

Sipuncula from the southern coast of Turkey (eastern Mediterranean), with a new report for the Mediterranean Sea

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Abstract: The faunistic analysis of hard and soft benthic samples taken from 0 to 200 m depths on the southern coast of Turkey in September and October 2005 yielded 18 sipunculan species and 20706 individuals belonging to nine genera. One species (*Nephasoma (Nephasoma) eremita*) is new to the Mediterranean fauna and ten species to the Levantine fauna of Turkey. Three alien sipunculan species, *Apionsoma (A.) misakianum*, *Aspidosiphon (A.) mexicanus* and *Aspidosiphon (A.) elegans*, were found in the area. *Aspidosiphon (A.) elegans*, a bio-eroder species, seems to have become established in the region. This study gives additional data regarding some morphological, distributional and reproductive features of the species found in the eastern Mediterranean Sea. A taxonomic key to the species found in the region is given.

Résumé : *Sipunculiens de la côte sud de Turquie (Méditerranée orientale) et nouveau signalement pour la Méditerranée.* L'analyse faunistique d'échantillons benthiques de substrats meubles et durs récoltés entre 0 et 200 mètres de profondeur sur la côte sud de la Turquie en septembre et octobre 2005 a permis de déterminer 18 espèces et 20706 individus appartenant à 9 genres différents de Sipunculiens. Une espèce (*Nephasoma (Nephasoma) eremita*) est nouvelle pour la faune méditerranéenne et dix espèces sont nouvelles pour la faune levantine de Turquie. Trois espèces exotiques *Apionsoma (A.) misakianum*, *Aspidosiphon (A.) mexicanus* et *Aspidosiphon (A.) elegans*, ont été trouvées dans la région. *Aspidosiphon (A.) elegans*, une espèce bio-érodeuse, semble s'être établie dans la région. Cette étude fournit des données supplémentaires concernant les caractéristiques morphologiques, les caractéristiques de distribution et de reproduction des espèces qui se trouvent dans la partie orientale de la Mer Méditerranée. La clé taxonomique des espèces trouvées dans la région est donnée.

Keywords: Sipuncula • Levantine Sea • Eastern Mediterranean • Turkey

Introduction

The phylum Sipuncula comprises approximately 150 species worldwide and 34 species in the Mediterranean Sea (Cutler, 1994; Açık, 2007). They are unsegmented, coelomate, bilaterally symmetrical and wormlike invertebrates mainly inhabiting marine waters.

Sipunculan species inhabiting the southern coast of Turkey have not been studied in detail to date. The data on this group from the area come from the publications by Açık (2008a & 2010), who found *Golfingia* (*G.*) *vulgaris vulgaris*, *Nephasoma* (*N.*) *rimicola*, *Onchnesoma steenstrupii*, *Phascolosoma* (*P.*) *stephensoni*, *Apionsoma* (*A.*) *misakianum*, *Aspidosiphon* (*Aspidosiphon*) *elegans*, and *A.* (*A.*) *misakiensis* on a variety of habitats at 0-31 m in the area.

The proximity to the Suez Canal and the presence of large harbors (i.e. Iskenderun, Antalya and Mersin Harbours) has caused the colonization of the southern coast of Turkey by alien species (Çinar et al., 2005). The record of alien species known from the area is continuously increasing, partly through the increase in the number of studies performed in the area, and partly through the impacts of vectors and the range extensions of alien species. Çinar et al. (2005) reported a total of 216 alien species on the Levantine coast of Turkey, and some of which have formed dense populations and possess economic value in the area. A total of 903 alien species are known from the Mediterranean Sea (Zenetos et al., 2008). The alien sipunculan species previously reported from the area were *A.* (*A.*) *elegans* and *A.* (*A.*) *misakianum* (Açık, 2008a & 2010).

The present paper deals with some morphological, distributional and reproductive features of sipunculan species collected from the southern coast of Turkey in September-October 2005.

Material and Methods

A cruise to the southern coast of Turkey (Levantine Sea) was undertaken in September and October 2005 to collect benthic samples from different habitats in 0-200 m at 148 stations. Sipunculan species were found at 86 stations. Scuba diving and snorkeling were used at shallow water (0-10 m) stations (Fig. 1). At deeper stations, sampling gears such as an anchor dredge (station numbers marked with "D" in Figure 2) and a Van Veen grab (sampling an area of 0.1 m²) (station numbers marked with "G" in Figure 2), were used. In shallow-water stations, various substrates (i.e., rocks, sand, algae, and phanerogams) were sampled, using a 20 x 20-cm quadrat. In addition, small samples of rocks were broken off with a hammer to collect boring species. Locality data including date, depth, and habitat structures are given in the material examined section of each species.

The samples were sieved through a sieve of 0.5 mm mesh and the material on the sieve was put in separate jars containing 4% seawater formaldehyde solution. In the laboratory, material was washed with tap water, sorted according to taxonomic groups under a stereomicroscope, and preserved in 70% ethanol. The sipunculans were separated from other benthic materials, then identified and counted using both stereo- and compound microscopes. Biometrical measurements of the largest and smallest individuals of each species such as the lengths of trunk, introvert, papillae, retractors, nephridia and hooks were measured by using ocular micrometer. Photographs were taken with a digital camera (Olympus, Camedia, C 7070) attached to stereo and compound microscopes. Terminology used for descriptions of the species follows Cutler (1994).

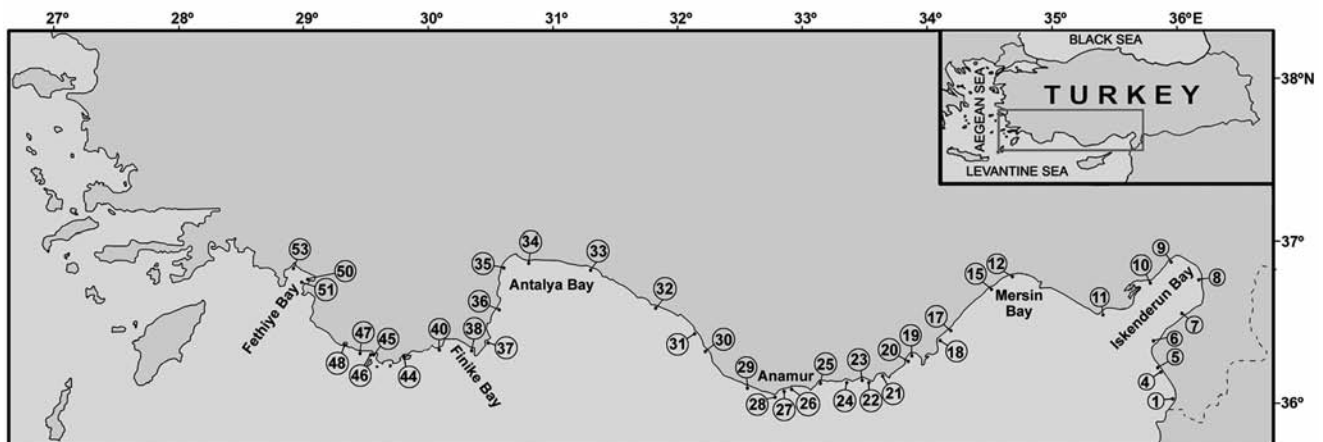
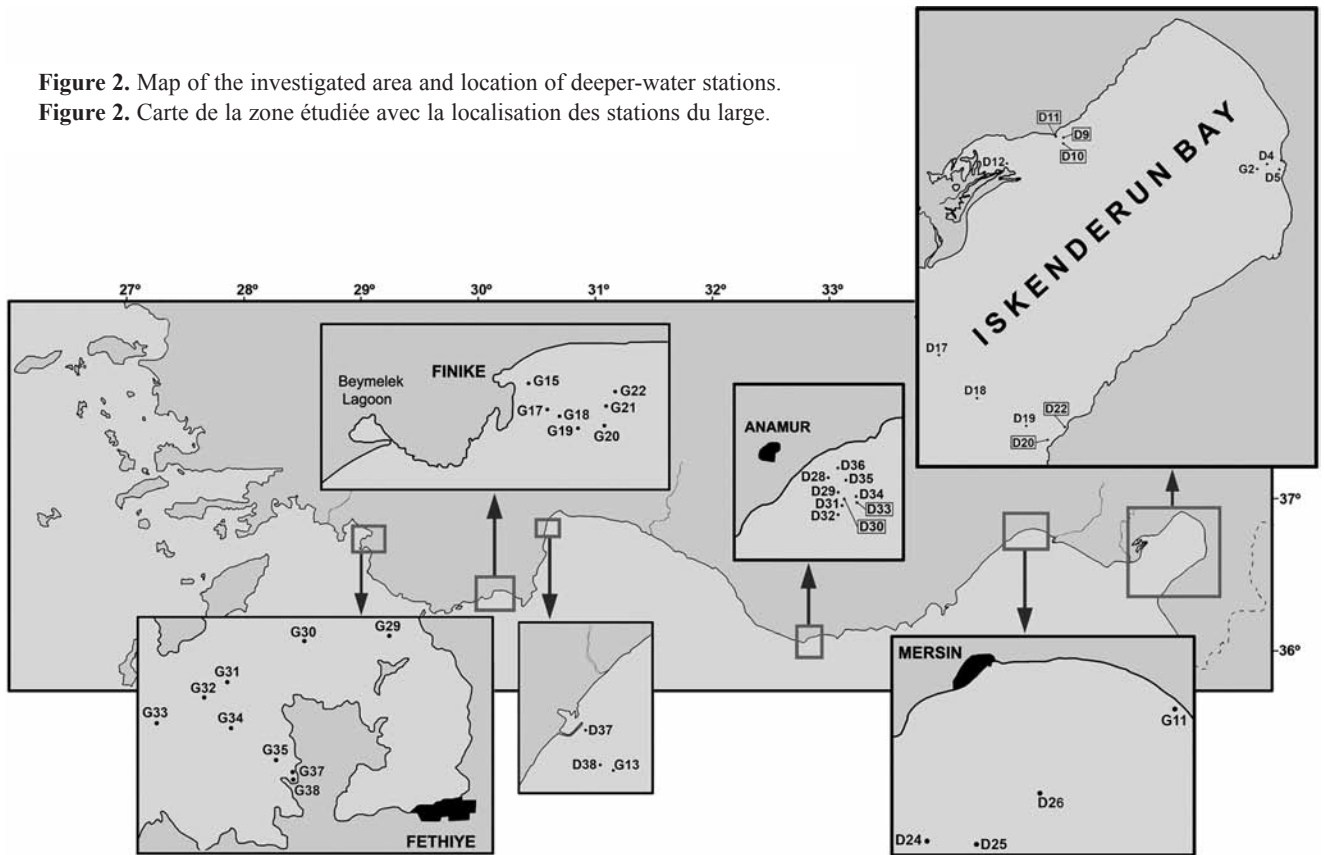


Figure 1. Map of the investigated area and location of shallow-water stations.

