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DYNAMICS OF SELECT PARASITE INFESTATION OF THE THREE- SPINED STICKLEBACK IN DEPENDENCE ON THE PLACE OF CATCHING IN THE SOUTHERN BALTIC

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Abstract

The three - spined stickleback *Gasterosteus aculeatus* (L.) has been a very frequent fish in coastal waters. The examined sticklebacks were collected from the Middle Coast (Rowy, Ustka, Darłowo, Kołobrzeg), from the Gulf of Gdańsk (Gdynia, Puck, Hel) and the Dead Vistula (Górki Wschodnie). The studies on the correlation between the dynamics of infestation and places of fish catching were carried out. Some species of parasites infected fish generally from the Middle Coast or from the the Gulf of Gdańsk. All species of *Acanthocephala*, *Gyrodactylus arcuatus* (*Monogenea*), glochidia (larvae *Bivalvia*) infected sticklebacks from the Middle Coast with the highest prevalence. Fish from the Gulf of Gdańsk were infected by *Apatemon* sp. (*Digenea*), *Schistocephalus solidus* (*Cestoda*) and *Thersitina gasterostei* (*Copepoda*) more often than remaining fish. Ciliates generally infected fish from the Dead Vistula.

Key words: three-spined stickleback *Gasterosteus aculeatus*, parasites, mean intensity and prevalence of infestation, Polish coastal zone of the Baltic Sea.

INTRODUCTION

During the last 70 years, the three-spined stickleback *Gasterosteus aculeatus* (L.) has been a frequent fish in the Polish coastal zone (Skóra 1993). Over this time a variety of changes in the coastal ecosystem have been observed, because of environmental pollution and rapidly growing urbanization in the coastal region of the Baltic Sea (Cyberski *et al.* 1993, Wołowicz *et al.* 1993). Some changes have taken place in phytobenthos and zoobenthos. Also fish stocks have decreased and in the last 90 years two species of sticklebacks, nine - spined *Pungitius pungitius* and especially three - spined *G. aculeatus*, have become predominant populations in the Baltic coastal water (Skóra 1992), by reason of their exceptional resistance to the degradation of the environment and their biology.

Research on the sticklebacks and their parasites from our coastal waters have been very important. Because of frequency, wide dispersion and many predators

having sticklebacks as food items, this species of fish have been a very important link in the trophic interactions of the Baltic. Because of their omnivorous nature, the stickleback have been one of the most infected fish and very important transmitter of parasites in the food-web.

The studies on the correlation between mean intensity, prevalence of infestation by some parasites and places of fish catching have been carried out. Differences in the infestation of three - spined stickleback from the investigated regions have been described below.

MATERIAL AND METHODS

3,510 sticklebacks were caught with a hand-net in the coastal zone of the Baltic Sea between January 1994 and December 1995. The hauls were taken every month from three regions: the Middle Coast (Rowy, Ustka, Darłowo, Kołobrzeg), the Gulf of Gdańsk (Gdynia, Puck, Hel) and the mouth of the Dead Vistula (Górki Wschodnie), see Fig. 1.

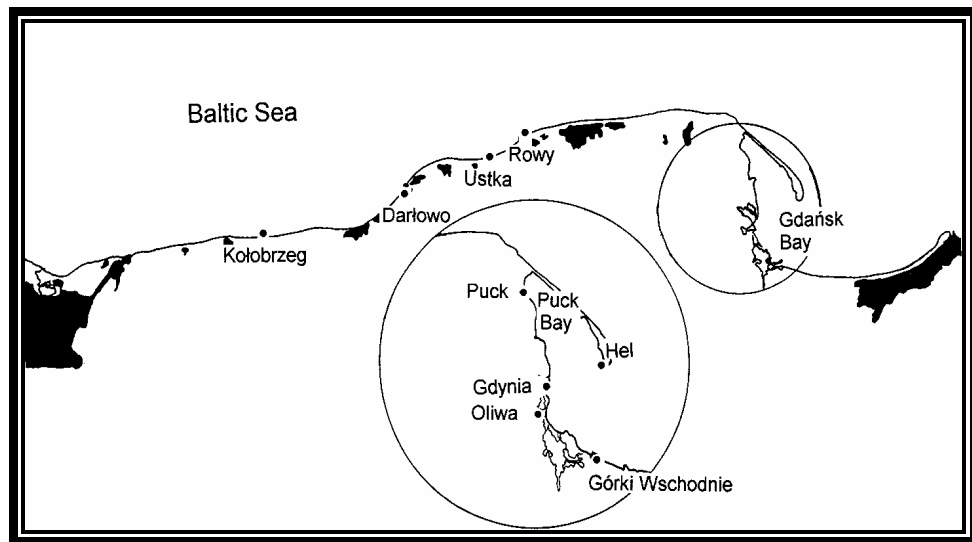


Fig. 1. Places of catching stickleback *Gasterosteus aculeatus* on the Polish coast of the Baltic Sea

