

FISH DIGENEANS FROM THE SEVEN ISLANDS ORNITHOLOGICAL
RESERVE AT OŚWIN LAKE POLAND. PART I.
POSTHODIPOSTOMUM CUTICOLA von NORDMANN, 1832

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Background. The study was carried out in the shallow, eutrophic Oświn Lake, in the area of the Seven Islands ornithological reserve (north-eastern Poland) to determine the infection of fish with digeneans maturing in piscivorous birds. This paper presents a comparative analysis of the occurrence of *Posthodiplostomum cuticola* in fishes from two parts of the reservoir differing in environmental conditions. The effect of fish size and season of sampling on the infection level was analysed.

Material and methods. Within 1998 and 1999, a total of 1091 fishes of 8 species dominating in the lake were examined. Samples were collected four times a year (in May, July, August, and October) simultaneously from the two examined parts of the lake.

Results. Metacercariae of *P. cuticola* occurred with high prevalence and intensity of infection in roach, rudd, white bream, and carp bream, and sporadically in crucian carp and European perch. The intensity of infection of fish from the western part of the lake was significantly higher compared with the eastern part; roach from the western pool were much more infected than in the other reservoirs of north Poland. The infection of roach, white bream and carp bream increased with total body length (TL), such a relationship was not reported for rudd. The infection of roach, white bream and carp bream varied significantly in different experimental periods while differences in the infection of rudd in samples were incidental.

Conclusion. Location-dependent occurrence of *P. cuticola* in fishes indicates that interchange between fish groups from the eastern and western pool of Oświn Lake is

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limited. Infection of rudd was of a more incidental character than the infection of roach, white bream, and carp bream.

Key words: parasite, fish, *Posthodiplostomum cuticola*, Oświn Lake, Seven Islands reserve, Poland.

INTRODUCTION

Metacercariae of *Posthodiplostomum cuticola* von Nordmann, 1832 parasitize cyprinids (Cyprinidae), percids (Percidae), pikes (Esocidae), salmonids (Salmonidae), and others (Bauer 1987) causing the formation of characteristic cysts, with a strong melanization. The intensive infections are referred to as the black spot disease.

Snails *Planorbis planorbis* and *P. carinatus* serve as a first intermediate host of *P. cuticola*. Piscivorous birds of Ardeidae, usually common heron (*Ardea cinerea*), purple heron (*A. purpurea*), Squacco heron (*Ardeola ralloides*), and night heron (*Nycticorax nycticorax*) (cf. Jara and Chodynieski 1999) are the final host. In the 1950s, the abundance of *P. cuticola* metacercariae was attributed to the presence of common heron colonies in the area of Oświn Lake (north-eastern Poland) (Kozicka 1963). At present, no breeding sites of heron are located in the Seven Islands reserve covering Oświn Lake (Sikora et al. unpublished). The closest colony is located 4.5 km to the south, at Rydzówka Lake (Mirowska-Ibron, personal communication). In the 1970s, after a rapid draw down, Oświn Lake underwent accelerated eutrophication. In 1983, intoxication with chemical fertilizers caused mass fish kills. Since that time, the reserve has been protected by the Ramsar Convention (The List of Wetlands of International Importance). At present, 122 species of birds are nesting in this area (Sikora et al. unpublished).

The water level increasing in 1993 prompted by the dam construction on the Oświnka River, caused a recession of the eutrophication process. At present, pond type Oświn Lake (surface area: 890 ha; mean depth: 1.7 m) is a reservoir of a moderately advanced eutrophication (Wróbel and Królikowska 1999, Królikowska and Wróbel unpublished, Wiśniewski unpublished). There are two large basins: eastern and western in the lake separated by a shallow (Fig. 1).

The western part is more overgrown by trees and bushes than the eastern one. The bottom of the eastern basin contrary to the western one is completely covered with hornwort (*Ceratophyllum demersum*). The current microbiological analysis of water indicated that the eastern part of Oświn Lake is more fertile (Własow et al. 2003).

