

## Check-list of Sipuncula from the coasts of Turkey

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**Abstract:** The present paper provides an updated taxonomic list of sipunculan species known from the coasts of Turkey. A total of 21 species belonging to 5 families have been reported from the region. Eighteen species were determined in the Levantine Sea, 17 species in the Aegean Sea, 6 species in the Sea of Marmara, and a single species in the Black Sea. The family Golfingiidae had the majority of species (8 species, 38%), followed by Phascolosomatidae (5 species, 24%), Aspidosiphonidae (4 species, 19%), Phascolionidae (3 species, 14%), and Sipunculidae (1 species, 5%), respectively. The hotspot areas for the sipunculan species richness were Anamur (12 species) and the Fethiye-Göcek Specially Protected Area (11 species) in the Levantine Sea, and İzmir Bay (10 species) in the Aegean Sea. Four alien species [*Nephasoma* (*N.*) *eremita*, *Apionsoma* (*A.*) *misakianum*, *Aspidosiphon* (*A.*) *mexicanus*, and *Aspidosiphon* (*A.*) *elegans*] have been encountered from the region, of which *A. (A.) misakianum* was the most common species. This paper also gives a brief description of all species together with figures and distributional features.

**Key words:** Sipuncula, check-list, distribution, alien species, species diversity, Turkey

### 1. Introduction

Sipunculans are widely distributed in the world's oceans from intertidal to abyssal depths (Cutler, 1994). They play an important role in bioerosion of calcareous habitats and rocks (Cutler, 1968; Peyrot-Clausade et al., 1992); as components of the diet of many fishes, sea anemones, decapod crustaceans, gastropods, sea stars, crabs, and cephalopods (Kohn 1975; Taylor 1989); and as bioturbators and active burrowers in sediments (Murina, 1984). The phylum has almost 150 species worldwide (Cutler, 1994) and 36 species are known from the Mediterranean Sea (Açık, 2011; Ferrero-Vicente et al., 2012).

In the Sea of Marmara, the first species report was given by Ostroumoff (1894, 1896), who found *Nephasoma* (*Nephasoma*) *diaphanes diaphanes* (Gerould 1913) (cited as *Petalostoma minutum* Keferstein, 1863) at depths of 25–77 m. Later 5 sipunculan species were found on hard (Demir, 1952) and soft (Caspers, 1968; Bacescu et al., 1971; Uysal et al., 2002; Albayrak et al., 2006; Acik, 2013) substrates in the region.

Kiseleva (1961) was the first to record sipunculan species from the Aegean coasts of Turkey. Kocataş (1978) later listed 3 sipunculan species on some photophilic algae in İzmir Bay. In the bay, several studies encountered sipunculan species in association with algae (Ergen and Çınar, 1994), sponges (Çınar et al., 2002), rocks (Açık,

2008), and soft substrata (Doğan et al., 2005; Koçak and Katağan, 2005; Aydın et al., 2007; Açık, 2009; Çınar et al., 2012). In Gencelli Bay and on Markiz Island, Ergen et al. (1994) and Dağlı et al. (2008) found 5 sipunculan species at depths between 5 and 50 m. The most detailed studies regarding the sipunculan diversity in the area were carried out by the present author (Açık, 2007, 2008, Acik, 2007; Açık, 2010), who found 17 sipunculan species from a variety of biotopes.

Sipunculans inhabiting the Black Sea have only been studied by Jakubova (1948), who identified *Nephasoma* (*Nephasoma*) *diaphanes diaphanes* (cited as *Phascolosoma* (*Petalostoma*) *minutum* Keferstein, 1863) in the Prebosphoric region.

In the Levantine Sea, sipunculans became a subject of study in 2008 when Mutlu and Ergev (2008) and Açık (2008) reported 2 species [*Onchnesoma steenstrupii* and *Aspidosiphon* (*Aspidosiphon*) *elegans*] from the area. Afterwards, 2 detailed studies performed in the Fethiye-Göcek Specially Protected Area (Açık, 2010) and along the coast (Açık, 2011) included a total of 18 species.

The aims of this study are to summarize the available information about the sipunculan diversity on the coasts of Turkey and to determine the distribution of species richness of this group in seas surrounding Turkey.

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**2. Materials and methods**

