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PSEUDODACTYLOGYRUS ANGUILLAE (YIN et SPROSTON, 1948) GUSSEV, 1965 AND *P. BINI* (KIKUCHI, 1929) GUSSEV, 1965 (MONOGENEA: PSEUDODACTYLOGYRIDAE) ON GILLS OF EUROPEAN EEL, *ANGUILLA ANGUILLA* (LINNAEUS, 1758) ASCENDING RIVERS OF THE POMERANIAN COAST, POLAND

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Background. Monogenean parasites *Pseudodactylogyrus anguillae* and *P. bini* were for the first time recorded on eel in 1995. The aim of the present study was to determine their distribution in Poland and to verify their measurements against literature data.
Material and methods. A total of 201 young eels ascending rivers of Polish Western Pomerania, emptying to the Baltic Sea, were collected and necropsied using commonly used methods.
Results. Altogether, 574 monogeneans were found on the gills of the eels studied, of which *P. anguillae* constituted 82%. Measurements of hard elements of the two species of parasites were similar to those already described from Poland.
Conclusion. The present paper constitutes a new record of *Pseudodactylogyrus anguillae* and *P. bini*, supported by measurements.

Key words: fish, European eel, *Anguilla anguilla*, gills, parasites, Monogenoidea, *Pseudodactylogyrus*

INTRODUCTION

Pseudodactylogyrus anguillae (Yin et Sproston, 1948) Gussev, 1965 and *P. bini* (Kikuchi, 1929) Gussev, 1965 are frequently encountered living together in one host. They were first detected in Europe in the late 1970s, brought from the Far East with juvenile Japanese eel, *Anguilla japonica* Temminck et Schlegel, 1847 (cf. Golovin 1977).

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Numerous authors (e.g. Molnar 1984, Buchmann et al. 1987, Nie and Kennedy 1991, Saraiva 1995) reported the parasites from both European- and Japanese eel, in cultured and wild populations. Marcogliese and Cone (1993) were the first to describe *P. anguillae* found on gills of American eel, *Anguilla rostrata* (Lesueur, 1817) in North America.

The first Polish record of the parasites dates back to 1995 (Dzika et al. 1995) when they were found on 23 specimens of wild eels.

The aim of the present study was to determine the distribution of *P. anguillae* and *P. bini* in Poland and to compare the parasites' dimensions with published records from elsewhere.

MATERIALS AND METHODS

Within 1999–2003, a total of 201 eels were examined. The fish were caught, between late June and early September, in three Western Pomeranian coastal rivers: the Radew (9 specimens), Rega (169 spec.), and the Wieprza (23). The eels weighed, on the average, 15.83 g, the mean total length was 23.76 cm. The parasites collected were stored in 70% ethyl alcohol; some were alum carmine-stained and permanently mounted. The parasites and hard elements of their opisthaptors were examined under Olympus DIC microscope and measured using PZO 15 KM measuring eyepiece. The measurements were taken following the system designed by Prost (1957).

RESULTS

Throughout the entire period of study, the gills of fish revealed the presence of 574 specimens of *Pseudodactylogyrus anguillae* and *Pseudodactylogyrus bini* the former accounting for 82% of all the parasites collected. The monogeneans occurred at an infection intensity ranging from 1 to 56 parasites on a fish. The heaviest mean infection of the two species combined was 12.75 spec. (in this number were 9.25 specimens of *P. anguillae* and 3.5 of *P. bini*) was recorded on gills of the eel caught in the Wieprza River in 1999, the lowest (combined) mean infection of 2.55 (1.82 *P. anguillae* and 0.73 *P. bini*) being observed in the Wieprza eel caught in 2003.

The combined abundance of the parasites in the eel population studied ranged from 0.26 to 6.73 specimens (in this number 0.14–4.78 *P. anguillae* and 0.12–1.95 *P. bini*). The lowest combined mean intensity was found for the eel caught in the Wieprza River in 1999, the highest mean intensity being recorded in the eel caught in 2001, also in the Wieprza.

The combined prevalence ranged from 4.0% (September 1999; Wieprza) to 78% (August 2001; Rega).

Results of the measurements are summarised in Table 1. The data on hamulus size obtained were compared with those reported by other authors (Table 2).