The fish were transported in the live - box to the laboratory, at the Department of Invertebrate Zoology, University of Gdansk, and immediately examined. The fish were killed by pithing and examined for ecto- and endoparasites with a binocular microscope. Parasites were prepared and preserved by typical methods for particular groups (Bylund *et al.* 1980). Mean intensity and prevalence of infestation were counted for all samples and compared in dependence on various factors, *e.g.* place of catching, described in this paper.

Statistical analysis were carried out in program SPSS/PC+, version 7.0 for Windows (prevalence - test of Pearson's chi-square conformity, mean intensity - multiple regression analysis).

RESULTS

As shown in Table 1, twenty five species and two parasites marked to the genus and also glochidia were found on or in the examined sticklebacks.

Table 1

List of parasites detected in / on the three-spined stickleback from the southern Baltic between January 1994 and December 1995

Taxa	Middle Coast	Gulf of Gdańsk	Mouth of the Dead Vistula
<i>Ciliata</i>			
<i>Trichodina domerguei</i>	+	+	+
<i>T. tenuidens</i>	+	+	+
<i>Microsporidia</i>			
<i>Glugea anomala</i> (cyst)	+	+	+
<i>Monogenea</i>			
<i>Gyrodactylus arcuatus</i>	+	+	+
<i>Digenea</i>			
<i>Diplostomum spathaceum</i> l.*	+	+	+
<i>Apatemon</i> sp. (cyst) l.	+	+	+
<i>Phyllodistomum folium</i>	+		
<i>Cestoda</i>			
<i>Proteocephalus filicollis</i>	+	+	+
<i>Schistocephalus solidus</i> l.	+	+	+
<i>Diphyllobothrium ditremum</i> l.	+	+	+
<i>Triaenophorus nodulosus</i> l.		+	
<i>Bothriocephalus scorpii</i> l.	+	+	
<i>Nematoda</i>			
<i>Eustrongylides mergorum</i> l.	+	+	
<i>Anisakis simplex</i> l.	+		
<i>Hysterothylacium aduncum</i> l.		+	+
<i>Raphidascaris acus</i> l.	+	+	+
<i>Ascarophis longispicula</i>	+	+	
<i>Spinitectus</i> sp.		+	
<i>Acanthocephala</i>			
<i>Neoechinorhynchus rutili</i>	+		
<i>Echinorhynchus borealis</i>	+		
<i>E. salmonis</i>	+		
<i>Acanthocephalus clavula</i>	+		
<i>A. lucii</i>	+		
<i>Pomphorhynchus laevis</i>	+		
<i>Hirudinea</i>			
<i>Piscicola geometra</i>		+	
<i>Mollusca</i>			
Glochidium indet. l.	+	+	+
<i>Crustacea</i>			
<i>Thersitina gasterostei</i>	+	+	+
<i>Argulus foliaceus</i>	+	+	+

* - l. - larval stages

In this study, some parasites, *i.e.* *Diplostomum spathaceum* (Digenea - metacercariae) and *Proteocephalus filicollis* (Cestoda - adult) were confirmed with similar intensity and prevalence of infestation in all places of catching (*D. spathaceum* - intensity near 5 indiv., prevalence near 40%, *P. filicollis* - intensity near 1,00 indiv., prevalence near 1,25%). *Glugea anomala* (Microsporidia) also occurred with insignificant differences in all samples.