Figure 1. Carte de la zone étudiée et localisation des stations côtières.

Figure 2. Map of the investigated area and location of deeper-water stations.
Figure 2. Carte de la zone étudiée avec la localisation des stations du large.



The specimens examined were deposited in ESFM [Ege Universitesi Su Urunleri Muzesi (Museum of Faculty of Fisheries, Ege University)].

Results and Discussion

A total of 18 species and 20706 individuals belonging to nine genera have been identified. Among them, one species is new to the Mediterranean fauna [*Nephasoma* (*Nephasoma*) *eremita*] and ten species [*Sipunculus* (*S.*) *nudus*, *Golfingia* (*G.*) *elongata*, *Nephasoma* (*N.*) *abyssorum abyssorum*, *N. (N.) constrictum*, *N. (N.) diaphanes diaphanes*, *Thysanocardia procera*, *Phascolion* (*I.*) *tuberculosis*, *P. (P.) strombus strombus*, *Aspidosiphon* (*A.*) *mexicanus* and *A. (A.) muelleri*] new to the fauna of southern coast of Turkey. The total number of sipunculan species now known from the Levantine fauna increased from 23 to 26; that known from the Levantine coast of Turkey increased from 10 to 20. The present material included three alien sipunculan species, namely, *Apionsoma* (*A.*) *misakianum*, *Aspidosiphon* (*A.*) *mexicanus* and *Aspidosiphon* (*A.*) *elegans*.

Key to the Sipunculan species found along the southern coast of Turkey

1. Tentacles in arc encircling dorsal nuchal organ; peripheral tentacles absent; hooks (when present) complex, in distinct rings (Class: Phascolosomatidea)2
- Tentacles arranges peripherally encircling central mouth; may be carried on stem-like outgrowths of oral disk or reduced to single dorsal pair; hooks (when present) simple, usually scattered (Class: Sipunculidea)7
2. Anal shield present (Family: Aspidosiphonidae; Genus: *Aspidosiphon*)3
- Anal shield absent (Family: Phascolosomatidae)6
3. Hooks arranged in rings on distal portion of introvert (Subgenus: *Aspidosiphon*)4
- Hooks not present, or if present not in rings (Subgenus: *Akrikos*)*Aspidosiphon (Akrikos) mexicanus*
4. Anal shield with extensive array of furrows present; not just around margin
.....*Aspidosiphon (Aspidosiphon) muelleri*
- Anal shield with randomly distributed hardened units; lacking extensive grooves or furrows5
5. All compressed hooks bidentate followed by dark conical hooks*Aspidosiphon (Aspidosiphon) elegans*

Distal hooks bidentate compressed hooks followed by proximal unidentate ones

.....*Aspidosiphon (Aspidosiphon) misakiensis*

6. Introvert much longer than trunk; hooks (if present) with basal spinelets; nephridia usually bilobed (Genus and Subgenus: *Apionsoma*).....*Apionsoma (A.) misakianum*

Introvert less than twice trunk length; hooks without basal spinelets; nephridia unilobed (Genus and Subgenus: *Phascolosoma*).....*Phascolosoma (P.) stephensoni*

7. Longitudinal muscles of body wall gathered into separate or anatomizing bands (Family: Sipunculidae; Genus and Subgenus: *Sipunculus*).....*Sipunculus (S.) nudus*

Longitudinal muscle of body wall in uniform continuous layer

8. A single nephridium present (Family: Phascolionidae)

Two nephridia present (Family: Golfingiidae)

9. Anus usually situated on anterior trunk; epidermal holdfasts or attachment papillae often present; retractor muscles highly fused but usually two to four origins apparent (Genus: *Phascolion*)

Anus situated on distal half of introvert; epidermal attachment papillae absent; retractor muscles appear as single column without separate origins (Genus: *Onchnesoma*)

10. Dorsal and ventral retractors of equal size; holdfasts weakly proteinized, if it all (Subgenus: *Isomya*).....

.....*Phascolion (Isomya) tuberosum*

Ventral retractor muscle much thinner than dorsal (one-tenth to one-half); many with distinct proteinized borders on holdfast papillae (Subgenus: *Phascolion*)

.....*Phascolion (Phascolion) strombus strombus*

11. Contractile vessel with numerous villi.(Genus: *Thysanocardia*).....*Thysanocardia procera*

Contractile vessel without villi

12. Four introvert retractor muscles (Genus: *Golfingia*)

.....*Golfingia (Golfingia) elongata*

Two introvert retractor muscles (Genus: *Nephasoma*).....

13. Introvert hooks in rings

.....*Golfingia (Golfingia) elongata*

Introvert hooks scattered

.....*Golfingia (Golfingia) vulgaris vulgaris*

14. Trunk with obvious pigmented, raised papillae ..

Trunk may have papillae (skin bodies), but they are unpigmented and barely raised above surface.....

15. Tentacles present, papillae uniformly distributed over trunk; length rarely exceeds width by more than eight times (flask shaped), anus on narrowed anterior region, which usually also exhibits an indented constriction, shallow to bathyal depths

.....*Nephasoma (Nephasoma) constrictum*

Tentacles reduced to lobes, papillae rare in mid trunk, trunk length commonly exceeds width by more than eight

times (slender cylinder); deep, cold water.....

.....*Nephasoma (Nephasoma) diaphanes diaphanes*

16. Hooks in distinct rings around introvert

.....*Nephasoma (Nephasoma) rimicola*

Hooks, if present, not in rings.....

17. Dark hooks have unique shape, arranged spirally,

like a barber's pole

.....*Nephasoma (Nephasoma) abyssorum abyssorum*

Hooks absent

.....*Nephasoma (Nephasoma) eremita*

***Sipunculus (Sipunculus) nudus* Linnaeus, 1766**

Material examined

ESFM-SIP/05-283, 10.09.2005, D20, 50 m, muddy sand, 1 specimen.

Remarks

This species is widely distributed in the Mediterranean Sea. It is the largest sipunculan species in the region and locally used as a fish bait. The other species of the genus living in the region is *Sipunculus (S.) norvegicus* Danielssen, 1869 which differs from *S. (S.) nudus* in having 20-24 longitudinal muscle bands and a flattened, elongated brain without digitate. The length of trunk of Mediterranean specimen of *Sipunculus (S.) nudus* is small (12.9 mm; Fig. 3A). However, this species is known to attain large sizes: Atlantic (max: 90 mm), Japan (max: 145 mm) and Spain (max: 340 mm) (Cutler et al., 1984; Cutler & Cutler, 1987; Saiz Salinas, 1993b).

Distribution

Cosmopolitan species (Cutler, 1994).

***Golfingia (Golfingia) elongata* (Keferstein, 1862)**

Material examined

ESFM-SIP/05-284, 23.09.2005, D30, 75 m, muddy sand, 1 specimen; ESFM-SIP/05-285, 23.09.2005, D33, 200 m, sandy mud, 1 specimen.

Remarks

The lengths of trunks of two specimens are 2.1 and 3 mm. The main diagnostic characters of *Golfingia (G.) elongata* are the presence of hooks (12.5-30 µm high, this study) in rings (8-12) and lustrous body wall (Fig. 3B). The distance between the posterior end of the trunk and the base of the ventral retractors (10-19%) of specimens of this species is much smaller than those reported by Cutler (1994) (30-40%) and Açık (2008b) (64%).

Golfingia (G.) elongata was previously reported from

sand bottoms (Cutler, 1973; Saiz Salinas & Villafranca Urchegui, 1990); in the community of *Nephrops norvegicus* and *Nucula profunda* (Murina & Zavodnik, 1985-1986); and among rocks, gravel, *Fucus*, sand and mud (Saiz Salinas, 1993b).

Distribution

Arctic Ocean, Mediterranean Sea (Stephen & Edmonds, 1972), Pacific and North Atlantic Oceans (Cutler, 1994).

Golfingia (Golfingia) vulgaris vulgaris (de Blainville, 1827)

Material examined

ESFM-SIP/05-126, 14.09.2005, K8, 1-3 m, rocks, 7 specimens; ESFM-SIP/05-127, 19.09.2005, K18, 0.5 m, *Corallina mediterranea*, 1 specimen; ESFM-SIP/05-128, 21.09.2005, K25, 3 m, *Posidonia oceanica*, 6 specimens; ESFM-SIP/05-129, 22.09.2005, K26, 0.1-3 m, rocks, 1 specimen; ESFM-SIP/05-130, 24.09.2005, K29, 2 m, *P. oceanica*, 3 specimens; ESFM-SIP/05-131, 03.10.2005, K44, 0.1-3 m, rocks, 3 specimens; ESFM-SIP/05-132, 03.10.2005, K45, 0.1-3 m, rocks, 7 specimens; ESFM-SIP/05-133, 03.10.2005, K45, 0.2 m, *C. mediterranea*, 1 specimen; ESFM-SIP/05-134, 03.10.2005, K45, 9 m, *P. oceanica*, 2 specimens; ESFM-SIP/05-135, 04.10.2005, K48, 0.2 m, *J. rubens*, 1 specimen; ESFM-SIP/05-136, 05.10.2005, K50, 6 m, *P. oceanica*, 4 specimens; ESFM-SIP/05-137, 05.10.2005, K51, 8 m, *P. oceanica*, 1 specimen; ESFM-SIP/05-138, 07.10.2005, K53, 0.3 m, *Sarcotragus* sp., 1 specimen; ESFM-SIP/05-139, 06.10.2005, G32, 100 m, mud, 1 specimen; ESFM-SIP/05-140, 06.10.2005, G38, 10 m, *P. oceanica*, 1 specimen; ESFM-SIP/05-141, 23.09.2005, D28, 25 m, muddy sand with *Caulerpa prolifera*, 1 specimen; ESFM-SIP/05-142, 23.09.2005, D29, 50 m, muddy sand with *C. racemosa*, 1 specimen; ESFM-SIP/05-143, 23.09.2005, D31, 100 m, sandy mud, 1 specimen; ESFM-SIP/05-144, 23.09.2005, D32, 200 m, mud, 2 specimens; ESFM-SIP/05-145, 23.09.2005, D35, 50 m, muddy sand with *C. racemosa*, 1 specimen; ESFM-SIP/05-146, 23.09.2005, D36, 25 m, muddy sand with *C. prolifera*, 7 specimens.