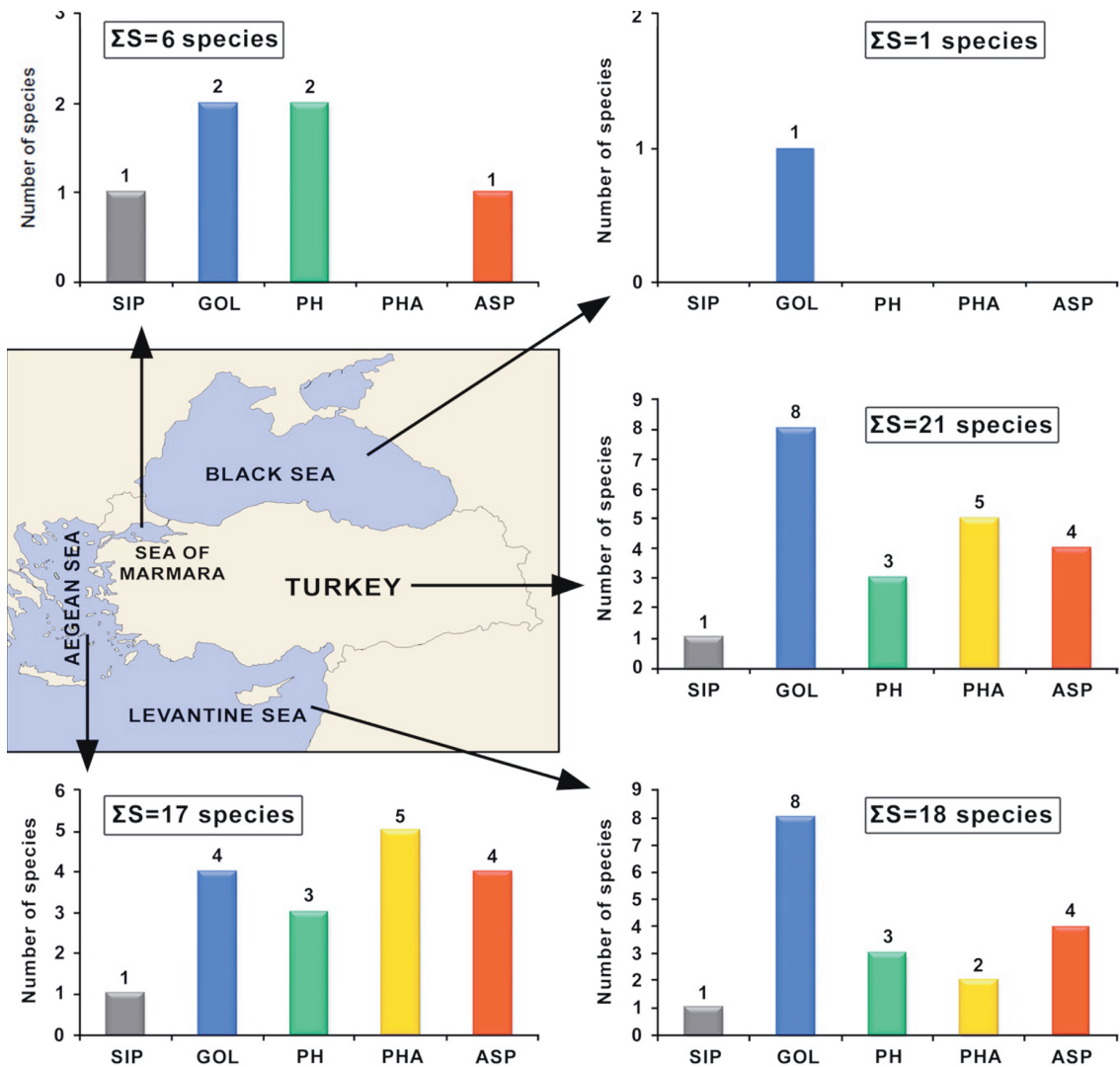
A check-list of sipunculans reported from the coasts of Turkey was prepared with the analysis of a total of 28 published papers up to May 2014. Species names recorded in publications were compiled and checked for their validity, and synonyms were made evident. The nomenclature used in this check-list is that of Cutler (1994). Sipunculan diversity was examined in the seas surrounding Turkey: the Black Sea, Sea of Marmara, Aegean Sea, and Levantine Sea. Habitat distributions and depth ranges of the species in the region together with synonymized species are provided in the Table. Brief descriptions of the species and their distributional characteristics are also given.

In order to assess the diversity hotspots and evaluate research efforts (gap analysis), the coasts of Turkey were

divided into a grid made up of 15 × 15 km units. All distribution data of species were entered into an Excel file and then imported and digitized with ArcGIS 9.3 software.

**3. Results and discussion**

Based on the compilation of papers on sipunculans reported from the coasts of Turkey, 21 valid species belonging to 5 families (Sipunculidae, Golfingiidae, Phascolionidae, Phascolosomatidae, and Aspidosiphonidae) were recognized (Table). The family Golfingiidae had the majority of species (8 species, 38% of the total species), followed by Phascolosomatidae (5 species, 24%), Aspidosiphonidae (4 species, 19%), Phascolionidae (3 species, 14%), and Sipunculidae (1 species, 5%), respectively (Figure 1).



**Figure 1.** The Sipuncula families represented by the number of species along the coasts of Turkey. SIP: Sipunculidae, GOL: Golfingiidae, PH: Phascolionidae, PHA: Phascolosomatidae and ASP: Aspidosiphonidae. ΣS indicates the total number of species reported from the sea.

**Table.** Species list of sipunculans from the coasts of Turkey. \*: Alien species; S: synonyms; BS: Black Sea; SM: Sea of Marmara; AS: Aegean Sea; LS: Levantine Sea; DR: depth range (I: 0–10 m; II: 11–50 m; III: 51–100 m; IV: 101–200 m; V: 201–400 m; VI: 401–600 m; VII: >600 m); H: habitat (Hs: hard substratum, including algae, sponge, mussels, etc.; Ss: soft substratum, including all phanerogams).

Group/species	BS	SM	AS	LS	DR	H	S
Class: Sipunculidea							
Order: Sipunculiformes							
Family: Sipunculidae							
<i>S. (S.) nudus</i> Linnaeus, 1766	-	28	10, 20, 21	26	I–III	Ss	
Order: Golfingiiformes							
Family: Golfingiidae							
<i>G. (G.) elongata</i> (Keferstein, 1862)	-	-	8, 20	26	I–IV	Hs, Ss	<i>Phascolosoma elongata</i>
<i>G. (G.) vulgaris vulgaris</i> (de Blainville, 1827)	-	-	10, 17, 20, 23, 24	25, 26	I–IV	Hs, Ss	<i>Phascolosoma vulgare</i>
<i>N. (N.) abyssorum abyssorum</i> (Koren and Danielssen, 1875) -	-	-	-	26	IV	Ss	
<i>N. (N.) constrictum</i> (Southern, 1913)	-	-	20	26	III–IV	Ss	
<i>N. (N.) diaphanes diaphanes</i> (Gerould, 1913)	3	1, 2, 6, 7	-	26	II–IV	Ss	
* <i>N. (N.) eremita</i> (Sars, 1851)	-	-	-	26	III	Ss	
<i>N. (N.) rimicola</i> (Gibbs, 1973)	-	-	-	25, 26	I–II	Ss	
<i>T. procera</i> (Moebius, 1875)	-	28	20, 23, 27	26	II–IV	Ss	
Family: Phascolionidae							
<i>P. (I.) tuberculosum</i> Théel, 1875	-	-	20	26	I–II	Hs, Ss	
<i>P. (P.) strombus strombus</i> (Montagu, 1804)	-	4	5, 10, 20, 23, 27	26	I–V	Hs, Ss	<i>Phascolion strombi</i>
<i>O. steenstrupii steenstrupii</i> Koren and Danielssen, 1875	-	28	13, 14, 17, 18, 20, 21, 23, 24, 27	22, 25, 26	I–IV	Hs, Ss	
Class: Phascolosomatidea							
Order: Phascolosomatiformes							
Family: Phascolosomatidae							
<i>P. (P.) agassizii agassizii</i> Keferstein, 1866	-	-	20	-	I	Hs, Ss	
<i>P. (P.) granulatum</i> Leuckart, 1828	-	-	8	-	I	Hs	<i>Physcosoma granulatum</i>
<i>P. (P.) stephensoni</i> (Stephen, 1942)	-	-	9, 11, 20, 24	25, 26	I–II	Hs, Ss	
* <i>A. (A.) misakianum</i> (Ikeda, 1904)	-	-	16, 20	25, 26	I–IV	Hs, Ss	
<i>A. (A.) murinae bilobatae</i> (Cutler, 1969)	-	-	20	-	IV	Ss	
Order: Aspidosiphoniformes							
Family: Aspidosiphonidae							
* <i>A. (A.) mexicanus</i> (Murina, 1967)	-	-	20, 23, 24, 27	26	I–IV	Hs, Ss	
* <i>A. (A.) elegans</i> (Chamisso and Eysenhardt, 1821)	-	-	19, 20, 24	19, 25, 26	I	Hs	
<i>A. (A.) misakiensis</i> Ikeda, 1904	-	-	20, 24	25, 26	I–III	Hs, Ss	
<i>A. (A.) muelleri</i> Diesing, 1851	-	4, 12, 15, 28	5, 8, 10, 11, 17, 20, 21, 23, 24, 27	26	I–IV	Hs, Ss	<i>Aspidosiphon clavatus</i>

