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Parasitology

PROTOZOANS PARASITIC ON *ANGUILLA ANGUILLA* (L.) FROM
THE SZCZECIN LAGOON AND RIVER Odra MOUTH

PASOŻYTNICZE PIERWOTNIAKI *ANGUILLA ANGUILLA* (L.) Z
ZALEWU SZCZECIŃSKIEGO I UJŚCIA RZEKI ODRY

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Protozoans parasitic on *Anguilla anguilla* (L.) caught in 5 areas of the Szczecin Lagoon and the River Odra mouth were studied in 1982 - 1983. A total of 11 protozoan species were found: *Ichthyophthirius multifiliis*, *Trichophrya piscium*, *Trichodina jadranica*, *Trichodinella epizootica*, *Myxidium giardi*, *Spironucleus mobilis*, *Eimeria anguillae*, *Zschokkella stettinensis*, *Sphaerospora gilsoni*, *Trypanosoma granulosum*, and *Myxobolus* sp. Six species were frequent or very common. The parasitic invasion was relatively strong.

INTRODUCTION

Protozoans parasitic on the eel, *Anguilla anguilla* (L.) were studied by, i.a., Debaisieux (1925), Jacob (1953), Copland (1982), Landberg (1983), Molnar et al. (1986), Kõie (1988), Saraiva and Chubb (1989). Publications dealing with Polish material are not numerous and cover a few species only. The ciliates *Ichthyophthirius multifiliis* were mentioned by Grabda (1971). Markiewicz and Mięgała (1980) described a *Trichodina* invasion in young eel kept in aquaria. Jastrzębski (1984) found *Eimeria anguillae* in the eel caught in lakes Mamry and Sunowo. A total of 5 species were found in the eel from the Szczecin Lagoon and Lake Dąbie (Einszporn-Orecka 1979; Wierzbicka and Einszporn-Orecka 1986; Wierzbicka 1986a, 1986b, 1987); 4 of those species, i.e., *Spironucleus anguillae*, *S. mobilis*, *Sphaerospora sphaerocapsularae*, and *Zschokkella stettinensis* proved new for the fish

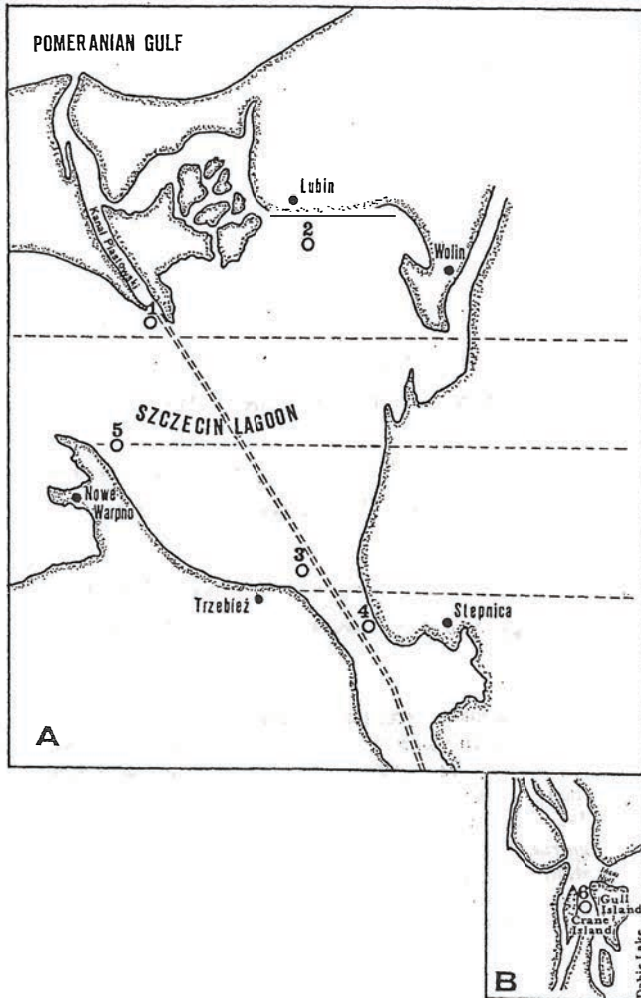


Fig. 1. Map of the Szczecin Lagoon (A) and Odra mouth (B)
 1 - Piastowski Canal; 2 - off Lubin; 3 - off Trzebież
 4 - off Stepnica; 5 - off Nowe Warpno; 6 - Stara Odra
 canal.

fauna. A brief note on some protozoans parasitising eel of the area was published earlier by Wierzbicka and Orecka-Grabda (1987). The present paper describes the parasitic protozoans found in the eel from the Szczecin Lagoon and compares the extent of invasions in different areas of the Lagoon.

