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CORRELATION BETWEEN MORPHOLOGICAL FORMS OF THE THREE -SPINED STICKLEBACK AND PARASITES INFESTATION IN THE BALTIC SEA

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Abstract

The three-spined stickleback *Gasterosteus aculeatus* (L.) has been a very frequent fish in the Baltic coastal waters. In the Baltic Sea occurred three morphological forms of the three-spined stickleback: *trachurus, semiarmatus* and *leiurus.* The distribution and frequency of all forms of the stickleback in the Baltic have been different. The examined sticklebacks were collected from the Gulf of Gdańsk (Gdynia, Puck, Hel) and the mouth of the Dead Vistula (Górki Wschodnie).

The studies on the correlation between the morphological forms of the stickleback and parasites' infestation were carried out. Some species of parasites infected first of all form *trachurus* or *leiurus* of the stickleback. Correlation was observed in some of marine parasites like *Thersitina gasterostei* (Pagenstecher, 1861) (*Copepoda*) and *Gyrodactylus arcuatus* (Bychowsky, 1933) (*Monogenea*), infected generally *trachurus* form. Freshwater ciliates from the family *Trichodina* or plerocercoids of *Schistocephalus solidus* (Müller, 1776) (*Cestoda*) were found generally on/in form *leiurus.*

Key words: three-spined stickleback *Gasterosteus aculeatus* (L.), morphological forms: *trachurus, semiarmatus, leiurus*, parasites, prevalence of infestation

INTRODUCTION

The fish from the family *Gasterosteidae* are commonly found in the northern hemisphere, in fresh water, brackish water and marine environment (Meakins and Walkey 1975, Wootton 1976). The three-spined stickleback has been became a predominant fish population in the Baltic coastal water (Skóra 1992; 1993a, b).

This species of fish has been very mutable (Penczak 1960a, b; 1962) and based on the number of lateral plates, the sticklebacks can be assigned to the three

morphological forms or morphs:

- *trachurus* has a complete row of lateral plates from the pectoral fin to the tail, has the biggest and slimmest body, marine form, can spawn in the shallow brackish waters,
- *semiarmatus* has a variable number of lateral plates, usually from the pectoral fin to half of body, anadromous form with preferences to the fresh water,
- *leiurus* has only a few plates near the pectoral fin or no plates, generally fresh water form, can reproduce in the adjacent rivers and drainage trenches (Penczak 1960a; Wootton 1976; Skóra 1993a, b; Virgil and McPhail 1994).

The distribution and frequency of all forms of the sticklebacks in the Baltic have been different. In the Gulf of Gdansk and the Puck Bay, the dominant form is *trachurus* and the less frequent is *leiurus* (Bańbura and Przybylski 1987, Bańbura 1994).

Research on the sticklebacks and their parasites from our coastal waters have been very important. Because of their omnivorous nature (Wootton 1976) the sticklebacks have been one of the most infected fish and a very important transmitter of parasites in the food - web to the predatory fish and fish - feeding birds (Morozińska-Gogol 1996, Rolbiecki *et al.* 1999).

Polymorphism of the stickleback never was examined in correlation to the parasite infestation. The studies on the correlation between prevalence of infestation by ecto- and endoparasites and morphological forms of the sticklebacks have been carried out.

MATERIAL AND METHODS

2880 sticklebacks (*trachurus* 2508, *semiarmatus* 287, *leiurus* 85) were caught with a hand - net in the coastal zone of the Gulf of Gdańsk (Gdynia, Puck, Hel) and the mouth of the Dead Vistula (Górki Wschodnie). The hauls from all places were taken every month for two years. All samples number 30 sticklebacks.

The fish were transported in the live - box to the laboratory, at the Department of Invertebrate Zoology, University of Gdańsk, and immediately examined. The morphological forms of all specimens were determined. The fish were killed by pithing and examined for ecto- and endoparasites with a binocular microscope. The skin and fins, eyes, gills, body cavity, liver, stomach, intestine and gonads were studied. 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 for morphological forms of the sticklebacks.

RESULTS

Three morphs of the sticklebacks were observed in the coastal water of the Gulf of Gdańsk and the mouth of the Dead Vistula. The form *trachurus* was the dominant and *leiurus* occurred rarely in the examined material.

In this study, some of parasites infected generally one of the morphs. Correlation was observed in the case of some ectoparasites like: *Trichodina domerguei* subsp. *domerguei* (Wallengren, 1897) and *T. tenuidens* (Faure-Fremiet, 1943)

(*Ciliata*), *Gyrodactylus arcuatus* (*Monogenea*) and *Thersitina gasterostei* (*Copepoda*) and also endoparasites like *Schistocephalus solidus* (*Cestoda* - plerocercoids).

Fresh water ciliates form the family *Trichodina* infected first of all sticklebacks with a few lateral plates (*leiurus)*. Prevalence of infestation counted 32.94% for *Trichodina domerguei* subsp. *domerguei* and 11.76% for *T. tenuidens.* The minimal prevalence of ciliates infestation was noted for full plated *trachurus* form (*T. domerguei* 23.28% and *T. tenuidens* 2.04%, Fig. 1).