Differences in the occurrence of black spot disease in particular parts of the lake were observed during catches (controlled by protection regulations). Location-dependent infection with *P. cuticola* was not investigated prior to the ecological catastrophe (Kozicka 1963, Grabda and Grabda unpublished). Therefore, it was reasonable to study the current rate of fish infection with *P. cuticola* in both parts of Oświn Lake. The effect of fish size and sample collection period on the infection level was also analysed.

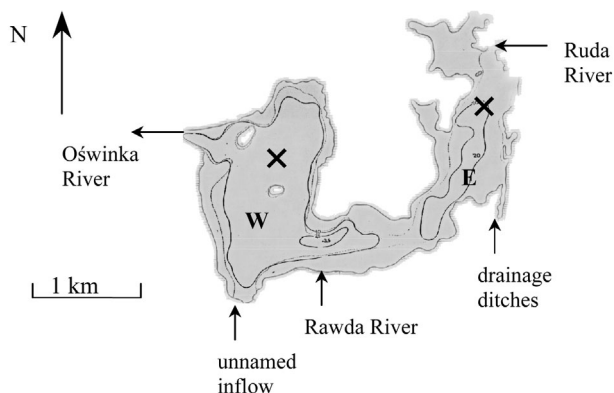


Fig. 1. Location of sampling areas of fish (X) in Oświn Lake; E, eastern-; W, western part of the lake

MATERIAL AND METHODS

Throughout 2 years (1998 and 1999), a total of 1091 fishes belonging to 8 dominant species were examined: northern pike (*Esox lucius*), roach (*Rutilus rutilus*), rudd (*Scardinius erythrophthalmus*), tench (*Tinca tinca*), white bream (*Blicca bjoerkna*), carp bream (*Abramis brama*), crucian carp (*Carassius carassius*), and European perch (*Perca fluviatilis*).

The fishes were caught with nets (mesh 30 x 30 mm) in the eastern and western basins four times per year (in May, July, August, and October) (Table 1). Specimens examined had a broad range in length (Table 2).

Table 1

Number of fish in samples from the eastern- (E) and western (W) part of Oświn Lake

Fish species	Samples							
	May 98	Jul 98	Aug 98	Oct 98	May 99	Jul 99	Aug 99	Oct 99
	No. E / No. W							
Northern pike	10 / 5	3 / 3	6 / 10	10 / 11	7 / 10	10 / 4	10 / 10	6 / 10
Roach	15 / 15	5 / 10	2 / 7	10 / 9	7 / 8	9 / 10	10 / 10	7 / 10
Rudd	14 / 9	10 / 6	9 / 3	8 / 5	10 / 10	10 / 8	10 / 10	8 / 6
Tench	3 / 1	8 / 1	10 / 5	10 / 10	10 / 10	10 / 10	10 / 10	6 / 9
White bream	15 / 13	7 / 10	0 / 5	0 / 10	10 / 10	10 / 2	10 / 10	7 / 10
Carp bream	14 / 14	10 / 10	10 / 10	10 / 8	10 / 10	10 / 10	10 / 10	7 / 10
Crucian carp	3 / 0	10 / 5	10 / 2	6 / 0	7 / 6	10 / 9	10 / 10	10 / 8
European perch	13 / 15	10 / 10	10 / 10	9 / 11	7 / 10	10 / 10	10 / 10	10 / 10

Table 2

Comparison of the total body length (TL) of fish sampled in the eastern (E) and western (W) part of Oświn Lake. *U*, Mann–Whitney statistics