1. Ostroumoff (1894); 2. Ostroumoff (1896); 3. Jakubova (1948); 4. Demir (1952); 5. Kiseleva (1961); 6. Caspers (1968); 7. Bacescu et al. (1971); 8. Kocataş (1978); 9. Ergen and Çınar (1994); 10. Ergen et al. (1994); 11. Çınar et al. (2002); 12. Uysal et al. (2002); 13. Doğan et al. (2005); 14. Koçak and Katağan (2005); 15. Albayrak et al. (2006); 16. Açıık (2007); 17. Acik (2007); 18. Aydın et al. (2007); 19. Açıık (2008); 20. Açıık (2008); 21. Dağlı et al. (2008); 22. Mutlu and Ergev (2008); 23. Açıık (2009); 24. Açıık (2010); 25. Açıık (2010); 26. Açıık (2011); 27. Çınar et al. (2012); 28. Acik (2013).

Eleven species occurred on both hard and soft substrata, 8 species only on soft substrata, and 2 species only on hard substrata. Three species [*P. (P.) agassizii agassizii*, *P. (P.) granulatum*, and *A. (A.) elegans*] were reported from depths between 0 and 10 m (Table). Eighteen species were determined in the Levantine Sea, 17 species in the Aegean Sea, 6 species in the Sea of Marmara, and 1 species in the Black Sea (Figure 1).

The scientific efforts to assess the diversity of sipunculans along the coasts of Turkey have shown a sharp increase after the year 2000. The authors that

made the major contributions to the understanding of the sipunculan diversity in the area were Demir (1952), Kocataş (1978), Ergen et al. (1994), and Açıık (2008, 2011) (Figure 2).

The highest numbers of sipunculan species were determined off Anamur (12 species) and in the Fethiye-Göcek Specially Protected Area (11 species) in the Levantine Sea, and in İzmir Bay (10 species) in the Aegean Sea, where intensive scientific efforts have been carried out, particularly thanks to Açıık (2010, 2011) (Figure 3). As the Black Sea and the Sea of Marmara were the least studied

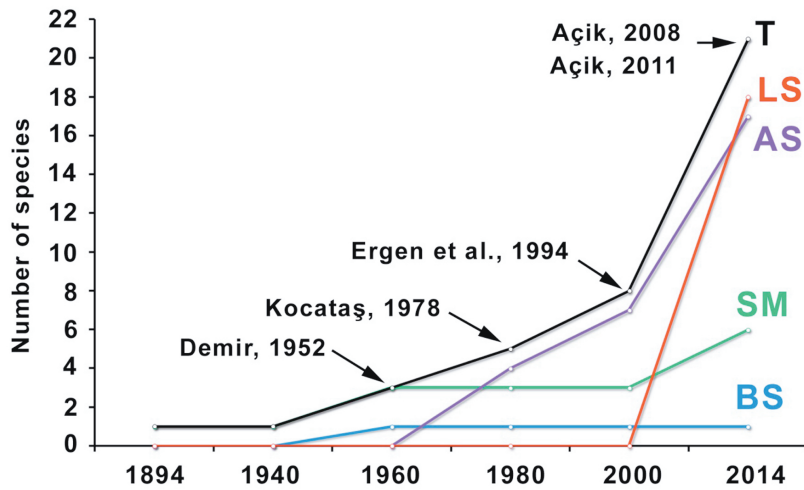


Figure 2. Yearly changes in the number of Sipuncula species reported from the coasts of Turkey and the papers published contributed to the increase of the number of species.

