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Occurrence of the Alien Species *Aspidosiphon (Aspidosiphon) elegans* (Sipuncula) on the Levantine and Aegean Coasts of Turkey

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Abstract: A total of 37 specimens of *Aspidosiphon (Aspidosiphon) elegans* were collected at 5 stations located along the Levantine coast of Turkey and at 1 station located near Foça (Aegean Sea). This species inhabited calcareous rocks, the mussel *Branchidontes pharaonis*, and the alga *Corallina mediterranea* between 0 and 3 m depths. The population density of this species in the area was found to be 25 ind. m^{-2}. As *Aspidosiphon (A.) elegans* is a bio-eroder species, its high population density may cause serious damage to coralligenous habitats. This study gives more data regarding the morphological, biological, and ecological features of the species in the eastern Mediterranean Sea.

Key Words: Sipuncula, *Aspidosiphon (Aspidosiphon) elegans*, alien species, Lessepsian, Aegean Sea, Levantine Sea, eastern Mediterranean

Yabancı tür *Aspidosiphon* (*Aspidosiphon*) *elegans* (Sipuncula)'ın Türkiye'nin Levantin ve Ege Denizi Kıyılarındaki Mevcudiyeti

Özet: *Aspidosiphon (Aspidosiphon) elegans*'a ait toplam 37 birey, Türkiye'nin Levantin kıyılarındaki 5 istasyondan ve Foça yakınlarındaki (Ege Denizi) 1 istasyondan toplanmıştır. Bu türe ait bireyler 0 ve 3 m derinliklerdeki kalkerli kayalar, *Branchidontes pharaonis* midyesi ve *Corallina mediterranea* algi üzerinden tespit edilmiştir. Bu türün bölgedeki populasyon yoğunluğu 25 birey m^{-2} olarak bulunmuştur. Ayrıca *Aspidosiphon (A.) elegans* biyoerozyona yol açan bir tür olduğundan, bu türün yüksek populasyon yoğunluğu kalkerli habitatlarda ciddi tehlikelere yol açabilir. Bu çalışmada bu türün Doğu Akdeniz'deki morfolojik, biyolojik ve ekolojik özellikleri hakkında ayrıntılı bilgiler verilmiştir.

Anahtar Sözcükler: Sipuncula, *Aspidosiphon (Aspidosiphon) elegans*, yabancı tür, Lessepsian, Ege Denizi, Levantin Denizi, Doğu Akdeniz

Introduction

The opening of Suez Canal in 1869 connected 2 different zoogeographical areas, the Red Sea and the Mediterranean Sea, and resulted in the immigration of Indo-Pacific species into the Mediterranean. To date, more than 400 species of Indo-Pacific origin have been recorded in the Mediterranean Sea (Zenetos, pers. com.). When it comes to alien sipunculan species in the Mediterranean, Açik et al. (2005) regarded 3 species, namely *Aspidosiphon* (*Aspidosiphon*) *elegans*, *Phascolosoma* (*Phascolosoma*) *scolops* (Selenka and de Man, 1883), and *Phascolion* (*Isomya*) *convestitum* Sluiter, 1902, as probable Lessepsian immigrants. However, Zenetos et al. (2005) added *Apionsoma* (*Apionsoma*) *trichocephalus* Sluiter, 1902 and *Phascolosoma* (*P.*) *scolops* as casual alien species and *Aspidosiphon* (*A.*) *elegans* and *Aspidosiphon* (*Akrikos*) *mexicanus* (Murina, 1967) as questionable alien species. They also excluded *P.* (*I.*) *convestitum* from the list of alien species in the Mediterranean Sea as it was originally described from the Mediterranean coast of France by Sluiter (1902).