Remarks

The specimens examined have trunk lengths ranging from 1.5-10.2 mm. The presence of scattered hooks (25-115 µm in this study) and both ends of trunk with dark brown or black papillae (20-65 µm) are diagnostic characters for the species (Fig. 3C). Ten specimens of this species have eggs in their coelom cavity, measuring 50-140 µm in diameter. Four specimens of endoprocts were found to be attached to the posterior part of the trunk of two individuals. The

endoproct *Loxosomella gautieri* Bobin & Prenant, 1953 was previously reported on the posterior and anterior parts of the trunk of this species collected from Marseille (Prenant & Bobin, 1956).

In the present study, this species was found in association with a variety of habitats (*Corallina mediterranea*, *Posidonia oceanica*, *Jania rubens*, rocks, mud, sandy mud, muddy sand with *Caulerpa prolifera* and muddy sand with *C. racemosa*) at depths ranging from 0 to 200 m. This species was previously found on rocks, mud, gravel and sand (Stephen, 1958; Saiz Salinas, 1993a); on rocks, muddy sand, sandy mud, sand, photophilic algae, *P. oceanica*, *Cladocora caespitosa* and *Pinna nobilis* and sandy mud with *C. prolifera* (Açik, 2008b & 2010).

Distribution

Northeast Atlantic, northwest Pacific and Indian Oceans (Saiz Salinas, 1993a); Mediterranean Sea and Red Sea (Cutler, 1994).

Thysanocardia procera (Moebius, 1875)

Material examined

ESFM-SIP/05-266, 30.09.2005, G18, 75 m, mud, 1 specimen; ESFM-SIP/05-267, 06.10.2005, G29, 25 m, sandy mud, 2 specimens; ESFM-SIP/05-268, 06.10.2005, G31, 75 m, muddy sand, 1 specimen.

Remarks

The specimens examined have a trunk length of 1.5-4.7 mm long (Fig. 3D) and differ from the other Mediterranean species of *Thysanocardia*, *Thysanocardia catharinae* (Grube, 1868), by the form of its nuchal organ (two oval lobes separated by a longitudinal groove in *T. procera*; single lanceolate lobe in *T. catharinae*).

Distribution

North Atlantic and Mediterranean Sea (Saiz Salinas & Villafranca Urchegui, 1990).

Nephasoma (Nephasoma) abyssorum abyssorum (Koren & Danielssen, 1875)

Material examined

ESFM-SIP/2005-18, 23.09.2005, Anamur, 200 m, on mud, 2 specimens.

Additional material examined

NMNH 153470, 23.09.1985, United States; North Carolina, Off Cape Fear, 11 specimens.

Remarks

The specimens examined (trunk length: 6 and 8 mm) have smooth, whitish body (Fig. 3E) and hooks spirally arranged on the introvert. The height of hooks (range: 35-65 μm) on the introvert of the eastern Mediterranean specimens of *Nephasoma (N.) abyssorum abyssorum* is higher than that (17.5-27.5 μm) of the North Atlantic specimens (NMNH 153470). However, the distance between the posterior end of the trunk and the base of the ventral retractors (50-60%), and the ratio of the nephridia length to the trunk (10-15%) of the specimens from two distant locations were almost similar.

Distribution

Northwestern Pacific, Atlantic, Arctic and Indian Oceans (Saiz Salinas, 1993a; Cutler, 1994).

Nephasoma (Nephasoma) constrictum (Southern, 1913)*Material examined*

ESFM-SIP/2005-23, 23.09.2005, Anamur, D30, 75 m, on muddy sand, 1 specimen; ESFM-SIP/2005-24, 23.09.2005, Anamur, D32, 200 m, on mud, 4 specimens; ESFM-SIP/2005-25, 23.09.2005, Anamur, D33, 200 m, on sandy mud, 1 specimen; ESFM-SIP/2005-26, 06.10.2005, Fethiye, G31, 75 m, on muddy sand, 5 specimens; ESFM-SIP/2005-27, 06.10.2005, Fethiye, G32, 100 m, on mud, 2 specimens.

Remarks

Nephasoma (N.) constrictum is mainly characterized by having a distinct constriction on the introvert-trunk junction (Fig. 3F) and a number of large papillae scattered on the trunk (length: 1.2-9 mm). It was reported that it shows some variations in terms of papillae and hooks (15-30 μm high, Fig. 5A) and that its juvenile forms resemble the species *Nephasoma (N.) diaphanes diaphanes* (Saiz Salinas & Villafranca Urchegui, 1990).

Distribution

North-eastern Atlantic and Indian Oceans, western and eastern Mediterranean Sea (Cutler, 1994; Açık et. al., 2005).

Nephasoma (Nephasoma) diaphanes diaphanes
(Gerould, 1913)*Material examined*

ESFM-SIP/2005-28, 23.09.2005, Anamur, D30, 75 m, on muddy sand, 2 specimens; ESFM-SIP/2005-29,

23.09.2005, Anamur, D33, 200 m, on sandy mud, 1 specimen; ESFM-SIP/2005-30, 23.09.2005, Anamur, D34, 100 m, on muddy sand, 1 specimen; ESFM-SIP/2005-31, 06.10.2005, Fethiye, G35, 75 m, on muddy sand, 1 specimen.

Additional material examined

NMNH 143959, 13.07.1977, North Atlantic Ocean, 265 m, Sta. 32626, 222 specimens.

Remarks

The specimens examined have a trunk length of 1.9-2.1 mm (Fig. 3G). *Nephasoma diaphanes* was previously considered as a synonym of *N. minutum* (Keferstein, 1862). Gibbs (1975) postulated that *N. minutum* has two distinct forms, a dioecious form found chiefly in deep water, and a hermaphroditic form found in shallow water around Europe and Scandinavia. However, Cutler & Cutler (1986) regarded these two species as distinct. According to them, *Nephasoma minutum* is a hermaphrodite species and its distribution limited in the northeastern Atlantic, whereas *N. diaphanes* is dioecious and cosmopolitan. In this paper, the name *N. diaphanes* was used throughout the paper.

The morphological features of the eastern Mediterranean specimen of this species are very similar to those collected from the northern Atlantic coasts (NMNH 143959). However, some slight differences were found between the distant populations of the species. The retractors of the specimens of *Nephasoma (N.) diaphanes diaphanes* collected from the coast of North Atlantic originated from 47% of the distance to the end of trunk, whereas those of the eastern Mediterranean specimens originated from 36.8-38% of the distance to the end of trunk. However, Cutler et al. (2001) determined it as 50-75%.

Distribution

Cosmopolitan in deep waters (Cutler, 1994).

Nephasoma (Nephasoma) eremita (Sars, 1851)*Material examined*

ESFM-SIP/2005-32, 23.09.2005, Anamur, D30, 75 m, on muddy sand, 1 specimen.

Additional material examined

NMNH 119398, 18.06.1962, North Atlantic Ocean, United States; off East Coast, 229 m, Sta. 53, 2 specimens; NMNH 119399, 25.05.1962, North Atlantic Ocean, United States; off East Coast, 824 m, Sta. 3, 2 specimens.

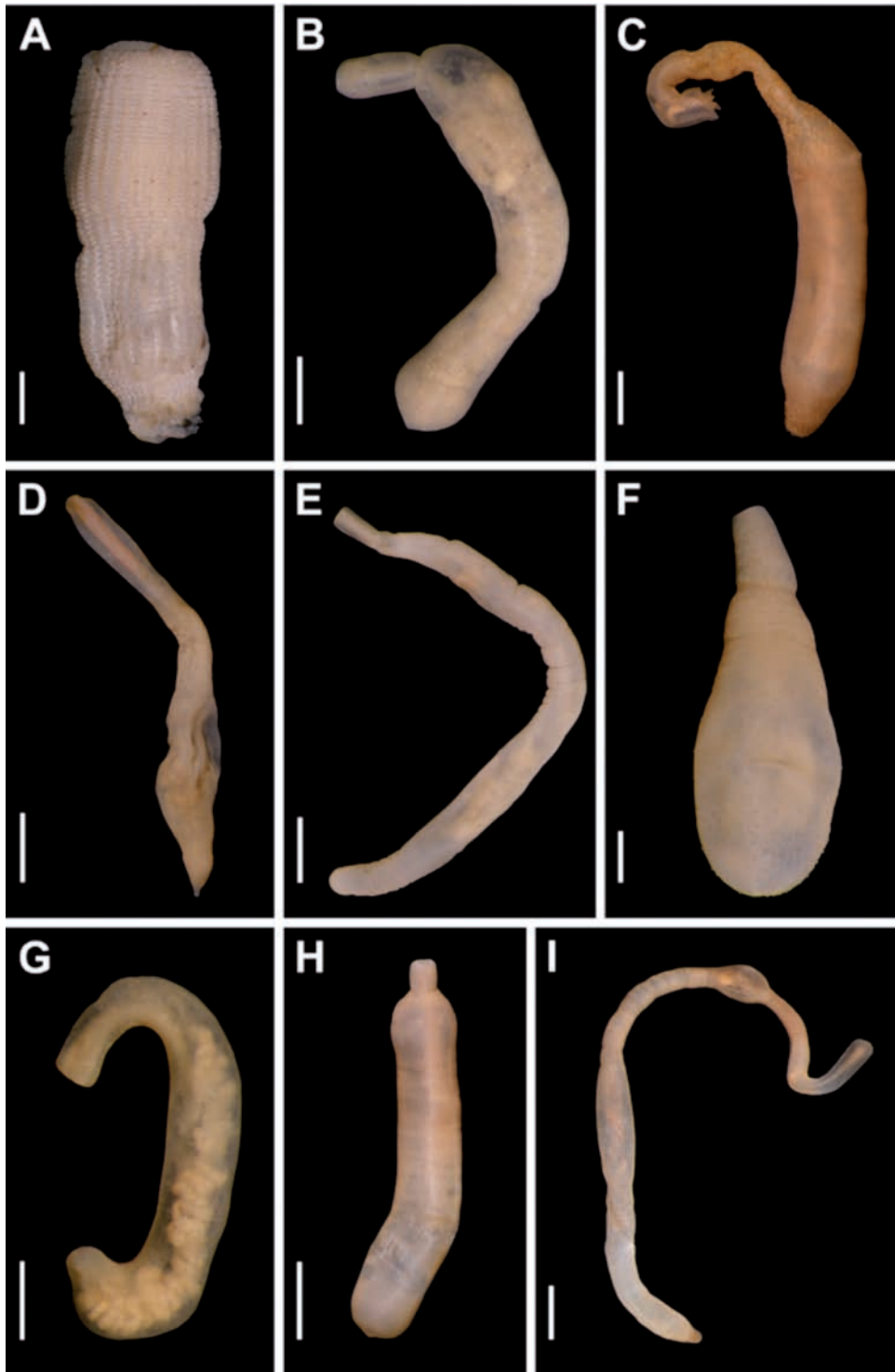


Figure 3. External morphology of species. Scale bars: A = 2 mm, B = 0.5 mm, C-E = 1 mm, F = 0.3 mm, G = 0.4 mm, H = 2 mm, I = 1 mm.