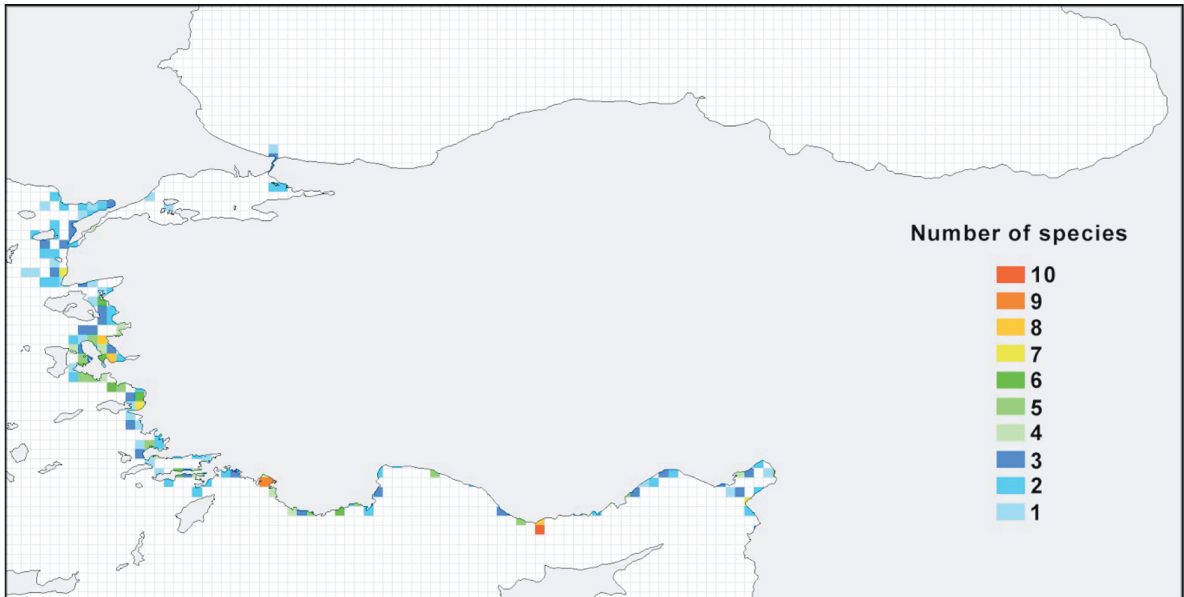


Figure 3. The distribution of the number of sipunculan species along the coasts of Turkey. Each grid has a dimension of 15 × 15 km.

regions in terms of sipunculan diversity, fewer numbers of species were found in these seas. According to their occurrences in the grid system (15 × 15 km) applied to the coasts of Turkey, *Onchnesoma steenstrupii steenstrupii* (92 grids), *Aspidosiphon* (*A.*) *misakiensis* (61 grids), *A.* (*A.*) *muelleri* (55 grids), *Phascolosoma* (*P.*) *stephensoni* (48 grids), *Golfingia* (*G.*) *vulgaris vulgaris* (41 grids), and *Apionsoma* (*A.*) *misakianum* (39 grids) were the species with the highest frequency values.

### 3.1. Alien sipunculan species on the coasts of Turkey

The Mediterranean basin has 6 alien sipunculan species belonging to 3 families, of which 4 species [*Apionsoma* (*A.*) *misakianum*, *Phascolosoma* (*P.*) *scolops*, *Aspidosiphon* (*A.*) *mexicanus*, and *A.* (*A.*) *elegans*] are established in the region and 2 species (*Apionsoma* (*A.*) *trichocephalus* and *Phascolion* (*P.*) *convestitum*) are casual (Çinar et al., 2011; Zenetos et al., 2010). More recently, Açık (2011) gave the first record of *Nephasoma* (*N.*) *eremita* in the Mediterranean Sea. This species might have been introduced to the region by ballast water of ships (Açık, 2011). Accordingly, 4 alien species [*N.* (*N.*) *eremita*, *A.* (*A.*) *misakianum*, *A.* (*A.*) *mexicanus*, and *A.* (*A.*) *elegans*] have been encountered along the coasts of Turkey (Açık, 2007, 2008, 2009, 2010, 2011; Açık, 2008, 2010; Çinar et al., 2012). The distribution of the number of alien species in the region is shown in Figure 4. The most common species in the area was *A.* (*A.*) *misakianum* (present in 39 grids), followed by *A.* (*A.*) *mexicanus* (34 grids), *A.* (*A.*) *elegans* (23 grids), and *N.* (*N.*) *eremita* (1 grid). The hotspot areas in terms of the number of alien sipunculan species were the Fethiye-Göcek Specially Protected Area,

Antalya Bay, Anamur, and İskenderun Bay in the Levantine Sea. There is no record of alien species in the Black Sea or the Sea of Marmara (Figure 4).

The morphological and distributional aspects of the species are given below.

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

**Description:** Body wall thin, light brown or yellowish white (Figure 5A). Distinct bands of circular and longitudinal (24–34) musculature. Short introvert without hooks but bearing triangular scale-like papillae. Four introvert retractor muscles. Two contractile vessels without villi. Brain with sponge-like processes. Spindle muscle unattached to body wall posteriorly.

**Distribution:** Cosmopolitan species (Cutler, 1994).

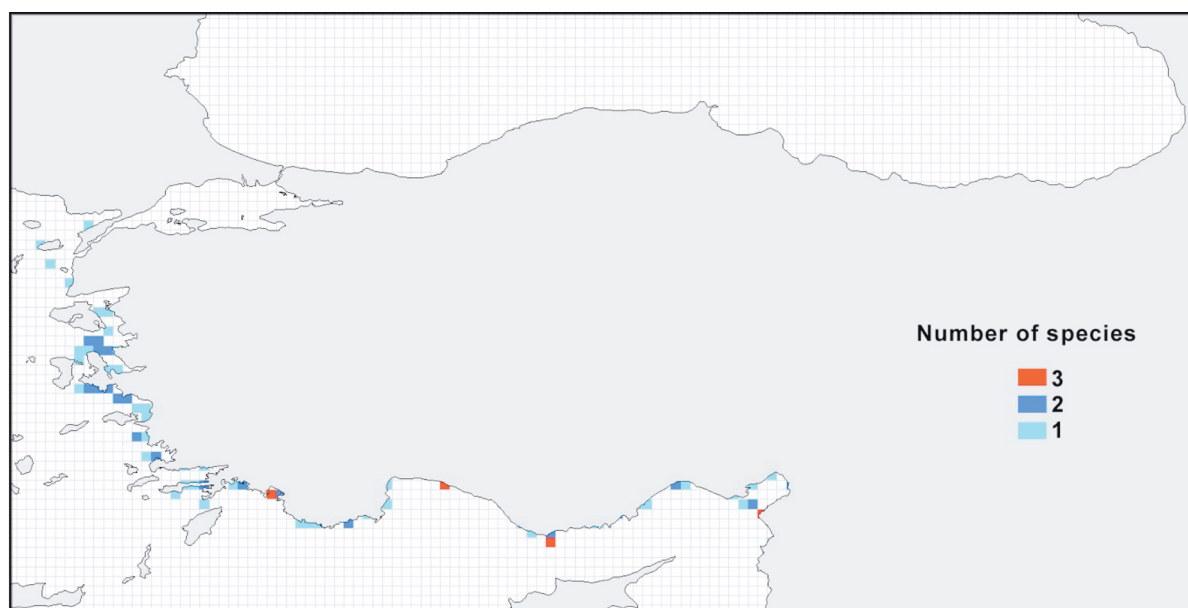
#### *Golfingia* (*Golfingia*) *elongata* (Keferstein, 1862)

**Description:** Body wall smooth, slender, and lustrous (Figure 5B). Short introvert with hooks in rings. Four retractor muscles. Nephridiopores at level of anus. Two reddish black eye spots present.

