one year inside the fish, which undoubtedly has a bearing on cod's parasitization continuity.

According to the Soviet authors, the parasitization of cod liver with larval *Contracaecum aduncum* has a clear seasonal nature. Gecevičjute (1955) found the lowest

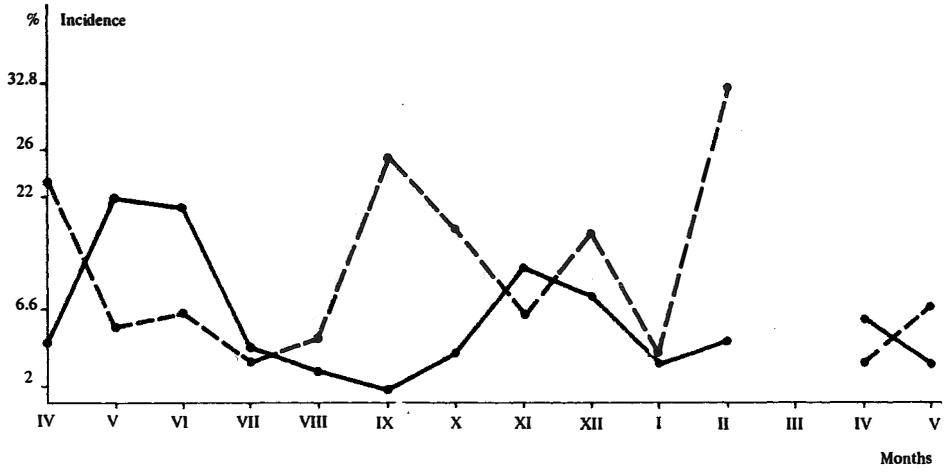

Fig. 4. Annual variability of the nematode larvae invasion
Solid line – the curve of *Anisakis* larvae invasion incidence
Dotted line – The curve of *Contracaecum* larvae invasion incidence

invasion incidence in winter (23% in January), the invasion increasing thereafter until June (72%). The subsequent decrease proceeded till next January. The observations discussed concerned cod off Klaipeda and from the Gotland Deep.

Our materials, however, failed to produce such a clearly regular picture of cod liver infestation.

Parasitization of cod in various regions of the Baltic

The cod specimens examined fall into 3 groups clearly different in their larval nematode invasion incidence: the fishes of the Pomeranian Bay and adjacent waters (Fishing quadrats B – F, 1 – 7), those of the central (G – J, 5 – 9) and the eastern Baltic (N – S, 7 – 13).

The *Anisakis* larvae were encountered only in cod of the western and central parts of the Baltic, while *Contracaecun* occurred in every cod group examined over the whole area of the sea.

The *Anisakis* invasion incidence shows an eastward decrease; the mean infestations computed for the western and central Baltic cod amount to 8.4 and 6.4%, respectively, no *Anisakis* larvae being found in the eastern group.

The opposite trend is observable in the *Contracaecum* larvae. The lowest invasion incidence (6.5%) was found in the "western" group while the "central" and "eastern" ones revealed higher incidences of 25.9 and 28.8%, respectively.

Infestation of cod by larval *Anisakis* depends on western herring entering the Southern Baltic spawning grounds; most herring stay in the Pomeranian Bay, only part of them migrates further to the east and disperses on the spawning grounds along the Baltic coast.