The Szczecin Lagoon is a shallow water body (mean and maximum depth of 4 and 7 m, respectively; the Lagoon is cut through by an artificially dredged navigation channel). The Lagoon's water is frequently mixed by wave action. The oxygen conditions are good; periodic oxygen hyper-saturation occurs in the summer. The Lagoon's water is periodically

strongly alkaline (pH about 10). Organic load differs between areas: lower loads occur in the northern part and higher in the south, in the mouth area of the River Odra discharging anthropogenic effluents. The Lagoon is strongly eutrophicated (in 1983, the mean annual concentrations of nitrogen and phosphorus compounds ranged within 1.45 - 2.93 and 0.28 - 1.08 mg/l, respectively; the respective maximum concentrations were 3.36 - 5.00 and 3.72 mg/l). The high fertility of the water results in phytoplankton blooms. The degraded environmental conditions favour infections and intoxications of fish (Orecka-Grabda 1986, 1993).

MATERIALS AND METHODS

The eel individuals examined were obtained from commercial catches effected in 5 areas of the Szczecin Lagoon: 1 - the Piastowski Canal (20 individuals), 2 - off Lubin (25), 3 - off Trzebież (71), 4 - off Stepnica (30), 5 - off Nowe Warpno (13), and 6 - the Odra mouth (24) (Fig. 1). The fish were examined in August 1982 (41 individuals caught off Trzebież) and in July and August 1983 (142 individuals caught in the areas listed above). A total of 183 individuals measuring 34 - 84 cm (total length) and weighing 70 - 1200 g were examined. The fish age, ranging from 1+ to 11+ (not counting the larval stage) was calculated from the number of rings on scales and on polishes otoliths.

Detailed anatomopathological and parasitological examinations were made on the fish immediately after they were sacrificed. The material scraped off the skin, gills, intestine, and urinary bladder was checked for parasites, as was the suspension obtained from the gall bladder. All the gill arches were examined whole under a stereomicroscope. Gill smears were silver-coated with AgNO_3 ; imprints from internal organs (three parts of kidney, liver, and spleen) and peripheral blood, intestine, and urinary bladder were stained using the Papanheim techniques (May-Grünwald and Giemsa). Fragments of strongly invaded organs were fixed in 5% formaldehyde and kept for further histologic studies.

RESULTS

The extent of invasion differed between species (Tab. 1). Most species occurred on the gills. Two parasites: *Ichthyophthirius multifiliis* and *Trichophrya piscium* were very rare in this study, while another two - *Trichodina jadratica* and *Trichodinella epizootica* were common eel parasites. The highest invasion incidence (100%) was found in the fish, caught off Nowe Warpno, which were kept in cages for about 3 days after capture. In other areas, the *T. jadratica* and *T. epizootica* invasion incidences ranged within 35 - 83.1% and 30 - 74.6%, respectively (Tab. 1). The intensity of invasion of the two ciliates was at its highest off Nowe Warpno, too (Tab. 2).

Myxidium giardi was the most frequent eel parasite, found not only on the gills, but also in other internal organs. The species produced a generally high invasion incidence (80 - 94.4%) reaching 100% in the Odra mouth (Tab. 1). Cysts of *M. giardi* were most numerous and most frequent in the gills, 75 - 95.6% of the fish examined being infested with the cysts (Tab. 3). The highest intensity of gill infection was recorded in the river mouth fish, 20.8% of which showed very numerous cysts and 4.2% were affected by a mass invasion. *M. giardi* cysts were found also in the kidney in 11.5% of the fish. The cyst occurred almost exclusively in the pronephros (4.2%) and in the mesonephros (8.4%), their invasion intensity ranging from single to numerous cyst. Additionally, a single cysts was

found in the spleen and about 10 very fine cysts were recorded on the occasion in the intestinal mucosa and in the skin.

