

Metazoan parasites of European eel (*Anguilla anguilla*) from the Köyceğiz- Dalyan estuarine channel system, Turkey

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Abstract

Metazoan parasites of European eel (*Anguilla anguilla*) were investigated between December 2009 and March 2010 in the Köyceğiz-Dalyan estuarine channel system in Turkey. A total of 73 *A. anguilla* were examined. In two fish (2.7%), no parasites were found. In the others, eight parasite species were found: *Pseudodactylogyrus anguillae*, Digenea gen. sp., *Bucephalus anguillae*, *Acanthocephalus clavula*, *Anguillicoloides crassus*, Tetracystidae gen. sp., *Ergasilus gibbus* and *Ergasilus lizae*. Most of the eels had two (37.0% of eels), three (31.5%) or one (15.1%) parasite species. Prevalence and mean intensity of the parasite species were: *P. anguillae*, 82.2%, 24.6; *E. gibbus*, 52.1%, 4.0; *A. crassus*, 39.7%, 3.3; *E. lizae*, 26.0%, 3.4; *B. anguillae*, 15.1%, 7.5; Digenea gen. sp., 11.0%, 9.0; *A. clavula*, 6.8%, 1.8; and Tetracystidae gen. sp., 1.4%, 3.0, respectively. *P. anguillae* and *B. anguillae* are new records for Turkey.

Introduction

Parasite communities of the European eel (*Anguilla anguilla*) have been widely studied by numerous authors (e.g. Sures et al., 1999; Aguilar et al., 2005). Also, there are many comprehensive studies dealing with monogenean and *Anguillicoloides crassus* infections of eel (Loukili and Belghyti, 2007; Rolbiecki, 2008). *Pseudodactylogyrus anguillae*, *A. crassus* and *Ergasilus gibbus* are specific to eels found in European fresh waters (Køie, 1991). *P. anguillae* is a monogenean parasite of *Anguilla* spp., originally described in the Japanese eel (*Anguilla japonica*). *P. anguillae* was first reported in Europe from western Soviet Union (Golovin, 1977). Another common parasite, *A. crassus*, is a nematode found in the swimbladder, and uses eels as its definitive host. This parasitic nematode was originally

described from *A. japonica* native to South-west Asia and was most probably introduced to the European continent in the 1980s from East Asian countries (Knopf and Mahnke, 2004). European eel is one of the most commercially important fish species in Turkey. Although *A. anguilla* is widely spread in Turkey, there are only a few studies on the parasite communities of the European eel. The aim of the present study was to determine metazoan parasites, their prevalence, mean intensity and abundance of the European eel from the Köyceğiz-Dalyan estuarine channel system.

Materials and methods

The Köyceğiz-Dalyan Nature Reserve is an important wetland area in south-western Turkey

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(36° 45' and 37° 15' N, 28° 22' 30" and 28° 52' 30" E). The outflow of Lake Köyceğiz, the Dalyan River enlarges into a labyrinth-like channel system discharging into the Mediterranean Sea. The Dalyan channel system is fed by Lake Köyceğiz, the Mediterranean Sea and sulphuric thermal springs located around of the channel system. The Köyceğiz-Dalyan estuarine channel system is 14 km in length and connects the meromictic Lake Köyceğiz and the Mediterranean Sea. The Dalyan water mass consists of an mixohaline upper layer from Lake Köyceğiz and a lower layer of Mediterranean Sea saline water mixed with the sulphuric thermal spring water. Mean salinity was 12-15 ‰ and mean temperature was 9.2-10.7°C during the investigation period.

A total of 73 European eels (*A. anguilla*) with a mean total length of 52.5 ± 10.2 , mean \pm SD cm (range 33.2–78.0 cm) and a mean weight of 312.3 ± 200.0 , mean \pm SD g (range 67.7–906.0 g) were examined between December 2009 and March 2010. Fish were caught by local fishermen and transferred live to the laboratory in aerated lake water. After each eel was killed, total length and weight were recorded. The fish were examined under a stereomicroscope (10X, 20X) for the presence of metazoan parasites. Parasite species with greater than 50% prevalence were considered core species and satellite species were those occurring at a prevalence of less than 10% for *A. anguilla*. Preparation of the slides was made according to Bylund et al. (1980). The parasite specimens were identified in accordance to Pugachev et al. (2010), Moravec (1994) and Spakulova et al. (2002). Prevalence, mean intensity and mean abundance were calculated in accordance to Bush et al. (1997).