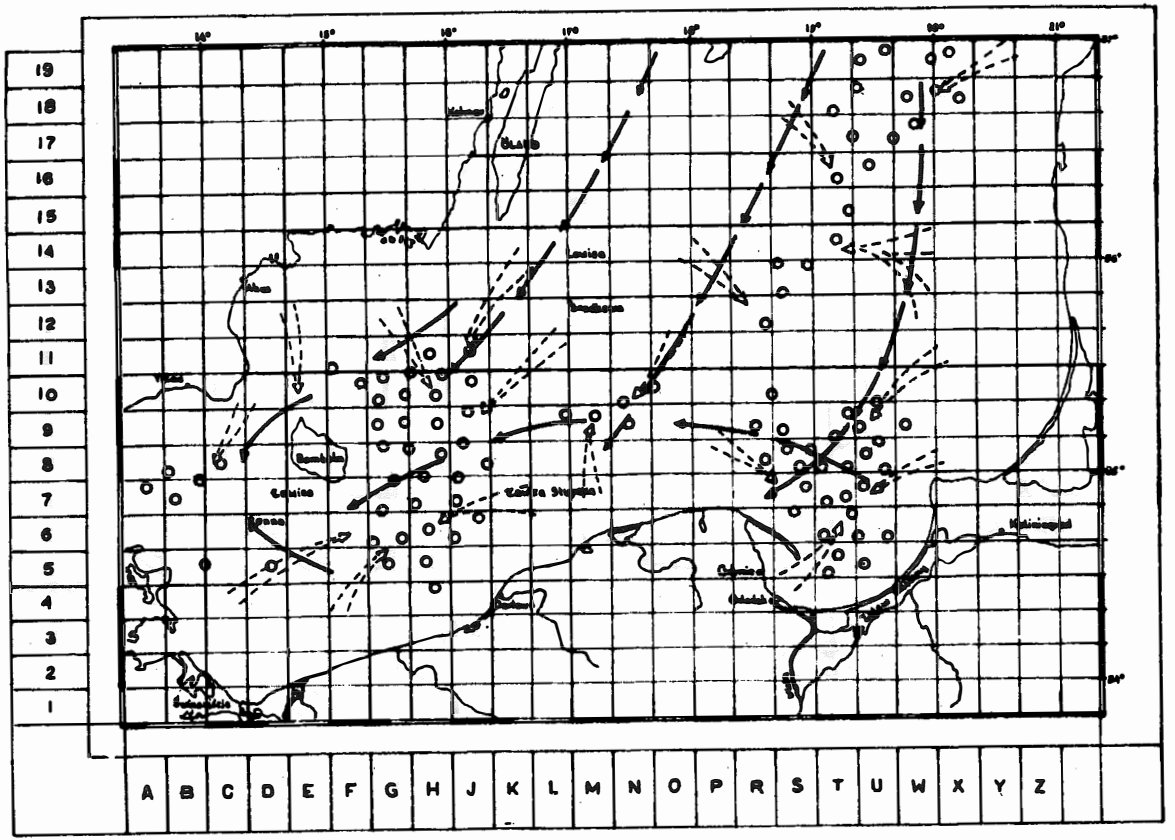

Fig. 5. Migrations and spawning grounds of Baltic cod (modified from Rutkowicz and Klimaj, 1962)
Circles denote spawning grounds of cod; solid arrows – main directions of feeding migrations and autumn – winter translocations; dotted arrows – main directions of spawning migrations