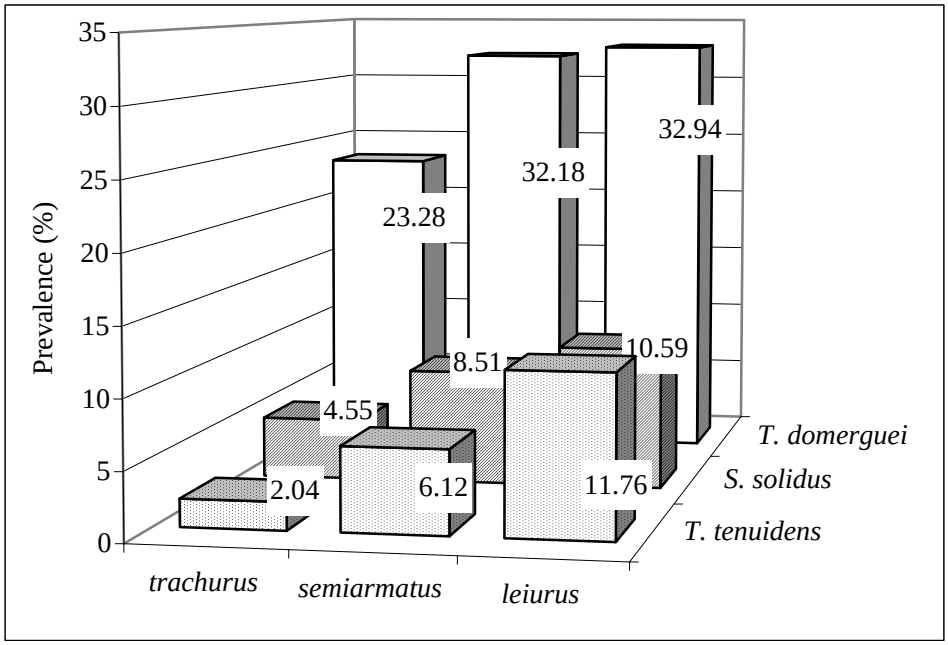

Fig. 1. Prevalence of infestation of the sticklebacks morphological forms by freshwater parasites ($p<0.05$)

Inversely, marine monogenean *Gyrodactylus arcuatus* were found generally on fish with a complete row of lateral plates from the pectoral fin to the tail - *trachurus* (12.23%, Fig. 2) and only 8.24% for *leiurus*.

The last ectoparasite was *T. gasterostei* occurring with highest prevalence on *trachurus* form (69.60%). The minimal prevalence was observed in the case of *leiurus* (44.71%, Fig. 2). This copepod is classifying as marine species.

The differences in prevalence of parasite's infestation were observed also in endoparasite case. Fresh water cestode *Schistocephalus solidus* (plerocercoid), like ciliates infected generally the less plated sticklebacks - *leiurus* (10.59%, Fig. 1).

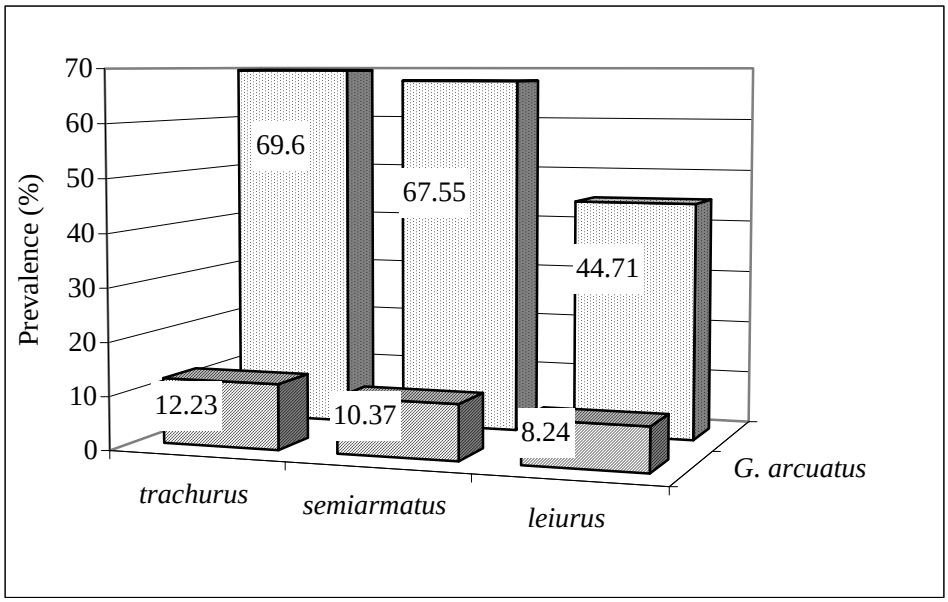

Fig. 2. Prevalence of infestation of the sticklebacks morphological forms by marine parasites ($p<0.05$)

DISCUSSION

Above-mentioned parasites, like the three-spined sticklebacks forms have been regarded as freshwater or marine species and forms. Ichthyologists described different preferences to the environment by the sticklebacks morphs and variations in behavior (Wootton 1976; Skóra 1993a, b; Virgil and McPhail 1994), where *trachurus* is a marine form, *leiurus* is a freshwater and *semiarmatus* is an intermediate form between mentioned above.