Ciliates from the genus *Trichodina* showed differentiation, *T. domerguei* were found with highest prevalence and intensity on fish from the mouth of the Dead Vistula. Highest prevalence of infestation by *T. tenuidens* was observed in the Dead Vistula but intensity in the Gulf of Gdańsk ($p < 0,005$), see Fig. 2. Both species of ciliates have different localisation on the host: *T. domerguei* occurred on the fins or body surface of stickleback and *T. tenuidens* on the gills. Remaining species infected with highest prevalence sticklebacks from the Gulf of Gdańsk or from the Middle Coast, *e.g.* *Gyrodactylus arcuatus* (Monogenea), *Argulus foliaceus* (Branchiura), glochidia (Mollusca - larvae of *Bivalvia*) - Middle Coast ($p < 0,005$) see Fig. 3 and *Apatemon* sp. (Digenea - metacercariae), *Schistocephalus solidus* (Cestoda - plerocercoids) and *Thersitina gasterostei* (Copepoda) - Gulf of Gdańsk ($p < 0,005$), see below for Fig. 4-5. Mean intensity of infestation by mentioned above parasites have also statistically significant differentiation.

Acanthocephala and *Nematoda* occurred rarely in the examined sticklebacks, but also preferred one of the regions. All species of *Acanthocephala* were found in fish from the Middle Coast. Some of *Nematoda* (*Eustrongylides mergorum*, *Anisakis simplex*) also occurred generally in this area. Fish from the Dead Vistula were infected by nematodes *Hysterothylacium aduncum* and *Raphidascaris acus* more than any other stickleback. But this group of parasites because of infrequent occurrence. Did not undergo statistical analysis.

DISCUSSION

The differences in prevalence and mean intensity of parasites infestation of the sticklebacks from mentioned regions were very interesting. The most important differences were observed between the Middle Coast and the Gulf of Gdańsk. The sticklebacks from the mouth of the Dead Vistula generally had a similar prevalence of infestation as fish from the Gulf of Gdańsk. Particular groups of parasites were described separately.

Ciliata

Trichodina domerguei was a predominante species in the Dead Vistula but a second species, *T. tenuidens*, did not has so clear a disposition. Both species have been in freshwater, with tolerance to the considerable changes of salinity (Basson, Van As 1991), but this factor was an unlikely reason of differences of infestation in the studied regions.

Ciliates from the family *Trichodina* generally infected fish from the polluted regions (Rohde 1993). It has been widely known, that the Vistula became one of the most important sources of Baltic pollution.

