

## Updated checklist of sponges (Porifera) along the coasts of Turkey

Bülent TOPALOĞLU<sup>1,2</sup>, Alper EVCEN<sup>3,\*</sup>

<sup>1</sup>Department of Marine Biology, Faculty of Fisheries, İstanbul University, İstanbul, Turkey

<sup>2</sup>Turkish Marine Research Foundation, İstanbul, Turkey

<sup>3</sup>Department of Hydrobiology, Faculty of Fisheries, Ege University, Bornova, İzmir, Turkey

Received: 30.05.2014

Accepted: 28.08.2014

Published Online: 00.00.2013

Printed: 00.00.2013

**Abstract:** This study compiled the data from previous papers emphasizing sponge species on the Turkish coasts. In total, 127 species belonging to 46 families have been reported: 83 species from the Aegean Sea, 63 species from the Sea of Marmara, 51 species from the Levantine Sea, and 2 species from the Black Sea. Among these species, 3 species are new records for the marine fauna of Turkey: *Rhizaxinella elongata*, *Axinyssa digitata*, and *Terpios gelatinosa*. *Raspalia viminalis* is a new record for the Sea of Marmara. The morphological and distributional features of 3 species are presented. In addition, a checklist of the sponge species reported from the Turkish coasts to date is provided.

**Key words:** Sponge diversity, new records, species distribution, Black Sea, Aegean Sea, Sea of Marmara, Levantine Sea

### 1. Introduction

The phylum Porifera (sponges) is known to be the most primitive metazoan group and has 4 classes, namely Calcarea (667 species in the world's oceans), Hexactinellida (589 species), Homoscleromorpha (84 species), and Demospongiae (6922 species) (Cárdenas et al., 2012; Van Soest et al., 2014).

In terms of the species richness, sponges are one of the most important groups (12.4% of total number of species) in the Mediterranean Sea (Coll et al., 2010). Zoogeographical distribution of sponge species in the Mediterranean was studied by Pérès and Picard (1958), Pansini and Longo (2003), and Voultsiadou (2009). The Mediterranean Sea was divided into 4 major zones by Voultsiadou (2009): northwestern, northeastern, central, and southeastern zones. The sponge biodiversity declines from west to east in the Mediterranean Sea (Voultsiadou-Koukoura and Van Soest, 1993). In the Levantine Sea, almost 85 sponge species have been reported by numerous authors (Burton, 1936; Lévi, 1956; Tournamal, 1967, 1969; Ilan et al., 1994, 2003; Perez et al., 2004; Vacelet et al., 2007; Vacelet and Perez, 2008; Voultsiadou, 2009), and the total number of the sponge species was reported to be 681 in the Mediterranean Sea (Coll et al., 2010).

According to Evcen and Çınar (2012), knowledge on the sponge species of the Turkish coasts is poor when

compared to that of the other parts of the Mediterranean. The oldest study on sponges of the coasts of Turkey dates back to 1885, when Colombo (1885) reported 5 sponge species from the Çanakkale Strait. Ostroumoff (1896) conducted a marine survey in the Sea of Marmara and reported 36 sponge species in the area. Devedjian (1926) also gave some information on sponges. Additional studies on sponge culture and economic importance were done by Dalkılıç (1982) and Gökalp (1974).

Sponge diversity in the Sea of Marmara was also studied by Demir (1952–1954), who found 12 sponge species near the Prince Islands and the İstanbul Strait. Afterwards, 1 sponge species was reported by Caspers (1968), 2 sponge species by Bayhan et al. (1989), 1 sponge species by Okuş (1986), and 19 sponge species by Topaloğlu (2001) in the area.

In the Aegean Sea, Sarıtaş (1972, 1973, 1974) conducted a series of studies on sponges and reported a total of 50 sponge species in İzmir Bay. Yazıcı (1978) collected sponge species around Gökçeada (northern Aegean Sea) and reported 15 sponge species. Several sponge species were also reported in general faunistic and ecological studies in the Aegean Sea (i.e. Geldiay and Kocataş, 1972; Kocataş, 1978; Ergüven et al., 1988; Katağan et al., 1991; Ergen et al., 1994; Çınar and Ergen, 1998; Kocak et al., 1999; Topaloğlu, 2001; Çınar et al., 2002). Evcen and Çınar (2012) studied

\* Correspondence: taha

the sponge species from the Levantine coast of Turkey and provided a checklist of sponges for the coasts of Turkey. The authors reported 115 sponge species on the coasts of Turkey. A recent study by Topaloglu et al. (2013) encountered 2 sponge species from the Black Sea coast of Turkey.

