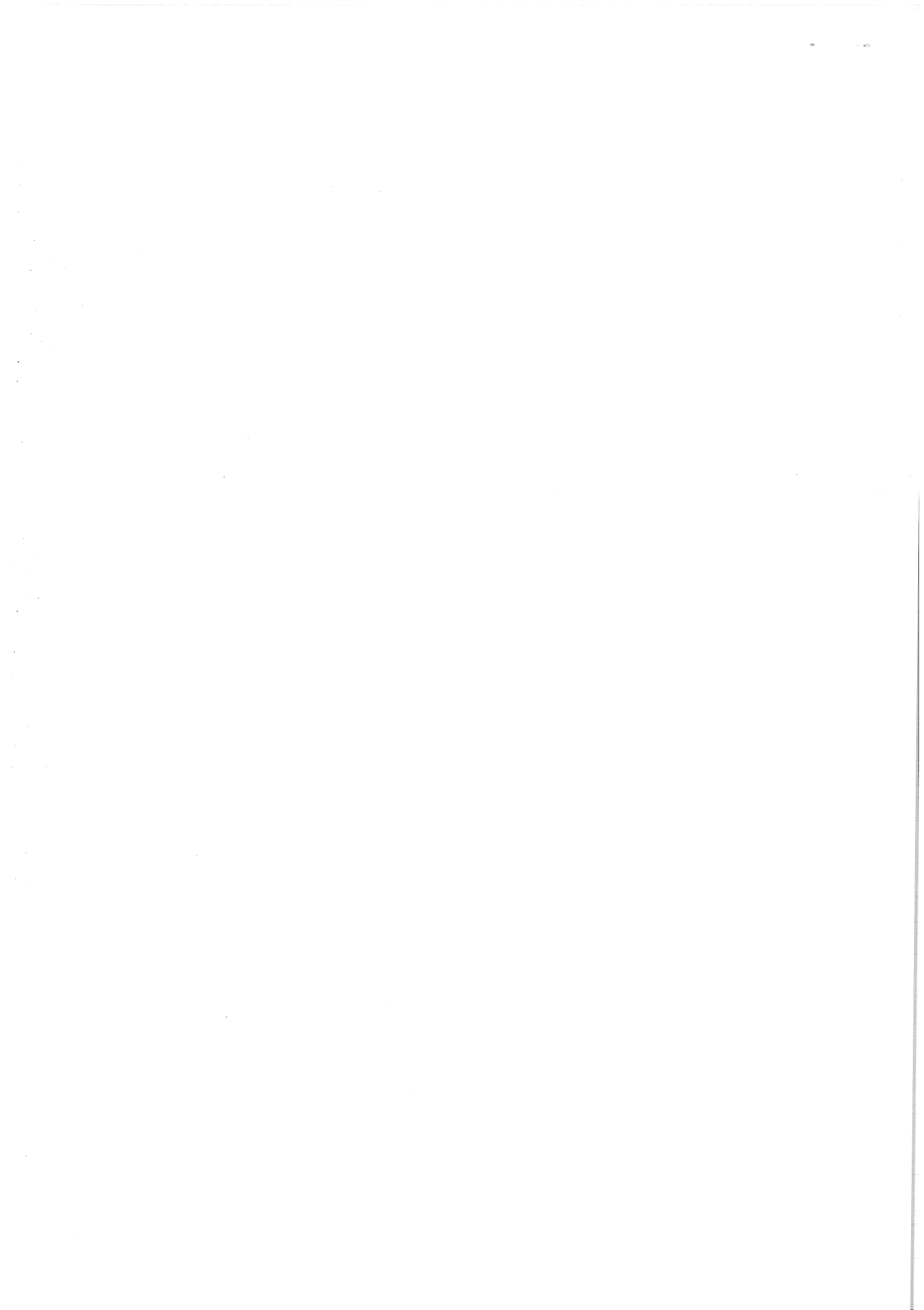


Parasitological information I.

1. Rokicki J., Vojtková L.: The dependence of parasitofauna on environmental factors of three - spined stickleback (*Gasterosteus aculeatus* L.) in the Gullmar Fiord (Skagerrak) 1

2. Rokicki J., Vojtková L.: The Parasitofauna of *Gasterosteus aculeatus* Linnaeus, 1758 in the Surroundings of Gdansk (Poland) . . . 10

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Czech Republic



The dependence of parasitofauna on environmental factors of three – spined stickleback (*Gasterosteus aculeatus* L.) in the Gullmar Fiord (Skagerrak).

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Summary

The parasites of three – spined stickleback (*G. aculeatus* L.) were studied in the Gullmar Fiord (west coast of Sweden – Skagerrak). Altogether 90 specimens of *G. aculeatus* from three localities were examined (Fig. 1, 2). Thirteen species of parasites were found: *Glugea anomala*, *Gyrodactylus arcuatus*, *Cryptocotyle lingua – metac.*, *Brachyphallus crenatus*, *Brachyphallus musculus*, *Derogenes varicus*, *Hemmiurus communis*, *Plagioporus alacer*, *Podocotyle atomon*, *Hirudinella spinulosa*, *Bothriocephalus scorpii*, *Raphidascaris acus*. *Gasterosteus aculeatus* L. is recorded as a new host *Hirudinella spinulosa* Yamaguti, 1938.