Among the internal organs, the kidney showed the strongest infection with spores of *Myxidium giardi*: 23.1 - 60.0%, depending on the area, of fish were affected, the incidence being 100% in the Odra mouth (Tab. 3). The spores occurred along the entire kidney; they were, however, most frequent and most abundant in the caudal section of the kidney. Similarly to the incidence, the highest spore invasion intensity was recorded in kidneys of the fish caught in the Odra mouth; numerous spores in the pro- and mesonephros were found in 30.4% of the fish; very numerous spores were present in 4.3% of the fish, while mass infection affected 4.3% of the fish. In other areas, numerous spores were found in the kidney of an eel caught off Lubin (4%), off Stepnica (3.3%), and the Piastowski Canal (5%); very numerous spores occurred in 5% of the fish in the Odra mouth. *M. giardi* spores were less common in the intestine (single spores occurring in 21.3 and numerous in 4.9% of the fish) and the urinary bladder (16.1% of the fish showed single and 1.1% numerous spores). They were rare in the liver, gall bladder, and spleen (Tab. 3). *M. giardi* plasmodia, usually single, were recorded in the kidney, liver, and spleen of 7.8% of the fish; the plasmodia were numerous in one fish (0.7%) only.

The occurrence of *Spiromucleus mobilis* and *Eimeria anguillae* was limited to the intestine only. The flagellates *S. mobilis* occurring off Trzebież, Stepnica, and in the Odra mouth were recorded very seldom. Their invasion incidence was as low as 2.8 - 4.2% (Tab. 1). The other species, *E. anguillae*, was more frequent, its incidence ranging within 8 - 20.8% (the parasites were absent in the Piastowski Canal fish only). The small number of the eel infected revealed, however, a strong invasion intensity; the oocysts were very numerous, a mass occurrence being recorded in one case (Tab. 1).

The sporozoans *Zschokkella stettinensis* and *Sphaerospora gilsoni* were fairly frequent parasites of the eel's urinary bladder. Those fish that were most affected were caught in the Odra mouth, the incidence of the two parasites being 50 and 97.5%, respectively. In other areas, the incidence of *Z. stettinensis* ranged within 20 - 33.3%, the corresponding range of *S. gilsoni* being 30 - 38% (Tab. 1). Both species attained the highest intensity of invasion in the Odra mouth (Tab. 2). The urinary bladder mounts contained not only spores, but also - and fairly frequently - numerous or very numerous plasmodia of the parasites.

The flagellate *Trypanosoma granulosum* is classified among the frequent parasites; its incidence ranged, depending on the area, from 15.4 to 64% and reached 95.8% in the Odra mouth (Tab. 1). Single to numerous *T. granulosum* were usually recorded in the peripheral blood; they occurred also in mounts made from material collected from internal organs: the kidney, liver, urinary bladder (6.9%) and gills (1.4%).

Table 1

Protozoan parasitisation of eel from different areas of the Szczecin Lagoon and River Odra mouth (%)

Parasitic species	Location in host		Piastowski Canal	Lubin	Trzebież	Stepnica	Nowe Warpno	Odra mouth
<i>Ichthyophthirius multifiliis</i> Fougnat 1876	gills	ext int	0	0	7.7 (+)	0	0	0
<i>Trichodina jadratica</i> Raabe 1958	gills	ext int	35.0 (+)	48.0 (+)-(++)	83.1 (+)-(++)	70.0 (+)-(++)	100.0 (+)-(+++)	66.7 (+)
<i>Trichodinella epizootica</i> Raabe 1950	gills	ext int	45.0 (+)-(+++)	64.0 (+)-(++)	74.6 (+)-(+++)	30.0 (+)-(+++)	100.0 (+)-(+++)	41.7 (+)-(+++)
<i>Trichophrya piscium</i> Bütschli 1889*	gills	ext int	0	0	0	0	0	4.2 (+++)
<i>Myxidium giardi</i> Cépède 1906	gills and other organ	ext int	80.0 (+)-(+++)	88.0 (+)-(+++)	94.4 (+)-(+++)	83.3 (+)-(+++)	84.6 (+)-(+++)	100.0 (+)-(+++)
<i>Spironucleus mobilis</i> Wierzbicka, Einszporn-Orecka	intestine	ext int	0	0	2.8 (+)-(++)	3.3 (+)	0	4.2 (++)
<i>Eimeria anguillae</i> Léger et Hollande 1922	intestine	ext int	0	8.0 (+)-(++)	16.9 (+)-(+++)	10.0 (+)	15.4 (+)-(+++)	20.8 (+)-(+++)
<i>Zschokkella stettinensis</i> Wierzbicka 1987	urinary bladder	ext int	20.0 (+)-(+++)	-	-	33.3 (+)-(+++)	30.8 (+)-(+++)	50.0 (+)-(+++)
<i>Sphaerospora gilsoni</i> (Debaisieux 1925)	urinary bladder	ext int	30.0 (+)-(+++)	-	-	33.3 (+)-(+++)	38.5 (+)-(+++)	87.5 (+)-(+++)
<i>Trypanosoma granuloso</i> Laveran et Mesnil 1909	blood	ext int	35.0 (+)-(++)	64.0 (+)-(++)	50.0 (+)-(++)	46.7 (+)-(++)	15.4 (+)	95.8 (+)-(++)