This study has compiled the existing literature on the sponge species of the Turkish coasts with 3 additional new records for the marine fauna of Turkey and 1 new record for the Sea of Marmara. The aims of the study were to point out the sponge diversity along the Turkish coasts and to provide a checklist of sponge species that have been reported from the region.

## 2. Materials and method

The checklist was prepared by compiling all available literature on the marine sponge species in the seas surrounding Turkey (Black Sea, Sea of Marmara, Aegean Sea, and Levantine Sea). The first records of species were identified for each sea and their depth and habitat distributions were examined in light of the available regional literature. In addition, some species that represent new records for the fauna of Turkey or for a sea are presented and marked as PS in the Table. The stations where new records of species were found are indicated in Figure 1.

The sponge specimens were collected by scuba diving and bottom-trawling. The samples were fixed in 4% formalin solution in the field and preserved in the 70% ethanol in the laboratory. Preparation of spicules followed the standard method proposed by Rützler (1978). The tissue samples were boiled in nitric acid and spicules were mounted on microscope slides permanently after rinsing in pure water and ethanol. The spicule types and sizes were

identified. The World Porifera Database (Van Soest et al., 2014) was used for the description of species.

In order to assess the diversity hotspots and the areas where weak and intensive research efforts have been performed to date (gap analysis), the coasts of Turkey were divided into grids of 15 × 15 km. All distribution data of species were entered into an Excel file and then imported and digitized with ArcGIS 9.3.

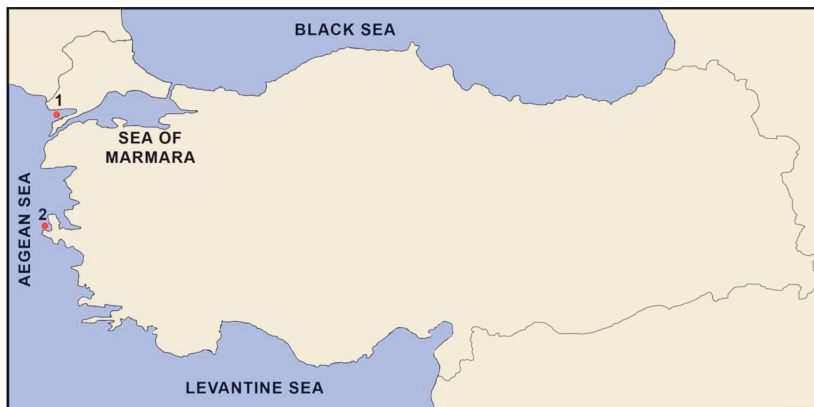
## 3. Results and discussion

A total of 127 sponge species are presented in this study for Turkish Coasts. Two of them were reported from the Black Sea, 63 from the Sea of Marmara, 83 from the Aegean Sea, and 51 from the Levantine Sea (Table; Figure 2). The list also includes 3 species (*Rhizaxinella elongata*, *Axinyssa digitata*, and *Terpios gelatinosa*) reported for the first time along the coasts of Turkey and 1 species (*Raspalia viminalis*) that is new to the Sea of Marmara. Brief descriptions of these species are given below.

### *Axinyssa digitata* (Cabioch, 1968)

**Material examined:** One specimen from Saros Bay (station 1), 100–200 m depth, bottom-trawling (see Figure 1).

**Description:** Specimen massive, base of 0.8–3 cm in thickness from which arise irregular often coalescing conical digitations of 0.3–2.2 cm in height and 0.2–1.5 cm in diameter at their base. The surface is conulose and hispid, and along the digitations the conules are aligned to form longitudinal ridges with intervals of 0.5–1.5 mm. Spicules: Oxeas only, of a single but very variable category. They frequently have stair-stepped ends, and stronglyloxea-like modifications are common. Most are curved and some have a median swelling. Size 315–890 × 6–22 μm (Figure 3). *A. digitata* has been reported from the coast of Israel (Carteron, 2002).



**Figure 1.** Sampling stations for 3 new records (1: station 1, Saros Bay, 2: station 2, Çeşme).

**Table.** Check list of sponge species from the coast of Turkey. 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); PS: present study.

