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Original papers

Parasite communities of European perch, *Perca fluviatilis* L. (Actinopterygii: Perciformes: Percidae) from lake Łebsko (Central Coast, Poland)

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ABSTRACT. Communities of parasites of European perch from lake Łebsko were studied and compared with similar communities from the Polish coastal zone. Parasites comprised 18 autogenic and 5 allogenic species. Most individual parasites belonged to allogenic species and were in larval stages. The majority of specimens were eye parasites with *Tylodelphys clavata* as the eudominant species. The dominant species, *Acanthocephalus lucii*, belongs to the intestine parasite community. Three marine species were found: *Bothriocephalus scorpii*, *Hysterothylacium aduncum* and *Echinorchynhus gadi*. The results indicate that the parasite fauna consists mostly of freshwater species, common in various types of European waters, while marine species were rarely observed.

Key words: metazoan parasites, parasite community, *Perca fluviatilis*, coastal lake Łebsko

Introduction

For many years, brackish environments were avoided by researchers, who have focused their studies on more homogeneous environments such as the open sea or freshwater reservoirs. Therefore, knowledge about the organisms living there and their parasites is scant.

The shallow coastal lakes are very dynamic ecosystems with constant fluctuations in physical and chemical parameters to which the communities of organisms living there must adapt [1]. Lake Łebsko is connected with the Baltic Sea through the Łeba Channel so that both freshwater and marine species can be found, with a predominance of euryhaline species. The conservation programs conducted in the Słowiński National Park have allowed regular ichthyologic study to be carried out, but the parasites of various fish species from Lake Łebsko have not been studied extensively [2–4].

The metazoan parasites of the European perch from the Polish coastal zone have been studied from the Pomeranian Bay and Szczecin Lagoon [5], Gulf of Gdańsk [6,7], Vistula Lagoon [7,8], and from Lake Resko and the Baltic Sea off Dźwirzyno [9]. The majority of studies on the parasites of perch have been performed outside the coastal zone [e.g. 10–15].

Fish living in the lacustrine environment are important to the ecosystem and to fishery management. They are associated with the other inhabitants of the lake by food webs and act as intermediate, definitive or paratenic hosts for many species of autogenic and allogenic parasites.

The aim of this study was to present the parasite fauna and communities of parasites associated with European perch from Lake Łebsko, the largest lake within the Słowiński National Park, and to better determine the distribution of parasites affecting perch in Poland. The parasite communities were analyzed and compared with results of studies from the Polish coastal zone.

Materials and Methods

Study area. Lake Łebsko (54°42′49″N, 17°24′32″E) is located on the Central Coast of Poland. Lying in the Słowiński National Park, Łebsko is the largest coastal lake in Poland, with an area of 7 142 ha. It comprises shallow water bodies

(max. depth 6.3 m, average 1.6 m), bordered by reeds and sedges, which provide good shelter for a rich variety of migratory and breeding water birds [16]. This mixo-oligohaline reservoir is separated from the Baltic Sea by a narrow strip of land (Mierzeja Łebska) and is connected to the Baltic Sea by the Łeba River [17]. The lake is situated 30 cm above sea level, and seawater flows back into it when winds blow from the north and northwest. After inflow, salinity could increase to 3‰ [18]. This connection allows fish or other organisms to migrate between the lake and the Baltic coastal waters. Many fish species, both freshwater and marine, are found here, and the following are commercially caught in Łebsko: carp bream *Abramis brama*, roach *Rutilus rutilus*, European perch *Perca fluviatilis*, European ell *Anguilla anguilla*, pikeperch *Sander lucioperca*, Northern pike *Esox lucius* and various salmonids. However, tench *Tinca tinca*, crucian carp *Carasius carasius*, Prusian carp *Carasius gibelio*, rudd *Scardinius erythrophtalmus*, white bream *Blicca bjoerkna* and ide *Leuciscus idus* are rarely fished.

European perch is a very important link in the lacustrine food web and one of the most valuable commercial fish species in the coastal lakes and offshore zone of the Baltic Sea. This species has been caught also in the sea up to 4 km from the coasts [19]. Perch fry feed on zooplankton and smaller invertebrates while adults feed on fish and various invertebrates.