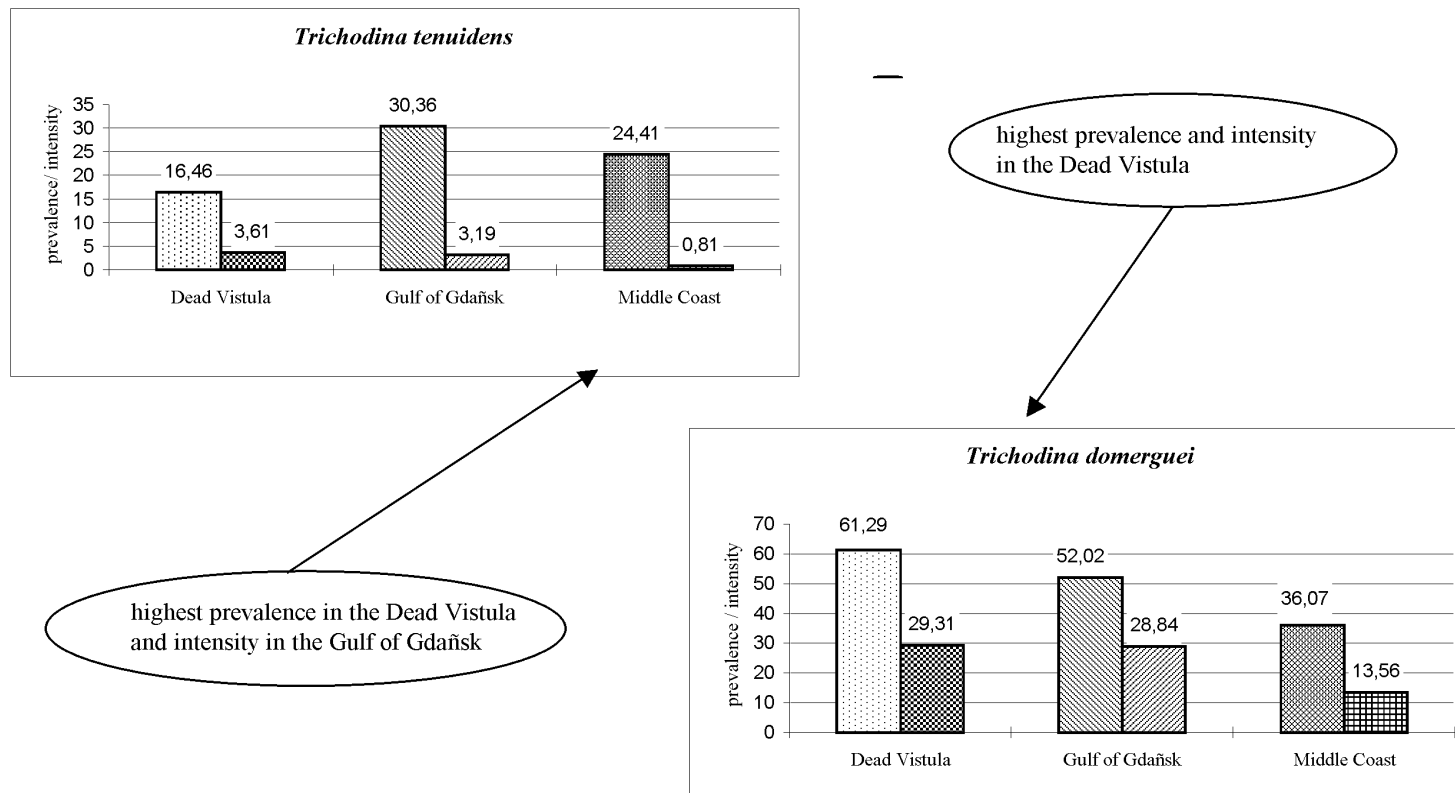


Fig. 2. Prevalence and mean intensity of infestation in various places of fish catching.
 * first columns - mean intensity, second - prevalence, in all figures.