Fish species	TL [cm] - E $\bar{x} \pm s$ (range)	TL [cm] - W $\bar{x} \pm s$ (range)	<i>U</i>	<i>P</i>
Northern pike	58.03 ± 12.35 (33.0–97.0)	56.99 ± 12.74 (33.0–77.0)	1932.5	> 0.05
Roach	19.48 ± 4.31 (14.0–31.0)	21.02 ± 4.82 (14.5–36.0)	2076.0	< 0.05
Rudd	22.64 ± 4.83 (13.5–32.0)	24.24 ± 4.07 (14.5–31.0)	1816.0	> 0.05
Tench	34.65 ± 4.94 (27.0–47.5)	33.57 ± 3.40 (27.5–40.0)	1695.5	> 0.05
White bream	18.29 ± 4.08 (13.0–27.5)	19.24 ± 4.07 (12.0–27.0)	1762.5	> 0.05
Carp bream	29.52 ± 4.03 (23.0–41.0)	27.62 ± 5.28 (12.0–42.0)	2581.5	< 0.05
Crucian carp	24.40 ± 5.48 (14.0–48.0)	26.50 ± 5.33 (11.0–35.0)	938.5	< 0.05
European perch	22.53 ± 6.42 (13.0–41.0)	22.67 ± 4.94 (13.5–35.0)	2936.5	> 0.05

The prevalence and intensity of infection (mean value and range) were calculated following Margolis et al. (1982). Non-parametric statistics were used to find differences in the infection of fish with *P. cuticola*: the Kruskal–Wallis *H*-test to compare the different sampling periods and the Mann–Whitney *U*-test to compare sampling sites. Differences in the total body length of fish examined in particular parts of the lake were estimated by *U*-test. To find the fish size and intensity of infection relationship the Pearson's correlation coefficient was calculated.

RESULTS

Cysts with metacercariae of *Posthodiplostomum cuticola* were observed in the skin, subcutaneous tissue, fins, and on the outer and inner side of the operculum and on the scales, gill arches and the mouth cavity of the most extensively infected fishes. The parasite numerously occurred in roach, rudd, white bream and carp bream; with intensity of infection up to 392, 282, 210, and 119 parasites per fish, respectively (Table 3). Crucian carp and European perch were sporadically infected (Table 3).

Table 3

Comparison of the fish infection with *Posthodiplostomum cuticola* in the eastern (E) and western (W) part of Oświn Lake

Fish	Prevalence [%] E / W	Intensity of infection	
		Mean E / W	Range E / W
Northern pike	0 / 0	0 / 0	0 / 0
Roach	63.1 / 81.0	9.3 / 60.3	1–56 / 1–392
Rudd	39.2 / 54.5	5.4 / 28.2	1–42 / 1–282
Tench	0 / 0	0 / 0	0 / 0
White bream	71.2 / 87.1	25.9 / 28.1	1–210 / 1–180
Carp bream	32.1 / 52.4	4.9 / 11.8	1–17 / 1–119
Crucian carp	0 / 2.5	0 / 1.0	0 / 1
European perch	1.3 / 0	3.0 / 0	3 / 0

Prevalence in roach varied from 0 to 80% in samples from the eastern basin and from 70 to 100% in samples from the western one. In rudd it ranged from 0 to 62.5% and from 20 to 83.3%, respectively; in carp bream—from 0 to 60% and from 14.3 to 87.5%, respectively; in white bream—from 40 to 100% in both pools (Fig. 2).