Over the course of six years (2001–2006), a total of 556 European perch from Lake Łebsko were sampled. The fish were purchased from professional fishermen. The fish were weighed (range 35.2–770.4 g, average 194.2 g) and measured (range 15.0–38.0 cm, average 23.8 cm). European perch were subsequently examined for ectoparasites and endoparasites using the standard procedures of parasitological examination and parasitic identification [e.g. 20]. The examination included the skin, fins, gills, eyes (lens and vitreous humour), body cavity and visceral organs (stomach and intestine, liver, heart, kidney, gonads and swim bladder).

The parasite communities were identified based on location in/on the hosts (e.g. eye, intestinal or gill parasites). They were also classified based on where they complete their life cycles and their dispersal strategy (autogenic and allogenic species) [21]. Autogenic parasites utilizing fish either as intermediate or definitive hosts and completing their entire life cycle in aquatic habitats, and allogenic parasites utilizing birds, mammals or reptiles as definitive hosts (fish act only as intermediate hosts) and completing their life cycles mainly in terrestrial environments [22]. Allogenic species can be easily transferred between reservoirs than autogenic species [23].

Parasitological indices, prevalence, mean and range intensity, and abundance, were calculated according to Pojmańska [23] and Bush et al. [24]. Prevalence, expressed as a percentage, is the number of hosts infected with a particular parasite species divided by the number of hosts examined. Mean intensity is the total number of individuals of a particular parasite species found in a sample divided by the number of hosts infected with that parasite. Range intensity is the highest and lowest number of individuals of a particular parasite species found in a single infected host in a sample. Abundance is the total number of individuals of a particular parasite species found in a sample divided by the number of examined fish, infected and uninfected.

The structure of parasite fauna was evaluated according to the abundance index: A>2, core species; 0.6–2, secondary species; 0.2–0.6, satellite species; and A<0.2 rare species [25] and dominance index.

To obtain the dominance, dominance index (D_i) was calculated as follow:

$D_i = n_i \times 100/N$ [%]

where 'n_i' is the total number of individuals of a species *i* and 'N' is the total number of all individuals [26,27].

The following scale for species dominance was used:

$D_i > 10\%$, eudominant (E);
$5.01\% < D_i < 10\%$, dominant (D);
$2.01\% < D_i < 5\%$, subdominant (Sd);
$1.01\% < D_i < 2\%$, recedent (R);
$D_i < 1\%$, subrecedent (Sr) [27].

Diversity and evenness were measured using ecological indices. Calculations were performed using BioDiversity Professional 2.0[1]:

Shannon-Wiener diversity index

$$H' = - \sum_{i=1}^{s} p_i \ln p_i$$

where 'S' – species richness (number of species), 'p_i' – proportion of species *i*;

[2] This free software was designed and developed by N. McAleece, J.D. Gage, P.J.D. Lambshead and G.L.J. Paterson and jointly developed by the Natural History Museum in London and the Scottish Association for Marine Science in Oban, Scotland.

Margalef 's diversity index

$M = S\text{-}1/\ln N$

where 'S' – species richness, 'N' – total abundance;

Pielou index of evenness

$J' = H'/H'_{MAX}$

where H' – Shannon-Wiener index, $H'_{MAX} = \ln S$ ('S' – number of species)

Simpson's diversity index and inverse Simpson's index

$D = \Sigma\, n_i(n_i\text{-}1)/N(N\text{-}1)$

where 'n_i' is the total number of individuals of a species *i* and 'N' is the total number of all individuals

Berger-Parker dominance index

$d = N_{max}/N$

where 'N_{max}' – number of individuals from the most abundant species,

'N' – number of individuals of all species. The reciprocal of the index, 1/d, is also used.

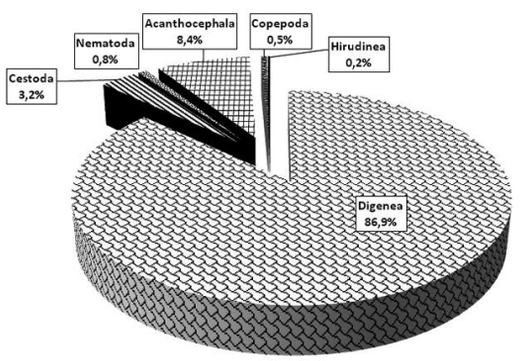

Fig. 1. Contribution (%) of representatives of the various parasitic taxa in collected material

