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RESEARCH PAPER

Sponge Fauna in the Sea of Marmara

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Abstract

Sponge species collected along the coasts of the Sea of the Marmara in 2012-2013 were identified. A total of 30 species belonging to 21 families were found, of which four species (*Ascandra contorta*, *Paraleucilla magna*, *Raspailia* (*Parasyringella*) *agnata* and *Polymastia penicillus*) are new records for the eastern Mediterranean, while six species [*A. contorta*, *P. magna*, *Chalinula renieroides*, *P. penicillus*, *R.* (*P.*) *agnata* and *Spongia* (*Spongia*) *nitens*] are new records for the marine fauna of Turkey and 12 species are new records for the Sea of Marmara. Sponge specimens were generally collected in shallow water, but two species (*Thenea muricata* and *Rhizaxinella elongata*) were found at depths deeper than 100 m. One alien species (*P. magna*) was found at 10 m depth at station K18 (Büyükada). The morphological and distributional features of the species that are new to the Turkish marine fauna are presented.

Keywords: Porifera, Benthos, Invertebrate, Turkish Straits System.

Marmara Denizi Sünger Faunası

Özet

Bu çalışmada, Marmara Denizi ve kıyılarında 2012-2013 yılları arasında toplanan Sünger örnekleri tanımlanmıştır. Toplam 21 Familyaya ait 30 tür tanımlanmış olup bunlardan dört tanesi (*Ascandra contorta, Paraleucilla magna, Raspailia (Parasyringella) agnata ve Polymastia penicillus*) doğu Akdeniz için, altı tanesi [*A. contorta, P. magna, Chalinula renieroides, P. penicillus, R. (P.) agnata ve Spongia (Spongia) nitens*] Türkiye sünger faunası için yeni kayıttır 12 tür ise Marmara Denizi için yeni kayıttır. Sünger örnekleri genel olarak sığ bölgelerden toplanmıştır. Ancak iki tür (*Thenea muricata ve Rhizaxinella elongata*) 100 metreden daha derinden örneklenmiştir. Bununla birlikte bir yabancı tür (*P. magna*) K18 numaralı istasyonda (Büyükada) 10 m derinlikte bulunmuştur. Çalışmada Türkiye sünger faunası için yeni olan türlerin morfolojik özellikleri ve dağılımları verilmiştir.

Anahtar Kelimeler: Porifera, Bentos, Omurgasız, Türk Boğazlar Sistemi.

Introduction

The Sea of Marmara, together with the İstanbul and Çanakkale Straits, is a small basin with a surface area of 11,500 km² and a maximum depth of 1390 m. This basin serves as an important biological corridor and an acclimatization zone for the biota of the Black Sea and Mediterranean Sea (Öztürk & Öztürk, 1996; Öztürk, 2002).

The first taxonomic study on sponge species along the Turkish coasts was carried out by Colombo (1885), who listed five sponge species from the Çanakkale Strait. To date, a total of 131 species have been recorded from the Turkish coasts (Topaloğlu and Evcen, 2014). The latest study by Gözcelioğlu *et al*. (2015) reported 10 species from the shallow waters of the Marmara and North Aegean Sea, of which three species were new to the marine fauna of Turkey and one species (*Hymedesmia* (*Hymedesmia*) *anatoliensis*) new to science. Therefore, the total number of the Turkish sponge fauna is recorded as 132, whereas 681 species are known from the Mediterranean Sea (Coll *et al.,* 2010). Studies on sponge species in the Sea of Marmara are limited when compared to those of the other parts of the Mediterranean Sea (Evcen and Çınar, 2012). In the Sea of Marmara, where the Mediterranean (lower layer) and the Black Sea (upper layer) waters meet, the phylum Porifera is composed of 63 species (Topaloğlu and Evcen, 2014), with no species

endemic to the area. Although, Ostroumoff (1896) mentioned the presence of two sponge species (*Cometella stolonifera* and *Suberites appendiculatus*) new to science in the region, they were later considered as *nomen nudum* as they were not adequately described (Evcen and Çınar, 2012). Sponge diversity in the Sea of Marmara was also reported by Demir (1952–1954), who found 10 sponge species near the Prince Islands and the İstanbul Strait. Later, 13 sponge species were reported by Caspers (1968), two sponge species by Bayhan *et al.* (1989), one sponge species by Okuş (1986), and 19 sponge species by Topaloğlu (2001). Some studies on the sponge culture and its economic importance were made by Dalkılıç (1982) and Gökalp (1974). Devedjian (1926) also provided some information about sponges harvested commercially in the Sea of Marmara.