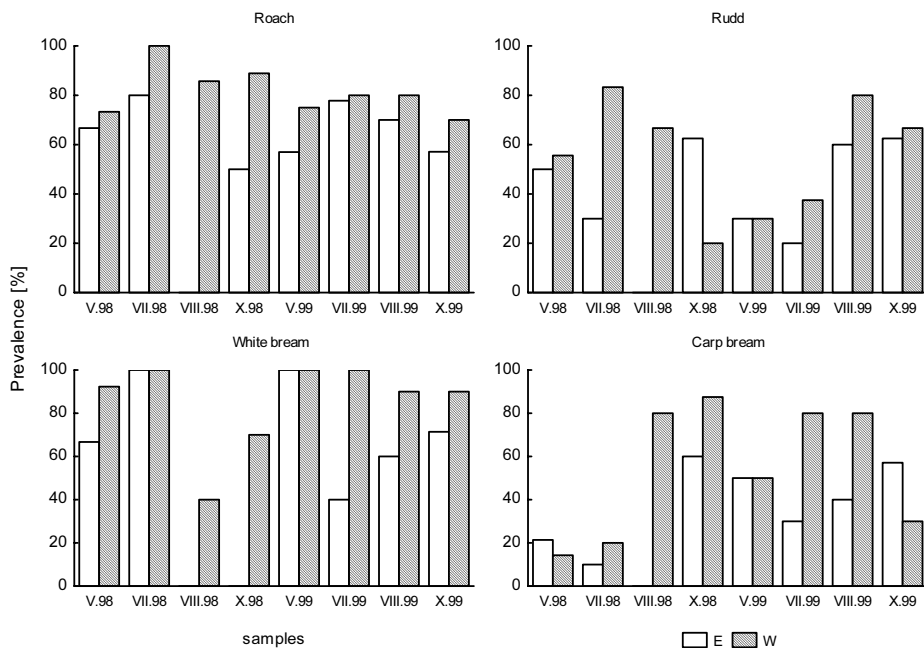


Fig. 2. Prevalence of *P. cuticola* in fish from eastern (E) and western (W) part of Oświn Lake

Intensity of infection in roach peaked in July 1998 in both pools (mean value 167.5 parasites per fish in the western part, and 19.2 in the eastern one) (Fig. 3). In rudd it peaked in May 1998 (82.2) and in October 1999 (11.2), respectively (Fig. 4). In white bream the intensity of infection increased in July 1998 in both basins and reached on an average 65.6 in the western- and 58.1 in the eastern pool (Fig. 5). In carp bream it peaked in August 1998 (24.1) and in May 1998 (10), respectively (Fig. 6).

In accordance with the H -test result the infection of roach, white bream and carp bream differed significantly in sampling periods (Figs. 3, 5, 6), the infection of rudd was not time-dependent (Fig. 4). The infection level of roach, rudd, white bream, and carp bream was visibly higher in the western part of the lake than in the eastern part (Table 3). Location dependent differences were found by U -test in all mentioned-above fishes (Figs. 3, 4, 5, 6). Number of parasites increased with increasing the total body length (TL) of roach, white bream, and carp bream (Fig. 7). Such a correlation did not occur in the case of rudd ($P > 0.05$).

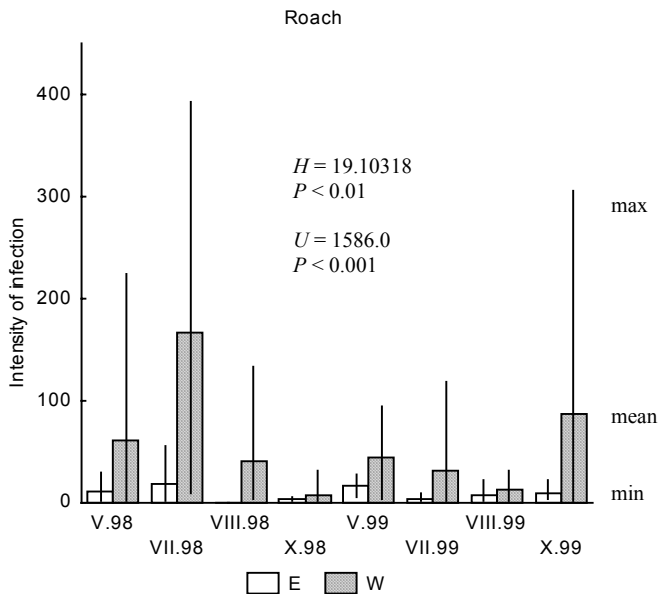


Fig. 3. Intensity of infection of roach with *P. cuticola* in samples from eastern- (E) and western (W) part of Oświn Lake; H , Kruskal–Wallis statistic for seasonal differences; U , Mann–Whitney statistic for location differences

