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NOTE

# *Anguillicola crassus* in the Baltic Sea: field data supporting transmission in brackish waters

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ABSTRACT: Between 1990 and 1992 deep-snouted pipefish *Syngnathus typhle* and black goby *Gobius niger* were found to be infested by Stage 3 and 4 larvae and preadults of the swim bladder nematode *Anguillicola crassus* in Wismar Bay (southwestern Baltic Sea) at a frequency of 9.6 and 0.7%, respectively. The high prevalence (59.4%) of nematodes in European eels *Anguilla anguilla* in the Baltic may therefore be attributable not only to freshwater habitation of some eels, but also to the possibility that they feed on affected copepods and small fishes in the brackish waters of the Baltic Sea.

KEY WORDS: *Anguillicola crassus* · Nematoda · *Syngnathus typhle* · Transmission in brackish water · Baltic Sea

In the past several decades, a number of parasitic species have been introduced into Europe. For example, in the 1960s and 1970s protozoans, cestodes and other kinds of parasites were imported with east Asian carps (Schäperclaus 1979).

In European eels *Anguilla anguilla* (L.), parasites which have been newly introduced to date include the genera *Pseudodactylogyrus* Gussev, 1965, *Anguillicola* Yamaguti, 1935, and *Paratenuisentis* Bullock & Samuel, 1975 (Molnár 1984, Peters & Hartmann 1986, Taraschewski et al. 1987). One such parasite is the swim bladder nematode *Anguillicola crassus* Kuwahara, Niini & Itagaki, 1974.

Since the beginning of the 1980s *Anguillicola crassus* has spread over wide areas of Europe (Køie 1991). Regarding its life cycle in Europe, De Charleroy et al. (1987) and Petter et al. (1990) have listed several entomostracan species known to serve as first intermediate hosts, i.e. the copepods *Macrocyclops albidus*, *M. fuscus*, *Paracyclops fimbriatus*, *Eucyclops serrulatus*, *E. macruorides*, *Cyclops strenuus*, *C. vicinus*, *Acanthocyclops robustus*, *A. vernalis* and *Diacyclops bicuspidatus*, and the ostracod *Cypria ophthalmica*. Kennedy & Fitch (1990) added the copepod *Diaptomus gracilis* and, from the Malacostraca, juvenile specimens of the amphipod *Gammarus pulex*.

Under experimental conditions, *Paracyclops fimbriatus* has been shown to transmit Stage 3 larvae ($L_3$) to eel (De Charleroy et al. 1990), and *Acanthocyclops robustus* to the guppy *Lebistes reticulatus* which acts as a second intermediate host (Petter et al. 1989). Kennedy & Fitch (1990) have also confirmed that larvae are transmitted to eels by *Cyclops vicinus* and *Macrocyclops albidus*. Fishes which have been reported as carriers of *Anguillicola crassus* are listed in Table 1.

**Materials and methods.** In 1990 and 1991, during an investigation of small littoral fishes in the Salzhaff, part

Table 1. Fishes reported as second intermediate or paratenic hosts for *Anguillicola crassus*. Fish which accept the $L_3$ from copepods without the larvae molting further are considered paratenic or transport hosts, such as bream and pike perch. If the larvae develop to $L_4$ and preadults, the fish are considered second intermediate hosts

| Fish species | Stages of *A. crassus* in fish | Source |
|---|---|---|
| *Abramis brama* (bream) | $L_3$ | Haenen & Van Banning (1990) |
| *Osmerus eperlanus* (smelt) | $L_3$, $L_4$ | |
| *Gymnocephalus cernuus* (ruffe) | $L_3$, preadults | |
| *Perca fluviatilis* (perch) | $L_3$, preadults | |
| *Stizostedion lucioperca* (pike perch) | $L_3$ | |
| *Gasterosteus aculeatus* (three-spined stickleback) | $L_3$, $L_4$, preadults | |
| *Lebistes reticulatus* (guppy) | $L_3$ | Petter et al. (1990) |

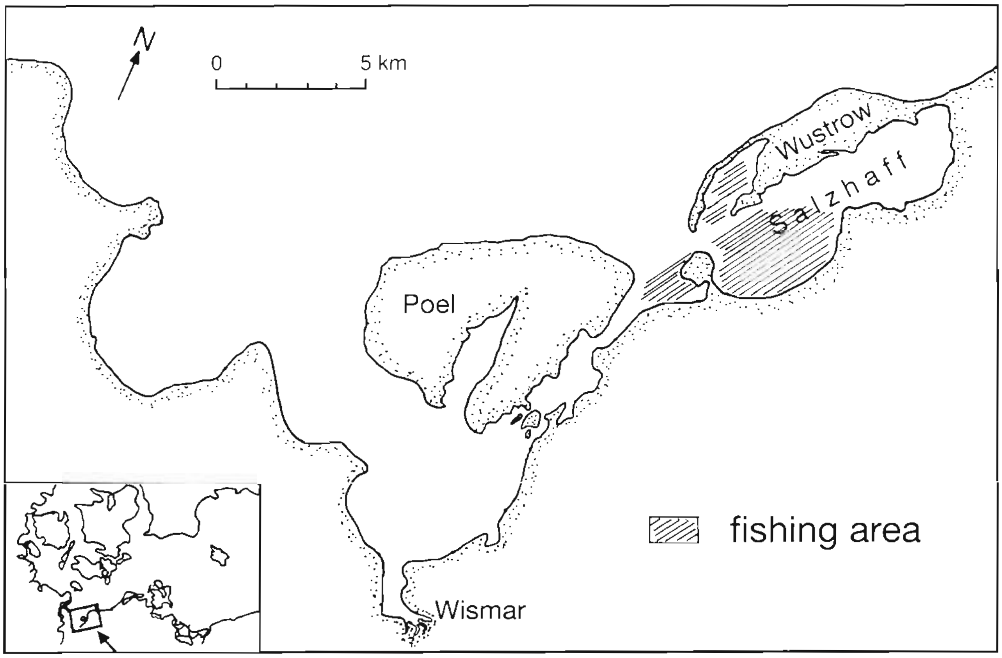


Fig. 1. Wismar Bay, southwestern Baltic Sea. The hatched area indicates where fish were collected for this study

of Wismar Bay on the southwestern Baltic Sea (Fig. 1), nematodes and larvae of *Anguillicola crassus* were sampled.