**Distribution:** Arctic Ocean, Mediterranean Sea (Stephen and Edmonds, 1972; Açık, 2011), Pacific and North Atlantic Oceans (Cutler, 1994).

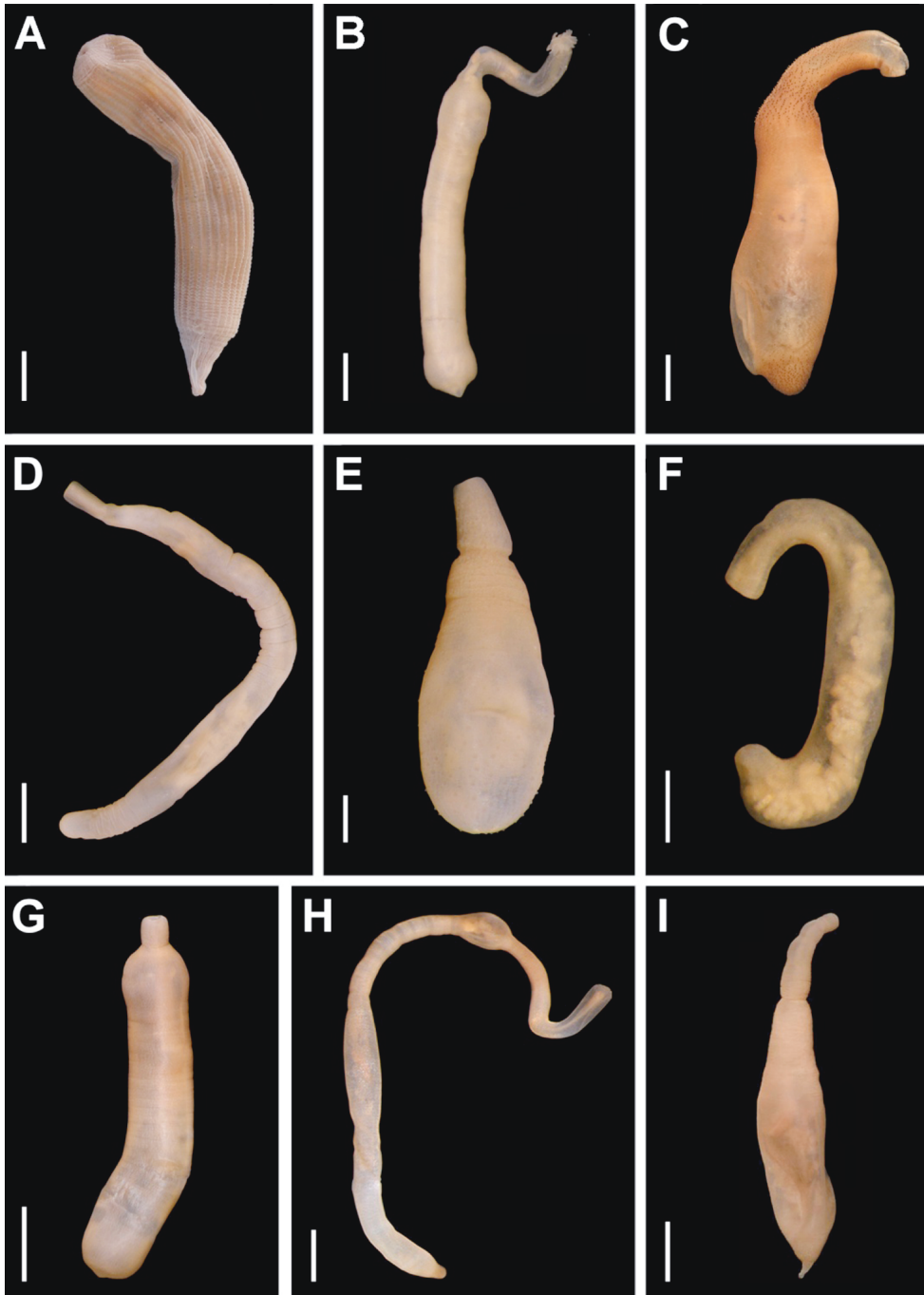
#### *Golfingia* (*Golfingia*) *vulgaris vulgaris* (de Blainville, 1827)

**Description:** Trunk cylindrical; skin smooth, translucent (Figure 5C). Both ends of trunk with dark brown or black papillae. Introvert with spine-like, dark, scattered hooks. Four retractor muscles. Ventral retractor muscles originating posterior to dorsal pair. Nephridiopores at level of anus. Two reddish black eye spots present.



**Figure 4.** The distribution of the number of alien sipunculan species along the coasts of Turkey. Each grid has a dimension of 15 × 15 km.





**Figure 5.** External morphology of species. **A)** *Sipunculus* (*S.*) *nudus*, **B)** *Golfingia* (*G.*) *elongata*, **C)** *Golfingia* (*G.*) *vulgaris vulgaris*, **D)** *Nephasoma* (*N.*) *abyssorum abyssorum*, **E)** *Nephasoma* (*N.*) *constrictum*, **F)** *Nephasoma* (*N.*) *diaphanes diaphanes*, **G)** *Nephasoma* (*N.*) *eremita*, **H)** *Nephasoma* (*N.*) *rimicola*, **I)** *Thysanocardia procera*. Scale bars: A = 4 mm, B = 1 mm, C and D = 1 mm, E = 0.3 mm, F = 0.4 mm, G = 2 mm, H = 1 mm, I = 2 mm (A–C, I = Aegean Sea, original; D–H= from Açık, 2011).