Key: fish *Gasterosteus aculeatus* L., parasites, environment, North Sea.

Introduction

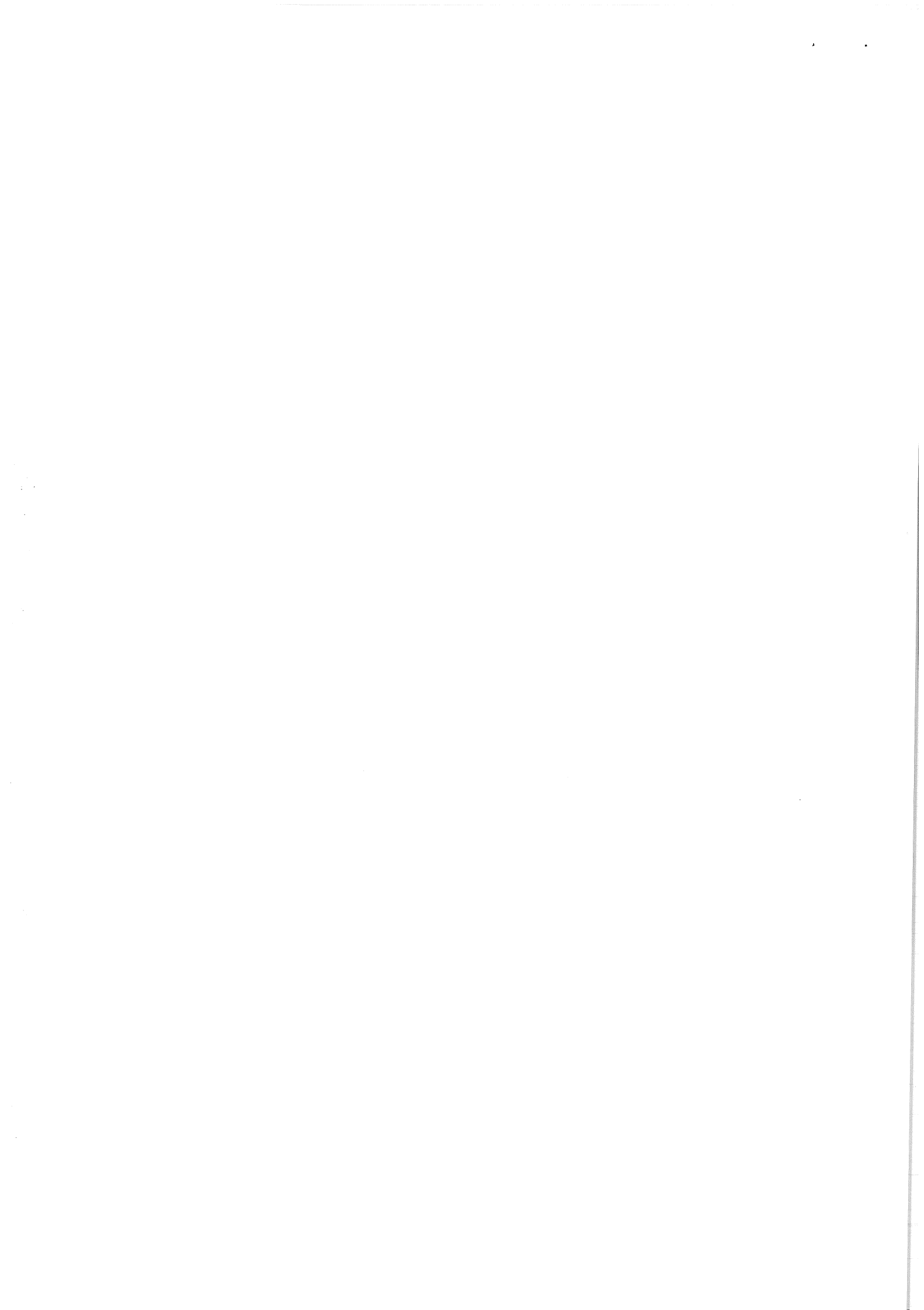
The three – spined stickleback is a common fish species in coastal waters world. Wide spread this small fish in the world and easy possibility of catching and breeding caused that is quite good recognised. *Gasterosteus aculeatus* can host many species of parasites. The influence of the environmental factors and pollution on parasites of three – spined stickleback were the subject of the works of Walkey (1970), Pascoe and Cram (1977), Möller – Buchner (1987), Zander and Westphal (1991). The aim of the present study was to analyse of the environmental influence on the parasitofauna of the *G. aculeatus*.

Material and methods

In July 1990 year 90 (3 × 30) fish specimens in three distinctly different sites in the Gullmar Fiord (Skagerrak) were examined (Fig. 1, 2).

1. „Gåsön“, Fiord mouth. Sandy bottom, partly muddy, covered by seagrass (*Zostera* or *Fucus* spp.) (depth 1 – 3 m, 7,7 – 8,0 mg/1 oxygen, 30% salinity).