This study describes the sponge specimens collected within the framework of a project supported by the Scientific and Technological Research Council of Turkey (TÜBİTAK, Number: 111Y268) regarding the biodiversity and community structures of benthic invertebrates in the Sea of Marmara. This paper aims to report the sponge diversity in the Sea of Marmara and to describe species new to the marine fauna of Turkey.

Material and Methods

The sponge specimens were collected at 23 stations located in the Sea of Marmara, together with Çanakkale and Istanbul Straits (Figure 1) in September-October 2012 and June 2013. Shallow-water benthic habitats (0-20 m depth) such as mussels and algae were sampled by scuba diving and snorkeling (station number marked with "K" in the map**)**. Soft-bottom samples were taken by a box core, sampling an area of 0.1 m² (station number marked with "Y" in the map**)**, a bottom-trawl (station numbers marked with "DT") and a beam trawl (station number marked with "BT") between 10 and 323 m depths.

The specimens were fixed with 4% formaldehyde and transferred to the laboratory. They were first rinsed with tap water and subsequently preserved in 70% ethanol. To observe the skeletal features of sponges, thin portions of both ectosomal and chaonosomal parts were cut with a razor blade, dried, cleaned and preserved in 70% ethanol. The preparation of spicules was made following the standard method proposed by Rützler (1978). The spicule types and sizes were identified. A minimum of 20 spicules of each type were measured with an ocular micrometer.

The specimens presented here are deposited at the Museum of the Faculty of Fisheries, Ege University (ESFM).

Results

Within the study period, 30 species belonging to two classes and 21 families were found on the coasts of the Sea of Marmara (Table 1). Calcarea were represented by three species (*Sycon raphanus*, *Sycon ciliatum* and *Paraleucilla magna*) and Demospongiae by 25 species. Among the families, Chalinidae (4 species) and Dysideidae (3 species) had the highest number of species. Four species (*Ascandra contorta*, *Paraleucilla magna*, *Polymastia penicillus* and *Raspailia* (*Parasyringella*) *agnata*) are new records for the eastern Mediterranean and six species (*A. contorta*, *P. magna*, *Chalinula renieroides*, *P. penicillus*, *R.* (*P.*) *agnata* and *Spongia* (*Spongia*) *nitens*] are also new records for Turkey. In addition, 12 species (*Ascandra contorta*, *P. magna*, *P. penicillus*, *C. renieroides*, *Haliclona* (*Halichoclona*) *fulva*, *Haliclona* (*Rhizoniera*) *sarai*, *R.* (*P.*) *agnata*, *Timea stellata*, *Crambe crambe*, *Pleraplysilla spinifera* and *S.* (*S.*) *nitens*, *Aplysilla sulfurea* Schulze, 1878) are new records for the Sea of Marmara. Seven sponge species (*Sycon raphanus*, *T. muricata*, *Dysidea fragilis*, *Raspailia* (*Raspailia*) *viminalis*, *H.*