ext - invasion incidence; int - invasion intensity;

(+) - single ÷ not numerous; (++) - rather numerous ÷ numerous; (+++) - very numerous; (++++) - mass occurrence

* *Trichophrya piscium* Bütschli 1889 after Lom and Dykova 1989
after Šulman 1984 - *Capriniana piscium* (Bütschli 1889) Jankowski 1973

Table 2

Intensity of eel parasitisation with some protozoan species (%)

Parasitic species	Piastowski Canal	Lubin	Trzebież	Stepnica	Nowe Warpno	Odra mouth
<i>Trichodina jadranica</i>						
single - not numerous	35.0	44.0	69.0	56.7	38.5	66.7
rather numerous - numerous	0	4.0	12.7	13.3	46.1	0
very numerous	0	0	1.4	0	7.7	0
mass occurrence	0	0	0	0	7.7	0
<i>Trichodinella epizootica</i>						
single - not numerous	35.0	52.0	53.5	16.6	38.5	37.5
rather numerous - numerous	5.0	12.0	18.3	6.7	46.1	0
very numerous	5.0	0	2.8	6.7	15.4	4.2
<i>Zschokkella stettinensis</i>						
single - not numerous	15.0			30.0	15.4	29.2
rather numerous - numerous	0	-	-	3.3	7.7	8.3
very numerous	5.0			0	7.7	12.5
<i>Sphaerospora gilsoni</i>						
single - not numerous	5.0			16.7	15.4	25.0
rather numerous - numerous	20.0	-	-	13.3	15.4	37.5
very numerous	5.0			3.3	7.7	20.8
mass occurrence	0			0	0	4.2

Table 3

Myxidium giardii infestation of different organs of eel (%)

Organ	Piastowski Canal	Lubin	Trzebież	Stepnica	Nowe Warpno	Odra mouth
Gills	75.0	76.0	88.0	76.7	76.9	95.8
single - not numerous	45.0	56.0	56.3	40.0	53.8	37.5
rather numerous - numerous	25.0	16.0	25.4	30.0	23.1	33.3
very numerous	5.0	4.0	7.0	6.7	0	20.8
mass occurrence	0	0	0	0	0	4.2
Kidney	45.0	60.0	36.7	30.0	23.1	100.0
pronephros	5.0	16.0	16.7 (+)	6.0 (++)	0	40.9 (+)
mesonephros	25.0 (+)	20.0 (+)	13.3	13.3 (++)	7.7 (++)	68.2 (+++)
mesonephros II	35.0	48.0	13.3	16.7 (+)	15.4	100.0
Intestine	30.0	32.0	19.7	16.7	38.5	41.7
Urinary bladder	25.0	-	-	10.0	7.7	25.0
Liver	0	16.0	4.3	13.3	0	26.1
Gall bladder	0	0	0	3.3	0	0
Spleen	5.0	16.0	13.0	6.6	0	33.3
Skin	0	0	0	0	0	4.2

Gills: infestation with cysts

Other organs infested with spores and cysts – single (+), numerous (++) , very numerous (+++)

DISCUSSION

Compared to the literature data, the parasitic protozoans found in the Szczecin Lagoon eel were represented by a higher number of species, as a total of 11 species belonging to different taxa were recorded in the present study. The eel caught in the eutrophic Lake Esrum (Denmark) had 5 parasitic protozoan species only (Køie 1988). Similarly, 5 species were found in the eel from River Este in northern Portugal (Saraiva and Chubb 1989). In the former Czechoslovakia, Lom and Dykova (1989) listed 9 species, while Šulman and Štejn (1962) recorded 6 species in the former Soviet Union.