2. „Skår“, near the ferry. Small bay with rich fauna of benthic macrofauna (depth 1 – 3 m, 7,9 – 8,3 mg/1 oxygen, 10 – 30% salinity).



3. Near „Harbour“. Small bay with muddy bottom, thickly covered by seagrass. The water constantly polluted with engine oils. Seagulls abundantly present. (depth 1 – 2 m, 8,8 – 10,0 mg/1 oxygen, 24% salinity) Fig. 1, 2.

Length of the fish was studied, 4,0 – 6,8 cm (average 5,5 cm), weight was 5,23 – 30,50 g (average 14,50 g).

Monogeneans were fixed in 4% formalin or in ammonium picrate. Trematodes and cestodes were fixed in 75% alcohol and stained with alumine carmin and mounted on slides in canada balsam. Nematodes were fixed in 75% alcohol with 5% glycerol added.

Results

In this material a total of 13 species of parasites were found: (of these 12 species of parasites we identified to species) : 1 Sporozoa, 1 Monogenea, 1 Trematode (metacercariae), 7 adult Trematode, 1 Cestoda plerocerkoid, 1 Nematoda and one crustacean.

The following parasites were noted:

1. *Glugea anomala* (Moniez, 1887)

Location in the host: in connective tissue of trunk under the skin. Prevalence and intensity of infection: two cysts were found in one fish (Table I).

2. *Gyrodactylus arcuatus* Bychowsky, 1933

Location in the host: on fish, skin and gills. Prevalence and intensity of infestation: Table I

3. *Cryptocotyle lingua* (Creplin 1825) metacercariae

Location in the host: in the subcutaneous tissue all over the host body mainly the skin. Prevalence and intensity of infestation: Table I

4. *Brachyphallus crenatus* (Rudolphi, 1802)

Location in the host: stomach, less frequently in intestine. Prevalence and intensity of infection: Table I. The largest prevalence and intensity was in Gåsön.

5. *Brachyphallus musculus* (Rudolphi, 1802)

Location in the host: stomach. Prevalence and intensity of infection: Table I. The immature and young trematodes without eggs were found very often.

6. *Derogenes varicus* (Müller, 1784)

Location in the host: stomach. Prevalence and intensity of infection: Table I.

7. *Hemiurus communis* (Odhner, 1905)

Location in the host: stomach. Locality: only Gåsön. Prevalence and intensity of infection: Table I.

8. *Plagioporus alacer* (Looss, 1901)

Location in the host: stomach. Locality: Skår and Harbour. Prevalence and intensity of infection: Table I.

bottom, thickly covered by se-
gine oils. Seagulls abundantly
(1, 24% salinity) Fig. 1, 2.
(average 5,5 cm), weight was

in ammonium picrate. Trematode
stained with alumine carmin
odes were fixed in 75% alcohol

sites were found: (of these 12
sporozoa, 1 Monogenea, 1 Tre-
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ank under the skin. Prevalence
in one fish (Table I).

Prevalence and intensity of infesta-

tion of cercariae
all over the host body mainly
Table I

in intestine. Prevalence and in-
tensity was in Gåsön.

intensity of infection: Table I.
Eggs were found very often.

intensity of infection: Table I.

Gåsön. Prevalence and intensity

and Harbour. Prevalence and

All found flukes of *G. aculeatus* had eggs. Body elongated, long 1,50 – 1,85 mm and wide 0,28 – 0,13 mm. Oral sucker is terminal located, size 0,10 – 0,13 × 0,13 – 0,14 mm. Short prepharynx. Round pharynx (0,06 – 0,08 × 0,07 mm). Oesophagus 0,08 – 0,10 mm. Two intestinal branches are 0,03 mm long. Large round ventral sucker between first and second third of body, large 0,14 – 0,18 × 0,16 – 0,17 mm. Ventral sucker opens behind cirrus pouch. Uterus with small number of eggs behind the ventral sucker. Eggs yellow, big, 0,03 – 0,05 × 0,07 – 0,08 mm. Ovary measures 0,10 – 0,16 × 0,14 – 0,17 mm. Anterior testis 0,13 – 0,15 × 0,15 – 0,17 mm, posterior testis 0,13 – 0,15 × 0,15 – 0,21 mm. Vitelline follicles formed by small round follicles, filling the whole space of the endposterior of body, the area between and around testes and extending along the margins of the body to the level of the oral sucker. This species was found in fishes of the family *Labridae* in England (Nicol, 1910) and *Percidae* in the Baltic Sea (Reimer, 1970).