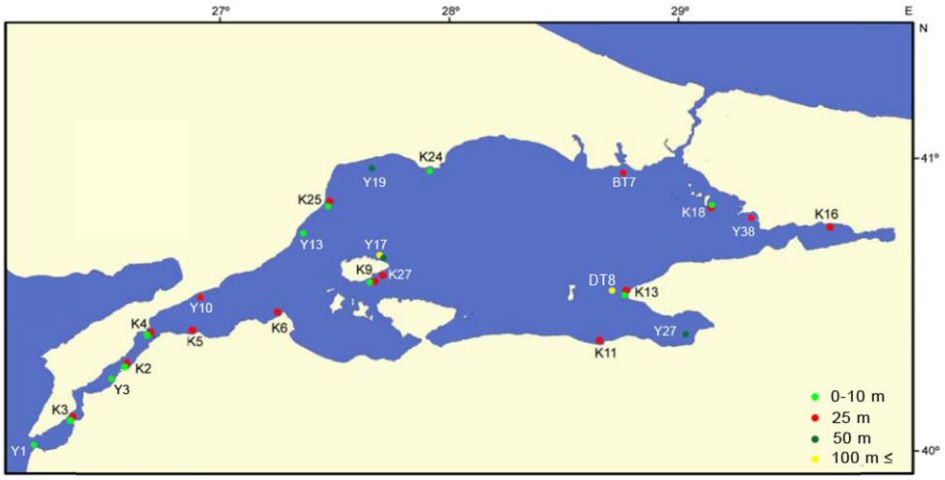

Figure 1. Map showing the sampling sites.

Table 1. Species found at stations along the coasts of the Sea of Marmara

	Number of Specimens	Substrata	Stations	Depths
CALCAREA				
Sycettidae				
Sycon ciliatum (Fabricius, 1780)	3	R	BT7	25 m
Sycon raphanus Schmidt, 1862	12	Hs, SS	Y1, Y17, Y19	10-100 m
Amphoriscidae				
**Paraleucilla magna* Klautau, Monteiro & Borojevic, 2004	1	R	K18	10 m
Leucaltidae				
**Ascandra contorta* (Bowerbank, 1866)	+50	R	K24	10 m
DEMOSPONGIAE				
Polymastiidae				
**Polymastia penicillus* (Montagu, 1814)	1	R	BT7	25 m
Chalinidae				
***Chalinula renieroides* Schmidt, 1868	8	CY, MG	K13, K18, K25	0-10 m
Haliclona (Reniera) cinerea (Grant, 1826)	1	R	K3	10 m
****Haliclona (Halichoclona) fulva* (Topsent, 1893)	3	R,CY	K13, Y27	10 m
****Haliclona* (*Rhizoniera*) *sarai* (Pulitzer-Finali, 1969)	1	R	K3	25 m
Theneidae				
Thenea muricata (Pulitzer-Finali, 1969)	1	Ss	Y17	100 m
Crambeidae				
****Crambe crambe* (Schmidt, 1862)	5	R	K4	0-25 m
Raspailiidae				
**Raspailia* (*Parasyringella*) *agnata* (Topsent, 1896)	1	Hs	Y10	25 m
Raspailia (*Raspailia*) *viminalis* Schmidt, 1862	2	Hs	Y10,Y3	25 m
Petrosiidae				
Petrosia (*Petrosia*) *ficiformis* (Poiret, 1789)	2	R	K2, K3	10-25 m
Axinellidae				
Axinella polypoides Schmidt, 1862	1	R	K6	25 m
Halichondriidae				
Ciocalypta penicillus Bowerbank, 1862	4	R	K18	10-25 m
Suberitidae				
Rhizaxinella elongate (Ridley & Dendy, 1886)	1	R	DT8	323 m
Timeidae				
****Timea stellata* (Bowerbank, 1866)	1	R	Y27	50 m
Tethyidae				
Tethya aurantium (Pallas, 1766)	2	R	K13	10 m
Clionidae				
Cliona celata Grant, 1826	3	R	K9	10-25 m
Irciniidae				
Ircinia variabilis Grant, 1826	9	R	K18, K24	10-25 m
Sarcotragus foetidus Schmidt, 1862	8	R		
Dysideidae				
Dysidea fragilis (Montagu, 1814)	38	P, R, Hs	K2,K3,K4, K9, K5, K11,K13, K18, Y13, Y38	10-20 m
Dysidea incrustans (Schmidt, 1862)	5	P	K3, K18, K25	0.5 m
****Pleraplysilla spinifera* (Schulze, 1879)	2	R	K2, K18	20-25 m
Thorectidae				
Scalarispongia scalaris (Schmidt, 1862)	1	R	K3	25 m
Spongiidae				
***Spongia (Spongia) nitens* (Schmidt, 1862)	1	R	K18	20 m
Spongia (*Spongia*) *officinalis* Linnaeus, 1759	1	R	K18	25 m
Darwinellidae				
****Aplysilla sulfurea* Schulze, 1878	5	R	K13	0-25 m
Aplysinidae				
Aplysina aerophoba (Nardo, 1833)	187	R	K2,K3,K4, K5, K6,K11,K18, K16, K24, K25	0-20 m

R: rocks and stones, serpulid reef, P: *Posidonia oceanica*, CY: *Cystoseira barbata*, SK:, A: algae, Hs: hard substrata in sandy bottoms, SS: Soft Substrata, MG: *Mytilus galloprovincialis*

*Species new to the eastern Mediterranean fauna, **species new to the Turkish marine fauna, ***species new to the Marmara Sea.