Group/Species	BS	SM	AS	LS	DR	H
Phylum: PORIFERA						
Class: CALCAREA						
Family: Sycettidae						
<i>Sycon ciliatum</i> (Fabricius, 1780)		2, 3			II	Hs
<i>Sycon raphanus</i> Schmidt, 1862		5	13, 15, 18, 19, 21	28	I–III	Hs
<i>Sycon tuba</i> Lendenfeld, 1891		3			III	Hs
Family: Grantiidae						
<i>Ute glabra</i> Schmidt, 1864		3			II	Hs
Family: Leucosoleniidae						
<i>Leucandra aspera</i> (Schmidt, 1862)		1	12, 13, 15		I–III	Hs
<i>Leucosolenia variabilis</i> (Haeckel, 1870)		5		28	I	Hs
Family: Clathrinidae						
<i>Clathrina clathrus</i> (Schmidt, 1864)				28	I	Hs
<i>Clathrina reticulum</i> (Schmidt, 1862)			12		II	Hs
Class: HOMOSCLEROMORPHA						
Family: Oscarellidae						
<i>Oscarella lobularis</i> (Schmidt, 1862)		1		26	I–II	Hs
Class: DEMOSPONGIAE						
Family: Tethyidae						
<i>Tethya aurantium</i> (Pallas, 1766)		1, 3, 5, 22	7, 8, 9, 11, 13, 15, 19	29	I–II	Hs
Family: Spirastrellidae						
<i>Diplastrella bistellata</i> (Schmidt, 1862)		3		28	I	Hs
<i>Spirastrella cunctatrix</i> Schmidt, 1868				26, 28	I–II	Hs
Family: Clionaidae						
<i>Cliona celata</i> Grant, 1826		22	23	28	I–III	Hs
<i>Cliona vermifera</i> Hancock, 1867			7		I	Hs
<i>Cliona viridis</i> (Schmidt, 1862)		3	7, 9, 13	26	I–II	Hs
<i>Cliona schmidtii</i> (Ridley, 1881)			7, 9	28	I	Hs
<i>Cliothisa hancocki</i> (Topsent, 1888)			7, 9		I	Hs
Family: Suberitidae						
<i>Aaptos aaptos</i> (Schmidt, 1864)		1, 22	9		I–III	Hs
<i>Protosuberites denhartogi</i> Van Soest & de Kluijver, 2003		5	8, 9		I–II	Hs
<i>Rhizaxinella elongata</i> (Ridley & Dendy, 1886)			PS1		I	Hs
<i>Rhizaxinella pyrifer</i> (Delle Chiaje, 1828)		25	15		I	Hs

Table. (Continued).

<i>Suberites carnosus</i> (Johnston, 1842)		5, 22			I-III	
<i>Suberites domuncula</i> (Olivi, 1792)	28	3, 5, 22	9, 11, 13, 15, 23		I-III	Hs
<i>Suberites ficus</i> (Johnston, 1842)		22			I-III	Hs
<i>Suberites massa</i> Nardo, 1847		3	18		I	Hs
<i>Terpios gelatinosa</i> (Bowerbank, 1866)			PS2		I	Hs
Family: Placospongiidae						
<i>Placospongia decorticans</i> (Hanitsch, 1895)			7,9		I	Hs
Family: Timeidae						
<i>Timea fasciata</i> Topsent, 1934			9		I	Hs
<i>Timea mixta</i> (Topsent, 1896)			8			
<i>Timea stellata</i> (Bowerbank, 1866)			8, 9, 12		I	Hs
Family: Chalinidae						
<i>Chalinula limbata</i> (Montagu, 1818)		5			I	Hs
<i>Dendrectilla tremitensis</i> Pulitzer-Finali, 1983				27	II	Hs
<i>Haliclona alba</i> (Schmidt, 1862)		3			I-II	Hs
<i>Haliclona flavescens</i> (Topsent, 1893)				26	II	Hs
<i>Haliclona (Gellius) dubia</i> (Babic, 1922)			8,9		I-II	Hs
<i>Haliclona (Gellius) fibulata</i> (Schmidt, 1862)		3	8,9		I	Hs
<i>Haliclona (Haliclona) simulans</i> (Johnston, 1842)			13, 16		II	Hs
<i>Haliclona (Halichoclona) fulva</i> (Topsent, 1893)				28	I	Hs
<i>Haliclona (Reniera) aquaeductus</i> (Schmidt, 1862)		3			VII	Hs
<i>Haliclona (Reniera) cinerea</i> (Grant, 1826)		5	15		I	Hs
<i>Haliclona (Reniera) cratera</i> (Schmidt, 1862)			15		I	Hs
<i>Haliclona (Reniera) mediterranea</i> Griessinger, 1971		22, 25		26	I-III	Hs
<i>Haliclona (Rhizoniera) sarai</i> (Pulitzer-Finali, 1969)				27	II	Hs
Family: Niphatidae						
<i>Pachychalina rustica</i> Schmidt, 1868		3			I	Hs
Family: Phloeodictyidae						
<i>Calyx nicaeensis</i> (Risso, 1826)				26	II	Hs
Family: Callyspongiidae						
<i>Siphonochalina coriacea</i> Schmidt, 1868		1	15		I-II	Hs
Family: Petrosiidae						
<i>Petrosia (Petrosia) ficiformis</i> (Poiret, 1789)		1, 22	8, 9, 15, 23	26, 28	I-III	Hs
<i>Petrosia pulitzeri</i> (Pansini, 1996)		22			I-III	Hs
<i>Petrosia (Strongylophora) vansoesti</i> Boury-Esnault, Pansini & Uriz, 1994				28	I	Hs