9. *Podocotyle atomon* (Rudolphi, 1802)

Location in the host: stomach. Locality: only Harbour. Prevalence and intensity of infection: three specimens were found in a single stickleback (Table I). Body flukes oval 0,89 – 1,04 mm long and 0,34 – 0,37 mm wide. The surface of the body is smooth. Oral sucker round 0,13 × 0,11 – 0,13 mm. Round pharynx 0,06 × 0,06 – 0,07 mm. Oesophagus short 0,02 mm. Intestinal branches extend to the end body. Ventral sucker 0,20 – 0,22 × 0,18 – 0,19 mm, larger than oral sucker. Ovary behind ventral sucker, oval and usually lobed, 0,15 × 0,08 mm. Testes behind ovary, oval, smooth or lobed. Anterior testis 0,14 × 0,11 mm, posterior testis 0,14 × 0,14 mm. Vitellaria lateral, from posterior margin of ventral sucker to posterior end of body. Genital bursa anterior to ventral sucker. Uterine loops between ventral sucker and ovary. Yellow eggs (only present 3 – 4) oval, 0,03 – 0,04 × 0,08.

10. *Hirudinella spinulosa* Yamaguti, 1938

Location in the host: intestine. Prevalence and intensity of infection: one specimen was found in stickleback from Gåsön. Body of fluke divided into two parts. Anterior part round or oval, 0,20 × 0,16 mm long. Posterior part elongated 1,0 mm long, 0,11 – 0,12 mm wide. In anterior part subterminal sucker, 0,06 × 0,07 mm. Pharynx 0,03 × 0,04 mm. Short oesophagus. Intestinal branches reach 0,06 – 0,08 mm from posterior end of body end. Ventral sucker large, round, 0,09 × 0,11 mm. Testis in anterior part size 0,03 × 0,04 mm. The uterus forms descending and ascending loops, with small yellow eggs. Eggs of the same size 0,02 × 0,10 mm. *Gasterosteus aculeatus* is new host for *Hirudinella spinulosa*.

11. *Bothriocephalus scorpii* (Müller, 1776) larva

Location in the host: intestine. Prevalence and intensity of infection: Table I.

12. *Raphidascaris acus* (Bloch, 1779)

Location in the host: Body cavity. Prevalence and intensity of infection: Table I.

13. *Thersitina gasterostei* (Pagenstecher, 1861) Location in the host: on the internal surface of the operculum. Prevalence and intensity of infection: Table I.

Discussion

The waters of „Harbour“ are considered to be the most oilpolluted of all the three investigated places. In present investigations ectoparasites such as *Gyrodactylus arcuatus* showed the highest intensity of invasion 18 specimens in Harbour, although only one stickleback was infected. Also another ectoparasite, *Thersitina gasterostei* showed a similar mean intensity of invasion in Harbour (Tab. 1). Experimental studies indicate that the number of ectoparasites such as trichodinid ciliates and monogeneans increase significantly on the fish following exposure to a pollutant, and this is supported by field data on other ciliates and monogeneans where of pollution has been clearly demonstrated (Khan, 1990, Valtonen and Koskivaara, 1987). Ectoparasites from stickleback indicate that the number of ectoparasites on stickleback does not confirm that Harbour was distinctly more polluted than Gåsön or Skår. Ectoparasites of stickleback show that the biodegradation of the environment in Harbour is rather superficial.

The predominant groups in Gullmar Fiord was *Trematoda digenea* (8 species), *Protozoa*, *Monogenea*, *Cestoda*, *Nematoda* and *Copepoda* were represented only by one species. In spite of differences in water salinity of the two points in the fiord and oil - pollution in Harbour the fish in the three localities studied in Gullmar Fiord have a rather similar parasite fauna. The differences are in *Glugea anomala*, *Hemmiurus communis* and *Hirudinella spinulosa*, they were present in the fiord entrance at Gåsön, but lacking in sites the fiord. The parasite *Podocotyle atomon* it was present sporadically in one place only. The lack of *Podocotyle atomon* in Gåsön can probably be connected with different distribution of snail *Littorina saxatilis* (Olivi), the first intermediate host of this digenea in Gullmar Fiord (Koie 1984). Sticklebacks become infested with *P. atomon* by eating amphipods, isopods, mysids. Sulgostowska and others (1987), investigating helminthofauna of platfish from Gdansk Bay, recorded the diminishing number of parasite species and the increase in the infestation intensity under the influence of pollution. The situation of the investigated stickleback is not at all similar. This can be caused by comparatively small changes in the investigated points and the nature of migration of this fish. The most frequent species was the metacercaria of *Cryptocotyle lingua*. Prevalence at the mouth of Gullmar Fiord was 76,6% (Gåsön), at the small bays inside the Gullmar Fiord 46,0% (Harbour) and at Skår 40,0%. Necessary for the

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Intensity of infection: Table I.
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Cryptocotyle lingua. Prevalence
Gåsön), at the small bays inside
Skår 40,0%. Necessary for the

development of this digenean are different gastropods, mainly *Littorina littorea* (L.) which is common in the fiord, and the definitive bird hosts especially *Laridae*. Sticklebacks living in shallow - water areas is exposed to infestation by the cercariae of *C. lingua* which penetrate the fish skin. *Glugea anomala* occurred only sporadically (Gåsön - 3,3%). The same was reported for stickleback from the estuary of Elbe. In that study the prevalence was 3,5% (Möller - Buchner, 1987). *Thersitina gasterostei* is a Copepod specific for *G. aculeatus*. Prevalence of infestation is lower in Gåsön (3,3%) than in other places (Skår - 36,6%, Harbour - 13,3%). It is also lower than in coastal waters of Britain (70%, Walkey), or North Schleswig - Holstein - Baltic Sea (50,0% Zander et al, 1991). Skår and Harbour represent sites sheltered from direct action while Gåsön is exposed to wave action. It is likely that the differences in degree of wave action is reflected in the parasitofauna. Example in this case it can be speculated that the infection of the stickleback by larvae of *T. gasterostei* is promoted by a lower rate of water movement. Trematoda as *Brachyphallus crenatus*, *Derogenes varicus*, *Hemmiurus communis* are marine species, and their higher infestation in Gåsön is connected with the most marine character of this point.