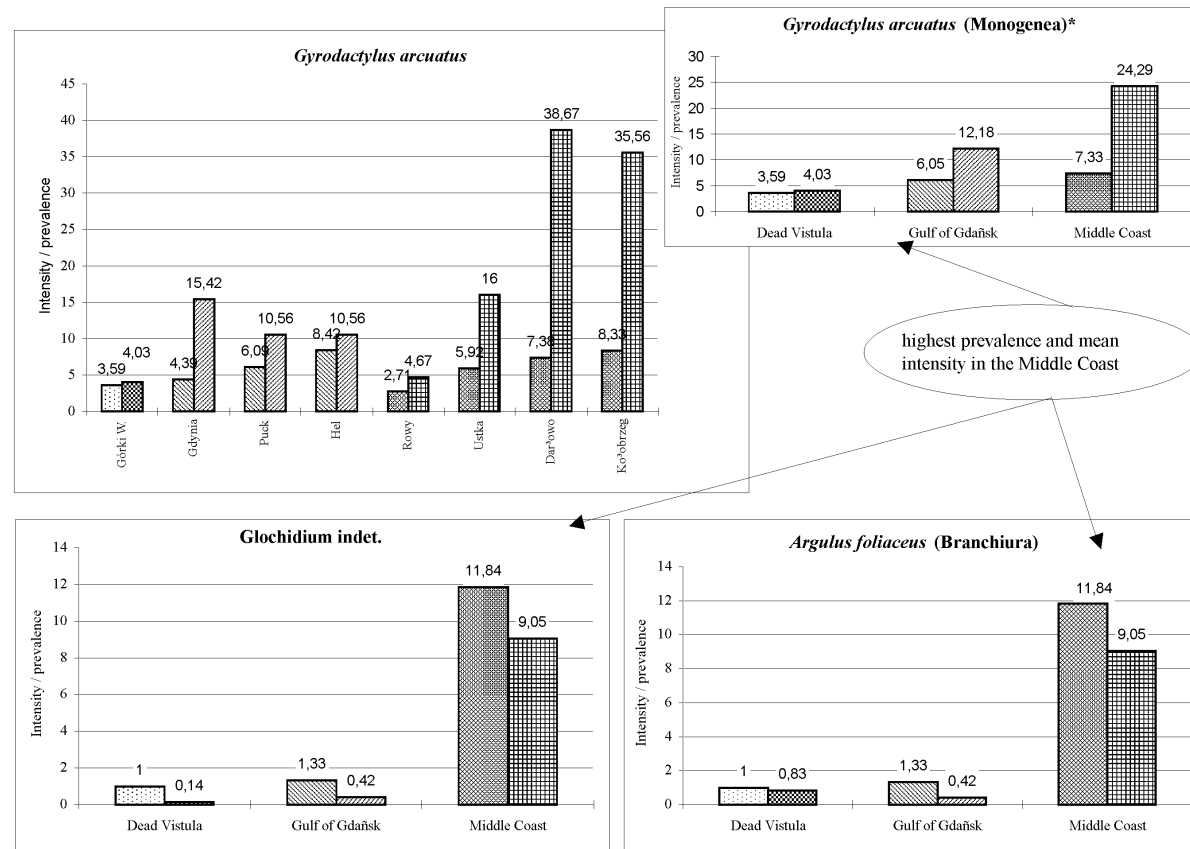


Fig. 3. Prevalence and mean intensity of infestation in various places of fish catching
 * first columns - mean intensity, second - prevalence, in all figures

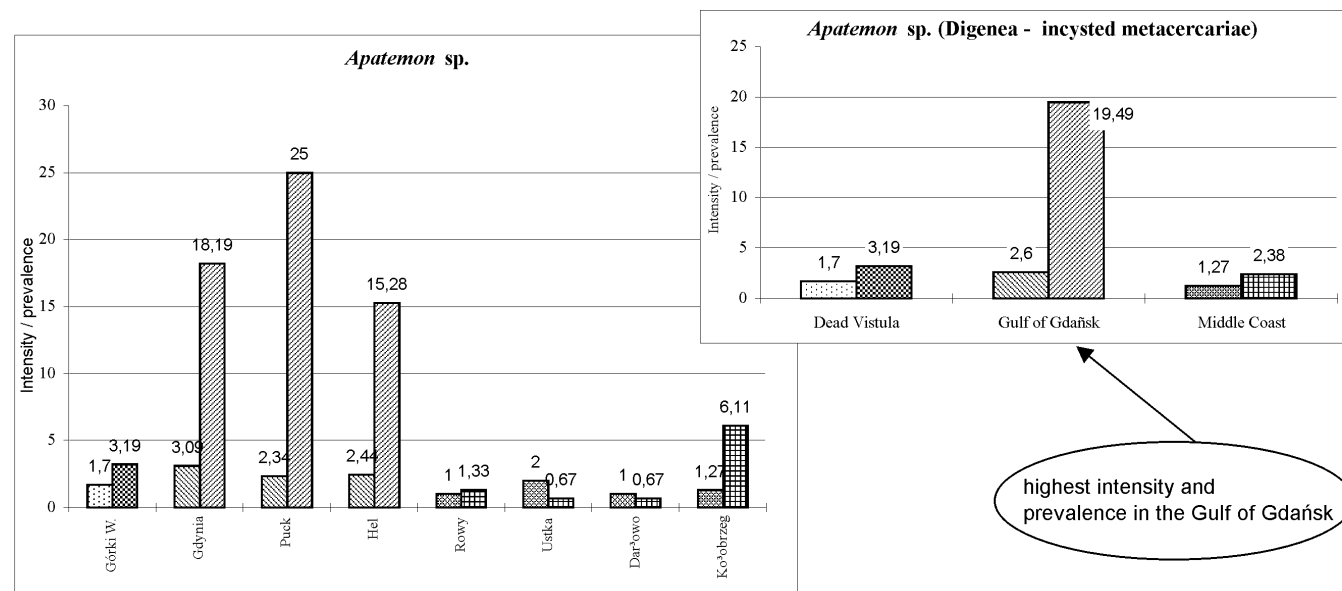


Fig. 4. Prevalence and mean intensity of infestation in various places of fish catching
 * first columns - mean intensity, second - prevalence, in all figures.