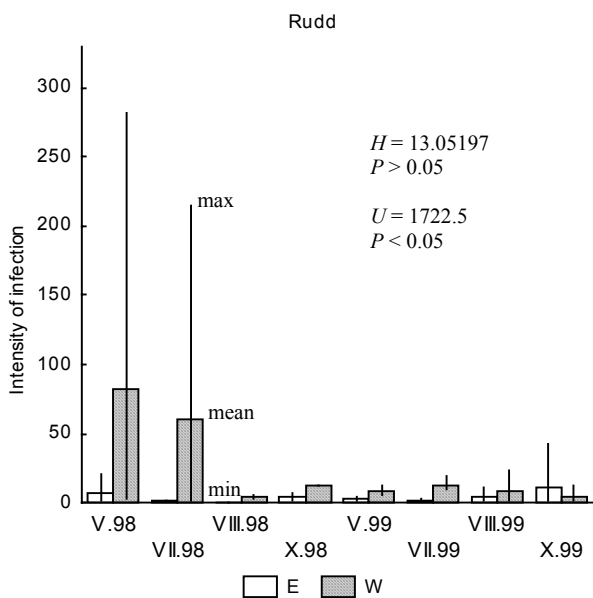


Fig. 4. Intensity of infection of rudd with *P. cuticola* in samples from eastern- (E) and western (W) part of Oświn Lake; H , Kruskal–Wallis statistic for seasonal differences; U , Mann–Whitney statistic for location differences

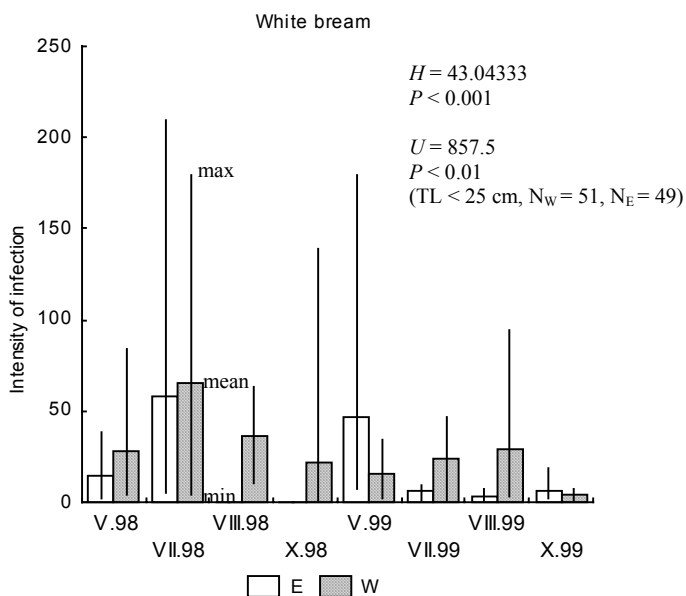


Fig. 5. Intensity of infection of white bream with *P. cuticola* in samples from eastern- (E) and western (W) part of Oświn Lake. H , Kruskal–Wallis statistic for seasonal differences. U , Mann–Whitney statistic for location differences

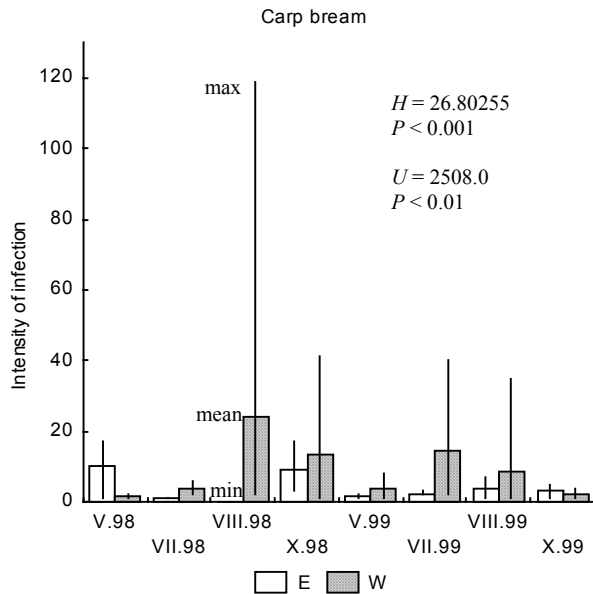


Fig. 6. Intensity of infection of carp bream with *P. cuticola* in samples from eastern- (E) and western (W) part of Oświn Lake; H , Kruskal–Wallis statistics for seasonal differences; U , Mann–Whitney statistic for location differences