*Distribution:* Northeast Atlantic Ocean, northwest Pacific Ocean, Indian Ocean (Saiz Salinas, 1993a); Mediterranean Sea and Red Sea (Cutler, 1994; Açık, 2011).

*Nephasoma* (*Nephasoma*) *abyssorum abyssorum* (Koren and Danielssen, 1875)

*Description:* Body wall smooth, whitish (Figure 5D). Trunk with elliptical skin bodies and some dome-shaped

papillae at posterior end. Introvert with digitiform tentacles. Hooks spirally arranged on introvert. Two retractor muscles. Weakly developed spindle muscle present. Eyespots absent.

*Distribution:* Northwestern Pacific, Atlantic, Arctic, and Indian oceans and Mediterranean Sea (Saiz Salinas, 1993a; Cutler, 1994; Açıık, 2011).

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

*Description:* Body wall semitransparent, pale gray and brownish (Figure 5E). Large, numerous dome-shaped papillae covering entire trunk; finger-like papillae on posterior part of trunk. Distinct constriction present on trunk-introvert junction. Hooks not present.

*Distribution:* Northeastern Atlantic Ocean, Indian Ocean, and Mediterranean Sea (Cutler, 1994; Açıık, 2011).

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

*Description:* Body wall translucent or transparent (Figure 5F). Trunk length 8–10 times longer than trunk width. Digitiform papillae at trunk end. Introvert with small scattered hooks and with few short tentacular lobes. Nephridiopores at level of anus.

*Remarks:* Cutler and Cutler (1986) regarded *Nephasoma (N.) minutum* as a hermaphrodite species and its distribution limited in the northeastern Atlantic, whereas *N. (N.) diaphanes* is dioecious and cosmopolitan. Therefore, the reports of *N. (N.) minutum* from the Mediterranean Sea, including those from the coasts of Turkey (i.e. Ostroumoff, 1894, 1896; Jakubova, 1948; Caspers, 1968; Bacescu et al., 1971), most likely are also *N. (N.) diaphanes diaphanes*.

*Distribution:* Cosmopolitan in deep waters (Cutler, 1994).

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

*Description:* Body wall smooth, pale creamy tan to dark reddish brown (Figure 5G). Unclear transverse and parallel grooves present on trunk wall. Cylindrical trunk with abrupt taper to introvert. Introvert with digitiform tentacles. Hooks absent. Nephridiopores anterior to anus.

*Distribution:* Northern and southern Atlantic, Arctic, Antarctic, and eastern Pacific oceans (Cutler, 1994), and Mediterranean Sea (Açıık, 2011).

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

*Description:* Body wall smooth, semitransparent (Figure 5H). Introvert shorter than trunk length. Hooks arranged in rings. Nephridiopores anterior to anus. Two reddish eye spots present.

*Distribution:* Southwestern England and Mediterranean Sea (Cutler, 1994; Açıık, 2010, 2011).

***Thysanocardia procera* (Moebius, 1875)**

*Description:* Skin smooth with fine ridges (Figure 5I). Tentacles surrounding bilobed nuchal organ. Two retractor

muscles fused for much of their length, originating in posterior third of length. Contractile vessel with villi. Nephridiopores at same level or slightly anterior to anus.

*Distribution:* North Atlantic Ocean and Mediterranean Sea (Saiz Salinas and Villafranca Urchegui, 1990; Açıık, 2011).

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

*Description:* Trunk cylindrical; skin semitransparent (Figure 6A). Holdfast papillae lack dark proteinized borders. Introvert with large, broad, recurved hooks. Two retractor muscles, of equal width, attached at near posterior part of trunk. Nephridiopore posterior to anus.

*Distribution:* Indian Ocean, western Pacific Ocean, Mediterranean Sea (Saiz Salinas and Villafranca Urchegui, 1990; Saiz Salinas, 1993b; Açıık, 2011), and Atlantic Ocean (Murina and Sørensen, 2004).

***Phascolion (Phascolion) strombus strombus* (Montagu, 1804)**

*Description:* Body wall semitransparent (Figure 6B). Distinct proteinized borders on holdfast papillae. Introvert with claw-like, pointed hooks. Ventral retractor muscles much thinner than dorsal pairs. Intestine in loose loops without spiral. Single nephridium located at right side of ventral nerve cord.

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

***Onchnesoma steenstrupii steenstrupii* Koren and Danielssen, 1875**

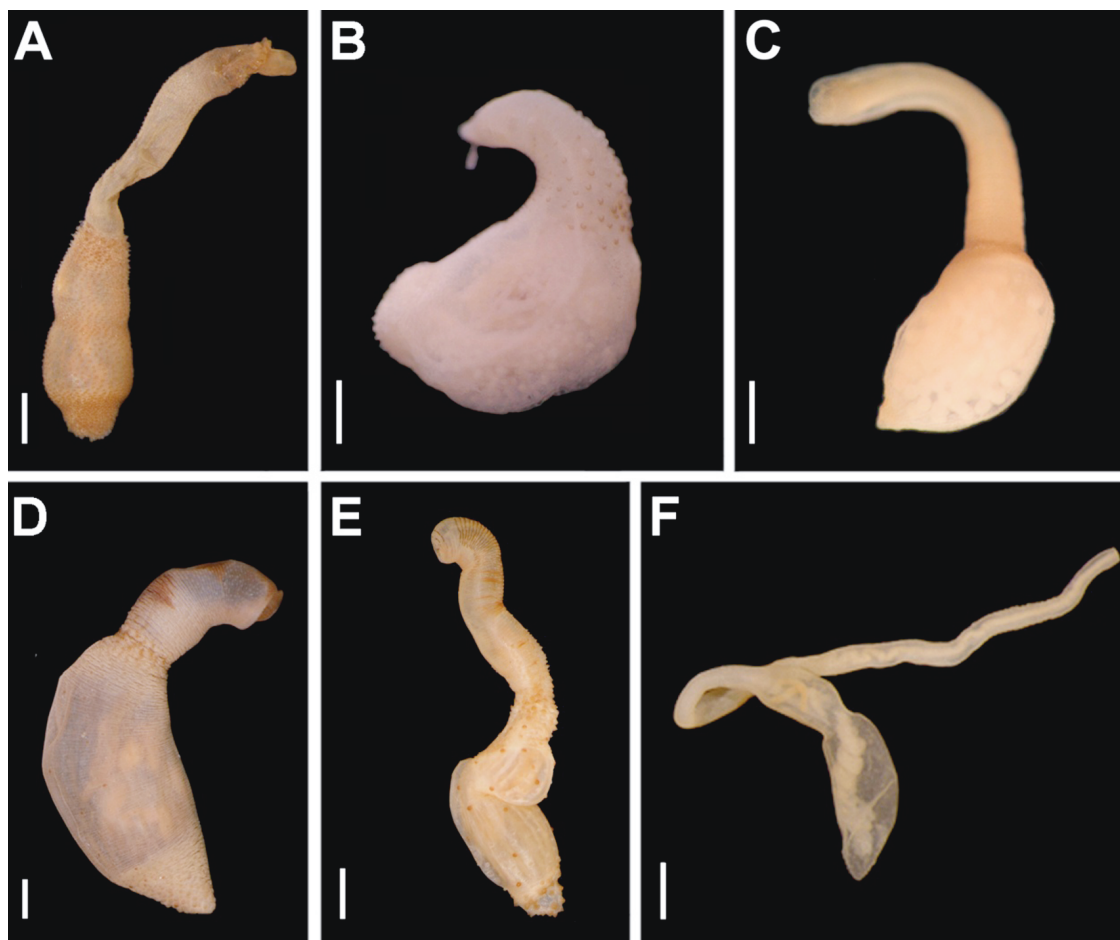
*Description:* Pear-shaped or barrel-shaped trunk variously colored: gray, yellow, orange, and rusty red (Figure 6C). Small papillae covering surface of trunk. Keel-like structures in posterior end of trunk. Only one retractor attached at posterior part of body. Spindle and wing muscle absent. Anus located near mouth. Intestine with several coils. Nephridia single, elongate.

