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First record of adult Nematomorpha *Gordius* sp. from western Anatolia (Turkey)

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Abstract: The Gordian worm, *Gordius* sp. (Nematomorpha, Gordiidae), is reported from Topçam Reservoir (Aydın, Turkey) as the first record for the group from southwestern Anatolia. One adult female Gordian worm was found coming out of the anal aperture of a specimen of Aegean chub, *Squalius fellowesii*. The *Gordius* sp. was then described by means of microscopic observation. The morphological features of the specimen and original pictures are given.

Key words: Nematomorpha, *Gordiidae*, Gordius, parasite, *Squalius fellowesii*, Turkey

1. Introduction

Nematomorpha comprises about 300 species of freshwater or marine worms distributed around the world and commonly called hairworms. The group consists of 2 classes: the freshwater hairworms or Gordiaceae (with 21 genera), and the marine hairworms or Nectonematoidae (with the single genus *Nectonema*) (Schmidt-Rhaesa et al., 2003; Poinar, 2008). All Nematomorpha are parasites during a phase of their life cycle. *Nectonema* species are parasites of decapod crustaceans, while Gordiaceae parasitize insects (usually crickets), myriapods, and more rarely chelicerates. Nematomorpha are relatively large organisms, with a body length of usually about 15–25 cm. The record holder is the tropical species *Gordius fulgur*, with a length of more than 2 m. Development starts with a tiny (100 µm) larva with 3 circlets of hooks and stylets.

Gordians develop as parasites at the immature stage, but they are free-living as adults (Storer and Usinger, 1965). These internal parasites alter the behavior of their terrestrial insect host, forcing them to enter the water to reach the parasites' reproductive habitat (Barber and Poulin, 2002). The hairworms then enter fresh water to mate, oviposit, and infect paratenic hosts. Freshwater hairworm adults, eggs, and preparasitic larvae occur in streams, ponds, lakes, and dam lakes. The adults range from tan to dark in color and from several centimeters to over a meter in length. The end of the tail can be rounded or bilobed. Hairworm preparasitic larvae are capable of encysting (undeveloped) in a wide range of paratenic hosts, including invertebrates and vertebrates. Development occurs in the body cavity (Poinar, 2001; Smith, 2001; Hanelt et al., 2005; Poinar, 2008). During their development, Nematomorpha species grow from a microscopic larva to a large worm whose size exceeds the length of the host by a considerable amount. When the development of the parasite has been completed, the worms occupy most of the host cavity; worms are only ready to emerge once they reach this stage (Thomas et al., 2002). The adults live in all types of freshwater habitats in the temperate and tropical regions of the world.

The knowledge of the phylum Nematomorpha is extremely limited. Some compiled information on freshwater Nematomorpha (horsehair worms) has been given from different localities in the world by many authors (Schmidt-Rhaesa, 1997; Poinar, 2001; Schmidt-Rhaesa et al., 2003; Poinar, 2008). With regard to the European Nematomorpha, their systematics and distribution are still uncertain (Perçin-Paçal and Sancar-Baş, 2010). Some areas lack records, and numerous taxonomic issues are still unresolved (Schmidt-Rhaesa, 1997; De Villalobos et al., 1999). Considering Turkey, the Nematomorpha fauna is completely unknown. Only one species of Nematomorpha (*Gordius aquaticus*, Linnaeus, 1758) has been reported from Ankara, Samsun, İstanbul, and Antalya by Oytun (1961), and from Isparta by Aydemir et al. (1996). Records of *G. aquaticus* were also reported by Perçin-Paçal and Sancar-Baş (2010) from the Sarıyer region (İstanbul).

The aim of this study was to report a first record of the Gordian worm, *Gordius* sp. (Nematomorpha, Gordiidae), from Topçam Reservoir (Aydın), representing the first occurrence of the group in southwestern Anatolia.

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2. Materials and methods

2.1. Study area

Topçam Dam Lake is located in the Büyük Menderes River basin (Aegean region, Turkey). It was built in 1984 for irrigation and flood prevention, and it is fed by Madran Stream. The lake volume is 83.50 hm^3 and the lake area is 4.20 km^2. It is 49.5 m at its deepest, but the water level is mutable and strongly influenced by rainfall and water use: it decreases in the late spring and summer because of irrigational use, and when rainfall begins in winter, the water level increases again (Şaşı, 2004).

The Nematomorpha was caught during a study carried out to collect data on the fish community of Topçam Dam Lake. The fish specimens were collected from January to September. During the study period, water temperatures varied from 7.42 to 28.90 °C, turbidity ranged from 65 to 300 cm, pH was 7.20–7.98, dissolved oxygen was 5.00–10.54, and conductivity was 118.10–151.50 µmhos/cm.