Table 1

Maximum hamulus length (μm) in *Pseudodactylogyrus bini* and *P. anguillae*

Author	*P. bini*	*P. anguillae*
Ogawa and Egusa (1976)	63	105
Golovin (1977)	62	100
Molnar (1983)	58	110
Chung et al. (1984)	61	114
Gusev (1985)	70	105
Buchmann (1987, 1997)	61	98
Dzika et al. (1995)	59.5	105
Saraiva (1995)	68	122
Present study	61	107

Table 2

Length (μm) of some skeletal elements of *Pseudodactylogyrus bini* and *P. anguillae*

Parasite species	Parameter	Hamulus length +	Hamulus length –	Hamulus shaft	Hamulus point	Bar length	Marginal hook length
P. bini	x	81.5	55.8	43.8	24.2	59.6	17.0
	SD	9.9	4.2	3.0	2.4	7.9	1.1
P. anguillae	x	134.7	99.1	76.9	31.5	71.0	74.0
	SD	7.8	4.8	5.5	1.7	10.7	8.1

+ Length of hamulus including the reflexed part of the internal process
– Length of hamulus except the reflexed part of the internal process

DISCUSSION

The study focused on wild eel ascending Polish rivers from the Baltic Sea. Of the two monogeneans parasitising gills of eel, *P. anguillae* was decidedly more abundant. Both species occur on eel in freshwater reservoirs. *P. anguillae* may also dwell and reproduce in brackish water habitats. Its upper salinity tolerance limit is 20‰ (Køie 1988). Thus the eel examined in this study could have become infected with *P. anguillae* earlier than they acquired *P. bini*. This could be the cause of the substantial difference between the abundances of the two parasites.

Both species displayed characteristic preferences for particular gill areas. *P. anguillae* was mostly found on the two posterior gill arches whereas *P. bini* was located on the two anterior arches. In addition, the two species differed also in the part of gill filaments they settled on. While *P. anguillae* was most often found on the proximal part of the filaments, *P. bini* preferred the medial and distal parts (Buchmann 1988d, 1989, Rodrigues and Saraiva 1996). The differences in location may be

indicative of the fact that, during migrations of the young eel, *P. bini* is more exposed to possible damage, which is perhaps also a cause of its lower abundance on gills of the eel examined.

Both species are able to produce pathological changes in the gills, the changes being more frequently inflicted by *P. bini*. This parasite is more confined to its original site of attachment and is found surrounded by the gill tissue that supplies a continuously renewed source of food. *P. anguillae* is able to move to other areas (Buchmann et al. 1987, Buchmann 1988b, c). Thus the proportion between the abundance values of the two species, observed in this study, in favour of the less pathogenic species, is advantageous to the host.

The infection intensity of gill parasites depends on the gill surface area, hence on the host's size and age. The eel examined were small, their mean weight ranging from 6.51 to 34.1 g. The combined mean infection intensity varied from 2.55 to 12.75 (1.82–9.25 *P. anguillae* and 0.73–3.5 *P. bini*), the highest values being recorded in September. With respect to both species, Saraiva (1995), who studied wild eel from the Este River in northern Portugal, reported mean intensity of 58.9–98.3. Such an extensive discrepancy between the mean intensities of eel infection in Polish and Portuguese rivers could have stemmed from a difference in fish age and/or in water temperature.

P. anguillae and *P. bini* are oviparous monogeneans. Their oviposition, embryonic development, as well as the larval and postlarval development are highly temperature-dependent. The egg development is greatly enhanced at temperatures exceeding 20°C, reaching optimum at 30°C. That temperature induces also a faster postlarval development. Under such thermal conditions, during its about 2-month-long life span, a single *P. bini* is able to produce more than 13 eggs a day. Mature parasites hatch from the eggs after 10–12 days. As shown experimentally, low oxygen saturation is capable of inhibiting embryonic development in monogenean eggs (Buchmann 1988a).

Nie and Kennedy (1991) observed monthly changes in the prevalence and abundance of *P. anguillae* infecting European eel in English rivers (near Exeter, Devon), the highest values being recorded in August. The water in Polish rivers does not warm up so much, for which reason, too, the parasites occur with a lower prevalence and mean intensity. A reduction in water temperature slows down the rate of development of various stages of the parasites. Experiments showed the duration of embryonic development to be extended to 100 days at 1–4°C, the postlarval development stopping altogether (Buchmann 1997). Thus long and cold winters are not advantageous for growth of the parasites' populations.

In addition to physical parameters, the abundance of monoxenous ectoparasites is affected by free-living and fouling organisms. Molnar (1971) suggested that bacteria and the associated fauna killed the eggs of monogenean parasites. The monogenean eggshells are more resistant than the delicate oncomiracidia. Copepods, turbellarians, rotifers, and oligochaetes were reported as responsible for changes in infection intensity and prevalence of *P. anguillae* and *P. bini* (cf. Buchmann 1988c, 1993).

The low number of the monogeneans on the gills of the Western Pomeranian eel examined could have also been a result of the activity of the rich and abundant free-living aquatic fauna.

Measurements of hard elements of the opisthaptor produced data (Table 1) very similar to those reported by Dzika et al. (1995). The maximum hamulus lengths of the two monogenean species given in the literature (Table 2) showed the highest values to be typical of *P. anguillae* parasitising European eel in Portugal (Saraiva 1995). In that study, both the hosts and their parasites lived in warm waters, experiencing no extensive winter cooling. Most probably, the parasites were not exposed to any heavy competition for food. In all likelihood, the effect of excessive density was absent as well, thus the parasites could have reproduced and grown unhampered. Hamuli of parasites collected from the eel living in cultures grew to smaller sizes.

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