Apart from the species richness, the eel protozoan parasites in the Szczecin Lagoon show also a high extent of invasion intensity. As many as 6 parasites were frequent or very common (Tab. 1). The strongest invasion was that of *Myxidium giardi*. Its incidence was similar to that described by Landsberg (1983) and by Saraiva and Chubb (1989). The location of *M. giardi* on host in the Szczecin Lagoon somewhat overlapped that reported by Landsberg (1983) and by Lom and Dykova (1989), but the parasites occurred additionally in the urinary bladder and skin. Lom and Dykova (1989) considered *M. giardi* the commonest eel parasite in the former Czechoslovakia. A slightly lower invasion incidence (65.8%) was reported by Køie (1988) who found *M. giardi* cysts on the gills only.

Trichodina jadratica and *Trichodinella epizootica* can be treated as common eel parasites as well. Generally, their incidence in the Szczecin Lagoon was 69.9 and 60.1%, respectively. The two species were frequently recorded in the former Czechoslovakia (Lom and Dykova 1989); on the other hand, Saraiva and Chubb (1989) found only *T. jadratica* (18% incidence), while Køie (1988) reported *Trichodia* sp. only (2.5% incidence).

With 54.3% incidence, *Trypanosoma granulosum* was a fairly common parasite, its incidence being lower than that in Lake Esrum with 100% of the fish affected (Køie 1988); Saraiva and Chubb (1989) reported a high (84%) incidence in River Este.

Sphaerospora gilsoni (43.3% incidence) and *Zschokkella stettinensis* (34.5%) belonged to fairly frequent parasites. *T. granulosum* and the two sporozoans were listed among the eel parasites by Lom and Dykova (1989), but *Z. stettinensis* was rare in the former Czechoslovakia.

Two other species, *Eimeria anguillae* and *Myxobolus* sp. occurred more seldom in the materials studied. The general incidence of *E. anguillae* was 13.1% and was close to that reported by Jastrzębski (1984). He had been finding single oocysts only, while the invasion intensity in the Szczecin Lagoon was occasionally very high.

The remaining three species, *Ichthyophthirius multifiliis*, *Trichophrya piscium*, and *Spiroucleus mobilis* were rare (Tab. 1). Similarly, a low incidence of *I. multifiliis* was re-

corded by Saraiva and Chubb (1989), while Koie (1988) reported a 30.8% incidence. No mention of *T. piscium* had been found in the available literature.

The major differences in the parasitic protozoan infection of eel in the Szczecin Lagoon can be found between the northern and southern areas of the Lagoon, the River Odra mouth in the latter in particular. The lowest number (7) of protozoan species was recorded in the fish caught near the Piastowski Canal, while the highest number (9) was typical of the Odra mouth. The ciliates *Trichodina jadratica* and *Trichodinella epizootica* were most common and most numerous on the fish caught off Nowe Warpno which had been kept close to the shore in cages for 3 days. The sporozoans *Myxidium giardi*, *Zschokkella stettinensis* and *Sphaerospora gilsoni* as well as the flagellates *Trypanosoma granulosum* were most numerous in the Odra mouth, too. The spatial differences in the extent of invasion is probably associated with differences in ecological conditions between the areas. Due to the connection with the Baltic Sea, the water of the northern part of the Lagoon is rather brackish; the southern areas are affected by the River Odra discharging a high load of anthropogenic pollution.

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PASOŻYTNICZE PIERWOTNIANKI *ANGUILLA ANGUILLA* (L.) Z ZALEWU
SZCZECIŃSKIEGO I UJŚCIA RZĘKI ODRY

STRESZCZENIE

Ocena fauny pasożytniczych pierwotniaków w latach 1982-1983 u *Anguilla anguilla* (L.) odławianych z 5 rejonów Zalewu Szczecińskiego i Starorzecza Odry wskazała różnice w zarazieniu w części północnej w stosunku do strefy południowej, zwłaszcza w ujściowym odcinku rzeki Odry. Nasilenie inwazji poszczególnymi pasożytami było zmienne. Najmniejszą liczbę (7 gatunków) stwierdzono w części północnej, w rejonie Kanału Piastowskiego, najwięcej (9 gatunków) w strefie południowej w Starorzeczu Odry. Nasilenie inwazji 4 gatunkami: *Myxidium giardii*, *Zschokkella stettinensis*, *Sphaerospora gilsoni*, *Trypanosoma granulatum* było największe u węgorzy pochodzących ze Starorzecza Odry i wahało się od 50 do 100%.

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