2.2. Collection

The specimen of Nematomorpha was collected from the fish, measured by means of a ruler, and then observed and described by means of a microscope according to Poinar (2001). The main morphological features of both Nematomorpha and the fish specimen, as well as the original pictures, are given.

3. Results

One female mature individual of Gordian worm was found emerging from the anal aperture of a specimen of Aegean chub, *Squalius fellowesii* (Günther, 1868) (Figure 1), a cyprinid species endemic to the Aegean drainages of Anatolia (Giannetto et al., 2012). The fish specimen was caught from Topçam Dam Lake during the spring season; it was a male with a total length of 20.4 cm and a total weight of 121 g.

The adult Gordian worm was 45.0 cm in length with a diameter of 1.4–2.2 mm. The hairworm ranged in color from yellowish gray to light amber and dark brown (Figure 2). Body was cylindrical, bluntly rounded at both ends; symmetry bilateral; no segmentation surface of the cuticle bearing complex plates. Posterior end was without lobes. The specimen had elevated areoles with apical filaments. Cuticle was completely smooth. Cuticular areoles were absent and it had a simple rounded border with a terminal cloaca, as in all females of the genus *Gordius*. The body of the horsehair worm was extremely long and threadlike. When found in the chub, it was twisted and coiled, much like a piece of discarded thread (Figure 3).

On the basis of the morphological characteristics, the specimen was described as a female of *Gordius* sp. However, it was not possible to define to which species of the genus this female specimen belongs.

4. Discussion

Freshwater hairworms are rarely collected since they normally occur in small numbers and are well camouflaged (Poinar, 2008). Gordiids are a group of parasites with a fairly wide range of hosts: different species of Coleoptera, Dermaptera, Hemiptera, Neuroptera, Orthoptera, and Trichoptera, as well as other invertebrates (Sloderbeck, 1995). Adults of the class Gordioidea are usually found emerging from parasitized coleopterans or orthopterans (Hanelt and Janovy, 1999). Hairworms are usually associated with invertebrates, and few reports discuss their interactions with vertebrate species (Fair et al., 2010). Our finding of the adult parasite in the body cavity of the fish may have occurred by direct ingestion of the adult free-form living in the water, or by consumption of an intermediate host (macroinvertebrates). Previous studies reported several cases of predation on gordiids by freshwater fish (Cochran et al., 1999; Poinar, 2001; Kinziger et al., 2002; Ruiz and Figueroa, 2005; De Villalobos et al., 2008). Gordiids are generally found coiled in the lower

Figure 1. *Squalius fellowesii* and *Gordius* sp. from Topçam Dam Lake.

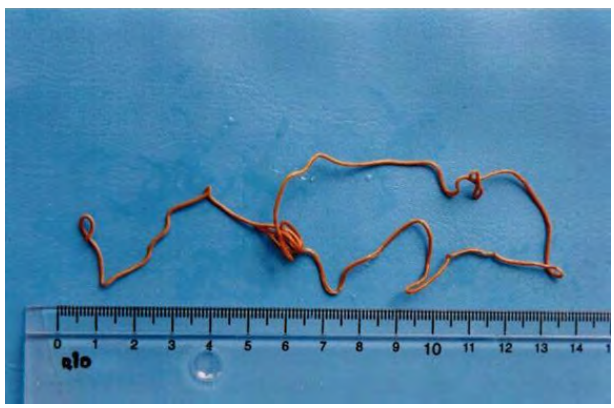

Figure 2. *Gordius* sp. from Topçam Dam Lake.