Results

A total of 23 parasitic taxa were recovered from the European perch. The total comprised seven digeneans including: *Apatemon gracilis*, *Azygia lucii*, *Bunodera luciopercae*, *Diplostomum* spp., *Posthodiplostomum brevicaudatum*, *Ichthyocotylurus platycephalus* and *Tylodelphys clavata*; four cestodes: *Bothriocephalus scorpii*, *Proteocephalus filicollis*, *P. percae*, *Triaenophorus nodulosus*; five nematodes: *Camallanus lacustris*, *C. truncatus*, *Hysterothylacium aduncum*, *Philometra obturans*, *Raphidascaris acus*; five acanthocephalans: *Acanthocephalus anguillae*, *Acanthocephalus lucii*,

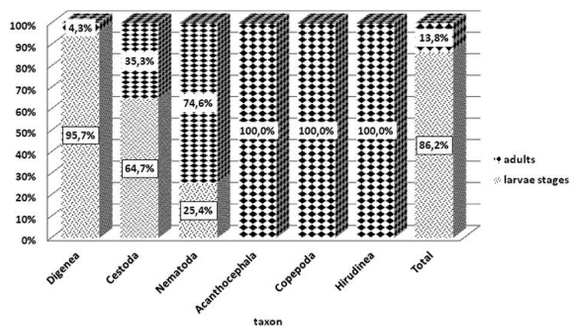

Fig. 2. Contribution (%) of parasites in larval and adult stages in particular parasite taxa

Echinorhynchus gadi, *Neoechinorhynchus rutili*, *Pomphorhynchus laevis*; one crustacean *Ergasilus sieboldi*, and one hirudinean, *Piscicola geometra*.

The most frequent taxon of parasites was Digenea, representing 86.9% of all parasites (Fig. 1). Fifteen species, 13.8% of the total parasites, were present as adults and eight as larval stages. The greatest proportion of parasites in the larval stages were found in digeneans and tapeworms, respectively 95.7% and 64.7%. The nematodes represented by both development stages, larval stages accounted for 25.4% (Fig. 2). Parasite fauna was dominated by endoparasites. Only two species of ectoparasites were noted: the copepod *E. sieboldi* and the leech *P. geometra*, both of which are rare species.

The most prevalent parasites were *T. clavata* and *Acanthocephalus lucii*, constituting respectively 23.74% and 15.65% of the total number. The highest mean intensity was observed in the case of two digeneans: *T. clavata*, of which 65.39 examples were identified and *B. luciopercae* with 19.24 individuals. The highest number of parasites in a single fish was found for *T. clavata*, 417 individuals and *B. luciopercae,* 166 individuals. The infection parameters of all parasites are given in Table 1.

The parasite fauna of the European perch consists of three marine species: *B. scorpii*, *H. aduncum* and *E. gadi.* All of them are intestinal parasites. Their parasitological indices were low and their dominance index placed all of them in the subrecedent class (Tables 1,2).

The community of intestinal parasites was taxonomically diverse, and found to consist of fourteen species: two digeneans *A. lucii*, *B. luciopercae*; four tapeworms *B. scorpii*, *P. filicollis*,

Table 1. Infection parameters of the European perch with parasites in Lake Łebsko (met. – metacercaria, pl. – plerocercoid, l. – larvae)