To sum up it can be said the parasitofauna of stickleback was similar in all the three investigated points of Gullmar Fiord. There were no extremities which would indicate excessive occurrence of one species of parasites and the disappearance of others. Contrary to a popular opinion, the parasitofauna of stickleback indicates that the biodegradation of environment in Harbour is rather superficial, and does not differ meaningfully from the other investigated places.

For *Plagioporus alacer*, *Podocotyle atomon*, *Hirudinella spinulosa* a widened description was given because their size differed from those already known and described.

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Table 1. Prevalence and intensity of infection

Parasite	n = 30		n = 30		n = 30	
			Locality		Harbour	
	preval.	inten.	preval.	inten.	preval.	inten.
<i>Glugea anomala</i>	3.3	2	-	-	-	-
<i>Gyrodactylus arcuatus</i>	30.0	1-3 (1.4)	50.0	1-60 (8.6)	3.3	18.0
<i>Cryptocotyla lingua</i>	76.6	1-22 (3.8)	40.0	1-11 (5)	46.0	1-30 (15.0)
<i>Brachyphallus crenatus</i>	63.3	1-22 (6.5)	10.0	2-14 (6)	20.0	1-3 (2.3)
<i>Brachyphallus musculus</i>	16.6	2-4 (2.8)	23.3	4-12 (7.2)	3.3	1
<i>Derogenes varicus</i>	40.0	2-16 (7)	6.6	1-2 (1.5)	6.6	1-12 (6.5)
<i>Hemmiurus communis</i>	20.0	2-10 (3)	-	-	-	-
<i>Plagioporus alacer</i>	-	-	23.3	1-10 (4)	36.6	1-37 (7.7)
<i>Podocotyle atomon</i>	-	-	-	-	3.3	3
<i>Hirudinella spinulosa</i>	3.3	1	-	-	-	-
<i>Bothriocephalus scorpii</i>	6.6	1-2 (1.5)	10.0	1 (1)	3.3	1
<i>Raphidascaris acus</i>	13.3	1-2 (1.2)	20.0	1-4 (1.6)	46.6	1-3 (1.4)
<i>Thersitina gasterostei</i>	3.3	12	36.6	1-11 (3)	13.3	1-7 (3.5)
number of species	11		9		10	

