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NOTE

Common sculpin *Cottus gobio* as a natural paratenic host of *Proteocephalus longicollis* (Cestoda: Proteocephalidae), a parasite of salmonids, in Europe

Franti$ek Moravec*

Institute of Parasitology, Academy of Sciences of the Czech Republic, Brani$ovská 31, 37005 >eské Budějovice, Czech Republic

ABSTRACT: Common sculpins *Cottus gobio* L. (Pisces: Cottidae), from the Ml)nsk) Brook near >eské 5leby in the 2umava National Park, southwestern Bohemia, Czech Republic, were found to harbour in their intestines juvenile cestodes *Proteocephalus longicollis* (Zeder, 1800), a common parasite of holarctic salmonids, with a prevalence of 60% and intensity of 1 to 11 (mean 5) parasites per fish; undoubtedly, these prey fish serve as paratenic hosts. In this locality, the definitive host of *P. longicollis* is the brown trout *Salmo trutta* m. *fario* L., large specimens of which apparently acquire infection of this parasite by feeding on infected sculpins. *C. gobio* is the first known natural paratenic host of *P. longicollis* in Europe.

KEY WORDS: Cestoda · *Proteocephalus longicollis* · Paratenic host · *Cottus gobio* · *Salmo trutta* m. *fario* · Czech Republic

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The cestode *Proteocephalus longicollis* (Zeder, 1800) is a widely distributed intestinal parasite of holarctic salmonids and, exceptionally, of other fishes (Scholz & Hanzelová 1998). It occurs in both wild and cultured fishes and is known to be the cause of economic losses, e.g., in cage-raising of rainbow trout *Oncorhynchus mykiss* (Walbaum) in Europe (Král 1977, Priemer 1980). In the Czech Republic, it has been reported, mainly under the synonym *P. neglectus* La Rue, 1911, from farmed *O. mykiss* (ponds in western and southern Bohemia and southern Moravia and the Jesenická water reservoir—see e.g. Král 1977, Prouza 1978, 1982, 1983, Scholz 1989, 1991), whereas the only record from the brown trout *Salmo trutta* m. *fario* L. is that by Moravec (1982a) from the Kamenice River in northern Bohemia.

Recent investigations into the helminth fauna of fishes in the streams of the National Park 2umava (the 2umava Mountains, southwestern Bohemia) revealed the presence of *Proteocephalus longicollis* in *Salmo trutta* m. *fario* in the Řasnice River near Hlini$tě (prevalence 17% and intensity 1 to 3 in a sample of 10 trout taken on 9 August 2000) and in the Ml)nsk) Brook near >eské 5leby (prevalence 36%, intensity 1 to 6 in a sample of 12 trout taken on 13 September 2000); whereas the tapeworms from August were fully gravid specimens, those from September were all juveniles with body length not exceeding 2 mm. Since the fish fauna of both localities is formed only by brown trout and common sculpin, there is no doubt that all these cestodes were *P. longicollis*. In the second locality (Ml)nsk) Brook), juvenile *P. longicollis* were also found in the anterior part of the intestine of 3 of 5 examined common sculpins *Cottus gobio* L. (prevalence 60%, intensity 1 to 11 [mean 5]) taken along with the sample of trout; the total body length of infected sculpins was 6 to 9 cm.

The juvenile *Proteocephalus longicollis* (10 specimens measured) from sculpins (Figs. 1 & 2), fixed in hot 4% formaldehyde, dehydrated and stained with carmine, were 666–1156 (mean 984) µm long and 204–313 (243) µm at maximum width. The body was elongate, with the scolex not well separated from the hindbody, and with a somewhat narrowed and rounded posterior end. The scolex was 204–245 (231) µm wide and in some specimens about 160 µm long, and had 4 round, muscular submedian suckers measuring 60–81 × 72–93 (69 × 79) µm and a small but well-developed apical organ measuring 21–30 × 30–45 (27 × 38) µm in a lateral view. The body was still unsegmented and without anlagen of genital organs; numerous minute calcareous corpuscles were scattered through the whole body.