In the Mediterranean Sea, *Apionsoma* (*A.*) *trichocephalus* was only reported in front of the Nile Delta at 24 m by Murina et al. (1999). *Phascolosoma* (*P.*) *scolops* was found both in the Adriatic Sea (Murina and Zavodnik 1985/1986) and at the coast of Cyprus (Açik et al., 2005). *Aspidosiphon* (*A.*) *elegans* was first reported

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from the Mediterranean Sea at the coast of Israel by Wesenberg-Lund (1957). There is no record of this species outside the Levantine Sea. *Aspidosiphon* (*A.*) *mexicanus* was reported from the eastern part of the Mediterranean Sea (Pancucci-Papadopoulou et al., 1999). Recently, Açik (2007) reported a dense population of *Apionsoma* (*Apionsoma*) *misakianum* Ikeda, 1904 from the Turkish coast of the Aegean Sea and postulated that it could be an alien species.

The Levantine coast of Turkey was exclusively colonised by the Indo-Pacific species because of its proximity to the Suez Canal. Çinar et al. (2005) reported a total of 216 alien species in the area, some of which have formed dense populations and possess economic value.

The present study provides information about the morphological and ecological characters of *Aspidosiphon* (*A.*) *elegans*. This species easily differs from the other species of *Aspidosiphon* by having an ungrooved anal shield, and bidentate hooks on rings followed by dark conical hooks on the proximal part of the introvert.

Materials and Methods

The material was collected at 5 shallow water stations (0-3 m) located along the Levantine coast of Turkey and at 1 station located near Foça (Aegean Sea) (Figure 1). At the stations, qualitative and quantitative samplings were performed to determine zoobenthic community structures. Quantitative samples were obtained using a quadrat with dimensions 20 × 20 cm. In the laboratory, the samples were sorted under a stereomicroscope and specimens of *Aspidosiphon* (*A.*) *elegans* were identified and counted. A number of biometrical features (i.e. the lengths of trunk and introvert, the lengths of retractors and nephridia, the length of hooks etc.) of the smallest and largest individuals of the species were measured using an ocular micrometer.

Additional specimens of *Aspidosiphon* (*A.*) *elegans* from Hawaii (Pacific Ocean), which were deposited at NMNH (National Museum of Natural History, Smithsonian Institution, USA), were examined and compared with those found in the eastern Mediterranean.

Photographs of specimens of *Aspidosiphon* (*A.*) *elegans* were taken using a digital camera (Olympus, Camedia C–7070) attached to the compound microscopes.

The specimens examined were deposited at the Museum of Faculty of Fisheries, Ege University (ESFM).

Results

***Aspidosiphon* (*Aspidosiphon*) *elegans* (Chamisso and Eysenhardt, 1821)**

Aspidosiphon elegans: Wesenberg-Lund, 1957: 198-199.

Aspidosiphon brocki: Stephen and Edmonds, 1972: 221, fig. 27b.

Aspidosiphon carolinus: Stephen and Edmonds, 1972: 222, figs. 27c-d.

Aspidosiphon elegans elegans: Stephen and Edmonds, 1972: 223, figs. 27e-f.

Aspidosiphon spinalis: Stephen and Edmonds, 1972: 234-235, figs. 27k-l.

Aspidosiphon (*Aspidosiphon*) *elegans*: Cutler and Cutler, 1989: 842-844, fig. 6; Cutler, 1994: 214, figs. 55a, 57b, 60a, 62a; Murina et al. 1999: 827.

Material examined

Levantine Sea: ESFM–SIP/2005–1, 13.09.2005, İskenderun Bay, K–6, 1-3 m, on rock, 1 specimen; ESFM–SIP/2005–2, 15.09.2005, İskenderun Bay, K–11, 0.1-3 m, on rocks, 21 specimens; ESFM–SIP/2005–3, 19.09.2005, Mersin Bay, K–17, 0.1-3 m, on rocks, 12 specimens, ESFM–SIP/2005–4, 19.09.2005, Mersin Bay, K–18, 0.1 m, on the mussel *Brachidontes pharaonis* (Fischer, 1870), 1 specimen; ESFM–SIP/2005–5, 21.09.2005, Aydıncık, K–24, 0.5 m, on the alga *Corallina mediterranea* Areschoug, 1 specimen.

Aegean Sea: ESFM–SIP/2006–1, 30.05.2006, Foça, 0.5-1 m, on rock, 1 specimen.

Pacific Ocean: NMNH 123011, 23.07.1985, Hawaii, 1 m, 13 specimens.