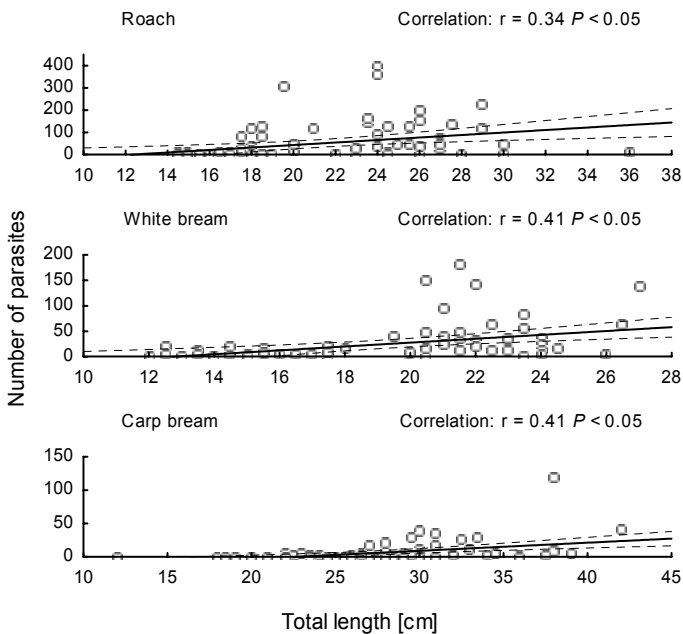


Fig. 7. Relationship between the number of *P. cuticola* and the total length (TL) of fish from western part of Oświn Lake

Thus, differences in body length of rudd examined in particular sites (Table 2) could not influence the location dependent differences. The total body length of white bream examined varied between the pools (Table 2) so, to find differences in the infection of fish, the groups of uniform length were chosen (TL < 25 cm; N_{west} = 51, N_{east} = 49) (Fig. 5).

DISCUSSION

Compared to the other reservoirs of northern Poland, the abundance of *Posthodiplostomum cuticola* in fish from Oświn Lake was exceptionally high, even in the 1950s (Kozicka 1963, Grabda and Grabda unpublished). Upon the activity of selective factors connected with ecological catastrophe (accelerated eutrophication, intoxication with chemical fertilizers, the mass fish kills in 1983), and then, upon the increase in water level in 1993—*P. cuticola* remains a characteristic component of piscine parasite fauna in the lake studied (Table 3). In the 1950s, the high infection level of roach, rudd and white bream was attributed to the size of the common heron colony at Oświn Lake (Kozicka 1963). At present, the main source of *P. cuticola* infective stages are probably beards migrating from the nearest colony because there are no breeding herons in the Seven Islands reserve covering Oświn Lake (Sikora at al. unpublished).

An analysis of samples from the eastern and western part of Oświn Lake indicated considerable differences in the occurrence of *P. cuticola* in the fish examined. This parasite was more abundant in the western part, with considerably higher infection of all important hosts (Table 2, Figs. 3–6). A clear difference was found in the maximum intensity of infection; in the eastern part—up to 56 cysts per fish occurred in roach, up to 42 in rudd, and up to 17 in carp bream, whereas in fish of the western part, the values reached up to 392, 282, and 119, respectively (Table 3). In most samples, the intensity of infection was higher in the western basin than in the eastern one (Figs. 3–6), but prevalence was usually high and uniform in both (Fig. 2).