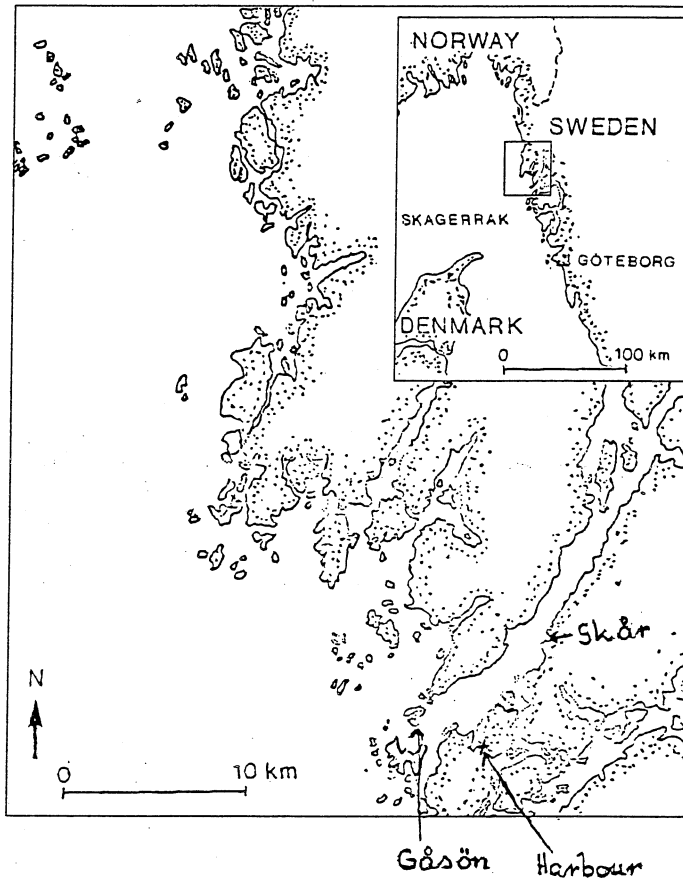


Fig 1. Skagerrak with Gullmar Fiord

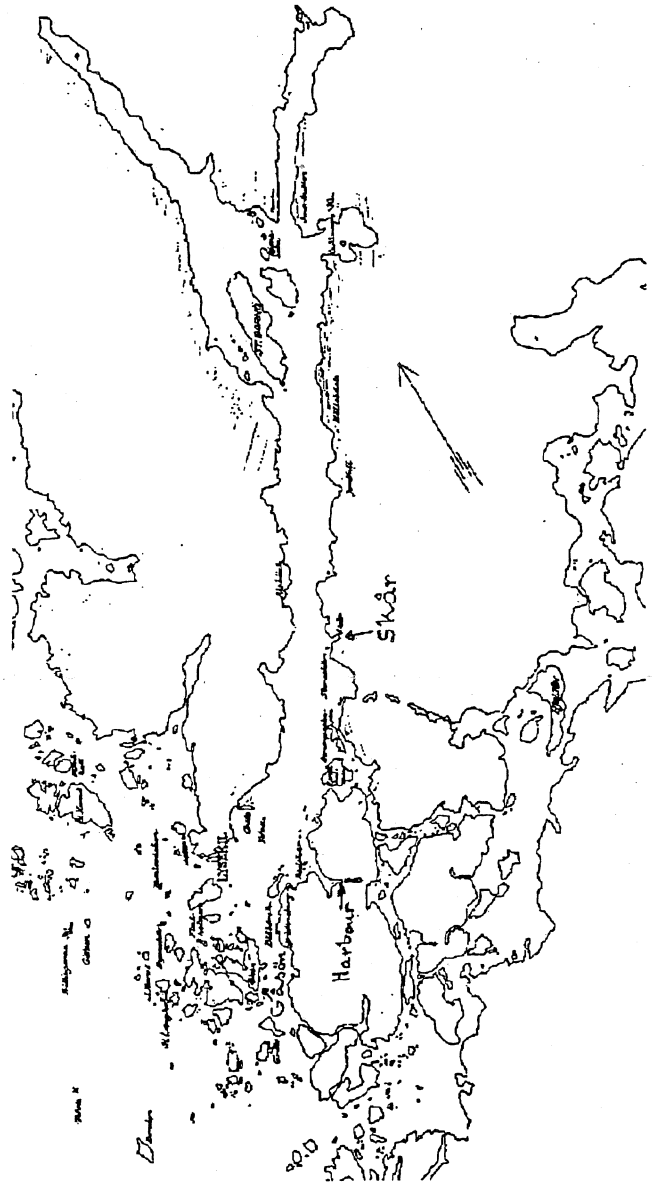
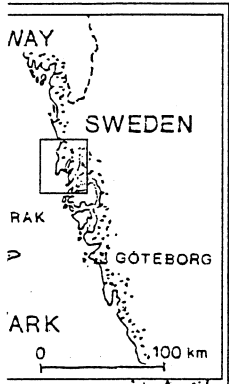


Fig 2. Localities in Gullmar Fiord

The Parasitofauna of *Gasterosteus aculeatus* Linnaeus, 1758 in the Surroundings of Gdansk (Poland)

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Introduction

The study of the parasitofauna of the stickleback *G. aculeatus* L. in Poland has been dealt with in a number of papers (see Grabda, 1971). The examined material came from different localities, mostly, however, from the area of the large lakes in the interior.

From the surroundings of Gdansk (the Baltic Sea coast) altogether 71 stickleback from 5 localities were examined. Grabda (1971) describes as localities coast of the Baltic, the cove of the river Vistula, the Bay of Gdansk, the Bay of Puck and the coast near port of Hel.

In the stickleback *G. aculeatus* in Poland altogether 22 species of parasites were found.

In July, 1988 and 1989 we had the opportunity of examining for the presence of parasites a small number of stickleback altogether 33 individuals coming from 4 localities in the surroundings of Gdansk.

Locality No. 1: lake in the reserve „Ptacie raj“, Gdansk Bay: 15 samples, prevalence 100%.

Locality No. 2: range of dead Vistula, near the Biological station of Gdansk University, Gorki Wschodnie. Three specimens of *G. aculeatus* examined, prevalence 100%.

Locality No. 3: Gdansk - Oliwa, pond in the centre of the town. Five fish examined, prevalence 66%.

Locality No. 4: Gdansk Bay (part of the Puck Bay) - the coast of the bay near the port of the town of Puck. 10 fish examined, prevalence 80%.

Results

In the stickleback examined we found altogether 10 species of parasites:

1. *Trichodina* sp. (probably *Trichodina domerguei* f. *latispina* Dogel, 1940). The most widely spread parasite, infecting skin and gills, extensity of invasion - 100%.

2. *Gyrodactylus arcuatus* Bychowsky 1933 - frequent in skin and gills, extensity of invasion 25%.