Description

Body wall thin, transparent, or semi-transparent (Figure 2A). Trunk 2.4 (smallest specimen)-11.3 (largest specimen) mm long, 1.3-2 mm wide. Introvert 8.3-11.2 mm long, 0.6-1 mm wide. Introvert as long as (large specimen) trunk length or longer (small specimen) than trunk length. Ungrooved anal shield granulous (Figure

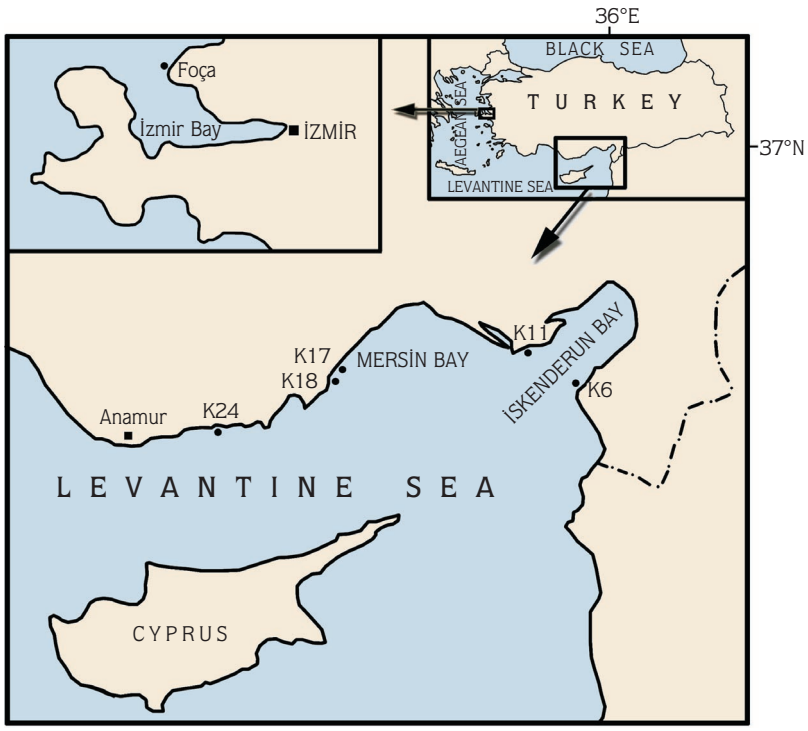

Figure 1. Map of the study area with the locations of sampling sites.

2B). Poorly developed caudal shield lighter in colour than anal shield (Figure 2C). Nephridiopores located just posterior to anus or at level of anus. Nephridia orange or dark brown (Figure 2D); 1.9-6.8 mm height, 0.1-0.4 mm wide. Nephridia length 60%-79.2% of trunk length. Two black eye spots present (Figure 2D). Bidentate hooks on rings located on distal part of introvert; 30-57.5 µm high, 32.5-52.5 µm thick at base (Figure 2E, 3A). Dark conical hooks scattered on proximal part of introvert; 27.5-62.5 µm high, 30-67.5 µm thick at base (Figure 3B). Introvert with 13-15 rings. Intestinal tract with about 14-20 coils, attached by a spindle muscle. Distance between posterior end of trunk and beginning of retractors 0.43-3.25 mm long. Retractors originating from 18% to 29% of the distance to the end of trunk.

Reproduction

Aspidosiphon (*A.*) *elegans* is known to reproduce asexually (Rice, 1970; Cutler, 1994). A small constriction occurs at the posterior part of the parent individual. In this study, 2 specimens with a posterior constriction were collected (Figure 3C). The area of the constriction is encircled externally by a blackened band (Figure 3C). This part (daughter) regenerates the body including the intestine, retractor muscles, and nephridia.

Ecology

This species was found in crevices of calcareous rocks, and on the mussel *Brachidontes pharaonis* and the red alga *Corallina mediterranea* between 0 and 3 m depths. The population density of this species in the area was 25 ind. m^{-2}.