In the eastern part of Oświn Lake, the infection of fish with *P. cuticola* was comparable to that reported in other lakes of northern Poland, e.g. in Družno Lake (Kozicka 1958), in Tajty Lake (Kozicka 1953), in Dgał Wielki and Warniak lakes (Grabda-Kazubaska et al. 1987), but in the western part it was usually higher.

In order to explain the different occurrence of parasite within the same water body, it should be mentioned that the presence of a parasite is, to a high extent, determined by the status of the final host in a given area (Xianghua 1987) and by the availability of intermediate hosts as well (Køie 1988, Moser and Cowen 1991).

The occurrence of Digenea may be limited by the distribution of snails—the intermediate hosts. Often, despite a high number of birds (the definitive host), common digenetic fish parasites are not observed in a given area. The restrictive effect of molluscs on digeneans has been observed in the Gulf of Gdańsk and the Vistula Lagoon (Rolbiecki et al. 1999), in the Gulf of Bothnia (Valtonen et al. 2001),

Kis-Balaton (Székely and Molnár 1996/1997) and in polluted Vatia Lake (central Finland) (Valtonen et al. 1997).

One cannot exclude that the different physicochemical conditions of water and sediments in the investigated basins of Oświn Lake (Wiśniewski unpublished) induced differences in the distribution of planorbid snails in the reservoir, and thus create differences in fish infection with *P. cuticola*. Lack of data referring to molluscs of Oświn Lake makes verification of this assumption impossible.

The western pool is more overgrown by bushes and tress than the eastern part, this may enhance development of allogenic parasites (Niewiadomska et al. 2001). On the other hand, the bottom of the eastern basin is strongly covered with *Ceratophyllum demersum*; it may discourage birds from hunting in this area, and affect a decrease of fish infection with *P. cuticola*. It may be well to add that the Rawda River, which provides Oświn Lake with water from Rydzówka Lake (inhabited by herons) falls into the western pool. (Is it infected?)

The results of this study indicated that there are some groups of roach, rudd, white bream, and carp bream staying for a longer period in the particular parts of Oświn Lake. The parasitological investigations of Balling and Pfeiffer (1997) confirmed that the interchange between perch and roach populations in Lake Constance is limited. Also Wierzbicki (1971) noted such isolation of perch groups in Dargin Lake.

P. cuticola causes pathological changes in the internal organs of host, which may lead to the death of young fish, especially. At a high intensity of infection, disturbance in the metabolism of fatty compounds occurs, and the body weight of infected fish decreases (Afanasjev 1978). Chykowski et al. (unpublished) did not find any limitation in fish grow rate in Oświn Lake.

The infection of roach, white bream and carp bream was positively correlated with total body length (TL) (Fig. 7). It demonstrates the acquisition of parasites with age (Croll 1977). Such a relationship was not observed in rudd ($P < 0.05$), thus, the infection of that fish is more incidental. The infection of rudd with *P. cuticola* did not depend on the sampling period, whereas infection of roach, white bream and carp bream differed significantly in seasons. However, no cyclic changes in parasite abundance, which occurs simultaneously in both pools and in all hosts, were observed (Figs. 2–6). Thus, there is no evidence for seasonal changes in the occurrence of *P. cuticola* in the fish examined.

SUMMARY

- 1) *Posthodiplostomum cuticola* occurred commonly and in high abundance in fishes of Oświn Lake and, upon the activity of selective factors, remains a characteristic component of fish parasite community.
- 2) The intensity of fish infection with *P. cuticola* in the western part of Oświn Lake was significantly higher than in the eastern part. Location-dependent occurrence of the parasite indicates that interchange between fish groups from the western and eastern pool of the lake is limited.

- 3) The infection rate of roach, white bream, and carp bream increased with an increasing of fish total body length as a result of parasite acquisition with age. The infection of rudd was of a more incidental character.
- 4) The changes in fish infection with *P. cuticola* in different samples were not of a seasonal character.

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