After observation of live larvae the parasites were fixed and preserved in 75% ethanol with 5% glycerol. Smaller specimens were measured in this fluid, while larger ones were first clarified in methyl benzoate. Some of the specimens were mounted in Canada balsam.

**Results and discussion.** *Anguillicola crassus* has been observed in eels from the German part of the southern Baltic coast since 1987 (Reimer 1987). In 1990 and subsequent years, during an investigation of small coastal fishes, we found larval specimens of *A. crassus* in the swim bladder of deep-snouted pipefish *Syngnathus typhle* and black goby *Gobius niger*.

In *Syngnathus typhle* (n = 178) prevalence was found to be 9.6%. We found parasite stage $L_3$ in the wall and both $L_4$ and preadult stages in the lumen of the swim bladder in this species. The overall length of the investigated pipefish varied between 6.5 and 23 cm (mean 12.13 cm). The infested pipefish ranged from 7.5 to 18.8 cm in length (mean 13.24), meaning that virtually all size groups of this species were infested. In the western part of the Baltic the deep-snouted pipefish is a part of the eel's diet (own obs. and pers. comm. by fishermen). As part of the food chain this fish is a likely transmitter of the swim bladder nematode.

In *Gobius niger* (n = 136) parasite prevalence was 0.7%. Only 1 small fish of 5.8 cm length was infested: we found 1 $L_3$ in the swim bladder wall. The overall length of the fish examined ranged from 4.4 to 10.1 cm (mean 6.28 cm).

Recently we also observed 1 $L_3$ larva in the kidney tissue of a flounder (n = 29) from Oder Bay, which is surprising, since the swim bladder is lacking in flatfishes. In other fishes that we have investigated, such as other kinds of gobies (*Pomatoschistus minutus*, n = 57; *P. microps*, n = 17; *Gobiusculus flavescens*, n = 4), various species of stickleback (*Gasterosteus aculeatus*, n = 80; *Pungitius pungitius*, n = 113; *Spinachia spinachia*, n = 46) and pipefish (*Nerophis ophidion*, n = 63), we have not found any larval stages of *Anguillicola crassus*. At present we cannot explain why, in the Baltic, only deep-snouted pipefish and on rare occasions black goby and flounder are affected and not other species, such as the three-spined stickleback, which is invaded in fresh water (Haenen & Van Banning 1990).

The $L_3$ larvae (n = 19) of *Anguillicola crassus* observed in this study were 0.43 to 1.06 mm long (mean 0.74 mm), with an oesophagus of 0.22 to 0.42 mm (mean 0.32 mm). $L_4$ larvae (n = 7) were 1.05 to 1.69 mm long (mean 0.45 mm). The single preadult specimen had a length of 7.5 mm, with an oesophagus of 0.68 mm and a buccal capsule of 0.17 × 0.045 mm. The $L_3$ is equipped with a larval tooth; $L_4$ and preadults possess a buccal capsule with 22 to 28 teeth (n = 8; mean 26 teeth). The size of the buccal capsule in $L_4$ and preadult stages was 0.17–0.020 × 0.020–0.045 mm. In adult speciments it is 0.021–0.027 × 0.048–0.063 mm (Taraschewski et al. 1987). We identified $L_3$ by comparing their morphological features with those of older stages; $L_4$ and preadults could be identified with certainty by counting the teeth of the buccal capsule.

Most authors cited above have mentioned the freshwater character of this nematode parasite. But Kennedy & Fitch (1990) proved that $L_2$ can survive not only in fresh water, but also in 25, 50 and 100 % seawater. In 25 % seawater (ca 8.5‰ S), the hatching rate reached 75 %, and survival and infectivity were highest. A brackish-water copepod, *Eurytemora affinis*, that was accidentally introduced in their experiments became infested.

In addition, De Charleroy et al. (1989) have reported the viability of free-living *Anguillicola crassus* larvae in brackish water of 15‰; at this salinity, the larvae lived for more than 3 wk. However, during an experiment involving malacostracan crustaceans, Køie (1991) failed to infect *Gammarus* sp., *Corophium volutator*, *Idothea* sp., and *Sphaeroma* sp. in 15‰ salinity.

The average salinity in the Salzhaff (see Fig. 1) is 11 to 12‰. In preliminary investigations of eels collected in this area we found an average parasite prevalence of 59.4 % (n = 64); in eels <48 cm (n = 28) prevalence was 46.44 % and intensity was 1.3 (individuals per eel), in eels 49 to 58 cm long (n = 22) prevalence was 54.4 % and intensity was 2.2, and in eels >59 cm (n = 14) prevalence was 92.9 % and intensity was 4.1.

It can be assumed that large eels become infested in the brackish environment of the Baltic due to the presence of larval stages in paratenic hosts inhabiting these waters. It is possible that the Baltic Sea, with its mesohaline brackish-water conditions, has favoured the spread of *Anguillicola crassus*.

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