(*H.*) *fulva, P. penicillus* and *Rhizaxinella elongata*) were found in soft substrata with shell fragments, while 25 species were found on rocks or stones. The majority of species (25 species) were found at 0-25 m depths, but two species (*T. muricata* and *R. elongata*) were found between 100 and 323 m depths at stations Y19, Y17 and DT8.

The morphological and distributional features of the species that are new to the Turkish marine fauna are presented below.

Calcarea, Bowerbank 1862
Leucaltidae Dendy & Row, 1913
***Ascandra contorta* (Bowerbank, 1866)**
Leucosolenia contorta Bowerbank, 1866: 29-32
Clathrina contorta, Klautau, Valentine 2003: 19-22; Figure 14(a-f).
Material examined: Multiple specimens collected at station K24 (40°57'55"N-27°57'24"E), on rock, 3m depth.
Notes: This species has a whitish irregular mass of anastomosed tubes which is massively encrusting to globular (Figure 2). It has a finely hispid surface. Consistency is soft and fragile. Its skeleton has triactines, tetractines, diactines and trichoxeas.
Ecology and Distribution: This species was commonly found on rocks between 10 and 30 m depths, but occasionally found in the intertidal region under stones along the coasts of the east Atlantic and Mediterranean (Burton, 1963).

Amphoriscidae Dendy, 1893
***Paraleucilla magna* Klautau, Monteiro & Borojevic, 2004**
Paraleucilla magna Klautau *et al*., 2004: 1-8, Figure 2 (a-c).
Material examined: K18 (40°50'26"N-29°07'33"E) , 10 m (ESFM–POR/2013–298).
Description: It is massive, thickly encrusting (Figure 3A). Consistency isa friable and very fragile. The surface is smooth. The oscules are terminal on erect tubes. The chonasomal skeletonincludes tetractines and triactines. Cortical andsubatrial tetractine have apical rays measuring 400-600 x 40- 50 µm; cortical andsubatrial triactine have rays: 80-100 long, 8- 10µm thick with basal ray slightly curved (Figure 3B-D).
Habitat and distribution: This species was previously found on natural and artificial hard substrata (Longo *et al.*, 2007). We found it on a stone at K18. It is a new record for the coasts of the eastern Mediterranean and Turkey. It was previously reported from the Atlantic (Brazilian coast) and Mediterranean (Tyrrhenian Sea, Ionian Sea, Adriatic Sea) (Klautau *et al.*, 2004; Longo *et al.*, 2007). It is an invasive alien species introduced to the area from the western Mediterranean via shipping (Longo *et al.* 2007).

Chalinidae Gray, 1867
***Chalinula renieroides* Schmidt, 1868**
Chalinula renieroides Schmidt 1868: 7; De Weerdt 2000: 59, Figure, 3u, 44a-c.
Material examined: K13 (40°50'26"N-29°07'33"E), 10 m (ESFM–POR/2013–325); K18 (40°50'26"N-29°07'33"E), 5 m (ESFM–POR/2013–325); K25 (40°51'59"N-29°07'33"E), 5 m.
Description: This species has fragile tissues and encrusting. It has a grey-brown color in alcohol. Oscules are 2-3 mm in size. Choanosomal skeleton has an arranged unispicular (occasionally paucispicular) reticulation that consists of 2-6 piculesin every cross section (Figure 4A). All skeletal lines comprise in moderate of spongin. Spicules only consist of robust, short, curved oxeas: 60-100 x 2-8 µm (Figure 4B-C).
Habitat and distribution: This species was found on a bivalve shell at 33 m depth. It was previously reported on rocks in the shallow-water environments in the western Mediterranean and Levantine Seas (Pulitzer-Finali (1978; De Weerdt, 2000; Voultsiadou, 2005).