*Distribution:* Atlantic Ocean, western Pacific Ocean, southwest Indian Ocean, Mediterranean Sea (Cutler, 1994; Açıık, 2011), and Red Sea (Pancucci-Papadopoulou et al., 1999).

***Phascolosoma (Phascolosoma) agassizii agassizii* Keferstein 1866**

*Description:* Body wall opaque (Figure 6D). Introvert with irregular dark pigmented bands. Hook with variable clear streak; triangle usually indistinct; unidentate, sometimes with small secondary tooth. Rings of hooks fewer than 50. Two pairs of retractors present. Spindle muscle arising in front of anus, attached to posterior end of trunk. Two dark eye spots present.

*Distribution:* North Pacific Ocean, Indian Ocean, subtropical eastern Atlantic Ocean, and Mediterranean Sea (Cutler, 1994; Açıık, 2008).



**Figure 6.** External morphology of species. **A)** *Phascolion (I.) tuberculosum*, **B)** *Phascolion (P.) strombus strombus*, **C)** *Onchnesoma steenstrupii steenstrupii*, **D)** *Phascolosoma (P.) agassizii agassizii*, **E)** *Phascolosoma (P.) stephensoni*, **F)** *Apionsoma (A.) misakianum*. Scale bars: A = 1 mm, B = 0.5 mm, C = 0.5 mm, D and E = 1 mm, F = 0.5 mm (A–E = Aegean Sea, original; F = from Açıık, 2011).

***Phascolosoma (Phascolosoma) granulatum* Leuckart, 1828**

**Description:** Body wall thick, not transparent, with irregular dark bands on introvert. Introvert nearly as long as trunk length. Papillae on trunk granular and dome-shaped. Hooks arranged in over 50 rings, some of them incomplete; with narrow clear streak with indistinct granular triangle; indistinct or no secondary tooth. Strong spindle muscle arising near anus; attached to posterior part of trunk. Contractile vessel simple. Two black eye spots present.

**Remarks:** Reexamination of the specimens previously identified as *P. (P.) granulatum* in the Aegean Sea by Ergen and Çınar (1994) and Çınar et al. (2002) revealed that they are, in fact, *Phascolosoma (P.) stephensoni*. The report of this species by Kocataş (1978) on some algae in İzmir Bay is also questionable, but his material is not available for examination.

**Distribution:** North Atlantic Ocean and Mediterranean Sea (Cutler, 1994).

***Phascolosoma (Phascolosoma) stephensoni* (Stephen, 1942)**

**Description:** Body wall opaque, light brownish (Figure 6E). Preanal and posterior papillae cone-shaped, smooth, red in color; those on midtrunk small, hemispherical. Hooks with distinct smooth streak, triangular space, and crescent. Most hooks with distinct secondary tooth. Two pairs of retractors present. Two black eye spots present.

**Distribution:** Western and northwestern Indian Ocean, eastern Atlantic Ocean, western Pacific Ocean, and Mediterranean Sea (Cutler, 1994; Açıık, 2011).

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

**Description:** Body wall thin, semitransparent (Figure 6F). Small, numerous brown papillae on posterior part of trunk. Small hooks with basal spinelets (4–5) on introvert. Four thin retractor muscles originating near middle of trunk, both pairs close to ventral nerve cord. Bilobed



nephridia usually similar in size, free; mostly orange in color; in some specimens, nephridia unequal in size. Nephridiopores located in front of anus. Two black eye spots present.

*Distribution:* Indian Ocean, Pacific Ocean, western Atlantic Ocean (Cutler, 1994), and Mediterranean Sea (Açık, 2011).