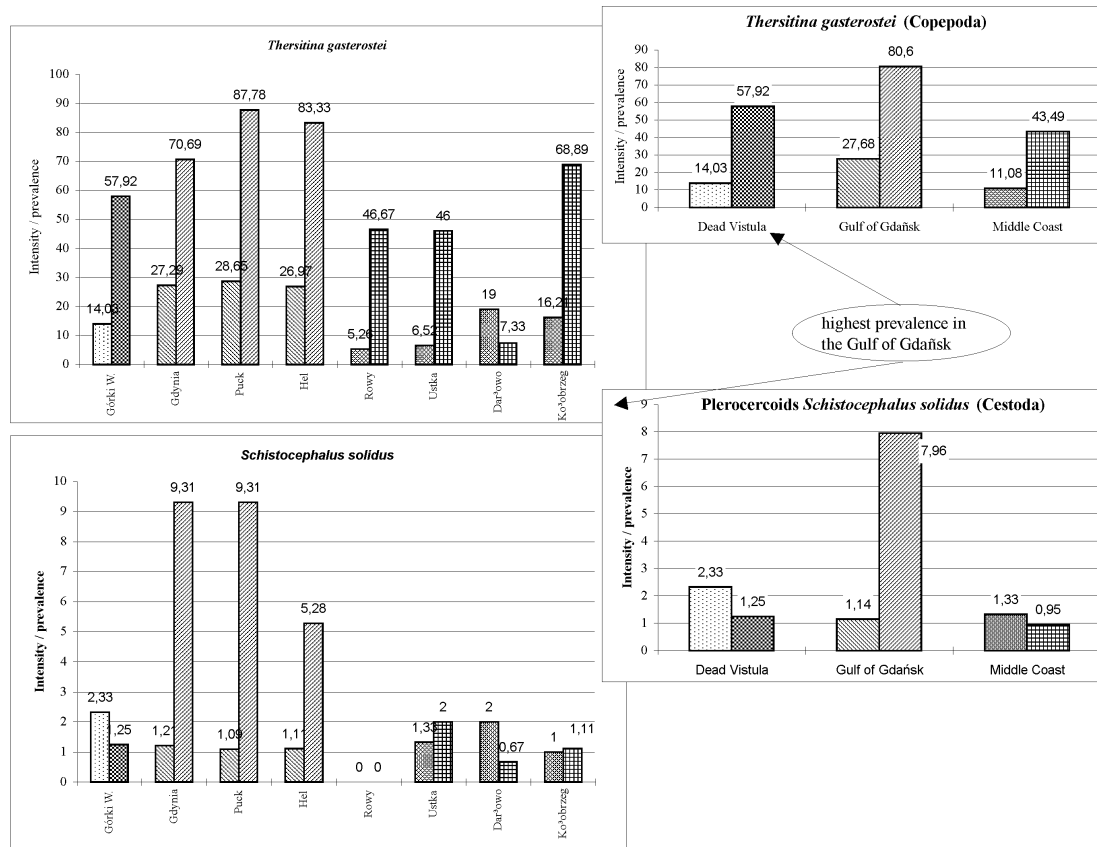


Fig. 5. Prevalence and mean intensity of infestation in various places of fish catching
 * first columns - mean intensity, second - prevalence, in all figures.

The Gulf of Gdańsk has been polluted by reason of the high urbanization of this region and by the Vistula waters. Conditions in our coastal water were favourable for high infestation by ciliates.

T. tenuidens was a rarer species than *T. domerguei* in all sampled regions. The localisations observed on stickleback have been typical for mentioned species (Calenius 1980, Levsen 1992). Interspecific competitions were a probable reason of the rarer occurrence of *T. tenuidens*. The gills were a place of parasitize for a typical and very frequent, parasite of the stickleback *Thersitina gasterostei* and also *Gyrodactylus arcuatus*, who forced out ciliates. On the fins and body surface generally occurred *T. domerguei*, sometimes competing with *G. arcuatus* for place, but only on the caudal fin .

Monogenea

Gyrodactylus arcuatus located on the gills and sometimes on the fins (especially caudal). *G. arcuatus* occurred on freshwater and brackish water fishes. Generally this species was recognized as a marine species (Harris 1985). *G. arcuatus* occurred more frequently in the western part of the investigated area for two reasons. One, the most probable, were interspecific competitions with copepods and ciliates. Second, were changes in hydrological conditions, especially salinity and pollution. From time to time in the Baltic have been observed an increase of salinity, generally in the western part of our coast, after an inflow of highly saline water from the North Sea through the Danish Straits (Wojewódzki 1991, Grelowski, Wojewódzki 1993).

Digenea

Similar infestation by *Diplostomum spathaceum* in all regions was a reason of wide distribution of hosts. The most important hosts were: first intermediate hosts - molluscs from the family *Lymnaeidae*, second intermediate hosts - many species of freshwater and brackish water fish, final hosts - many species of birds, especially from family *Laridae*.