**Table.** (Continued).

Family: Dictyonellidae					
<i>Acanthella acuta</i> Schmidt, 1862	22		26	I–III	Hs
<i>Dictyonella incisa</i> (Schmidt, 1880)			27	II	Hs
<i>Dictyonella obtusa</i> (Schmidt, 1862)	3			II	Hs
<i>Dictyonella plicata</i> (Schmidt, 1880)	22			I–III	Hs
Family: Axinellidae					
<i>Axinella cannabina</i> (Esper, 1794)	3, 22	13, 15, 23	26	I–III	Hs
<i>Axinella damicornis</i> (Esper, 1794)	3, 22	9, 23	26	I–III	Hs
<i>Axinella polypoides</i> Schmidt, 1862	22	13, 15, 23		I–III	Hs
<i>Axinella pumila</i> Babic, 1922		9		II	Hs
<i>Axinella verrucosa</i> (Esper, 1794)		9, 13, 15	26	II	Hs
Family: Halichondriidae					
<i>Axinyssa digitata</i> (Cabiocch, 1968)		PS1		I	Hs
<i>Ciocalypta carballoi</i> Vacelet, Bitar, Carteron, Zibrowius & Perez, 2007			25	II	Hs
<i>Ciocalypta penicillus</i> (Schmidt, 1862)	22			I–III	Hs
<i>Hymeniacion perlevis</i> (Montagu, 1818)	6	12		II	Hs
<i>Halichondria (Halichondria) panicea</i> (Pallas, 1766)	5	10, 15		I	Hs
<i>Halichondria (Eumastia) sitiens</i> (Schmidt, 1870)	6				
Family: Bubaridae					
<i>Hymenhabdia intermedia</i> Sarà & Siribelli, 1960			28	I	Hs
Family: Ancorinidae					
<i>Ancorina cerebrum</i> (Schmidt, 1862)	3	9		III	Hs
<i>Dercitus (Stoeba) plicatus</i> (Schmidt, 1868)		9		I	Hs
<i>Holoxea furtiva</i> Topsent, 1892		7, 9		I	Hs
<i>Stelletta dorsigera</i> Schmidt, 1864		9, 12		II	Hs
<i>Stelletta grubii</i> (Schmidt, 1862)		9		I	Hs
<i>Stelletta stellata</i> Topsent, 1893		9		I–II	Hs
<i>Stryphnus ponderosus</i> (Bowerbank, 1866)		9		III	Hs
Family: Pachastrellidae					
<i>Thenia muricata</i> (Bowerbank, 1858)	3	9		III–VII	Hs
Family: Geodiidae					
<i>Erylus discophorus</i> (Schmidt, 1862)		5, 7, 8, 9	28	I	Hs
<i>Geodia cydonium</i> (Jameson, 1811)	1, 3, 20	7, 8, 9, 13, 15		I–III	Hs
<i>Geodia conchilega</i> Schmidt, 1862	3	8, 9		I	Hs
<i>Geodia tuberosa</i> Schmidt, 1862	3			I	Hs
<i>Penares euastrum</i> (Schmidt, 1868)		9		III	
<i>Penares helleri</i> (Schmidt, 1864)		15		I	Hs