Discussion

The external and internal morphological characters of specimens of *Aspidosiphon* (*A.*) *elegans* found during this study coincide with the original and subsequent descriptions of the species. However, there are some differences between the Mediterranean specimens of this species and others reported outside the Mediterranean. For instance, the trunk length of the species from the coasts of Japan and Indian Ocean is very long (58 mm and 57 mm) (Cutler and Cutler, 1979; Cutler et al., 1984), when compared to that (11.3 mm) of the specimens found in the present study.

The number of hook rings (13-15) on the introvert of the Mediterranean specimens of *Aspidosiphon* (*A.*) *elegans* is lower than that (35-100) reported by Stephen and Edmonds (1972). The number of intestine coils (14-

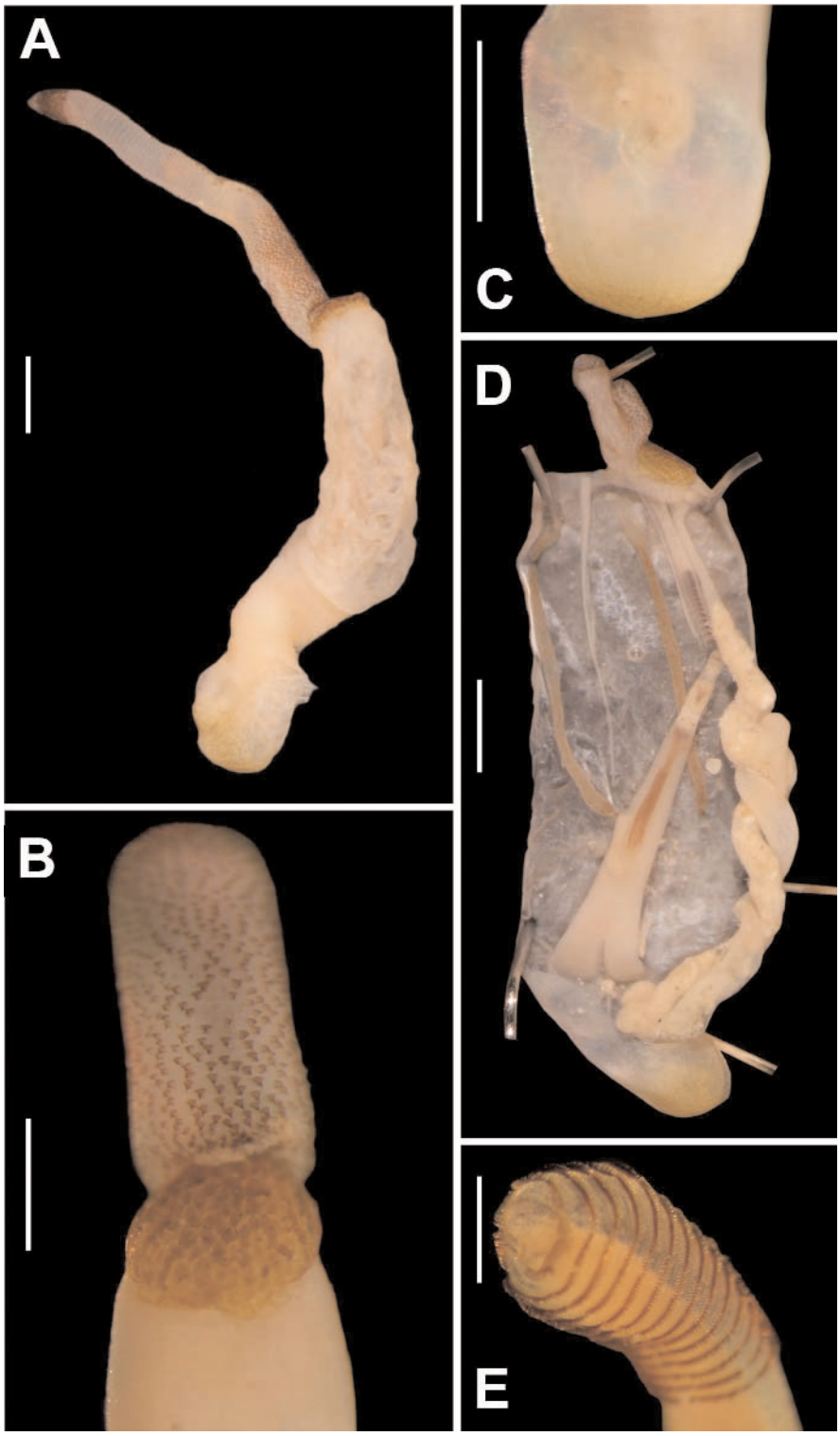

Figure 2. *Aspidosiphon* (*Aspidosiphon*) *elegans*. A. Trunk and partly everted introvert of the specimen ESFM–SIP/2006–1, B. View of the anal shield of the specimen ESFM–SIP/2005–3, C. View of the caudal shield of the specimen ESFM–SIP/2005–3, D. Internal anatomy of the specimen ESFM–SIP/2005–3, E. Bidentate hooks on rings of the introvert of the specimen ESFM–SIP/2005–3. Scale bars: A = 1 mm, B = 0.5 mm, C = 1 mm, D = 1 mm, E = 0.5 mm.