Also parasitologists described parasites like freshwater or marine species. All species discussed in this paper have been described in the literature as freshwater or marine parasites. Both trichodinids have been a freshwater, with tolerance to the considerable changes of salinity (Dartnall and Walkey 1979, Basson and Van As 1991). Freshwater character has also *S. solidus* (Dartnall and Walkey 1979). *G. arcuatus* was recognized as a marine species (Harris 1985). Also typical for stickleback *T. gasterostei* was a marine species (Gurney 1913, 1933; Hanek and Molnar 1974; Kabata 1992). Both marine species showed tolerance to decrease of salinity. Monogenean was found also in freshwater fishes (Kamiso and Olson 1986, Malmberg 1990) and copepods occasionally were found in the fresh water (Walkey *et al.* 1970, Marcogliese 1992) - generally these occurrences were a result of the fish migrations.

Ecto- and endoparasites discussed in this paper preferred morphs of the sticklebacks with the same habits. Freshwater parasites infected with highest prevalence *leiurus* stickleback, attentive as freshwater form and inversely marine parasites preferred *trachurus* form with preferences to the marine or brackish water.

Ectoparasites have found actively the fish - hosts and they have been exposed to changes of environment factors, especially in the case of food or spawning migrations. The most important were salinity (Prost 1959; Möller 1978; Dartnall and Walkey 1979; Dick and Belosevic 1981; Marcogliese 1992) and temperature (Möller 1978, Poulin and FitzGerald 1988, Höglund and Thulin 1990, Waadu and Chappell 1991). Also the effects of pollution on the ectoparasitofauna have been observed by Rohde (1993), Yeomans *et al.* (1997) and Galli *et al.* (1998). It is possible that changes in environmental factors determined parasite's infestation.

The fish infected by endoparasites by feeding larval stages of parasites with an intermediate hosts, especially invertebrates, sometimes another fish. The three-spined stickleback is the second intermediate host for plerocercoids and the adults occurred in fish-feeding birds as seagulls. The stickleback infected by *S. solidus* by feeding on the crustaceans, especially *Cyclops* sp. (Meakins and Walkey 1975). Pojmańska (1991) mentioned *Eucyclops serrulatus, Acanthocyclpos bicuspidatus, A. viridis* as the first intermediate hosts. The crustaceans have been one of the most important food items of the sticklebacks (Manzer 1976, Horsted *et al.* 1988, Folstad *et al.* 1994). It is possible that differences in infestation of the morphological forms depended on place of living. *Trachurus* spawned in the brackish water of the Baltic Sea and migrated to the open sea, *leiurus* migrated in spawning time to the freshwater. Because they have different behavior, it is possible, that they have also dissimilar diet - and infected more or less by parasites. It could be a very interesting problem for ichthyologist examined fish food.

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KORELACJA POMIĘDZY FORMAMI MORFOLOGICZNYMI CIERNIKA A INWAZJĄ PASOŻYTÓW W BAŁTYKU

Streszczenie

Ciernik jest rybą wykazującą niezwykłą zmienność morfologiczną. W związku z liczbą tarczek kostnych pokrywających ciało ryby, wyróżnia się kilka typów morfologicznych. Przypisuje im się też różne preferencje co do środowiska. Formę *trachurus* uważa się za morską, odbywającą tarło w słonawych wodach Bałtyku, *semiarmatus* za pośrednią, z preferencją do wód słodkich a *leiurus* traktuje się jako odmianę słodkowodną, rozradzającą się w pobliskich rzekach i kanałach melioracyjnych. W Bałtyku występują wszystkie wspomniane formy morfologiczne ciernika, których rozmieszczenie i liczebność wzdłuż naszego wybrzeża jest różna. Trzy formy były stwierdzone w Zatoce Gdańskiej, przy czym najliczniej stwierdzano formę *trachurus* a najrzadziej *leiurus*. Na zachód od Zatoki Gdańskiej nie stwierdzono formy *leiurus.*

Wyniki przeprowadzonych badań parazytologicznych ciernika, wykazały związek pomiędzy polimorfizmem ciernika a stopniem inwazji niektórych pasożytów. Korelację zaobserwowano między innymi w przypadku typowych dla ciernika widłonogów *Thersitina gasterostei* oraz przywr monogenetycznych *Gyrodactylus arcuatus,* które zarażały przede wszystkim cierniki *trachurus.* Wymienionym pasożytom, podobnie jak formie ciernika przypisuje się morski charakter. Inaczej przebiegała inwazja słodkowodnych orzęsków z rodzaju *Trichodina* oraz plerocerkoidów *Schistocephalus solidus.* Powyższe pasożyty zarażały najczęściej słodkowodną formę *leiurus.*