	Prevalence [%]	Intensity [ind.]			Abundance [ind.]
		mean	range ±	SD	
Apatemon gracilis met.	11.33	3.67	1-28	1,90	0.42
Azygia lucii	0.36	1.00	1	0.07	0.004
Bunodera luciopercae	3.78	19.24	1-166	7.84	0.73
Diplostomum spp. met.	4.50	4.76	1-21	1.55	0.21
Ichthyocotylurus platycephalus met.	0.36	1.50	1-2	0.71	0.005
Posthodiplostomum brevicaudatum met.	3.78	5.00	1-23	5.50	0.19
Tylodelphys clavata met.	23.74	65.39	1-417	55.69	15.52
Bothriocephalus scorpii	0.54	1.00	1	0	0.005
Proteocephalus filicollis	1.08	1.67	1-3	0.82	0.02
Proteocephalus percae	6.47	2.81	1-8	1.88	0.18
Triaenophorus nodulosus pl.	9.71	3.87	1-18	1.79	0.38
Camallanus lacustris	3.78	2.29	1-18	11.11	0.09
Camallanus truncatus	0.54	1.33	1-2	0.58	0.01
Hysterothylacium aduncum l.	1.62	1.87	1-4	1.05	0.03
Philometra obturans l.	0.18	1.00	1	0.04	0.002
Raphidascaris acus	0.18	1.00	1	0.04	0.001
Acanthocephalus lucii	15.65	8.29	1-53	11.79	1.30
Acanthocephalus anguillae	2.34	5.31	1-18	6.01	0.12
Echinorchynhus gadi	0.72	8.00	2-16	7.12	0.06
Neoechinorhynchus rutili	1.26	1.71	1-5	1.50	0.02
Pomphorhynchus laevis	1.80	3.40	1-15	0.82	0.06
Ergasilus sieboldi	2.88	2.88	1-9	0.70	0.08
Piscicola geometra	0.54	1.33	1-2	0.12	0.01

P. percae; four nematodes *C. lacustris*, *C. truncatus*, *H. aduncum, R. acus*; five acanthocephalans *A. lucii*, *A. anguillae*, *E. gadi*, *N. rutili* and *P. laevis*. One of them, *P. percae* is classified as a specialist species. *Acanthocephalus lucii* is a dominant species (Table 2). Only 13.6% of the parasites were in the larval stages (Fig. 3). Acanthocephalans dominated, representing 52.1% of the total (Fig. 4). *T. nodulosus* was associated with the digestive system: This tapeworm was encysted in the liver.

The community of eye parasites was composed of digeneans metacercariae, including *A. gracilis*, *Diplostomum* spp., *P. brevicaudatum* and *T. clavata,* and also nematode larvae *P. obturans.* The eye

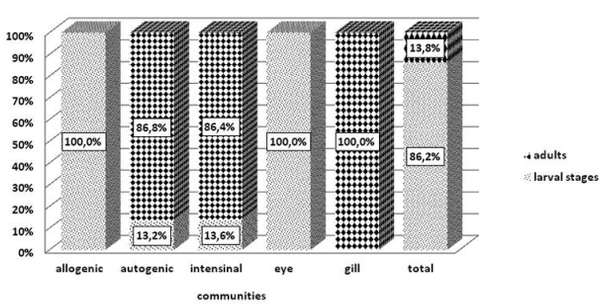

Fig. 3. Contribution (%) of parasites in larval and adult stages in particular parasite taxa

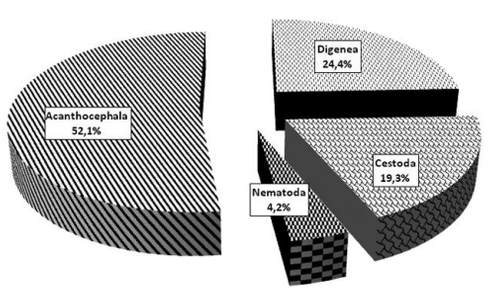

Fig. 4. Contribution (%) of representatives of various parasitic taxa in intestinal parasites community of European perch

Table 2. Dominance index (D_i) of pearch parasites in Lake Łebsko. (eudominant (E), dominant (D), subdominant (Sd), recedent (R), subrecedent (Sr))

Parasites	D_i [%]	Class of dominance
Apatemon gracilis	2.11	Sd
Azygia lucii	0.02	Sr
Bunodera luciopercae	3.70	Sd
Diplostomum spp.	1.09	R
Ichthyocotylurus platycephalus	0.03	Sr
Posthodiplostomum brevicaudatum	0.96	Sr
Tylodelphys clavata	78.96	E
Bothriocephalus scorpii	0.03	Sr
Proteocephalus filicollis	0.09	Sr
Proteocephalus percae	0.92	Sr
Triaenophorus nodulosus	1.91	R
Camallanus lacustris	0.44	Sr
Camallanus truncatus	0.04	Sr
Hysterothylacium aduncum	0.16	Sr
Philometra obturans	0.01	Sr
Raphidascaris acus	0.01	Sr
Acanthocephalus anguillae	0.63	Sr
Acanthocephalus lucii	6.60	D
Echinorhynchus gadi	0.29	Sr
Neoechinorhynchus rutili	0.11	Sr
Pomphorhynchus laevis	0.31	Sr
Ergasilus sieboldi	0.42	Sr
Piscicola geometra	0.01	Sr

parasites were the most numerous group with *T. clavata* as the eudominant species (Table 2). The community of gill parasites consisted of only one species of copepod: *E. sieboldi*, which is a member of the subrecedent class.