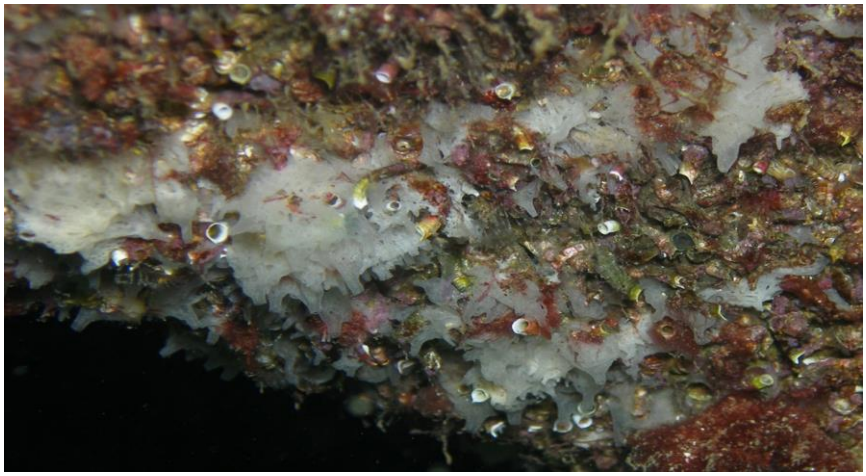

Figure 2. Photograph of *Ascandra contorta* in situ.

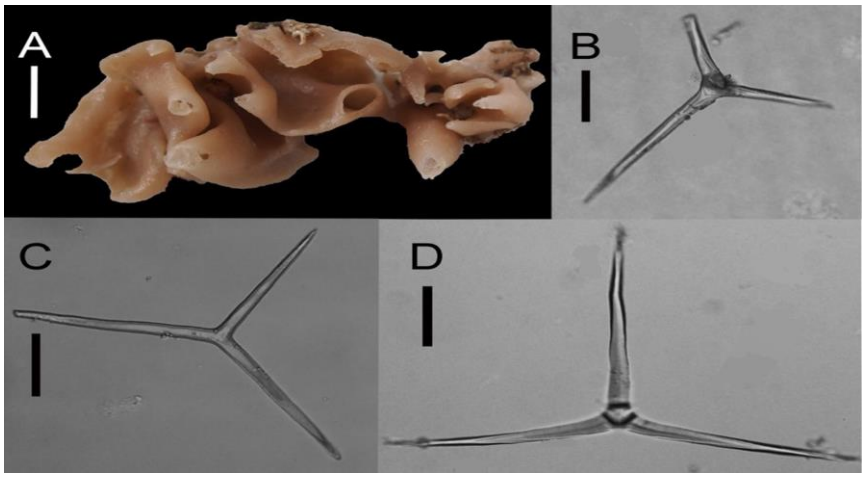

Figure 3. *Paraleucilla magna*: A. General view (scale: 2.5 cm), B. cortical tetractine (scale: 250 µm); C. cortical triactine (scale: 150 µm); D. subatrial tetractine (scale: 200 µm).

Polymastiidae Gray, 1867

***Polymastia penicillus* (Montagu, 1818)**

Spongia penicillus Montagu, 1818: 93.

Polymastia mammeata Bowerbank 1866: 170.

Polymastia penicillus, Vosmaer 1882: 26; Morrow and Boury-Esnault, 2000: 330, Figure 2(A-C).

Material examined: BT7, Beam Trawl, (start: 40°58'00"N-28°46'31"E; finish: 40°57'42"N-28°47'10"E), 25 m, on rocks with serpulid aggregations (ESFM–POR/2013–298), 1 specimen.

Description: The specimen is a fistulose sponge which has a greyish color in alcohol. It has massive and hispid structure (Figure 5A). The surface of the body is covered by vertical, conical, papillae which are smooth and clean. The oscules and pores are located in papillae. The megascleres are tylostyles of three dimension which are; primary tylostyles 750-1600 x 8-12 µm; medium-sized tylostyles of the tangential which is in subectosomal layer: 250-750 x 6-8 µm; and small ectosomal tylostyles: 50-250 x 2-6 µm, respectively (Figure 5B, C). Those tylostyles form radiate skeleton.

