Determination of the swim bladder parasite *Anguillicola crassus* (Nematoda, Dracunculoidea) in the European Eel, *Anguilla anguilla* (Linnaeus, 1758) from the locality Çamalti Tuzla of Izmir Bay, Eastern Aegean Sea

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**Abstract**

We, here, aimed to determine the presence of *Anguillicola crassus*, a swim bladder parasite, in 89 (male: 45; female: 44) dead European eel specimens obtained seasonally between 2020–2021 from a regional fisherman, who has fished with fyke net in the locality Tuzla of Izmir Bay, Eastern Aegean Sea. Out of 21 male European eels caught in winter, only one specimen (TL: 48.5 cm and TW: 247.12 g) had 23 swim bladder parasites (adult nematodes: 15, larvae: 8) and similarly, only one parasite was found in one specimen (TL: 37.5 cm and TW: 88.47 g) of 8 eels caught in spring. No parasite was found in the female eels. At the examinations, it was determined that all adult *Anguillicola crassus* specimens were females and the minimum-maximum and average length values in adult and larval parasites were, respectively, 1.5–2.5 cm (1.99 ± 0.31) and 0.7–1.3 cm (1.025 ± 0.240). Consequently, the species *A. crassus*, a swim bladder parasite, was found in European eels from the locality Çamalti Tuzla in two seasons (winter and spring) and this parasitic nematode were only in male eels. This study is a first and remarkable one having evidential value, which shows the presence of the species *A. crassus* among the eel population in the locality Çamalti Tuzla of Izmir Bay. Besides, it is a population that should be monitored due to the status of *Anguilla anguilla* on the IUCN red list.

**Keywords:**

*Anguillicola crassus*  
Swim bladder parasite  
Nematoda  
*Anguilla anguilla*  
Aegean Sea

**Introduction**

With a wide range around the world, *Anguilla anguilla* (Linnaeus, 1758), also known as the European eel (Fam: Anguillidae) is a demersal and catadromic species that distributes from the Atlantic coasts of Scandinavia and Morocco to the Baltic, Black Sea and Mediterranean (Freyhof and Kottelat, 2008). In Turkey, it is known to be found in the rivers and streams opening to Aegean Sea, the Sea of Marmara, Black Sea and Mediterranean (Rad et al., 2013; Kanjuh et al., 2018). The European eels are evaluated as "CR" (critically endangered) category in the Red List given by IUCN, since their populations have decreased since the 1970s due to many reasons such as being an economic species, fishery pressure and habitat loss (Pike and Clock, 2020). As a result of the decrease in natural populations, European eel farming, which is mainly associated with recirculation systems, has come into prominence and while eel farming is highly developed mainly in France, Portugal, Spain and the United Kingdom, approximately 50 percent of total European eel production of over 10500 tones is provided from the Netherlands (FAO, 2009).

The genus Anguillacola containing parasitic nematodes has five species described in *Anguilla anguilla*. These are; *Anguillicola crassus*, *Anguilla australis*, *Anguilla diffenbachii*, *Anguillicola novaezelandiae*, *Anguillicola papernai* (Rolbiecki and Rokicki, 2005). Of these five species, *A. crassus* was first described among the European eels in Belgium (De Charleroy, 1986). Koie (1988) and Innal et al. (2018) reported that this parasitic species was accidentally transmitted to the European continent with the eels, *A. japonicus*, brought from Asia in the 1980s. Moreover, Han et al. (2008) also stated that *A. crassus* may cause population losses of the European eels due to its high pathogenicity.

Although the European eels are fundamentally piscivorous, they are also infected with *A. crassus* while...
feeding on intermediate hosts such as benthic crustaceans and copepods or on paratenic (transport) hosts such as amphibians, mollusks and insect larvae, which play an important role in the nematode’s life cycle (Yalçın Özdişik and Solak, 2007). However, these parasites develop on the eel's swim bladder wall as the infected third-stage fish larvae pass into the fourth stage. By sucking the blood of their host, adult parasites live in the lumen of the swim bladder (De Charleroy et al., 1990; Moravec and Koncny, 1994; Šezkey, 1994; Moravec, 1996; Moravec and Škoríková, 1998).

While investigations on *A. crassus*, a swim bladder parasite of *A. anguilla*, had started 30 years ago (Taraschewski et al., 1987; De Charleroy et al., 1990; Thomas and Ollevier, 1992; Rolbiecki and Rokicki, 2005; Gargouri et al., 2006; Knopf, 2006; Ashworth et al., 2009; Heitlinger et al., 2009; Weclawski et al., 2013), it is seen that the studies carried out in our country began in mid-2000s and were scarce in number (Genç et al., 2005; Genç et al., 2008; Innal et al., 2018).