The most diverse parasite community were autogenic species, which comprised 18 species in total, including two digeneans (*A. lucii*, *B. luciopercae*), four tapeworms (*B. scorpii*, *P. filicollis*, *P. percae*, *T. nodulosus*), five nematodes (*C. lacustris*, *C. truncatus*, *H. aduncum*, *P. obturans*, *R. acus*), five acanthocephalans (*A. anguillae*, *A. lucii*, *E. gadi*, *N. rutili*, *P. laevis*), one copepod (*E. sieboldi*) and one leech (*P. geometra*). Three species, *T. nodulosus*, *H. aduncum*, *P. obturans* (13.2%), occurred as larval stages and the remaining as adults (Fig. 3). The dominant taxon was Acanthocephala (Fig. 5).

Only five taxa belong to allogenic species (*A. gracilis*, *Diplostomum* spp., *P. brevicaudatum*, *I. platycephalus* and *T. clavata*). All of them have birds as a final host. Nevertheless, most of the parasites collected from Łebsko are allogenic (83.2%) (Fig. 6).

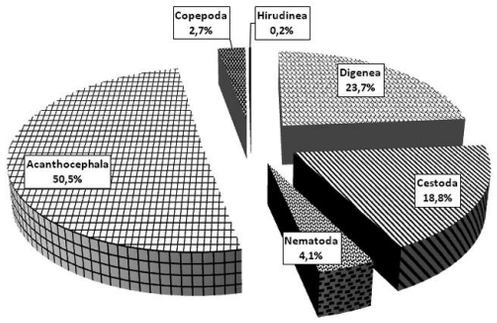

Fig. 5. Contribution (%) of representatives of particular parasitic taxa in community of autogenic species of European perch

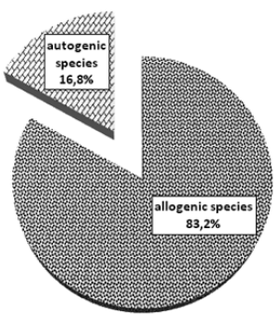

Fig. 6. Contribution (%) of autogenic and allogenic parasites of European perch

Based on the abundance index, one species of metazoan parasite predominates: *T. clavata* and secondary species are *Acanthocephalus lucii* and *B. lucioperca.* Satellite species included two digeneans, *A. gracilis* and *Diplostomum* spp., and the cestode *T. nodulosus.* The remaining species of parasites were classified as rare.

According to the dominance index only one species is eudominant, *T. clavata* (78.96%), and one dominant, *Acanthocephalus lucii* (6.60%). The most frequent class of dominance is subrecedent, with seventeen species (Table 2).

The biodiversity indices indicate that the highest diversity and evenness were observed in the community of autogenic species and the next in the community of intestinal parasites. The highest dominance occurred in the community of eye parasites and in the community of allogenic species (Table 3).

Table 3. Values of the diversity indices for parasite communities in European perch from Lake Łebsko

Index	communities					
	all metazoan	allogenic	autogenic	gill	eye	intestine
Berger-Parker Dominance (d)	0.79	0.95	0.392	1	0.95	0.433
Berger-Parker Dominance (1/d)	1.266	1.053	2.553	1	1.053	2.312
Shannon H'	0.427	0.11	0.82		0.109	0.728
Pielou J'	0.313	0.157	0.654		0.181	0.619
Simpsons Diversity (D)	0.631	0.903	0.225	1	0.903	0.268
Simpsons Diversity (1/D)	1.586	1.108	4.439	1	1.107	3.727
Margalef index	12.876	1.768	13.476	5.413	1.011	8.69

Discussion

Digenea was the most abundant group of parasites in freshwater [e.g. 12,13,28,29] and brackish water localities. Flukes were detected in many species of fish from the Gulf of Gdańsk [6–8,30] and the Vistula Lagoon [7,8], in roach and carp bream from Lake Łebsko [2,3], carp bream from the Lake Jamno [31] and also in perch from the Baltic Sea and Lake Resko [9] or in the estuary of the Odra River [5].