Habitat and Distribution: This species is usually found on subsurface of the rocks and shady sites Ackers *et al*., 1992). It was previously reported from the north-east Atlantic (Boury-Esnault, 1974; 1987) and the Mediterranean (Pansini, 1987).

Remark: The genus *Polymastia* is represented by eight species in the Mediterranean: *P. penicillus*, *P. mamillaris*, *P. robusta*, *P. inflata*, *P. polytylota*, *P. tissieri*, *P. harmelini* and *P. sola* (Van Soest *et al*., 2015). *Polymastia penicillus* is morphologically very close to *P. mamillaris* [present in the western Mediterranean, Pulitzer-Finali (1978)], but two species differ from each other in terms of the spicules size (from 2 µm to 12 µm in *P. penicillus*, while from 11 µm to 24 µm in *P. mamillaris*) (Morrow and Boury-Esnault, 2000). In addition, *P. penicillus* is being newly reported for the eastern Mediterranean Sea.

Raspailiidae Nardo, 1833

***Raspailia (Parasyringella) agnata*(Topsent, 1896)**

Axinella agnata Topsent 1896: 129.

*Raspailia (Parasyringella) agnata*Uriz & Maldonado 1993: 355, Figure. 2a-c.

Material examined: Y10 (40°30'38"N-26°54'58"E), 25 m (ESFM–POR/2013–305), 1 specimen.

Description: The specimen is recognizable with cylindrical, erect body (8 cm high). Surface is quite hispid and velvety (Figure 6A). Color is ochre in alcohol. Consistency is tough and flexible. Its spicules are curved oxeas and relatively long styles. Styles (500–1000 x 10–28 µm) which cause hispidation and small styles (Figure 6B). These spicules protrude from sponge surface. Thin oxeas are slightly curved (200–400 x 8–10 µm). Choanosome skeleton consists of multispicular distinct tract. Ectosome has specialized skeleton of small oxeas grouped into brushes standing perpendicular to surface. Spongin is abundant around the spicule tracts.

Habitat and Distribution: This species was only found on calcareous rocks at station Y10. It was previously reported from the northeastern Atlantic and the Mediterranean (Uriz and Maldonado. 1993).

Spongiidae Gray, 1867

***Spongia (Spongia) nitens*(Schmidt, 1862)**

Ditela nitens Schmidt 1862: 24, 1864.

Spongia (Spongia) nitens, Manconi, 2013; 41.

Material examined: K18 (40°50'26"N-29°07'33"E), 10 m (ESFM–POR/2012–299), 1 specimen.

Description: Sponge fragment is formless (Figure 7A). Colour of the sponge body varies greyish light to brown. Consistency is compressible and also elastic. The oscula has 4 mm in diameter. Skeleton network of primary fibres (35–60 µm) is rarely cored by grain (pith) and secondary fibers lack pith and are much thinner: (15-35 µm) (Figure 7B).

Habitat and Distribution: This species was previously collected in different hard bottom habitats

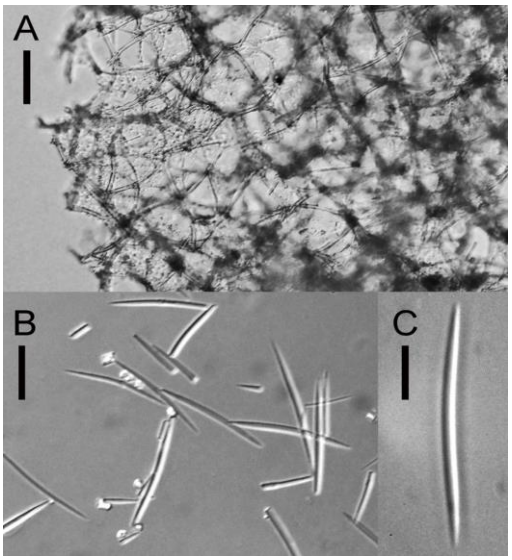

Figure 4. *Chalinula renieroides*. A. Choanosomal skeleton (Scale: 150 μm); B. Overview of spicules (Scale: 60 μm); C. Oxea (Scale: 20 μm).