*Apionsoma (Apionsoma) murinae bilobatae* (Cutler, 1969)

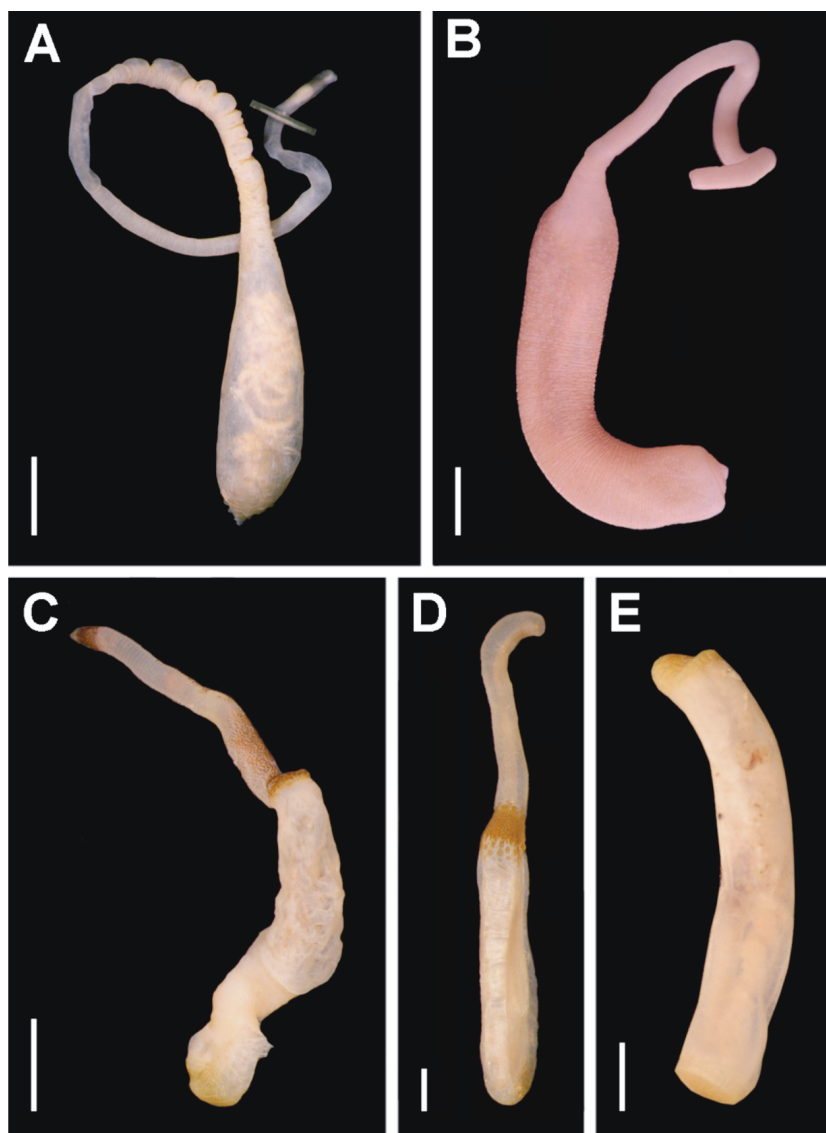
*Description:* Trunk cylindrical or flask-like (Figure 7A). Skin thin, transparent or thick, opaque, furrowed. Papillae on trunk globular, rosette sometimes dome-like shaped. Introvert with rings of hooks. Accessory comb

with 4–6 spinelets at base of hooks. Ventral retractors thicker than dorsal ones. Nephridia mostly orange in color; one or bilobed; second lobe smaller than primary lobe. Nephridiopores located in front of anus.

*Distribution:* Western and eastern Atlantic Ocean, Mediterranean Sea, 2 sides of Indian Ocean (Cutler, 1994; Açık, 2008).

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

*Description:* Body wall thin, light yellowish (Figure 7B). Anal shield weakly developed. Caudal shield not clear. Introvert at typical angle (45–50) with main trunk axis. Intestinal spiral attached to the posterior part of trunk by spindle muscle. Nephridiopores posterior to anus.



**Figure 7.** External morphology of species. A) *Apionsoma (A.) murinae bilobatae*, B) *Aspidosiphon (A.) mexicanus*, C) *Aspidosiphon (A.) elegans*, D) *Aspidosiphon (A.) misakiensis*, E) *Aspidosiphon (A.) muelleri*. Scale bars: A = 1 mm, B and C = 2 mm, D = 1 mm, E = 2 mm (A–E = Aegean Sea, original).

*Distribution:* Western Atlantic Ocean, Indian Ocean and Mediterranean Sea (Pancucci-Papadopoulou et al., 1999; Açıık, 2011).

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

*Description:* Body wall thin, transparent or semitransparent (Figure 7C). Ungrooved anal shield granulous. Caudal shield usually weakly developed. Dark brown bidentate compressed hooks on rings located on distal part of introvert. Dark conical hooks scattered on proximal part of introvert. Nephridia orange or dark brown. Two black eye spots present.

*Distribution:* Western Pacific Ocean, Indian Ocean, western Atlantic Ocean, Red Sea (Cutler, 1994), and Mediterranean Sea (Wesenberg-Lund, 1957; Açıık, 2011).

*Aspidosiphon (Aspidosiphon) misakiensis* Ikeda, 1904

*Description:* Body wall semitransparent (Figure 7D). Anal shield without grooves or furrows. Caudal shield with vague radial grooves. Spine-like papillae scattered on introvert. Light brown bidentate hooks in rings followed by scattered unidentate hooks. Gut loosely wound in ill-defined coils. Two retractors joined for most of their length, arising very close to posterior end of trunk. Nephridiopores posterior to anus or at same level. Two black eye spots present.

*Distribution:* Pacific Ocean, eastern and western Atlantic Ocean, and Mediterranean Sea (Cutler, 1994; Açıık, 2011).

*Aspidosiphon (Aspidosiphon) muelleri* Diesing, 1851

*Description:* Body wall thin, semitransparent (Figure 7E). Anal and caudal shield black-brown in color and grooved. Spine-like papillae scattered on introvert. Longitudinal musculature continuous. Light brown bidentate hooks in rings followed by scattered unidentate hooks. Retractor muscles attached at near posterior part of trunk. Anus and nephridiopores placed at same level.

*Distribution:* Northeastern Atlantic Ocean, eastern Pacific Ocean, Mediterranean Sea, Red Sea (Cutler, 1994; Açıık, 2011), and Indian Ocean (Saiz Salinas, 1993a).

This paper has compiled all existing species data regarding Sipuncula along the coasts of Turkey and provides an updated taxonomic list for the future studies. In order to better understand the distributional and ecological features of species inhabiting the coasts of Turkey (especially the Sea of Marmara and Black Sea), more samples, including from different habitats (hard substratum, algae, etc.) and depths (deep waters remain largely unexplored), should be collected and investigated.

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