Five of the seven digeneans (*A. gracilis*, *Diplostomum* spp., *P. brevicaudatum*, *I. platycephalus* and *T. clavata*) represented allogenic species, and mostly belonged to the community of eye parasites. All of them are limnetic species, but Rolbiecki [32] suggests that *Diplostomum* spp. and *T. clavata* have already been classified as brackish water species. Kesting and Zander [33] report that *Diplostomum* spp. can still exist in the water at salinities of 10–12‰. A similar distribution is described for autogenic species common in the Baltic Sea, such as the acanthocephalans *Pomphorhynchus laevis* and *Neoechinorhynchus rutili* [34].

Wierzbicka et al. [9] compared infection of European perch from the sea and Lake Resko Przymorskie. They found that *Diplostomum* spp. often infects fish from the sea while *T. clavata* prefer hosts from the lake. Digenean species, which are eye parasites, have a complex life cycle and reach maturity in different species of fish-eating birds. The high parasitological indices of infection associated with digenean metacercariae are a consequence of the presence of gastropods as intermediate hosts and the richness of water birds, which serve as definitive hosts. Because the snails can also exist in brackish water of lower salinity, these digeneans are found in several fish species of the coastal zone of the Baltic Sea [34]. A total of 59 breeding species of water birds was observed in the vicinity of Lake Łebsko [16]. As in Łebsko, *T. clavata* is one of the most prevalent parasites of perch in the Polish coastal zone and adjacent waters [30,8,9,5]. The subdominant species, *A. gracilis* is considered to be a typical parasite of perch. In brackish waters, it is also found in both three-spined and nine-spined sticklebacks [35]. Rolbiecki et al. [7] report that in the Gulf of Gdańsk, only 1.7% of perch was infected with *A. gracilis*, while at the same time, up 15.4% of three-spined sticklebacks were infected. But in the Vistula Lagoon *A. gracilis* was found in 5.1% of perch. The final species of eye parasite, *P. brevicaudatum*, belongs to a rare species (subrecedent), not only in Łebsko, but also in other reservoirs [10,11,28,8].

The final allogenic species, *I. platycephalus*, also has a complex life cycle with snail, fish and bird hosts [36], and many freshwater fish species act as second intermediate hosts. The parasite was found in small number in the Gulf of Gdańsk [7], Vistula Lagoon [7,8] and Lake Resko [9]. Wierzbicka et al. [9] did not find this species in adjacent sea localities. Similarly, perch from the estuary of the Odra River were found to be uninfected according to Sobecka and Słomińska [5].

Among the autogenic species, limnetic species predominante. They are well-known to occur in European perch from freshwater reservoirs [10–14]. Freshwater parasites are typical also for freshwater fish species living in the coastal zone of the Baltic Sea [5,6,8,9,35].

The acanthocephalan *A. lucii,* the second core species, occurs with high parameters of infection in perch from freshwater localities [e.g. 12,13] and the coastal zone, where it is one of the most abundant parasites [6,8,9,30]. Like other acanthocephalans, *A. lucii* is unspecialized.

Two species of *Proteocephalus* tapeworms were

noted in perch. *P. filicollis*, first of all matured in three-spined stickleback *Gasterosteus aculeatus* [37] but sometimes extend in percid fishes [38,39]. *P. filicollis* was found also in round goby *Neogobius melanostomus* an invasive species in the Polish fauna of the Vistula Lagoon [32]. Rolbiecki [8] found 20.2% of perch to be infected with *P. filicollis* in the Vistula Lagoon and only 4.9% with *P. percae.* Sobecka and Słomińska [5] in the Odra River estuary found 9.09% perch infected with *P. percae* but Wierzbicka et al. found 28.8% in Lake Resko [9]. In Łebsko it is respectively 1.08% (*P. filicollis*) and 6.47% (*P. percae*). Perch longer than 22.5 cm acquired *P. percae* tapeworms. Valtonen and Rintamäki [40], studying perch from the Gulf of Bothnia and Lake Yli Kitka, found highest prevalence of infection with *P. percae* to be in the bay (60%) rather than the lake (10%). The highest rate of infection was noted among medium-sized fishes more than 18 cm length.