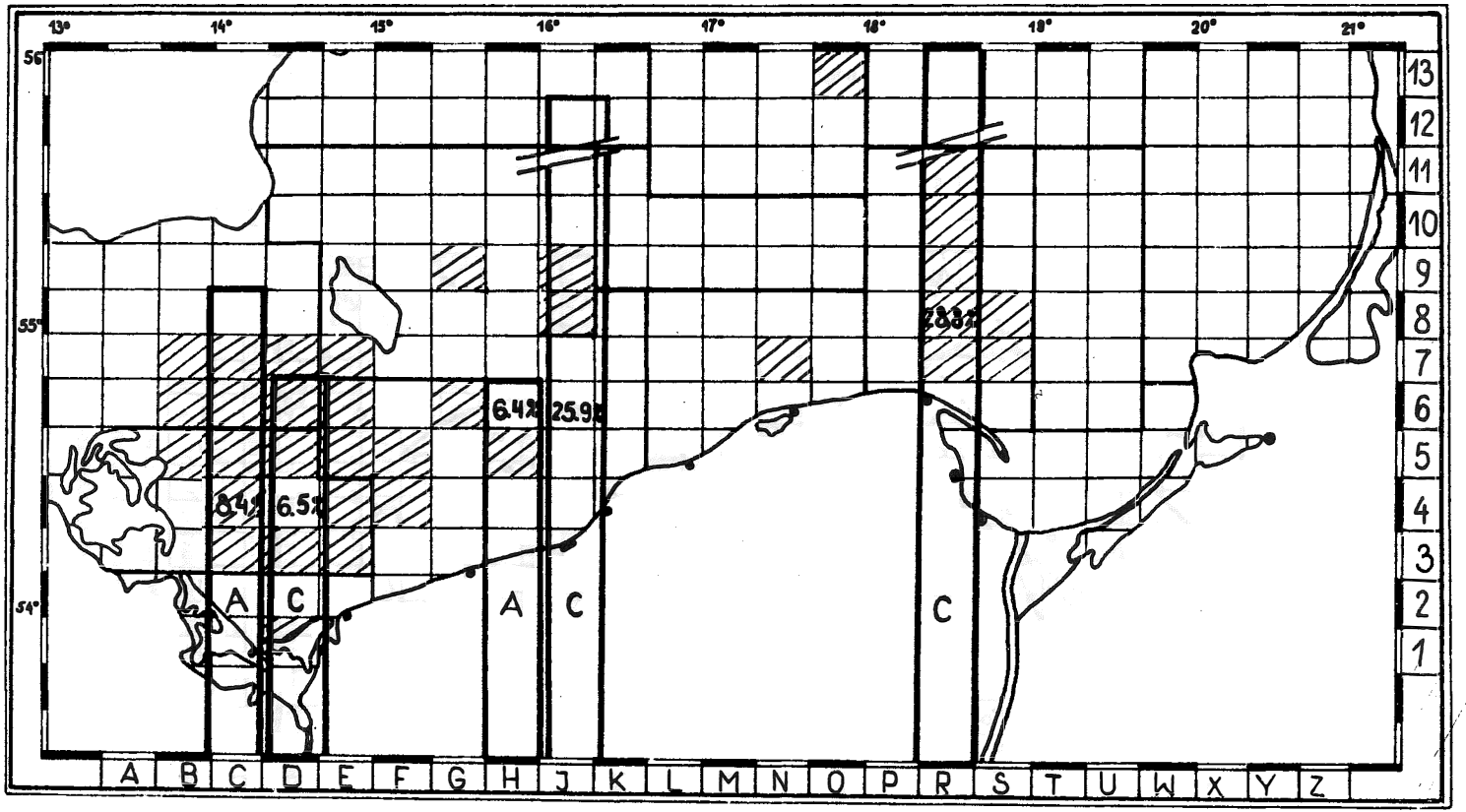

Fig. 6. Incidences of invasion by larval *Anisakis simplex* and *Contracaecum aduncum* in various regions of the Baltic
Hatched squares – sites of capture of cod investigated
Bars denoted with "A" – the *Anisakis* larvae invasion incidence
Bars denoted with "C" – the *Contracaecum aduncum* larvae invasion incidence

Fairly small numbers reach the Gdańsk Bay, a chance of infesting cod of the area thus being reduced.

However, since parasitized herring reach the Puck Bay spawning grounds (J. Grabda, 1974a; Strzyżewska and Popiel, 1974) a possibility of invasion in cod cannot be eliminated in spite of the fact that the Gdańsk Bay cod examined were free of the *Anisakis* larvae.

An ever-increasing invasion of *Anisakis* in fish is at present observed in seas all over the world (Roskam, 1966; Rae, 1963, 1972; Wootten and Weddel, 1974, and others).

DISCUSSION

The larvae of 3 economically important anisakid species: *Terranova* (= *Porrocaecum* = *Phocanema*) *decipiens, Anisakis* (= *Stomachus*) *simplex* and *Contracaecum aduncum* are noted in viscera and muscles of cod. They are particularly frequent in the northern hemisphere seas and bring about great economic losses through disqualifying the fillets affected. Besides, as it has been mentioned in the Introduction, *Terranova* and *Anisakis* are a potential threat to man so that a special larval-killing technology needs to be employed while processing the infested fishes, the production costs being thus increased.

The larvae of *Terranova decipiens* were found in cod of the Riga Bay (Dogiel, Petrushevskij, Polynski, 1958) and a possibility of their invasion should be borne in mind, although we were unable to find any larvae of this species. A chance for the Southern Baltic cod to be parasitized is rather negligible since seals, the definite hosts for the species, are very rare here. The first hosts from which the invasion can spread and affect fish are various crustaceans. Amphipods, crabs, shrimps, and other crustaceans were experimentally infested with larvae reared from eggs, but no data indicating their being the natural actual hosts exist (Myers, 1960).

The larvae of *Contracaecum aduncum* are harmless to man, but their strong invasion causes a detestable appearance of fish so that the fishes must be gutted according to the sanitary regulations.

On the other hand, the *Anisakis* larvae cause a serious problem. They harmfully affect the human health, in view of which infested fish have to be scrupulously examined and subject to some special technologic treatment killing the larvae possibly overlooked upon the check-up.