Results

The parasite communities of the eels were dominated by the monogenean gill parasite *P. anguillae* (prevalence 82.2%). The second most prevalent parasite was the copepod *E. gibbus* (52.1%) and the third most prevalent parasite was *A. crassus* (39.7%). Data on the composition of the all other parasite species of the eels are summarised in Table 1.

The prevalence and mean intensity of *P. anguillae* peaked in the 45.0-54.9 cm size classes as 90% and 32.1 respectively. The prevalence of *E. gibbus* changed from 55% at the smaller size class to a minimum value of 33.3% at the largest size class, whereas maximum mean intensity (7.3) was found in the 45.0-54.9 cm size class of the fish host. . The maximum value of prevalence of *A. crassus* was found at the 33.2- 44.9 cm size class as 50.0%, but maximum mean intensity (4.8) recorded in the largest size class. Both maximum prevalence (55.5%) and mean intensity (6.6) of *E. lizae* was found in the largest size class of the eels. Data with *P. anguillae*, *E. gibbus*, *A. crassus* and *E. lizae* according to size classes are given in Table 2.

The other parasite species showed relatively lower occurrence. A total of 82 *B. anguillae* (prevalence 15.1%), 72 Digenea gen. sp. (11.0%), nine *A. clavula* (6.8%) and three Tetracystida (1.4%) individuals were collected from one eel in the biggest size class. The results of the present study show that *P. anguillae* and *E. gibbus* can be considered as core species and *A. clavula* and Tetracystida as satellite species.

The frequency distribution of the number of parasite species per eel are given in Figure 1.

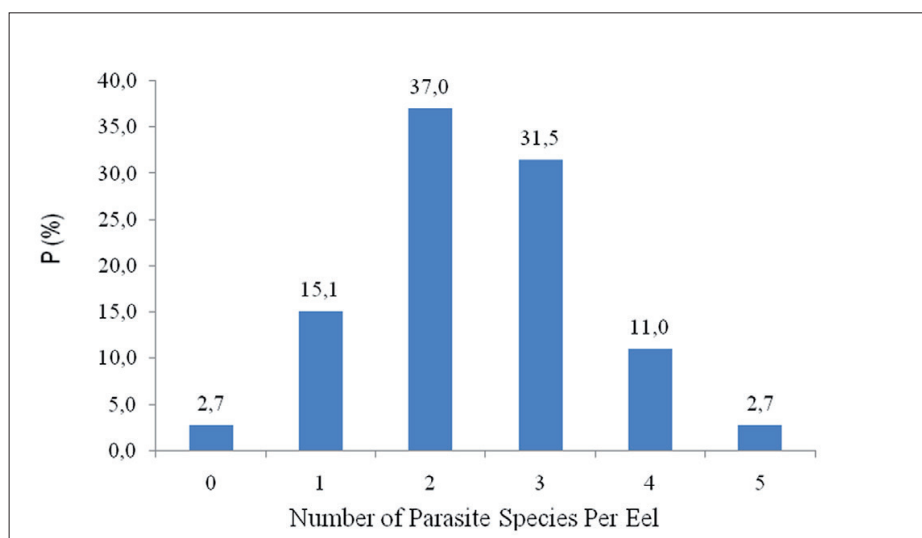
Table 1. Infection data for metazoan parasites of *Anguilla anguilla* from the Köyceğiz-Dalyan estuarine channel system.