As noted by Scholz [41], *T. nodulosus* was recorded more often than *P. percae* in Lake Łebsko. The tapeworm *T. nodulosus* is a monoxenous parasite of Northern pike. The first intermediate hosts are Copepoda and the main second intermediate host is European perch, in which plerocercoids are encysted in the liver. Brinker and Hamers [42] propose that the trophic state of water is a important factor affecting the rate of infection with *T. nodulosus*. Parasitological indices increase as the trophic level decreases and are highest in oligotrophic waters. As Łebsko is a hypereutrophic lake, parasitological indices are not very high.

P. obturans is a species widely distributed in Palearctic and occurs in fresh and brackish waters [43]. Northern pike is a specific final host while perch, pikeperch, bream and rudd are the main paratenic hosts in which larvae located in the vitreous body of eye [44]. Several copepods act as intermediate host [43,45]. The prevalence of *P. obturans* in pikeperch in Łebsko is 5.7%. The reservoir of this parasite are bream and perch, prevalence is, respectively 0.3% and 0.2%.

European perch is one of the many hosts of *C. lacustris* and infected by feeding on infected copepods. In Łebsko *C. lacustris* occurs with *C. truncatus*. Wierzbicka et al. [9] also noted both nematodes. They observed that *C. truncatus* more often infected perch from the sea and *C. lacustris* from the lake.

Because of low salinity, marine parasites are not very frequent. Only *B. scorpii*, *H. aduncum* and *E. gadi* are a marine species [9,38,46–48]. All of these species are widely distributed. In the Baltic Sea *B. scorpii* and *H. aduncum* are also found as far as the Gulf of Gdańsk and *E. gadi* is found as far as the central Baltic and the Gulf of Finland [34]. List of marine parasites found in European perch from the Polish coastal zone is provided in Table 4.

B. scorpii and *H. aduncum* are accidental parasites of perch. *H. aduncum* parasitizing mainly marine fishes, especially cods, and migratory fishes, and with them may be brought into freshwater environments [49,50]. *E. gadi* is unspecialized regarding both intermediate and final hosts [34] and also occurred in many fishes from the Baltic and adjacent waters. These species are known from perch from the Baltic Sea, the Vistula Lagoon, the estuary of the Odra River and lake Resko [5,6,8,9].

Because of the connection between the Łebsko and the Baltic Sea, fish, as other organisms, can migrate between these environments. Some marine fish like *Clupea harengus*, *Gadus morhua*, *Belone belone*, *Platichthys flesus*, *Pleuronectes platessa*, *Psetta maxima,* and *Osmerus eperlanus* in spring (for spawning). Freshwater species from the coastal water of the Baltic Sea have also been found in Lake Łebsko [18], some of which can act as reservoirs of parasites and transmit them between lake and sea. Rokicki [47] suggests that European perch, pikeperch and European eel from the Vistula Lagoon became infected with parasites by feeding on flat fish and eelpout which had migrated from the Gulf of Gdańsk. An abundant population of smelt and three-spined stickleback has been found in Łebsko [51], and also in the coastal zone of the Baltic Sea. As smelt and stickleback form part of the diet of perch [52], parasites can go on to infect the perch. *H. aduncum* has been found in smelt [6,53] and stickleback [35]. Stickleback can be also a host of *B. scorpii. H. aduncum* and *B. scorpii,* seen in flounder [54]. Flounders occurred in the lake Łebsko throughout the year [18] and could be a reservoir of both these parasites and *P. laevis* [55].

Conclusions

1. The results of studies conducted on European perch from Lake Łebsko and their comparison with results of the other authors from various reservoirs (fresh and brackish waters) indicate that the same dominant species are found with high parasitological indices in all locations.
2. The most frequent taxon was Digenea, repre-

senting 86.9% of all parasites. Most of them belong to the eye parasite community with eudominant species *T. clavata*. Allogenic species dominate autogenic species, as larvae stages dominate adults, but the community of autogenic species was found to be most diverse. Ectoparasites were represented only by two species.

3. The presence of marine species (*B. scorpii*, *H. aduncum*, *E. gadi*) in the parasite fauna of perch from the coastal lakes and the coastal waters of the Baltic Sea is the only difference between freshwaters and estuaries, but their share is small. Marine species of parasites nevertheless are more often observed in marine fish species.

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