Figure 3. Morphologie externe des espèces. Echelle : A = 2 mm, B = 0,5 mm, C-E = 1 mm, F = 0,3 mm, G = 0,4 mm, H = 2 mm, I = 1 mm.

A. *Sipunculus (S.) nudus* ESFM-SIP/2005-283. **B.** *Golfingia (G.) elongata* ESFM-SIP/2005-284. **C.** *Golfingia (G.) vulgaris vulgaris* ESFM-SIP/2005-126. **D.** *Thysanocardia procera* ESFM-SIP/2005-266. **E.** *Nephasoma (N.) abyssorum abyssorum* ESFM-SIP/2005-18. **F.** *Nephasoma (N.) constrictum*. ESFM-SIP/2005-27. **G.** *Nephasoma (N.) diaphanes diaphanes* ESFM-SIP/2005-30. **H.** *Nephasoma (N.) eremita* ESFM-SIP/2005-32. **I.** *Nephasoma (N.) rimicola* ESFM-SIP/2005-33.

Description

Body wall smooth, pale creamy tan to dark reddish brown. Unclear transverse and parallel grooves present on trunk wall. Cylindrical trunk with abrupt taper to introvert (Fig. 3H). Trunk 9.8 mm long, 2 mm wide. Introvert partly retracted, 3.8 mm long, 0.8 mm wide. Mouth at distal end of introvert surrounded by 30 digitiform tentacles (Fig. 5B). Hooks absent. Intestinal spiral with 33 coils (Fig. 5C). Esophagus attached to retractors by connective tissue. Gonadal ridges located near base of ventral retractor muscles (Fig. 5D). Distance between posterior end of trunk and base of retractors 7 mm. Retractors originating from 71.4% of distance to end of trunk. Nephridiopores anterior to anus. Nephridia 1.3 mm height, 0.4 mm wide. Nephridia length 13.3% of trunk length.

Remarks

The report of *Nephasoma (N.) eremita* in the present study extends its distributional range to the Mediterranean Sea. In the study area, this species was found at 75 m depth off Anamur. It is being newly recorded from the Mediterranean Sea. This species could have been introduced to the area by ballast waters of ships.

The morphological features of the eastern Mediterranean specimen of *Nephasoma (N.) eremita* are very similar to those collected from the northern Atlantic coasts (NMNH 119398 and NMNH 119399). However, some slight differences were found between the distant populations of the species. The distance between the posterior end of the trunk and the base of the ventral retractors (71.4%) of the eastern Mediterranean specimen is longer than that (49-62%) of the north Atlantic specimens. Cutler & Cutler (1980) and Stephen & Edmonds (1972) reported this distance as 50%. The ratios between the nephridia and the trunk lengths of the Mediterranean and north Atlantic specimens were found to be 13.3% and 9.1-11.8%, respectively. However, Cutler (1973) determined this ratio as 20-25%. This difference in the ratio could be attributed to population characters of the species living in different ecological and hydrographical conditions. As it has only one specimen, the variations of this ratio in the Mediterranean population couldn't be determined. More individuals are needed to get a reliable conclusion if this ratio is a size-dependent or a constant character for a given population.

Distribution

Northern and Southern Atlantic, Arctic, Antarctic and eastern Pacific coasts (Cutler, 1994).

Nephasoma (Nephasoma) rimicola (Gibbs, 1973)*Material examined*

ESFM-SIP/2005-33, 05.10.2005, Fethiye, K50, 6 m, on *Posidonia oceanica*, 3 specimens.

Remarks

The specimens examined have a trunk length of 2-8.5 mm (Fig. 3I). This species easily differs from the other species of *Nephasoma* in having hooks (22-40 µm high) arranged in rings (5-16, Fig. 5E).

In the present study, *Nephasoma (N.) rimicola* was only found on a *Posidonia oceanica* bed at 6 m depth. This species was previously reported on muddy and sandy substratum with shell fragments in deep waters (352-720 m) in the Alboran Sea and the eastern Atlantic Ocean (Saiz Salinas & Villafranca Urchegui, 1990); and on *P. oceanica* in shallow waters (24 m) on the southern coast of Turkey (Açık, 2010).

Distribution

Southwestern England; western and eastern Mediterranean Sea (Cutler, 1994; Açık, 2010).

Phascolion (Isomya) tuberculosum Théel, 1875*Material examined*

ESFM-SIP/05-269, 21.09.2005, K25, 3 m, *P. oceanica*, 1 specimen; ESFM-SIP/05-270, 07.10.2005, K53, 0.3 m, *Sarcotragus* sp., 1 specimen; ESFM-SIP/05-271, 09.09.2005, D9, 25 m, sandy mud, 3 specimens; ESFM-SIP/05-272, 09.09.2005, D10, 50 m, sandy mud, 1 specimen; ESFM-SIP/05-273, 23.09.2005, D29, 50 m, muddy sand with *Caulerpa racemosa*, 1 specimen; ESFM-SIP/05-274, 23.09.2005, D36, 25 m, muddy sand with *C. prolifera*, 2 specimens.

Remarks

The trunk lengths of this species ranged from 1.1 to 3.8 mm (Fig. 4A). The shape and size of hooks and the lack of dark proteinized borders around the holdfast papillae are diagnostic characters for the species. The holdfast papillae diameter (max: 70 µm) of the Mediterranean specimens of *Phascolion (I.) tuberculosum* is smaller than that previously reported (max: 330 µm) by Cutler & Cutler (1985). In addition, the lengths of hooks on the introvert of this species reported from the coast of Spain (70-250 µm) and the north-eastern Atlantic (80-100 µm) by Saiz Salinas (1988b & 1993b) are longer than those of the specimens from the eastern Mediterranean Sea (20-40 µm). The difference in the length of hooks between the populations could be attributed to the size of worms.

Sipunculans are known to provide a suitable surface to which smaller metazoans can attach (Cutler, 1994). Two specimens of an endoproct species were found to be attached to the posterior part of the trunk. Hyman (1959) reported *Loxosomella* species on the anterior end of the species. Hylleberg (1970) also found at least 19 species of hydroids and bryozoans inhabiting the external surface of this species.

Distribution

Indian, western Pacific Oceans, Mediterranean Sea (Saiz Salinas & Villafranca Urchegui, 1990; Saiz Salinas, 1993b); and Atlantic Ocean (Murina & Sørensen, 2004).

Phascolion (Phascolion) strombus strombus (Montagu, 1804)

Material examined

ESFM-SIP/05-265, 30.09.2005, G17, 50 m, mud, 1 specimen.

Remarks

This single, small specimen (trunk: 1.6 mm, Figure 4B) has a distinct proteinized border on holdfast papillae (25-45 µm in height). This species is mainly distinguished from the other *Phascolion* species of the Mediterranean Sea by having the ventral retractor muscles much thinner than dorsal pairs and claw like, pointed hooks (20-40 µm long, in this study). The maximum height of holdfast papillae on the trunk of the Levantine specimens was found to be 45 µm, whereas it was reported as 120 µm from the coast of Aegean Sea (Açık, 2008b) and 250 µm from the other parts of the Mediterranean (Pancucci-Papadopoulou et al., 1999). The maximum height of hooks (40 µm) on the introvert of specimens collected during this study is much smaller than that reported from the coast of Aegean Sea (62.5 µm) (Açık, 2008b) and Spain (75 µm) (Saiz Salinas, 1993b). The difference in the length of hooks between the populations could be attributed to the size of worms.

Distribution

North Atlantic, Arctic and Pacific Oceans, Mediterranean Sea, Red Sea (Cutler et al., 2004) and southwest Indian Ocean (Cutler & Cutler, 1996).