*E-mail: moravec@paru.cas.cz

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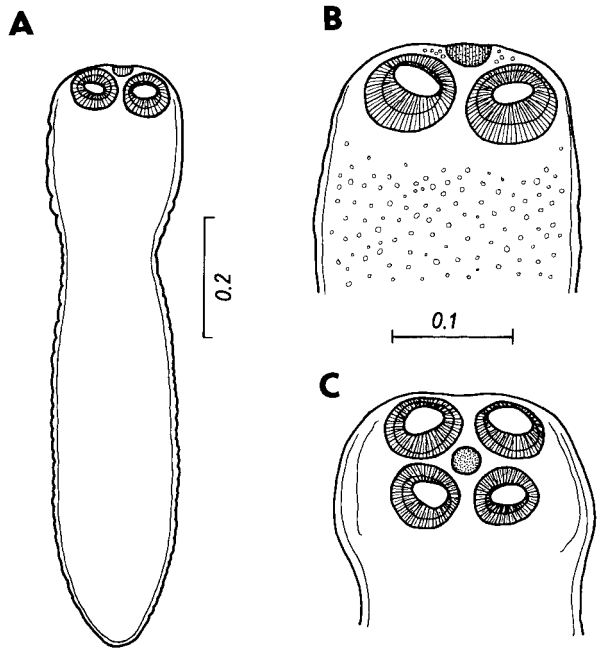

Fig. 1. *Proteocephalus longicollis* (Zeder, 1800). Young specimens from *Cottus gobio*. (A) General view. (B, C) Scolex, dorsoventral and subapical views. Scale bars in mm

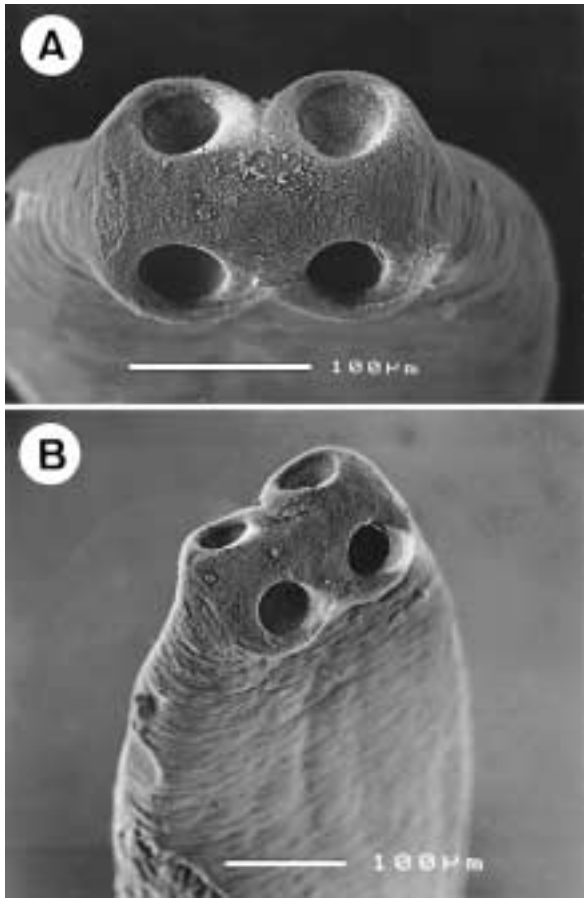

Fig. 2. *Proteocephalus longicollis* (Zeder, 1800). SEM micrographs of young specimens from *Cottus gobio*. (A, B) Scolex, apical and subapical views

The life cycles of *Proteocephalus* spp. include cyclopid and diaptomid copepods as obligate intermediate hosts in which the larval stage, mostly termed the procercoid, develops (Scholz 1999). Although infected copepods are generally considered to be the principle or the only source of *Proteocephalus* infections for the fish definitive host, it has been reported for some species of this genus that small prey fishes harbouring juvenile cestodes may serve as transport or paratenic hosts (e.g. Jarecka & Doby 1965, Willemse 1969, Chubb 1982, Scholz 1991). The young cestodes do not continue to grow and develop, but they survive for some time in these hosts and may be an important source of infection for their piscivorous fish definitive hosts (Scholz 1999).