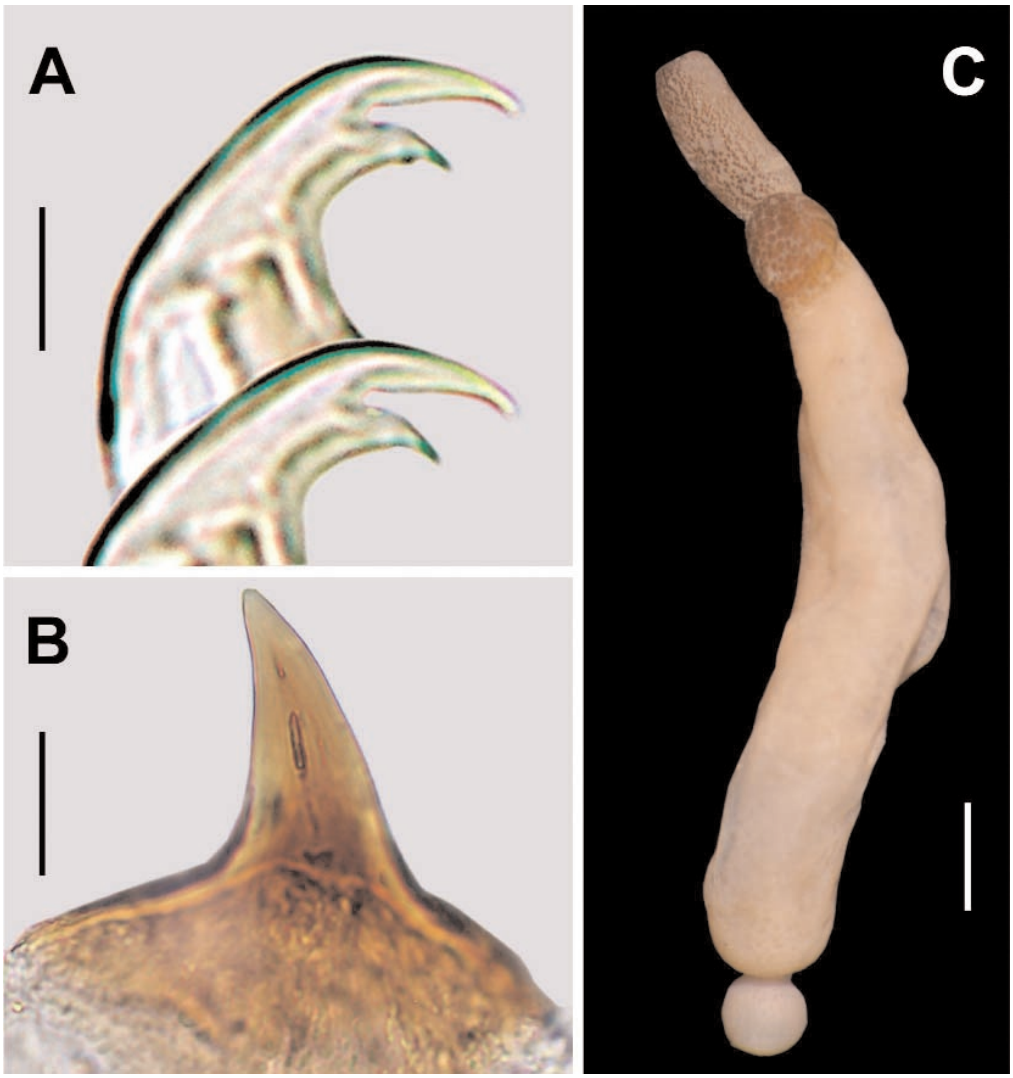

Figure 3. *Aspidosiphon* (*Aspidosiphon*) *elegans*. A. Bidentate hook of the introvert of the specimen ESFM–SIP/2005–2, B. Unidentate hook of the introvert of the specimen ESFM–SIP/2005–2, C. Asexual reproduction of the specimen ESFM–SIP/2005–2. Scale bars: A = 9.5 µm, B = 18.5 µm, C = 1 mm.

20) is lower than that (23-30) reported by Stephen and Edmonds (1972). Cutler (1994) reported that retractors originate from 5% to 15% of the distance to the end of the trunk, whereas retractors on the Mediterranean specimens originate from 18% to 29% of the distance to the posterior end of the trunk. The other difference is the number of eyespots; Wesenberg-Lund (1957) reported 3 eyespots on the introvert of specimens collected from the Israeli coast, whereas only 2 black eyespots are present on the introvert of specimens from the coasts of Turkey.

The Mediterranean specimens of *Aspidosiphon* (*A.*) *elegans* were compared with those collected from the coast of Hawaii (NMNH 123011) and it was found that there was no distinct morphological difference between the 2 populations. However, the trunk size of the Hawaiian worms is larger (18.7 mm) than that of the Mediterranean worms (11.3 mm). The retractors of the largest specimen from the coast of Hawaii originated from 21% of the distance to the end of trunk, whereas those of the largest Mediterranean specimen emerged from 29% of the distance to the end of trunk. The length of unidentate hooks on the proximal part of introvert of the largest specimen from the coast of Hawaii is smaller (45 µm) than that of the Mediterranean specimen (62.5 µm). However, the lengths of bidentate hooks on the

distal parts of introvert of specimens from the 2 distant locations are similar (57.5 µm).