Onchnesoma steenstrupii steenstrupii Koren & Danielssen, 1875

Material examined

ESFM-SIP/05-34, 13.09.2005, K6, 1-3 m, rocks, 2

specimens; ESFM-SIP/05-35, 17.09.2005, K12, 0.1 m, *Brachidontes pharaonis*, 1 specimen; ESFM-SIP/05-36, 19.09.2005, K18, 0.5 m, *Corallina mediterranea*, 6 specimens; ESFM-SIP/05-37, 21.09.2005, K23, 0.5 m, *C. mediterranea*, 1 specimen; ESFM-SIP/05-38, 24.09.2005, K29, 2 m, *Posidonia oceanica*, 9 specimens; ESFM-SIP/05-39, 25.09.2005, K31, 2 m, *Zostera marina*, 1 specimen; ESFM-SIP/05-40, 03.10.2005, K44, 3 m, *Z. marina*, 17 specimens; ESFM-SIP/05-41, 03.10.2005, K45, 2 m, sand, 6 specimens; ESFM-SIP/05-42, 03.10.2005, K45, 9 m, *P. oceanica*, 26 specimens; ESFM-SIP/05-43, 05.10.2005, K50, 5 m, muddy sand, 25 specimens; ESFM-SIP/05-44, 05.10.2005, K50, 6 m, *P. oceanica*, 23 specimens; ESFM-SIP/05-45, 05.10.2005, K51, 8 m, *P. oceanica*, 6 specimens; ESFM-SIP/05-46, 09.09.2005, G2, 50 m, mud, 1 specimen; ESFM-SIP/05-47, 17.09.2005, G13, 75 m, mud, 13 specimens; ESFM-SIP/05-48, 30.09.2005, G17, 50 m, mud, 10 specimens; ESFM-SIP/05-49, 30.09.2005, G18, 75 m, mud, 25 specimens; ESFM-SIP/05-50, 30.09.2005, G19, 100 m, mud, 28 specimens; ESFM-SIP/05-51, 30.09.2005, G20, 100 m, mud, 11 specimens; ESFM-SIP/05-52, 30.09.2005, G21, 75 m, mud, 10 specimens; ESFM-SIP/05-53, 06.10.2005, G29, 25 m, sandy mud, 44 specimens; ESFM-SIP/05-54, 06.10.2005, G30, 50 m, sandy mud, 95 specimens; ESFM-SIP/05-55, 06.10.2005, G31, 75 m, muddy sand, 47 specimens; ESFM-SIP/05-56, 06.10.2005, G32, 100 m, mud, 37 specimens; ESFM-SIP/05-57, 06.10.2005, G33, 200 m, mud, 1 specimen; ESFM-SIP/05-58, 06.10.2005, G34, 100 m, mud, 31 specimens; ESFM-SIP/05-59, 06.10.2005, G35, 75 m, muddy sand, 9 specimens; ESFM-SIP/05-60, 06.10.2005, G37, 25 m, muddy sand with *Udotea petislata*, 3 specimens; ESFM-SIP/05-61, 06.10.2005, G38, 10 m, *P. oceanica*, 2 specimens; ESFM-SIP/05-62, 09.09.2005, D4, 25 m, muddy sand, 73 specimens; ESFM-SIP/05-63, 09.09.2005, D9, 25 m, sandy mud, 17 specimens; ESFM-SIP/05-64, 09.09.2005, D10, 50 m, sandy mud, 25 specimens; ESFM-SIP/05-65, 10.09.2005, D11, 10 m, muddy sand, 14 specimens; ESFM-SIP/05-66, 10.09.2005, D12, 9 m, muddy sand, 1 specimen; ESFM-SIP/05-67, 10.09.2005, D18, 100 m, mud, 18 specimens; ESFM-SIP/05-68, 10.09.2005, D19, 75 m, sandy mud, 48 specimens; ESFM-SIP/05-69, 10.09.2005, D20, 50 m, muddy sand, 63 specimens; ESFM-SIP/05-70, 10.09.2005, D22, 10 m, sand, 1 specimen; ESFM-SIP/05-71, 17.09.2005, D24, 75 m, mud, 24 specimens; ESFM-SIP/05-72, 17.09.2005, D25, 75 m, mud, 5 specimens; ESFM-SIP/05-73, 17.09.2005, D26, 50 m, mud, 3 specimens; ESFM-SIP/05-74, 23.09.2005, D28, 25 m, muddy sand with *Caulerpa prolifera*, 30 specimens; ESFM-SIP/05-75, 23.09.2005, D29, 50 m, muddy sand with *Caulerpa racemosa*, 97 specimens; ESFM-SIP/05-76, 23.09.2005, D30, 75 m, muddy sand, 1 specimen; ESFM-

SIP/05-77, 23.09.2005, D31, 100 m, sandy mud, 115 specimens; ESFM-SIP/05-78, 23.09.2005, D32, 200 m, mud, 12 specimens; ESFM-SIP/05-79, 23.09.2005, D33, 200 m, sandy mud, 35 specimens; ESFM-SIP/05-80, 23.09.2005, D34, 100 m, muddy sand, 11 specimens; ESFM-SIP/05-81, 23.09.2005, D35, 50 m, muddy sand with *C. racemosa*, 172 specimens; ESFM-SIP/05-82, 23.09.2005, D36, 25 m, muddy sand with *C. prolifera*, 307 specimens; ESFM-SIP/05-83, 27.09.2005, D37, 25 m, muddy sand, 2 specimens; ESFM-SIP/05-84, 27.09.2005, D38, 50 m, mud, 1 specimen.

Remarks

The specimens examined have pear-shaped or barrel-shaped trunks (1-2.5 mm long) (Fig. 4C), with thin introverts partially retracted (6.4-9 times the trunk length when everted). The presence of small papillae (10-30 µm long, in this study) covering the surface of the trunk and the keel-like structures (22-28) in the posterior end of the trunk are diagnostic characters of this species. Some specimens of this species had elliptical eggs in the coelom cavity with the longer axis 150-170 µm in diameter and the smaller axis 120-135 µm in diameter (Fig. 5F).

Onchnesoma steenstrupii steenstrupii was found at depths ranging from 0 to 200 m in the study area. This species was known to occur at deep waters (i.e. 3362 m) (Saiz Salinas, 1988b).

Distribution

Atlantic, western Pacific and southwest Indian Oceans, Mediterranean Sea (Cutler, 1994) and Red Sea (Pancucci-Papadopoulou et al., 1999).

Phascolosoma (Phascolosoma) stephensoni (Stephen, 1942)

Material examined

ESFM-SIP/05-286, 12.09.2005, K1, 1-3 m, rocks, *Jania rubens* and *Brachidontes pharaonis* 1027 specimens; ESFM-SIP/05-289, 11.09.2005, K4, 0.5 m, ropes, 30 specimens; ESFM-SIP/05-290, 12.09.2005, K5, 1-3 m, rocks, *J. rubens* and *B. pharaonis* 50 specimens; ESFM-SIP/05-293, 13.09.2005, K6, 1-3 m, rocks, *Sarcotragus* sp., *J. rubens* and *Cystoseira* sp., 441 specimens; ESFM-SIP/05-297, 08.09.2005, K7, 0-1 m, rocks and *Cystoseira elegans*, 64 specimens; ESFM-SIP/05-299, 14.09.2005, K8, 1-3 m, rocks and *Cystoseira* sp., 109 specimens; ESFM-SIP/05-301, 14.09.2005, K9, 0.1-3 m, rocks, port's piling and *Sarcotragus* sp., 77 specimens; ESFM-SIP/05-304, 15.09.2005, K10, 1-3 m, rocks and *Sarcotragus* sp., 217 specimens; ESFM-SIP/05-306, 15.09.2005, K11, 0.1-3

m, rocks, 46 specimens; ESFM-SIP/05-307, 18.09.2005, K15, 0.2-3 m, rocks and *B. pharaonis*, 39 specimens; ESFM-SIP/05-309, 19.09.2005, K17, 0.1-3 m, rocks, *J. rubens* and *Sarcotragus* sp., 748 specimens; ESFM-SIP/05-402, 19.09.2005, K18, 0.1-0.5 m, *Corallina mediterranea* and *B. pharaonis*, 443 specimens; ESFM-SIP/05-404, 19.09.2005, K19, 0.1-5 m, rocks, *B. pharaonis* and *C. mediterranea*, 1333 specimens; ESFM-SIP/05-407, 20.09.2005, K20, 0.1-5 m, rocks and *J. rubens*, 21 specimens; ESFM-SIP/05-409, 20.09.2005, K21 0.1-5 m, rocks, 483 specimens; ESFM-SIP/05-410, 21.09.2005, K23, 0.1-5 m, rocks, *J. rubens* and *C. mediterranea*, 854 specimens; ESFM-SIP/05-413, 21.09.2005, K24, 0-5 m, rocks, *J. rubens*, *Sphacelaria cirrosa* and *Corallina elongata*, 401 specimens; ESFM-SIP/05-417, 21.09.2005, K25, 0.1-5 m, rocks and *P. oceanica*, 53 specimens; ESFM-SIP/05-419, 22.09.2005, K26, 0.1-3 m, rocks, *J. rubens*, *Padina pavonica*, *C. mediterranea* and *Sargassum hornsuchii*, 970 specimens; ESFM-SIP/05-424, 22.09.2005, K27, 0.1-5 m, rocks, *Spondylus gaederopus*, *Sarcotragus* sp., *J. rubens*, *B. pharaonis*, *Halopteris scoparia* and *C. mediterranea*, 415 specimens; ESFM-SIP/05-431, 23.09.2005, K28, 0.3-1 m, sand and *B. pharaonis*, 338 specimens; ESFM-SIP/05-433, 24.09.2005, K29, 0.1-3 m, rocks, *J. rubens*, *C. elongata*, *P. oceanica* and *Sarcotragus* sp., 89 specimens; ESFM-SIP/05-438, 24.09.2005, K30, 0.1-3 m, rocks, *J. rubens*, *P. oceanica* and *H. scoparia*, 115 specimens; ESFM-SIP/05-442, 25.09.2005, K31, 0.2 m, *C. mediterranea* and *J. rubens*, 583 specimens; ESFM-SIP/05-444, 25.09.2005, K32, 2 m, rocks, 19 specimens; ESFM-SIP/05-445, 25.09.2005, K33, 0.1-3 m, rocks, *P. oceanica*, *J. rubens*, and *C. mediterranea*, 1312 specimens; ESFM-SIP/05-450, 26.09.2005, K34, 1 m, port's piling, 62 specimens; ESFM-SIP/05-451, 28.09.2005, K35, 0.1-4 m, rocks, *J. rubens*, *B. pharaonis* and *Sarcotragus* sp., 79 specimens; ESFM-SIP/05-455, 28.09.2005, K36, 0.1-4 m, rocks and *C. elegans*, 69 specimens; ESFM-SIP/05-458, 29.09.2005, K37, 0.1-3 m, rocks, *Zostera marina* and *B. pharaonis*, 54 specimens; ESFM-SIP/05-461, 29.09.2005, K38, 0.3 m, *J. rubens* and *Cystoseira crinita*, 14 specimens; ESFM-SIP/05-463, 01.10.2005, K40, 0.1-3 m, rocks, *J. rubens* and *C. mediterranea*, 149 specimens; ESFM-SIP/05-466, 03.10.2005, K44, 0.1-3 m, rocks, ropes, *C. mediterranea*, *J. rubens*, *C. elegans* and *Sarcotragus* sp., 446 specimens; ESFM-SIP/05-472, 03.10.2005, K45, 0.1-9 m, rocks, *C. mediterranea*, *Amphiroa rigida* and *P. oceanica*, 393 specimens; ESFM-SIP/05-476, 03.10.2005, K46, 0.1-5 m, rocks, *J. rubens*, *C. elegans* and *C. mediterranea*, 749 specimens; ESFM-SIP/05-480, 04.10.2005, K47, 0.2 m, *H. scoparia* and *J. rubens*, 72 specimens; ESFM-SIP/05-482, 04.10.2005, K48, 0.1-7 m, rocks, *J. rubens*, *H. scoparia* and *C. mediterranea*, 767 specimens; ESFM-SIP/05-486, 04.10.2005, K49, 0.1-5 m,

rocks, sand, *Cystoseira* sp. and *J. rubens*, 91 specimens; ESFM-SIP/05-490, 05.10.2005, K51, 0.1-3 m, rocks, sand, *J. rubens* and *S. hornsuchii*, 85 specimens; ESFM-SIP/05-494, 07.10.2005, K53, 0.1 m, *C. elegans*, 29 specimens; ESFM-SIP/05-495, 10.09.2005, D22, 10 m, sand, 2 specimens.