As mentioned above, the larvae of *Anisakis simplex* in cod were for the first time recorded from the Southern Baltic. Undoubtedly this nematode's invasion has been more and more increasing over recent years, but the main reason for its absence from cod found hitherto seems to be the lack of more extensive investigations concerning both the number of fish affected and the area surveyed. Furthermore, the investigations should be long-term (at least one year) thus eliminating errors introduced by a possible seasonal occurrence of the parasite. The studies carried out by Markowski (1933), Janiszewska (1937), Studnicka (1965) and Rokicki (1975) were unfortunately concentrated in the eastern part of the Baltic, i.e., in the Gdańsk Bay, where the *Anisakis* larvae are absent from cod.

CONCLUSIONS

The results presented in this paper allow the following conclusions to be drawn:

1. A mixed larval nematode invasion, of 3rd stage of *Anisakis simplex* and *Contracaecum aduncum* invading its definite host, is observed in Baltic cod.
2. Western herring entering the Baltic from the west to spawn here is for Baltic cod the source of invasion by the *Anisakis simplex* larvae. Man can be accidentally infested by the larvae, the more so that they occur in fish flesh and other edible parts (liver, gonads).
3. *Contracaecum aduncum* is a common parasite occurring in many Baltic fish species. Adult cod can be infested via other fishes like sprat, flounder, eel pout, greater sand eel, small cod, and others. These larvae are harmless to man, the predatory fishes being their definite hosts.
4. The incidence of invasion by the both nematode species increases with growth of cod, the proportion of larvae-carrying fishes increasing in food.
5. No seasonal pattern was detected in the *Anisakis* and *Contracaecum* larvae occurrence in Baltic cod. The incidence of the both species' invasion varies irregularly throughout the year.
6. The intensity of the both species' invasion is not uniform over the whole area of the Baltic. The highest incidence and intensity of the *Anisakis* larvae invasion were recorded from the western Baltic (the Pomeranian Bay and adjacent fishing grounds), decreasing to the east. No *Anisakis* larvae were found in cod from the Gdańsk Bay. An increase in the invasion should be, however, taken into consideration since western herring, though in small numbers, reach the Puck Bay spawning grounds.

Cod is parasitized by the *Contracaecum aduncum* larvae over the whole Southern Baltic, the invasion in creasing to the east.

ACKNOWLEDGEMENTS

I would like to express my sincere thanks to Mrs Mirosława Żak, Mrs Urszula Żarska and Mr Wawrzyniec Wawrzyniak M.Sc. for their assistance in examining the fishes, while Mrs Ewa Sobecka's effort in drawing the figures and graphs is gratefully acknowledged as well.

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WYSTĘPOWANIE LARW NICIENI Z RODZINY *ANISAKIDAE* W DORSZU BAŁTYCKIM (*GADUS MORHUA CALLARIAS* L.) I DYNAMIKA ICH INWAZJI

Streszczenie

Zbadano 1215 dorszy (*Gadus morhua callarias* L.) długości całkowitej 31–95 cm, pochodzących z Południowego Bałtyku.

Badania przeprowadzono w cyklu rocznym w okresie od 30 kwietnia 1974 do 15 maja 1975 roku. Ryby pobierano z połowów przemysłowych po 2 próby, liczące około 50 sztuk dorsza każda, miesięcznie.

W narządach jamy ciała badanych dorszy znaleziono dwa gatunki larw nicieni, a mianowicie: *Anisakis simplex* (Rud.) i *Contracaecum aduncum* (Rud.).

Prześledzono dynamikę inwazji obu gatunków larw oraz przeanalizowano źródła zarażenia dorsza bałtyckiego.

W wyniku badań ustalono następujące wnioski:

1. W dorszu bałtyckim występuje mieszana inwazja larw nicieni *Anisakis simplex* i *Contracaecum aduncum* w III stadium rozwojowym, inwazyjnym dla żywicieli ostatecznych tych nicieni.
2. Źródłem inwazji larw *Anisakis simplex* dla dorsza bałtyckiego jest śledź zachodni, przychodzący do Bałtyku na tarło z zachodu, z rejonów pozabałtyckich. Larwami *Anisakis* może zarazić się przypadkowo człowiek, tym bardziej że larwy występują w mięśniach i narządach jadalnych ryb (wątroba, gonady).
3. *Contracaecum aduncum* jest pasożytem pospolitym, występującym w wielu gatunkach ryb bałtyckich. Dorsz dorosły zaraża się larwami za pośrednictwem innych ryb jak szprot, stornia,

węgorzyca, dobijak, małe dorsze i inne. Larwy *Contracaecum aduncum* są dla człowieka nieszkodliwe, ich żywicielami ostatecznymi są ryby drapieżne.