Second parasite *Apatemon* sp. first of all occurred in the Gulf of Gdańsk, despite having the same intermediate hosts. The final host of this species generally have been birds from the family *Anatidae*. The biggest flocks of ducks were observed at the time of researches exactly in the Gulf of Gdańsk.

Cestoda

The typical parasite of *G. aculeatus*, cestode *Schistocephalus solidus* has been widely distributed in the northern hemisphere (Kennedy 1974, Wootton 1976, Margolis, Arthur 1979, Möller-Buchner 1987). In the Polish coastal zone, plerocercoids of *S. solidus* were the most frequent parasite in the Gulf of Gdańsk. The first intermediate host has been cyclops, second - sticklebacks, final - gulls and many other fish-feeding birds. Probably it was a reason of the very frequent presence of parasites, that all hosts occurred, which enabled parasites to close the life cycle. Very important were the food preferences of sticklebacks.

Acanthocephala

All acanthocephalans occurred only in the Middle Coast, but prevalence was not high like in research managed by Valtonen, Crompton (1990) in the Botnian Bay. Absence of this group of parasites in the stickleback from Gdańsk Bay and the Dead Vistula were really interesting, because their important intermediate hosts like *Candona neglecta*, *Asellus meridiens*, *Gammarus pulex*, *Pontoporeia affinis*, *Pallasea quadrispinosa* and larvae of *Sialidae* have been known organisms from remaining regions (Żmudziński, Ostrowski 1990, Szymelfenig, Miłosek 1993, Wiktor 1993). From the mentioned hosts only *Gammarus* sp. was observed by Kotwicki (1993) in food of the stickleback from Puck Bay. Something caused changes in food preferences in the investigated regions. Probably it was the proportion between groups of organisms, that were food items - stickleback eaten organism's ease of approach in the region.

Nematoda

The same reasons as in the case of acanthocephalans - food items.

Mollusca

On the investigated sticklebacks glochidia were observed first of all in the Middle Coast. Live molluscs alived in the shallow parts of the ports and most probably in the Paręta, Wieprza and Stupia rivers, which have fallen into the sea along the Middle Coast. Stickleback often swam into the rivers, especially in spawning-time and were infected by parasites.

Crustacea

The reason for infestation by *Argulus foliaceus* was similar to the molluscs larvae. *Thersitina gasterostei* has been a brackish water parasite (Kabata 1992), sporadically found in freshwater. The explanation was fact, then stickleback from the Middle Coast many time spent, in freshwater for example for spawning. It was possible that some of them lost parasites in the migration between brackish water and freshwater environments (Möller 1978).

CONCLUSION

- Composition of some parasites on / in the three - spined stickleback, prevalence and intensity of infestation were dependent on the place of catching, e.g. hydrological conditions, like salinity and pollution, and proportions between groups of organisms which were intermediate hosts and also food items of the stickleback (food preferences). It was also the influence of the presence of predators, which ate sticklebacks and enabled parasites to finish their life cycles.

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DYNAMIKA ZARAŻENIA PASOŻYTAMI CIERNIKA W ZALEŻNOŚCI OD MIEJSCA POŁOWU W POŁUDNIOWYM BAŁTYKU

Streszczenie

Ciernik *Gasterosteus aculeatus* bardzo licznie występuje w przybrzeżnych wodach Bałtyku. Badane cierniki były odławiane na Środkowym Wybrzeżu (Rowy, Ustka, Darłowo, Kołobrzeg), z Zatoki Gdańskiej (Gdynia, Puck, Hel) oraz ujścia Martwej Wisły (Górki Wschodnie). W niniejszej pracy zamieszczono wyniki badań dotyczących dynamiki zarażenia cierników z różnych punktów polskiego wybrzeża. Niektóre gatunki pasożytów zarażały przede wszystkim cierniki ze Środkowego Wybrzeża lub z Zatoki Gdańskiej. W przypadku wszystkich gatunków kolcogłówów, *Gyrodactylus arcuatus* (Monogenea), *Argulus foliaceus* (Branchiura) oraz glochidiów (larwy małży) stwierdzono wyższą ekstensywność zarażenia cierników ze Środkowego Wybrzeża. Ryby z Zatoki Gdańskiej były zarażane częściej przez *Apatemon* sp. (Digenea), *Schistocephalus solidus* (Cestoda) i *Thersitina gasterostei* (Copepoda). Orzęski z rodzaju *Trichodina* zarażały przede wszystkim cierniki złowione w Martwej Wiśle.