Parasite	Site of infection	Infected fish (n)	Prevalence (%)	Total parasites (n)	Mean intensity	Range
<i>Pseudodactylogyrus anguillae</i>	Gills	60	82.2	1476	24.6	1–199
<i>Digenea</i> sp.	Intestine	8	11.0	72	9.0	1–34
<i>Bucephalus anguillae</i>	Intestine	11	15.1	82	7.5	1–23
Tetraphyllidea (larvae)	Intestine	1	1.4	3	3.0	0–3
<i>Anguillicoloides crassus</i>	Swimbladder	29	39.7	97	3.3	1–14
<i>Acanthocephalus clavula</i>	Intestine	5	6.8	9	1.8	1–5
<i>Ergasilus gibbus</i>	Gills	38	52.1	151	4.0	1–39
<i>Ergasilus lizae</i>	Gills	19	26.0	64	3.4	1–14

Table 2. Infection data with *Pseudodactylogyrus anguillae*, *Ergasilus gibbus*, *Anguillicoloides crassus* and *Ergasilus lizae* according to size classes of *Anguilla anguilla* from the Köyceğiz-Dalyan estuarine channel system.

Size classes of eel (cm)	n	<i>P. anguillae</i>		<i>E. gibbus</i>		<i>A. crassus</i>		<i>E. lizae</i>	
		P (%)	MI	P (%)	MI	P (%)	MI	P (%)	MI
33.2–44.9	19	84.2	20.8	55.0	4.4	50.0	2.5	15.0	2.0
45.0–54.9	20	90.0	32.1	50.0	7.3	40.0	2.9	30.0	1.5
55.0–64.9	25	75.0	16.6	50.0	2.5	35.0	3.4	25.0	3.0
≥65.0	9	66.6	27.4	33.3	1.7	44.4	4.8	55.5	6.6

P (prevalence), MI (mean intensity).

**Figure 1.** Frequency distributions of the number of parasite species per *Anguilla anguilla* from Köyceğiz-Dalyan estuarine system.

Discussion

Investigations on the parasite fauna of the European eel have been carried out by some authors in fresh water, brackish water and marine environment. Jacob et al. (2008) examined metazoan parasite communities of European eel in fresh water, brackish water and marine localities and recorded 16, 11 and seven taxa, respectively. *A. crassus* and *Pseudodactylogyrus* spp. were found in fresh water and brackish water localities and not in the marine environment. The strictly host-specific introduced parasites *A. crassus* and *P. anguillae* could not be found in the marine environment of the North Sea. They are restricted to fresh and brackish waters, where they occur with high prevalence. The intestinal helminth communities in Tiber eels were species-poor and characterised by low diversity (Kennedy et al. 1998). The component community of marine and freshwater eels was characterised by low diversity and a high dominance of a single species (Kristmundsson and Helgason, 2007). Sures et al. (1999) investigated parasite communities of eels from the River Rhine and 12 parasite species were found.

Metazoan parasites of *A. anguilla* in the Köyceğiz-Dalyan estuarine channel system were composed of typically fresh water and marine species. Eels were heavily dominated by one specialist monogenean, *Pseudodactylogyrus anguillae*; other parasites consisted of two species of digenea (*B. anguillae* and *Digenea* sp.), one species of nematoda (*A. crassus*), one generalist acanthocephala (*A. clavula*) and two copepods (specialist *E. gibbus* and generalist *E. lizae*). Tetrathyllidae were recorded only in the intestine of one eel. Our findings show that eels have a rather low species richness; the great majority of the eels were infested with two or

three parasite species (Figure 1) and parasite communities were dominated by *P. anguillae* in this estuarine habitat. Only two host fish were infected by five metazoan parasite species. According to Køie (1988), the salinity tolerance limit of *P. anguillae* is 20‰. This finding agrees with our result of recording *P. anguillae* but not *P. bini* in a brackish water environment. Jakob et al. (2008) remarked that *Pseudodactylogyrus* spp. is found with a moderate to high prevalence (43.3–76.0%) in brackish water. Our prevalence of 82.2% for *P. anguillae* is similar to this finding. The prevalence of *A. crassus* was reported in brackish water habitat as 40–46 % by Jakob et al. (2008). In the present study the prevalence of *A. crassus* was similar to the above-mentioned result, at 39.7%. However, it is clear that variation in biotic and abiotic features of the ecosystem is reflected in the composition and structure of eel parasite component communities. It is not common to report infection of two copepod gill parasites coexisting on the gills of eels (Aguilar et al., 2005; Maillo, 2005); in the present study we found *E. gibbus* and *E. lizae* with *P. anguillae* on the gills of *A. anguilla*.

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