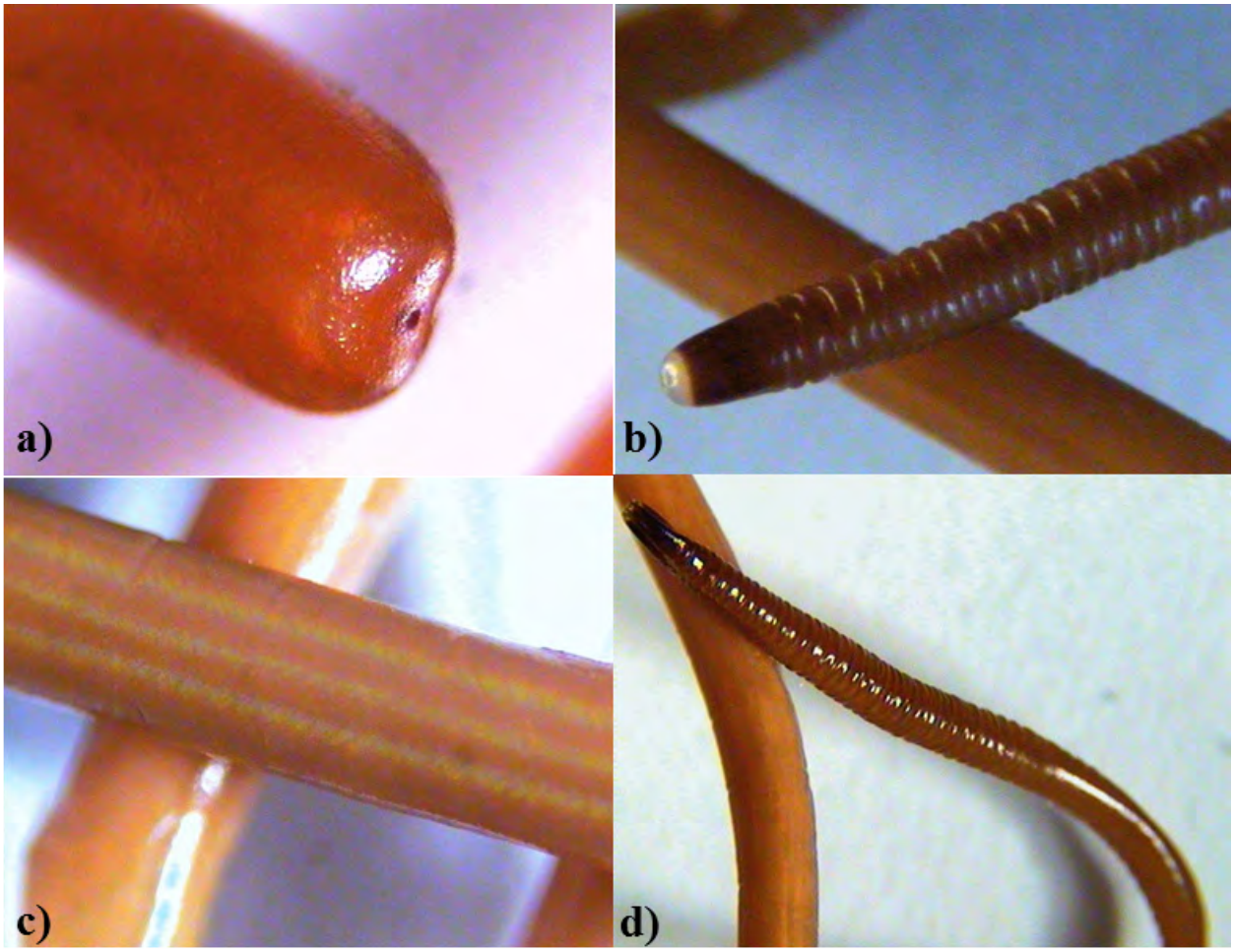

Figure 3. Microscopic images of the female *Gordius* sp. from Topçam Dam Lake: a) posterior end of the female (the cloacal aperture); b) anterior end of the specimen (the calotte and pigment ring); c) cuticle; d) anterior segmentation.

part of aquatic vegetation or with vegetal debris (leaves, sticks, etc.) at the bottom of streams, i.e. places where they are camouflaged (Hanelt et al., 2005). However, horsehair worms are more vulnerable to predation by fish when the adults emerge from their insect host (Thomas et al., 2002; Ponton et al., 2006), during reproduction (McLennan and MacMillan, 1984; Cochran et al., 1999), or when swimming in calm waters (Hanelt et al., 2005).

Currently, among more than 300 species of horsehair worms known, about a third have been recorded from Europe (Schmidt-Rhaesa, 1997). Nevertheless, no or only a few records are known from some countries (Schmidt-Rhaesa and Prous, 2010). This study represents the first record of the genus *Gordius* from western Anatolia.

G. aquaticus is the best known species among nematomorphs. Nevertheless, its diagnostic characters were recently reviewed by means of new instruments and methods such as SEM, revealing characters (i.e. the presence of fine bristles in the posterior end and different fine structures of the cuticular surface) that were not included in the previous description of the species and that have a fundamental role in taxonomical classification (Schmidt-Rhaesa, 2010). *G. aquaticus* larvae were found in the lamprey species *Lampetra planeri* (Bloch) and *L. fluviatilis* (L.) (Malmqvist and Moravec, 1978). With regard to Turkey, *G. aquaticus* is the only species reported to date (Oytun, 1961; Aydemir et al., 1996; Perçin-Paçal and Sancar-Baş, 2010). Further investigations by means of new instruments such as SEM are strongly encouraged to increase the knowledge on this group and to provide precise information about the distribution and accurate identification of Nematomorpha in Turkey.

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