Two specimens of *Aspidosiphon* (*A.*) *elegans* were found to reproduce asexually at the stations, forming a budding at the posterior end. Rice (1970) also cited this reproduction type in this species and demonstrated that when this smaller part detached from the posterior part of the parent individual a new individual formed. Rice (1970) pointed out that this species might also reproduce sexually as she observed gonads at the base of retractor muscles.

Aspidosiphon (*A.*) *elegans* was previously reported to be a common species in the shallow waters of the Indian and western Pacific Oceans, and the Red Sea (Cutler, 1994). Wesenberg-Lund (1957) firstly reported it in the Mediterranean: only at the Israeli coast. This study extends its distributional range to the northern part of the Levantine Sea as well as the Aegean Sea. This species is reported here for the first time from the Aegean Sea.

This species was previously found within lime-sandstones at 0.05 m depth at the Israeli coast (Wesenberg-Lund, 1957) and on corals and rocks in the Pacific and Indian Oceans (Cutler and Cutler, 1979; Cutler et al., 1984). In the present study, this species was frequently encountered in crevices of calcareous rocks, and on the mussel *Brachidontes pharaonis* and the red alga *Corallina mediterranea* between 0 and 3 m depths. The population density of this species in the Levantine Sea was relatively low (25 ind. m^{-2} on *B. pharaonis* and *C. mediterranea*). However, more material is needed to give a more reliable conclusion about its real population status at the coasts of Turkey. The present study shows that this species has become well acclimatised to the eastern Mediterranean Sea, especially to the Levantine Sea.

The impact of this species on the prevailing ecosystem is unknown at this stage. This species is known to be a bio-eroder of calcareous substrates such as rocks, stones, or corals (Cutler, 1994). When it attains a high population density in the area, it may cause serious damage to these habitats.

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