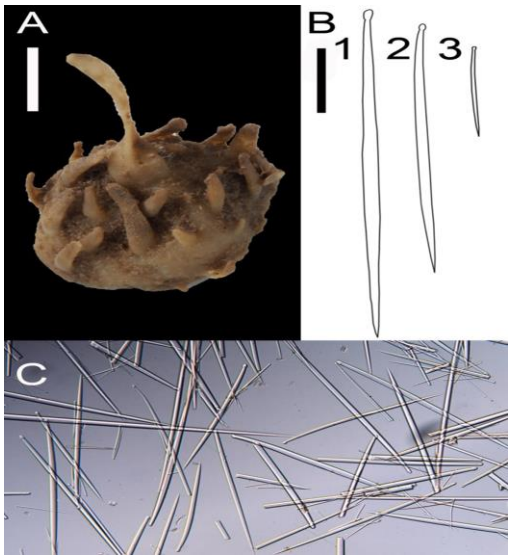

Figure 5. *Polymastia penicillus*, A. General view (scale:1.5 cm), B. Spicules: 1. Primary tylostyle; 2. medium-sized tylostyle; 3. small tylostyle (scale: 100 μm) C. Overview of spicules.

(cave, coralligenous community, detritic and rocky) in the Mediterranean Sea (Sarà 1968; Gerovasileiou and Voultsiadou, 2012; Manconi *et al*., 2013).

Remarks: The morphology of *Spongia (Spongia) nitens*is very similar to that of *Spongia (Spongia) officinalis*, which are very difficult to distinguish them from each other. However, the primary fibers of *S.(S.) officinalis* are composite near their extremity and include some foreign bodies, such as foreign spicules or sometimes small sand grains. *S. nitens* has primary fibers that are non-composite and without foreign bodies, but with a more or less clear pith.

Discussion

Prior to this study, a total of 132 sponges were reported from the coasts of Turkey. A total of 63, 13, 83 and 51 sponge species were previously reported in the Sea of Marmara, Black Sea, Aegean Sea and Levantine Sea (Turkish coast), respectively. The present study added six species which makes 138 sponges known along the coasts of Turkey and 12 species which makes 75 in the Sea of Marmara.

Knowledge on deep-water sponge fauna is scarce in the eastern Mediterranean. In the whole Mediterranean basins, 171 demosponges and 3 hexactinellids were reported from the deep-waters (Pansini and Longo, 2003). We found two sponge species (*Thenea muricata* and *Rhizaxinella elongata*) at depths deeper than 100 m in the Sea of Marmara. *Thenea muricata* and *R. elongata* were previously determined from soft bottoms, mostly in deep waters

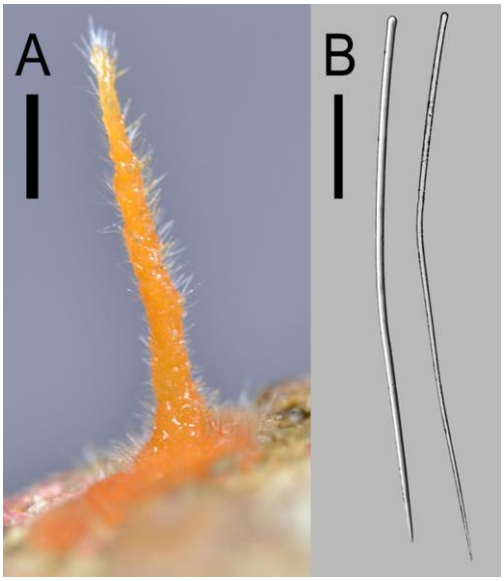

Figure 6. *Raspailia (Parasyringella) agnata* A. General view (Scale: 3 cm) B. Styles (Scale: 100 µm).