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G. aculeatus Linnaeus,
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stickleback *G. aculeatus* L. in Poland
Grabda, 1971). The examined
however, from the area of the

Sea coast) altogether 71 stickleback
(1971) describes as localities
the Bay of Gdansk, the Bay

together 22 species of parasites

of examining for the presence
over 33 individuals coming from

Łódź", Gdansk Bay: 15 samples,

the Biological station of Gdansk
of *G. aculeatus* examined, pre-

centre of the town. Five fish

Gdansk Bay) - the coast of the bay
examined, prevalence 80%.

over 10 species of parasites:

Argulus f. latispina Dogel, 1940).
and gills, extensity of invasion

frequent in skin and gills, ex-

3. *Diplostomum spathaceum* (Rudolphi, 1819) Braun, 1893 - metacercariae,
eye lens, extensity of invasion 55%. Body length 0,207 - 0,614 (0,371) mm and
body width 0,165 - 0,326 (0,213) mm. The oral sucker situated subterminally
measures 0,043 - 0,059 (0,048) mm x 0,046 - 0,063 (0,051) mm, ventral sucker
0,033 - 0,050 (0,042) x 0,033 - 0,056 (0,045) mm. The Brandes organ is oval,
measures 0,059 - 0,083 (0,072) x 0,066 - 0,083 (0,072) mm.

4. *Tetracotyle* sp. - only at localities No. 1 and No. 2 in the body cavity
near the eye of stickleback dark cystae were found. The cystae are oval, 0,521 -
0,535 mm long and 0,366 - 0,394 mm wide. Thickness of the envelope 0,014 -
0,056 mm. Extensity of invasion 17%, intensity of invasion 1 - 3. For the time
being it has been impossible to determine the cystae in detail.

5. *Phyllodistomum folium* (Olfers, 1916) - in the urinary tract of one spe-
cimen from locality No. 1. Seven adult trematodes were found. The trematode
P. folium has not been found in Poland in *G. aculeatus* before. Extensity of
invasion 3,03%.

6. *Proteocephalus filicolis* (Rudolphi, 1802) - intestine, prevalence 6,6%. The
body of the adult tapeworms is 17 mm long. The scolex measures 0,245 mm,
bearing 4 suckers of the dimensions 0,077 - 0,084 by 0,056 - 0,084 mm. The
front segments younger ones, are 0,525 - 0,775 mm wide and 0,197 mm high.
Ripe body segments measure 1,015 - 1,057 mm by 0,197 - 0,296 mm. Intensity
of invasion - 2, extensity of invasion 3,03%.

7. *Schistocephalus solidus* (Müller, 1776) - plerocercoid. In the body cavities
of 2 stickleback young unripe larvae were found. Intensity of invasion 1 - 5,
extensity of invasion 6,6%.

8. *Raphidascaris gracillima* (Linstow, 1800) Skrjabin, 1923 - intestine, liver.
Intensity of invasion 1 - 4, extensity of invasion 20%. A rare parasite. Markowski
(1933) found nematodes near the Hel Peninsula in 2 stickleback out of 29
specimens examined (6,8%).

9. *Thersitina gasterostei* (Pagenstecher, 1861) - a frequently occurring pa-
rasitic crustacean. A specific parasite of stickleback, in northern seas also occu-
rring in other fish species. Extensity of invasion - 6,06%, intensity of invasion
1 - 15.

10. *Argulus foliaceus* (Linnaeus 1758) - on the skin of fish very young indi-
viduals were found. Extensity of invasion 6,06%, intensity 1 - 10.

In all stickleback individuals examined 10 species of parasites were found -
Table 1.

Grabda (1971) processed data of different authors from Poland who dealt
with the parasitofauna of fishes, including *Gasterosteus aculeatus*. The material
originated from different localities of the country, mostly, however, from the
area of large lakes (e. g. the Masurian Lakes) or from the coast of the Baltic

(Gdansk Bay, Puck Bay, etc.). So far 22 parasite species have been found in *G. aculeatus* in Poland. The parasitofauna of *G. aculeatus* in the surroundings of Gdansk was also studied by Rokicki (1975) who found 4 parasite species.

In our material, although it was not voluminous, 10 species of parasites were found (Table 1). The species *Proteocephalus filicolis* and *Tetracotyle* sp. were found in *G. aculeatus* in Poland for the first time. The research will be continued.

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e species have been found in *aculeatus* in the surroundings to found 4 parasite species. nous, 10 species of parasites *s filicolis* and *Tetracotyle sp.* st time. The research will be

(*Strigeida, Trematoda*) in the L.) Journ. Helminthology, 34:

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Polski. II. Pasozyty kraglo-

er Fische des polnischen Bal-*anthocephala*). Archwm. Hyd-

the Gdansk Bay (Baltic Sea).