Remarks

This common species has a trunk length ranging from 4 to 22.5 mm (Fig. 4D) and possesses 22-23 longitudinal muscle bands at nephridia level. The presence of cone-like preanal (60-290 µm long) and posterior papillae (70-180 µm long), and hooks with distinct streak, triangular space and crescent (17.5-50 µm long, Fig. 5G) distinguish this species from other *Phascolosoma* species in the Mediterranean Sea. Some specimens of this species were found with eggs in their coelomic cavities; longer axis is 110-175 µm in length, smaller axis 95-130 µm in length.

Phascolosoma (*P.*) *stephensoni* was found in a variety of habitats (see material examined section) in the present study. This species was previously reported on *Dendropoma petraeum*, *Lithophyllum incrustans*, rocks, photophilic algae and sponge (Saiz Salinas, 1986); on *Mytilus-Chthamalus* assemblage and the community of *Rissoella* (Saiz Salinas, 1988a); and on rock, *Cystoseira spinosa*, *P. oceanica* and mud bottoms (Açık, 2010).

Distribution

Western and northwestern Indian Ocean, eastern Atlantic and western Pacific Oceans, and Mediterranean Sea (Cutler, 1994).

Apionsoma (*Apionsoma*) *misakianum* (Ikeda, 1904)

Material examined

ESFM-SIP/05-85, 19.09.2005, K19, 0.1 m, *Corallina mediterranea*, 1 specimen; ESFM-SIP/05-86, 22.09.2005, K26, sand, 1 specimen; ESFM-SIP/05-86, 25.09.2005, K33, 0.1-3 m, rocks, 1 specimen; ESFM-SIP/05-7, 04.10.2005, K47, 0.2 m, *Halopteris scoparia*, 1 specimen; ESFM-SIP/05-88, 06.10.2005, G30, 50 m, sandy mud, 1 specimen; ESFM-SIP/05-89, 06.10.2005, G32, 100 m, mud, 1 specimen; ESFM-SIP/05-90, 06.10.2005, G35, 75 m, muddy sand, 6 specimens; ESFM-SIP/05-91, 10.09.2005, D18, 100 m, mud, 1 specimen; ESFM-SIP/05-92, 10.09.2005, D19, 75 m, sandy mud, 20 specimens; ESFM-SIP/05-93, 10.09.2005, D20, 50 m, muddy sand, 4 specimens; ESFM-SIP/05-94, 17.09.2005, D24, 75 m, mud, 4 specimens; ESFM-SIP/05-95, 23.09.2005, D29, 50 m, muddy sand with *Caulerpa racemosa*, 10 specimens; ESFM-SIP/05-96, 23.09.2005, D30, 75 m, muddy sand, 4

specimens; ESFM-SIP/05-97, 23.09.2005, D31, 100 m, sandy mud, 13 specimens; ESFM-SIP/05-98, 23.09.2005, D32, 200 m, mud, 41 specimens; ESFM-SIP/05-99, 23.09.2005, D33, 200 m, sandy mud, 105 specimens; ESFM-SIP/05-100, 23.09.2005, D34, 100 m, muddy sand, 2 specimens; ESFM-SIP/05-101, 23.09.2005, D35, 50 m, muddy sand with *C. racemosa*, 24 specimens; ESFM-SIP/05-102, 23.09.2005, D36, 25 m, muddy sand with *C. proliferata*, 1 specimen.

Remarks

This small (trunk length: 0.8-11 mm), flask shaped worm (Fig. 4E) has an introvert which is 5-10 times the trunk length. *Apionsoma* (*A.*) *misakianum* differs from the other Mediterranean species of *Apionsoma* in having small rounded papillae on the posterior part of the trunk (15-50 µm in diameter, in this study), mostly equal bilobed nephridia and small hooks (20-35 µm high) with basal spinelets (5-7) on the introvert.

Açık (2007) reported that this species could be an alien species for the Mediterranean Sea. However, it was postulated that it could be a species that has been misidentified or overlooked in the Mediterranean Sea as it was very common in the Aegean Sea. Therefore, the previous reports of the *Apionsoma* species in the Mediterranean should be checked if this species also exists in the other basins of the Mediterranean Sea. Açık (2010) and this study showed that this species also abundantly occurs on the southern coast of Turkey.

Distribution

Indian, Pacific and western Atlantic Oceans (Cutler, 1994); Mediterranean Sea (Açık, 2007).

Aspidosiphon (*Akrikos*) *mexicanus* (Murina, 1967)

Material examined

ESFM-SIP/05-103, 14.09.2005, K8, 1-3 m, rocks, 1 specimen; ESFM-SIP/05-104, 25.09.2005, K33, 2 m, *Posidonia oceanica*, 5 specimens; ESFM-SIP/05-105, 03.10.2005, K44, 3 m, *Zostera marina*, 1 specimen; ESFM-SIP/05-106, 30.09.2005, G17, 50 m, mud, 3 specimens; ESFM-SIP/05-107, 30.09.2005, G18, 75 m, mud, 5 specimens; ESFM-SIP/05-108, 30.09.2005, G19, 100 m, mud, 6 specimens; ESFM-SIP/05-109, 30.09.2005, G20, 100 m, mud, 7 specimens; ESFM-SIP/05-110, 30.09.2005, G21, 75 m, mud, 6 specimens; ESFM-SIP/05-111, 30.09.2005, G22, 50 m, mud, 1 specimen; ESFM-SIP/05-112, 06.10.2005, G29, 25 m, sandy mud, 6 specimens; ESFM-SIP/05-113, 06.10.2005, G30, 50 m, sandy mud, 1 specimen; ESFM-SIP/05-114, 06.10.2005, G31, 75 m,

muddy sand, 9 specimens; ESFM-SIP/05-115, 06.10.2005, G32, 100 m, mud, 5 specimens; ESFM-SIP/05-116, 06.10.2005, G33, 200 m, mud, 5 specimens; ESFM-SIP/05-117, 06.10.2005, G34, 100 m, mud, 4 specimens; ESFM-SIP/05-118, 10.09.2005, D17, 100 m, mud, 4 specimens; ESFM-SIP/05-119, 10.09.2005, D18, 100 m, mud, 3 specimens; ESFM-SIP/05-120, 10.09.2005, D20, 50 m, muddy sand, 1 specimen; ESFM-SIP/05-121, 17.09.2005, D24, 75 m, mud, 9 specimens; ESFM-SIP/05-122, 17.09.2005, D25, 75 m, mud, 4 specimens; ESFM-SIP/05-123, 23.09.2005, D30, 75 m, muddy sand, 1 specimen; ESFM-SIP/05-124, 23.09.2005, D31, 100 m, sandy mud, 1 specimen; ESFM-SIP/05-125, 27.09.2005, D38, 50 m, mud, 1 specimen.

Remarks

The length of trunk of this species ranges from 1.5 to 14.5 mm. This species is mainly characterized by ill-defined anal shield (Fig. 4F) and the presence of scattered hooks (17.5-30 μm long, Fig. 5H).

Aspidosiphon (A.) mexicanus was first reported from the Mediterranean Sea by Murina & Zavodnik (1985-1986) and questionably considered as an alien species (Zenetos et al., 2005). This study shows that it has a wider distributional range than previously depicted, abundantly occurring along the southern coast of Turkey. As it is distributed in the western Atlantic and Indian Oceans, it is difficult to determine at this stage from where and how it has been introduced to the Mediterranean. Dense populations of it on the southern coast of Turkey might indicate that it could have been transported from the Indian Ocean via ships. However, more data are needed to realize its origin.

In the present study, this species was found on *Posidonia oceanica*, *Zostera marina*, mud, sandy mud, muddy sand and rocks. This species was previously reported within empty mollusk shell (Saiz Salinas, 1993a); and on silt, sand and muddy sand bottom (Pancucci-Papadopoulou et al., 1999).

Distribution

Western Atlantic and Indian Oceans and Mediterranean Sea (Pancucci-Papadopoulou et al., 1999).

Aspidosiphon (Aspidosiphon) elegans (Chamisso & Eysenhardt, 1821)

Material examined

ESFM-SIP/05-1, 13.09.2005, K-6, 1-3, rocks, 2 specimens; ESFM-SIP/05-2, 15.09.2005, K-11, 0.1-3 m, rocks, 25 specimens; ESFM-SIP/05-3, 19.09.2005, K-17, 0.1-3 m,

rocks, 60 specimens; ESFM-SIP/05-4, 19.09.2005, K-18, 0.1 m, *Brachidontes pharaonis*, 1 specimen; ESFM-SIP/05-5, 21.09.2005, K-24, 0.5 m, *Corallina elongata*, 2 specimens; ESFM-SIP/05-496, 12.09.2005, K1, 1 m, rocks, 1 specimen; ESFM-SIP/05-497, 14.09.2005, K8, 1-3 m, rocks, 43 specimens; ESFM-SIP/05-498, 14.09.2005, K9, 0.1-3 m, rocks, 1 specimen; ESFM-SIP/05-499, 15.09.2005, K10, 1-3 m, rocks, 50 specimens; ESFM-SIP/05-500, 19.09.2005, K17, 0.1 m, *Jania rubens*, 1 specimen; ESFM-SIP/05-501, 19.09.2005, K19, 0.1-5 m, rocks, 3 specimens; ESFM-SIP/05-502, 19.09.2005, K19, 0.1 m, *Corallina mediterranea*, 2 specimens; ESFM-SIP/05-503, 20.09.2005, K22, 1-3 m, rocks, 13 specimens; ESFM-SIP/05-504, 20.09.2005, K22, 2 m, *Cladocora caespitosa*, 6 specimens; ESFM-SIP/05-505, 21.09.2005, K24, 0-5 m, rocks, 37 specimens; ESFM-SIP/05-506; 21.09.2005, K24, 0.5 m, *Sphacelaria cirrosa*, 1 specimen; ESFM-SIP/05-507, 24.09.2005, K29, 0.1 m, *J. rubens*, 1 specimen; ESFM-SIP/05-508, 24.09.2005, K29, 0.1 m, *C. elongata*, 5 specimens; ESFM-SIP/05-509, 24.09.2005, K30, 0.1-3 m, rocks, 2 specimens; ESFM-SIP/05-510, 25.09.2005, K33, 0.1-3 m, rocks, 53 specimens; ESFM-SIP/05-511, 25.09.2005, K33, 0.1 m, *J. rubens*, 2 specimens; ESFM-SIP/05-512, 25.09.2005, K33, 2 m, *P. oceanica*, 1 specimen; ESFM-SIP/05-513, 25.09.2005, K33, 0.1 m, *C. mediterranea*, 2 specimens; ESFM-SIP/05-514, 28.09.2005, K35, 0.1-3 m, rocks, 1 specimen; ESFM-SIP/05-515, 28.09.2005, K36, 0.1-4 m, rocks, 54 specimens; ESFM-SIP/05-516, 03.10.2005, K44, 0.1-3 m, rocks, 47 specimens; ESFM-SIP/05-517, 03.10.2005, K44, 0.1 m, *C. mediterranea*, 16 specimens; ESFM-SIP/05-518, 03.10.2005, K45, 0.1-3 m, rocks, 38 specimens; ESFM-SIP/05-519, 03.10.2005, K45, 0.2 m, *C. mediterranea*, 13 specimens; ESFM-SIP/05-520, 03.10.2005, K45, 0.2 m, *Amphiroa rigida*, 1 specimen; ESFM-SIP/05-521, 03.10.2005, K46, 0.1 m, *J. rubens*, 1 specimen; ESFM-SIP/05-522, 03.10.2005, K46, 0.1-5 m, rocks, 2 specimens; ESFM-SIP/05-523, 04.10.2005, K48, 0.1-7 m, rocks, 2 specimens; ESFM-SIP/05-524, 10.09.2005, D22, 10 m, rocks, 1 specimen.