Scholz (1991) found the maximum length of experimentally obtained procercoids of *Proteocephalus longicollis* from copepods to be 590 µm, but Priemer (1987) gave a length of 600 to 940 µm for conspecific procercoids from copepods 62 d post infection. This is approximately the same size as that found in juvenile cestodes from naturally infected *Cottus gobio*. Consequently, this suggests that the cestodes either do not develop at all or develop only slightly in this paratenic host.

In *Proteocephalus longicollis*, natural fish paratenic hosts were reported only from Lake Baikal in Siberia, where small cottocomephorids and cottids heavily infected with juvenile cestodes were an important source of infections of this parasite for the definitive hosts, Baikal whitefishes *Coregonus autumnalis migratorius* (Georgi) and *Coregonus lavaretus baicalensis* Dybowsky (Rusinek 1987, Rusinek & Pronin 1991). In Europe, no natural paratenic hosts of *P. longicollis* have so far been recorded.

The relatively high rate infection of juvenile *Proteocephalus longicollis* in *Cottus gobio* in the Ml)nsk) Brook may be surprising, because this fish feeds mainly on larger benthic invertebrates such as larvae of aquatic insects and gammarids (Baru$ & Oliva 1995). However, the locality where infected sculpins were found is rather exceptional in that the fish sample was taken from the section of the brook just below a small water reservoir constructed on it. Since brown trout *Salmo trutta* m. *fario* smolts are cultured in this reservoir, where relatively dense populations of copepods *Macrocyclops fuscus* (Jurine) and *Acanthocyclops vernalis* Fischer) occur, copepods harbouring procercoids of *P. longicollis* can easily enter the brook with water

from the reservoir, where they are available to sculpins. This seems to explain the relatively high rate of *P. longicollis* infection in sculpins.

Although sculpins can be assumed to acquire *Proteocephalus longicollis* infection by feeding on infected copepods, the possibility cannot be excluded that they may become infected while feeding on some invertebrate paratenic hosts. This has not so far been demonstrated for *P. longicollis*, but megalopteran larvae (*Sialis*) were found to serve as paratenic hosts in other *Proteocephalus* spp. (Vojtková & Koubková 1990, Kennedy et al. 1992, Scholz & Moravec 1993, Moravec et al. 1997).

Sculpins frequently become a prey of large trout (Baru$ & Oliva 1995), which explains infections of *Proteocephalus longicollis* in these fish, because it is difficult to believe that large trout acquire infection via planktonic copepods. Besides sculpins, large trout undoubtedly acquire infection of *P. longicollis* by cannibalism, preying on small infected trout. Transmission of *P. longicollis* from one trout to another was demonstrated experimentally by Priemer (1980).

In addition to *Proteocephalus longicollis*, the common sculpin *Cottus gobio* is known to be the source of infection for brown trout with some other helminth parasites. It currently serves as the paratenic host of the nematode *Cystidicoloides ephemeridarum* (Linstow, 1872) (Moravec 1971, Moravec & De 1982) and as the intermediate or paratenic host of the nematode *Raphidascaris acus* (Bloch, 1779) (Moravec 1970, Gelnar et al. 1990), frequent gastrointestinal parasites of European salmonids. Moreover, *C. gobio* serves frequently as the definitive host for the trout intestinal trematode *Crepidostomum metoecus* (Braun, 1900); having been ingested by a trout, the adult trematodes survive in this new, so-called postcyclic host. This was confirmed experimentally (Moravec 1982b). The same was found for the acanthocephalan *Pomphorhynchus laevis* (Müller, 1776) (Kennedy 1999).

It is also highly probable that the Carpathian sculpin *Cottus poecilopus* Heckel, which occurs in the Czech Republic only in the Danube River and the Oder River drainage systems, serves as a natural paratenic host of *Proteocephalus longicollis*; this is suggested by the successful experimental infection of this fish with copepods harbouring procercoids of *P. longicollis* by Scholz (1991).

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