Population losses due to pathogenic reasons among European eels, extremely important for world and national fisheries, are very important for these fishes that are listed as critically endangered in the IUCN list. Therefore, the finding presented here for Izmir Bay, Eastern Aegean Sea is the first study for the prevalence of *A. crassus*, a parasitic species specific to the European eel population.

**Materials and Method**

We had met up with *A. crassus*, a swim bladder parasite, in two specimens of the 89 dead European eels, which were obtained seasonally between 2020-2021 from a local fisherman who has fished with fyke net in the locality Çamalti Tuzla of Izmir Bay (Figure 1, 2). The total length (TL, cm) and weight (TW, g) measurements of the fish specimens brought to the laboratory were measured with a ruler (1mm scale) and a digital balance (a precision of 0.1 g), respectively, and then their sex determinations were made by dissection.

The parasitic nematode worms on the swim bladder of the dissected fish specimens were collected with a fine-tipped forceps. In order to identify the parasite, determined as *A. crassus*, we used the descriptions given by Moravec and Taraschewski (1988) and Moravec (1994). Then, total lengths (TL, cm) of parasitic nematodes *A. crassus* with fusiform body, whose sexes were determined according to De Charleroy et al. (1990), were measured (Figure 3).

The prevalence percentage values (Pr%) or incidence rate of the parasite samples found on the host and the intensity values (Int), which give the number of individuals belonging to the parasite species on a single host, were determined according to Bush et al. (1997).

**Results**

In this project, a total of 89 (♂:45, ♀: 44) *Anguilla anguilla* specimens (36 in winter, 15 spring, 9 autumn and 29 summer) from the locality Tuzla of Izmir Bay were examined seasonally. Among the specimens, the two male European eels obtained in the seasons of winter and spring were infested with *A. crassus*, however, no parasite was found in female specimens. The length and weight values of two fish infected with *A. crassus* species were 48.5, 37.5 cm and 247.12, 88.47 g, respectively.

During the dissection, a total of 24 *A. crassus* specimens, of which 16 adult females (min-max: 1.5-2.5, 1.95±0.35 cm) and 8 at larval stage (min-max: 0.7-1.3; 1.025±2.40 cm) were determined (Figure 4). It has been seen that the nematode specimens densely located in the swimbladder region have gray-black color and fusiform body type.

While 15 adults and 8 larvae of the parasitic nematode were encountered in winter, 1 adult parasite in spring. The intensity range values of *A. crassus* among infected eels were calculated as 1-14, with an average of 7.5. While the prevalence (%) results of the parasites were 2.78% in the spring season, it was 6.67% in the winter season.

**Figure 1.** The locality Çamalti Tuzla of Izmir Bay where European eel specimens were caught

**Figure 2.** The European eel (*Anguilla anguilla*) specimens, caught in the locality Tuzla of Izmir Bay.

**Figure 3.** *Anguillicola crassus* (Moravec and Taraschewski, 1988; Moravec, 1994) A, B – head end of male and female, C – buccal capsule of female, D – posterior end of male, E – tail of male, F – caudal end of female, G – vulva, H – larva from uterus.
in European eels from the Thames basin, calculated the prevalence range as 12-32%. Since the sampling basin is in the tidal zone, they stated that the infection levels may be different due to the salinity differences between the sampling stations and the tolerance limits of the parasite's developmental stages to salt water. In their study that they had given the first record of *A. crassus* in eels from Ireland, Evans and Matthews (1999) found the prevalence range of 2-14% in six lakes they had chosen from the Erne basin. Then, Evans et al. (2002), once again, stated the prevalence value as 9.9% in their study from the Erne basin. In our study, the computed prevalence values in winter and spring are 2.78% and 6.67%, respectively, and when compared, they seem to be similar with the prevalence values given by Evans and Matthews (1999) for the Erne basin. The reasons for the differences between studies in the prevalence values of this parasitic nematode are as follows; biotic and abiotic factors in the sampling area, the structure of the eel population having parasitic nematodes, the age of the fish (Innal et al., 2018), and the consumption of infected food groups (Polzer and Taraschewski, 1993). Findings in our study may suggest that the sex of the host is also important, as only male eels have these parasites.

As a result, this is a first and remarkable study, which has evidential value, since it shows the presence of the species *A. crassus* among the eel population in the locality Tuzla of Izmir Bay, Eastern Aegean Sea and it is a population that should be monitored due to the status of *Anguilla anguilla* on the IUCN red list.

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