Remarks

The trunk of this species is smooth, white or semi-transparent (Fig. 4G) and 2.1-24 mm long. This species is mainly characterized by having ungrooved anal shield (Fig. 5I), usually weakly developed caudal shield and dark brown bidentate compressed hooks (25-50 μm high, in this study) in rings followed by dark scattered conical hooks (17.5-45 μm high). *Aspidosiphon (A.) elegans* is known to reproduce asexually (Rice, 1970; Cutler, 1994; Aık, 2008a). Some specimens of this species were found to reproduce asexually at stations, forming a budding at the posterior end. A small constriction occurs at the posterior



Figure 4. External morphology of species. Scale bars: A = 0.5 mm, B = 0.4 mm, C = 0.5 mm, D = 3 mm, E = 0.5 mm, F = 3 mm, G = 1 mm, H = 1 mm, I = 0.5 mm.

Figure 4. Morphologie externe des espèces. Echelle : A = 0,5 mm, B = 0,4 mm, C = 0,5 mm, D = 3 mm, E = 0,5 mm, F = 3 mm, G = 1 mm, H = 1 mm, I = 0,5 mm.

A. *Phascolion (I.) tuberculosum* ESFM-SIP/2005-271. **B.** *Phascolion (P.) strombus strombus* ESFM-SIP/2005-265. **C.** *Onchnesoma steenstrupii steenstrupii* ESFM-SIP/2005-81. **D.** *Phascolosoma (P.) stephensoni* ESFM-SIP/2005-293. **E.** *Apionsoma (A.) misakianum* ESFM-SIP/2005-99. **F.** *Aspidosiphon (A.) mexicanus* ESFM-SIP/2005-114. **G.** *Aspidosiphon (A.) elegans* ESFM-SIP/2005-515. **H.** *Aspidosiphon (A.) misakiensis* ESFM-SIP/2005-181. **I.** *Aspidosiphon (A.) muelleri* ESFM-SIP/2005-280.

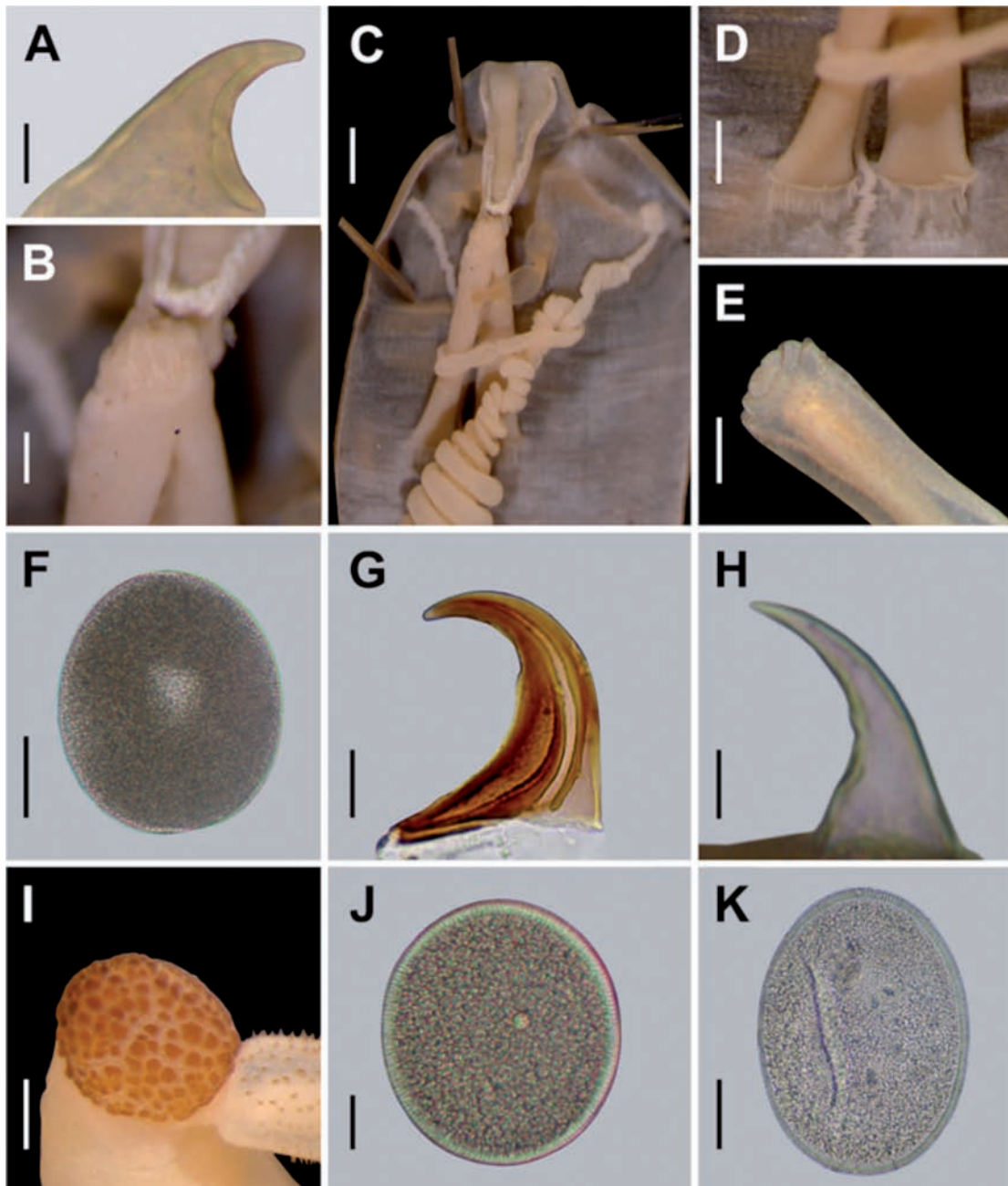


Figure 5. A. *Nephasoma (N.) constrictum* ESFM-SIP/2005-26. Hook on the introvert. B–D. *Nephasoma (N.) eremita* ESFM-SIP/2005-32. Digitiform tentacles, internal organs and gonadal ridges. E. *Nephasoma (N.) rimicola* ESFM-SIP/2005-33. Rings of hooks on the introvert. F. *Onchnesoma steenstrupii steenstrupii* ESFM-SIP/2005-81. Egg in coelomic cavity. G. *Phascolosoma (P.) stephensoni* ESFM-SIP/2005-293. Hook on the introvert. H. *Aspidosiphon (A.) mexicanus* ESFM-SIP/2005-114. Hook on the introvert. I. *Aspidosiphon (A.) elegans* ESFM-SIP/2005-515. Anal shield. J. *Aspidosiphon (A.) misakiensis* ESFM-SIP/2005-181. Egg in coelomic cavity. K. *Aspidosiphon (A.) muelleri* ESFM-SIP/2005-280. Egg in coelomic cavity. Scale bars: A = 10 μ m, B = 0.2 mm, C = 0.8 mm, D = 0.5 mm, E = 0.3 mm, F = 50 μ m, G = 10 μ m, H = 10 μ m, I = 0.3 mm, J = 20 μ m, K = 30 μ m.

Figure 5. A. *Nephasoma (N.) constrictum* ESFM-SIP/2005-26. Crochet sur l'introvert. B–D. *Nephasoma (N.) eremita* ESFM-SIP/2005-32. Tentacules digitiformes, organes internes et crêtes génitales. E. *Nephasoma (N.) rimicola* ESFM-SIP/2005-33. Anneaux de crochets sur l'introvert. F. *Onchnesoma steenstrupii steenstrupii* ESFM-SIP/2005-81. Oeuf dans la cavité coelomique. G. *Phascolosoma (P.) stephensoni* ESFM-SIP/2005-293. Crochet sur l'introvert. H. *Aspidosiphon (A.) mexicanus* ESFM-SIP/2005-114. Crochet sur l'introvert. I. *Aspidosiphon (A.) elegans* ESFM-SIP/2005-515. Bouclier Anal. J. *Aspidosiphon (A.) misakiensis* ESFM-SIP/2005-181. Oeuf dans la cavité coelomique. K. *Aspidosiphon (A.) muelleri* ESFM-SIP/2005-280. Oeuf dans la cavité coelomique. Echelle : A = 10 μ m, B = 0,2 mm, C = 0,8 mm, D = 0,5 mm, E = 0,3 mm, F = 50 μ m, G = 10 μ m, H = 10 μ m, I = 0,3 mm, J = 20 μ m, K = 30 μ m.

part of the parent individual. The area of the constriction is encircled externally by a blackened band (Fig. 4G). This part (daughter) regenerates the body including the intestine, retractor muscles, introvert and nephridia.

As it occurs in the Red Sea, this species was considered as a Lessepsian migrant. *Aspidosiphon (A.) elegans* is also known as a bio-eroder of calcareous rocks, stones or corals (Cutler, 1994). The present study showed that this species has become established in the area, dominating the shallow water benthic habitats, preferably calcareous rocks. The asexual reproduction strategy of this species might lead to form dense populations in the area. The magnitude of its impact on the habitats as a bio-eroder species should be studied.