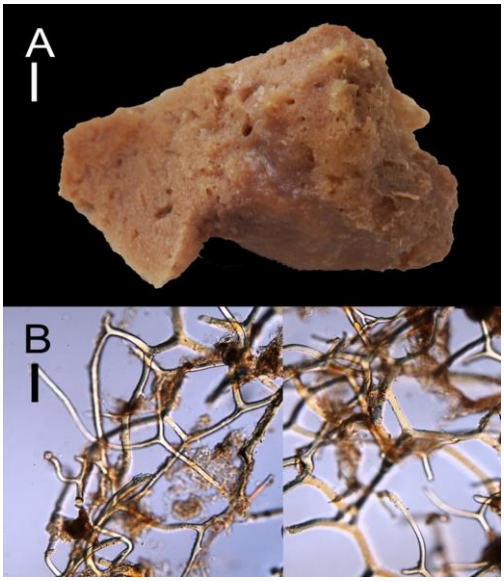

Figure 7. *Spongia (Spongia) nitens*, A. General view (scale: 5 cm), B. Skeleton network (scale: 300 µm).

(120–4020 m and 90 m downwards) in the Mediterranean Sea (Maldonado, 2"002; Carteron, 2002). However, the vertical distribution of *T. muricata* was reported to be primarily related to muddy soft bottoms, not depths (Pansini and Musso, 1991).

The Mediterranean Sea has been greatly influenced by the establishment of alien species, especially after the opening of the Suez Canal in 1869 (Por, 1978; Galil *et al*., 2002; Zenetos *et al*., 2005; Zenetos *et al*., 2010). Almost 955 alien species have been reported from the Mediterranean Sea so far (Zenetos *et al*., 2010). The majority of alien species (almost 75%) are known from the eastern part of the Mediterranean (Zenetos *et al.*, 2005). No alien sponge species has been reported along the coasts of Turkey and Sea of Marmara up to date (Çınar *et al*., 2011). Based on the reports by Burton (1963) and Tsurnamal (1969), Por (1978) regarded five sponge species [*Cinachyrella tarentina* (Pulitzer-Finali, 1983) (cited as *Chrotella cavernosa* (Lamarck, 1815) *Lissodendoryx* (*Waldoschmittia*) *schmidti* (Ridley, 1884) (cited as *Damiriana schmidti* (Ridley, 1884); *Geodia micropunctata* Row, 1911; *Hyrtios erecta* (Keller, 1889) (cited as *Heteronema erecta* Keller, 1889), *Haliclona* (*Gellius*) *bubastes* (Row, 1911) (cited as *Reniera spinosella* Row, 1911) as lessepsian migrants. Since the identifications of the sponge species by Burton (1963) and Tsurnamal (1969) were thought unreliable (communicated with J. Vacelet), Zenetos *et al.* (2005) did not take these sponge species into account in their review study on the

Mediterranean alien species. In addition, the specimens identified as *Haliclona viridis* (Keller, 1889) along the Mediterranean coast of Egypt (Burton, 1936) were turned out to be the Red Sea species *Amphimedon chloros* Ilan, Gugel and van Soest, 2004, which could be a lessepsian migrant (Ilan *et al*., 2004). Recently, Longo *et al.* (2007) reported the invasive calcareous sponge, *Paraleucilla magna*, from various sites (Tyrrhenian Sea, Adriatic Sea, Ionian Sea) in the Mediterranean Sea. This species was originally described from the western Atlantic (Brazilian coast) (Klautau *et al.*, 2004) and was thought to have been introduced to the Mediterranean by ballast waters of ships. It was previously reported to have invaded the mussel farms and artificial hard substrata such as floats and submerged ropes along the coasts of Italy (Longo *et al*., 2007). The pathway through which the species had been established in the Sea of Marmara is unknown at this stage, but as the region has very busy international marine traffic, we assume that, this species could have been transferred to the area by hull fouling or ballast water of ships from the Indo-Pacific/tropical Atlantic regions (as a primary introduction) or from the coasts of Italy (as a secondary introduction). The patchy distribution of this species indicates no adverse effect on the native communities, but if it forms a dense population in the course of time, the potential ecological impact of this alien sponge species includes the competition with native species for suitable substrate and the negative effect on overgrown organisms (Pansini *et al.*, 2011).

This study has contributed to our knowledge regarding the diversity of sponge species along the eastern Mediterranean and the Sea of Marmara. However, some habitats of sponge communities such as coralligenous formations, hard bottoms in deep-water habitats and sea caves have not been adequately investigated in the Sea of Marmara. Further researches, thus, are needed to elucidate the sponge diversity in the region.

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