4. Wraz ze wzrostem dorszy zwiększa się ekstensywność inwazji larwami obu gatunków nicieni, co jest uwarunkowane coraz większym udziałem ryb (nosicieli larw) w pokarmie dorszy.
5. Nie zaobserwowano sezonowości w występowaniu larw nicieni w dorszu bałtyckim w cyklu rocznym. Ekstensywność inwazji waha się w ciągu całego roku w sposób nieregularny.
6. Nasilenie inwazji obu gatunków larw nicieni nie jest jednolite na całym obszarze Bałtyku. Największa ekstensywność i intensywność larw *Anisakis simplex* występuje w części zachodniej Bałtyku na obszarze Zatoki Pomorskiej i łowisk przyległych i zmniejsza się w kierunku wschodnim. W okolicach Zatoki Gdańskiej larw *Anisakis* nie znaleziono. Należy się jednak liczyć ze wzrostem inwazji, ponieważ śledź zachodni dociera również, choć w małej liczbie, na tarliska Zatoki Puckiej. Zarażenie dorszy przez larwy *Contracaecum aduncum* występuje na całej przestrzeni Południowego Bałtyku ale wykazuje tendencję wzrostu w kierunku wschodnim.

Я. Грабда

ЛИЧИНКИ НЕМАТОД ИЗ СЕМЕЙСТВА ANISAKIDAE У БАЛТИЙСКОЙ ТРЕСКИ (GADUS MORHUA CALLARIAS L.) И ДИНАМИКА ИХ ИНВАЗИИ

Р е з ю м е

Исследованиям было подвергнуто 1215 экз. трески (Gadus morhua callarias L.) абсолютной длиной от 31 до 95 см, выловленной в южной части Балтийского моря.

Исследования были проведены в годовом цикле в период с 30 апреля 1974 г. по 15 мая 1975 г. Рыбу брали из промысловых уловов по 2 пробы в месяц, в каждую из которых брали по 50 экземпляров трески.

В органах полости тела исследуемой трески обнаружены два вида личинок нематод, а именно: Anisakis simplex (Rud.) и Contracaecum aduncum (Rud.).

Прослежена динамика инвазии обоих видов личинок и проанализирован источник заражения балтийской трески.

В результате исследований сделаны следующие выводы:

1. У балтийской трески наблюдается смешанная инвазия личинок нематод Anisakis simplex и Contracaecum aduncum в III стадии развития, которая является стадией инвазии этих нематод для конечных их хозяев.
2. Источником инвазии личинок Anisakis simplex для балтийской трески является западная сельдь, приходящая в Балтийское море на нерест с запада, из внебалтийских районов. Личинками Anisakis может заразиться и человек, тем более, что личинки могут находиться в мышцах и органах съедобных рыб (печень, гонады).
3. Contracaecum aduncum является обыкновенным паразитом, встречающимся у многих видов балтийских рыб. Взрослая треска заражается личинками посредством других рыб, а именно: шпрота, речной камбалы, бельдюги, мелкой трески и др. Личинки Contracaecum aduncum безвредны для человека, их конечными хозяевами являются хищные рыбы.

4. Вместе с ростом трески увеличивается экстенсивность инвазии личинок обоих видов нематод, что обусловлено всё большим удельным весом рыб (носителей личинок) в корме трески.
5. В ходе исследований не отмечена сезонность в появлении личинок нематод у балтийской трески в годовом цикле. Экстенсивность инвазии колеблется в течение всего года нерегулярно.
6. Усиление инвазии обоих видов личинок нематод в Балтийском море неоднородно. Наибольшая экстенсивность и интенсивность инвазии личинок Anisakis simplex наблюдается в западной части Балтийского моря, в Поморской бухте и в близлежащих районах лова и уменьшается в направлении на восток. В районе Гданьской бухты личинки не были обнаружены. Следует, однако, считаться с увеличением инвазии, т.к. западная сельдь заходит также, хотя и в небольшом количестве, в районы нереста Пуцкой бухты. Заражение трески личинками Contracaecum aduncum наблюдается на всём протяжении южных районов Балтийского моря, однако проявляет тенденцию к увеличению в направлении на восток.

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Received: 15 XII 1975 r.