Distribution

Mediterranean Sea (Wesenberg-Lund, 1957), Red Sea, Indian and western Pacific Oceans, from northern Brazil to Florida, Caribbean and Bermuda, (Cutler, 1994).

Aspidosiphon (Aspidosiphon) misakiensis Ikeda, 1904

Material examined

ESFM-SIP/05-147, 12.09.2005, K1, 0.2-3 m, rocks, *J. rubens* and *B. pharaonis*, 83 specimens; ESFM-SIP/05-150, 11.09.2005, K4, 0.5 m, ropes, 9 specimens; ESFM-SIP/05-151, 12.09.2005, K5, 0.3-3 m, rocks and *J. rubens*, 95 specimens; ESFM-SIP/05-153, 13.09.2005, K6, 0.1-3 m, rocks, sand, *Sarcotragus* sp., *J. rubens* and *Cystoseira* sp., 723 specimens; ESFM-SIP/05-158, 13.09.2005, K7, 0-3 m, rocks, sand and *C. elegans*, 8 specimens; ESFM-SIP/05-161, 14.09.2005, K8, 1-3 m, rocks, 13 specimens; ESFM-SIP/05-162, 15.09.2005, K10, 0-3 m, rocks, 15 specimens; ESFM-SIP/05-163, 15.09.2005, K11, 0.1-3 m, rocks, 5 specimens; ESFM-SIP/05-164, 18.09.2005, K15, 0.2-3 m, rocks, 1 specimen; ESFM-SIP/05-165, 19.09.2005, K17, 0.1-3 m, rocks, *J. rubens* and *Sarcotragus* sp., 221 specimens; ESFM-SIP/05-168, 19.09.2005, K18, 0.1-0.5 m, *C. mediterranea* and *B. pharaonis*, 49 specimens; ESFM-SIP/05-170, 19.09.2005, K19, 0.1-5 m, rocks and *C. mediterranea*, 453 specimens; ESFM-SIP/05-172, 20.09.2005, K20, 0.1-5 m, rocks, *Spondylus gaedropanus* and *Sarcotragus* sp., 47 specimens; ESFM-SIP/05-175, 20.09.2005, K21, 0.1-5 m, rocks and sand, 7 specimens; ESFM-SIP/05-177, 20.09.2005, K22, 0.1-3 m, rocks, 383 specimens; ESFM-SIP/05-178, 21.09.2005, K23, 0.1-5 m, rocks, *J. rubens* and *C. mediterranea*, 143 specimens; ESFM-SIP/05-181, 21.09.2005, K24, 0-5 m, rocks and *C. elongata*, 150 specimens; ESFM-SIP/05-183, 21.09.2005, K25, 0.1-5 m, rocks and *P. oceanica*, 179 specimens; ESFM-SIP/05-185, 22.09.2005, K26, 0.1-3 m, rocks and *C. mediterranea*, 24 specimens; ESFM-SIP/05-

187, 22.09.2005, K27, 0.1-5 m, rocks, *S. gaedropanus*, *Sarcotragus* sp., *J. rubens*, *B. pharaonis*, *H. scoparia* and *C. mediterranea*, 126 specimens; ESFM-SIP/05-194, 23.09.2005, K28, 0.3-1 m, sand and *B. pharaonis*, 6 specimens; ESFM-SIP/05-196, 24.09.2005, K29, 0.1-2 m, *C. elongata*, *P. oceanica* and *Sarcotragus* sp., 100 specimens; ESFM-SIP/05-199, 24.09.2005, K30, 0.1-3 m, rocks, *J. rubens*, *P. oceanica* and *H. scoparia*, 84 specimens; ESFM-SIP/05-203, 25.09.2005, K31, 0.1-3 m, rocks, *C. mediterranea*, *Zostera marina* and *J. rubens*, 107 specimens; ESFM-SIP/05-207, 25.09.2005, K32, 2 m, rocks, 16 specimens; ESFM-SIP/05-208, 25.09.2005, K33, 0.1-3 m, rocks, *P. oceanica*, *J. rubens* and *C. mediterranea*, 283 specimens; ESFM-SIP/05-212, 26.09.2005, K34, 1 m, port's piling, 4 specimens; ESFM-SIP/05-213, 28.09.2005, K35, 0.1-4 m, rocks, *J. rubens*, *B. pharaonis* and *Sarcotragus* sp., 13 specimens; ESFM-SIP/05-217, 28.09.2005, K36, 0.1-4 m, rocks, *C. elegans* and *J. rubens*, 124 specimens; ESFM-SIP/05-220, 29.09.2005, K37, 0.1-3 m, rocks, *J. rubens* and *B. pharaonis*, 49 specimens; ESFM-SIP/05-223, 29.09.2005, K38, 0.3 m, *J. rubens*, 1 specimen; ESFM-SIP/05-224, 01.10.2005, K40, 0.1-3 m, rocks, *J. rubens* and *C. mediterranea*, 61 specimens; ESFM-SIP/05-227, 03.10.2005, K44, 0.1-3 m, rocks, ropes, *Z. marina*, *C. mediterranea*, *J. rubens*, *C. elegans* and *Sarcotragus* sp., 582 specimens; ESFM-SIP/05-234, 03.10.2005, K45, 0.1-9 m, rocks, 288 specimens; ESFM-SIP/05-238, 03.10.2005, K46, 0.1-5 m, rocks, *J. rubens*, *C. elegans* and *C. mediterranea*, 197 specimens; ESFM-SIP/05-242, 04.10.2005, K47, 0.2 m, *H. scoparia*, 4 specimens; ESFM-SIP/05-243, 04.10.2005, K48, 0.1-7 m, rocks and *H. scoparia*, 23 specimens; ESFM-SIP/05-245, 05.10.2005, K50, 0.1-3 m, rocks, *Cystoseira* sp. and *J. rubens*, 72 specimens; ESFM-SIP/05-248, 05.10.2005, K51, 0.1-8 m, rocks, *J. rubens*, *P. oceanica* and *S. hornsuchii*, 13 specimens; ESFM-SIP/05-252, 07.10.2005, K53, 0.1-5 m, *C. elegans*, *Aplysina aerophoba*, *Sarcotragus* sp. and sandy mud, 44 specimens; ESFM-SIP/05-256, 30.09.2005, G15, 10 m, *Z. marina*, 1 specimen; ESFM-SIP/05-257, 06.10.2005, G38, 10 m, *P. oceanica*, 2 specimens; ESFM-SIP/05-258, 09.09.2005, D5, 11 m, rocks, 6 specimens; ESFM-SIP/05-259, 09.09.2005, D9, 25 m, rocks, 1 specimen; ESFM-SIP/05-260, 10.09.2005, D22, 10 m, rocks and sand, 39 specimens; ESFM-SIP/05-262, 23.09.2005, D29, 50 m, muddy sand with *Caulerpa racemosa*, 1 specimen; ESFM-SIP/05-263, 23.09.2005, D30, 75 m, muddy sand, 1 specimen; ESFM-SIP/05-264, 23.09.2005, D36, 25 m, muddy sand with *C. prolifera*, 1 specimen.

Remarks

These cylindrical worms have trunks from 2.1 to 13 mm long. Like *Aspidosiphon (A.) elegans*, it has also ungrooved

anal shield (Fig. 4H) but mainly differs from *A. (A.) elegans* in having gut with ill-defined coils and light brown bidentate hooks (22.5-40 µm high) in rings (20-50) followed by scattered unidentate hooks (15-40 µm high). Some specimens of this species have eggs with the longer axis 60-125 µm in diameter and the smaller axis 50-115 µm in diameter (Fig. 5J).

In the present study, *Aspidosiphon (A.) misakiensis* was found in a variety of habitats (see material examined section). This species was previously found on sand, mud, rocks, corals, photophilic algae, sponges and *Posidonia oceanica* (Cutler et al., 1984; Saiz Salinas, 1986; Açıık, 2008b & 2010).

Distribution

Pacific, eastern and western Atlantic Oceans and western Mediterranean Sea (Cutler, 1994).

Aspidosiphon (Aspidosiphon) muelleri Diesing, 1851

Material examined

ESFM-SIP/05-275, 06.10.2005, G30, 50 m, sandy mud, 1 specimen; ESFM-SIP/05-276, 06.10.2005, G31, 75 m, muddy sand, 2 specimens [one individual within a shell of *Nassarius pygmaeus* (Lamarck, 1822)]; ESFM-SIP/05-277, 10.09.2005, D20, 50 m, muddy sand, 1 specimen; ESFM-SIP/05-278, 10.09.2005, D22, 10 m, sand, 1 specimen; ESFM-SIP/05-279, 23.09.2005, D28, 25 m, muddy sand with *Caulerpa prolifera*, 1 specimen [within a shell of *Bittium reticulatum* (da Costa, 1778)]; ESFM-SIP/05-280, 23.09.2005, D29, 50 m, muddy sand with *Caulerpa racemosa*, 3 specimens [one individual within a shell of *Vexillum ebenus* (Lamarck, 1811), two individuals within a shell of *Antalis inaequicostata* (Dautzenberg, 1891)]; ESFM-SIP/05-281, 23.09.2005, D35, 50 m, muddy sand with *C. racemosa*, 2 specimens; ESFM-SIP/05-282, 23.09.2005, D36, 25 m, muddy sand with *C. prolifera*, 3 specimens.

Remarks

The trunk length of this species ranges from 2 to 16 mm. The continuous longitudinal musculature and the longitudinal grooves of the anal shield (11-13) (Fig. 4I) are diagnostic characters of this species. Eggs were found in the coelomic cavity of a specimen at D29 (ESFM-SIP/2005-280); longer axis 65-140 µm in length, smaller axis 50-120 µm in length (Fig. 5K).

Many *Aspidosiphon* species are known to inhabit empty mollusk shells (Cutler, 1994). This species was found within empty shells of *Bittium reticulatum*, *Vexillum ebenus*, *Antalis inaequicostata* and *Nassarius pygmaeus* in

this study. Zavodnik & Murina (1976) reported this species within shells of *Turritella tricarinata*, *Murioidea blainvillei*, *Dentalium dentale* and *D. vulgare* in the North Adriatic Sea. Koukouras et al. (1985) also found it within shells of *Turritella communis* in the north Aegean Sea.

Distribution

Indian Ocean (Saiz Salinas, 1993a), northeastern Atlantic and eastern Pacific Oceans, Mediterranean Sea and Red Sea (Cutler, 1994).

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