Table 1: List of parasites found in stickleback (*Gasterosteus aculeatus*) in the surroundings of Gdansk

Author	Grabda, 1971	Rokicki, 1975	own material			
			loc. No. 1	loc. No. 2	loc. No. 3	loc. No. 4
Species	extensity of invasion in %					
<i>Trichodina domerguei</i>	-	-	100.0	-	-	100.0
f. <i>latispina</i>	-	-	6.6	-	-	80.0
<i>Gyrodactylus arcuatus</i>	10.0	-	66.6	-	20.0	-
<i>Diplostomum spathaceum</i>	-	-	6.6	66.6	-	-
<i>Tetracotyle sp.</i>	-	-	-	-	-	-
<i>Brachyphallus crenatus</i>	-	4.16	-	-	20.0	-
<i>Phyllostomum folium</i>	-	-	6.6	-	-	-
<i>Proteocephalus filicolis</i>	-	-	-	-	-	-
<i>Proteocephalus percae</i>	17.20	29.1	-	-	-	-
<i>Trienophorus nodulosus</i>	3.44	12.50	-	-	-	-
<i>Schistocephalus solidus</i> pler.	75.80	8.33	-	6.6	-	-
<i>Raphidascaris gracillima</i>	6.89	-	20.0	-	-	-
<i>Neoechinorhynchus rutili</i>	10.3	-	-	-	-	-
<i>Piscicola geometra</i>	+	-	-	-	-	-
<i>Thersitina gasterostei</i>	66.1	-	66.6	100.0	-	60.0
<i>Caligus lacustris</i>	40.0	-	-	-	-	-
<i>Argulus foliaceus</i>	-	-	13.3	-	-	-

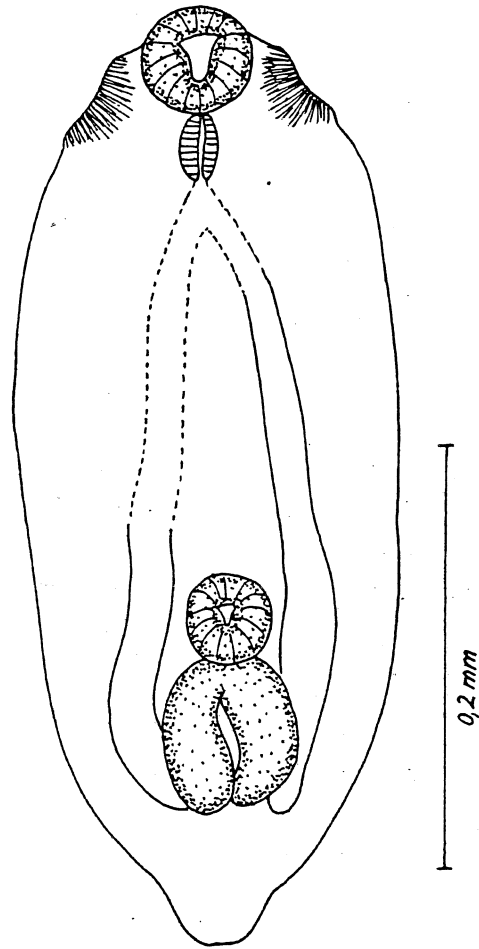
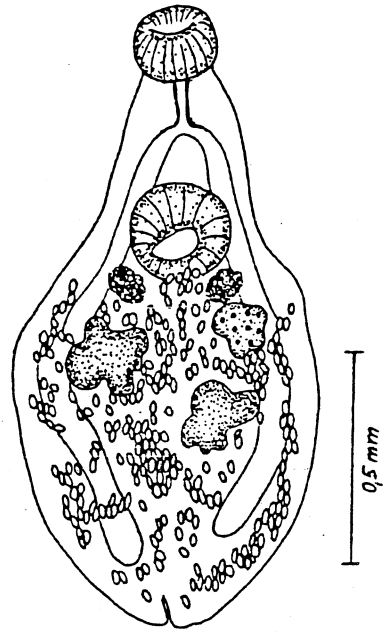
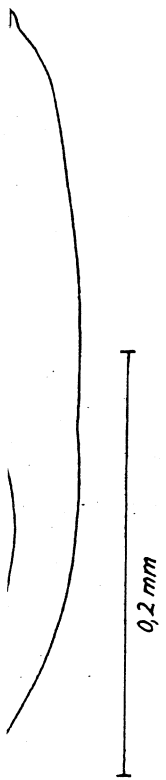


Fig. 1. *Diplostomum spathaceum* – metacercaria

Fig.



- metacercaria

Fig. 2. *Phyllodistomum folium* - adult fluke from *Gasterosteus aculeatus* L.

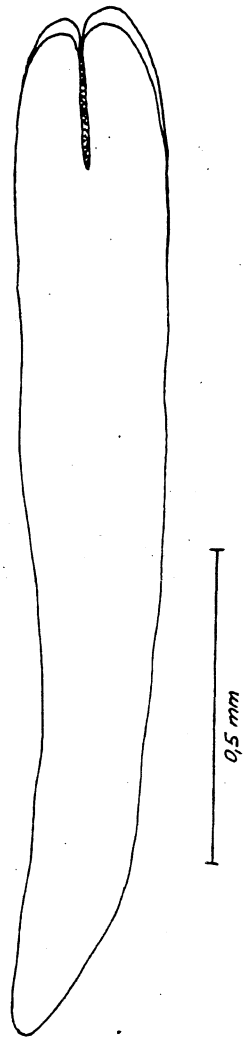


Fig. 3. *Schistocephalus solidus* – plerocercoid