**Table.** (Continued).

Family: Calthropellidae					
<i>Calthropella stelligera</i> (Schmidt, 1868)		9		I	Hs
Family: Thoosidae					
<i>Alectona millari</i> Carter, 1879		7	28	I	Hs
Family: Mycalidae					
<i>Mycale (Aegogropila) contareni</i> (Martens, 1824)	3	8,9	28	I-III	Hs
<i>Mycale (Aegogropila) rotalis</i> (Bowerbank, 1874)		8,9	28	I-III	Hs
<i>Mycale (Aegogropila) tunicata</i> (Schmidt, 1862)		8,9		I-III	Hs
<i>Mycale (Mycale) lingua</i> (Bowerbank, 1866)			28	I	Hs
<i>Mycale (Carmia) macilenta</i> (Bowerbank, 1866)		8,9		I-III	
<i>Mycale (Mycale) massa</i> (Schmidt, 1862)	3	7,9	28	I-III	Hs
Family: Tetillidae					
<i>Craniella cranium</i> (Müller, 1776)		9		III	Hs
Family: Samidae					
<i>Samus anonymus</i> Gray, 1867		9		I	Hs
Family: Plakinidae					
<i>Plakina monolopha</i> Schulze 1880		9		I	Hs
Family: Agelasidae					
<i>Agelas oroides</i> (Schmidt, 1862)	19	9, 15, 23	26	I-III	Hs
Family: Myxillidae					
<i>Myxilla (Myxilla) prouhoi</i> (Topsent, 1892)		9		II-III	Hs
<i>Myxilla (Myxilla) rosacea</i> (Lieberkühn, 1859)		7, 8, 9, 15		I-III	Hs
Family: Coelosphaeridae					
<i>Lissodendoryx (Anomodoryx) cavernosa</i> (Topsent, 1892)		8		I	Hs
Family: Crambeidae					
<i>Crambe crambe</i> (Schmidt, 1862)		7,9	26, 28	I-II	Hs
Family: Crellidae					
<i>Crella (Crella) elegans</i> (Schmidt, 1862)	6			IV	Hs
<i>Crella (Pytheas) fusifera</i> Sarà, 1969		9		II	Hs
Family: Hymedesmiidae					
<i>Hemimycale columella</i> (Bowerbank, 1874)		15	26, 28	I	Hs
<i>Phorbas fictitius</i> (Bowerbank, 1866)	1, 3		26, 28	I-II	Hs
<i>Phorbas plumosus</i> (Montagu, 1818)			28	I	Hs
<i>Phorbas tenacior</i> (Topsent, 1925)			26	II	Hs
Family: Acarnidae					
<i>Acarnus tortilis</i> Topsent, 1892		8,9		I-II	Hs
Family: Tedaniidae					
<i>Tedania (Tedania) anhelans</i> (Lieberkühn, 1859)	3	8, 9, 13, 15		I-II	Hs

**Table.** (Continued).

Family: Raspailiidae					
<i>Raspailia (Raspailia) viminalis</i> Schmidt, 1862	PS3	9, 11, 15		II	Hs
Family: Microcionidae					
<i>Clathria (Clathria) coralloides</i> (Olivi, 1792)		15		II	Hs
<i>Clathria (Microciona) strepsitoxa</i> (Hope, 1889)	22	23		I–III	Hs
<i>Clathria (Thalysias) jolicoeuri</i> (Topsent, 1892)		8, 12		II	Hs
Family: Desmacellidae					
<i>Desmacella inornata</i> (Bowerbank, 1866)			28	I	Hs
Family: Irciniidae					
<i>Ircinia dendroides</i> (Schmidt, 1862)			28	I	Hs
<i>Ircinia variabilis</i> (Schmidt, 1862)	3	15	26	I–II	Hs
<i>Sarcotragus foetidus</i> Schmidt, 1862	3	12, 15, 18, 20, 24	28	I–II	Hs
<i>Sarcotragus spinosulus</i> Schmidt, 1862			26, 28	II	Hs
Family: Dysideidae					
<i>Dysidea avara</i> (Schmidt, 1862)	3	13, 15	26	I–III	Hs
<i>Dysidea fragilis</i> (Montagu, 1818)	28	3	15	27	I–III
<i>Dysidea incrustans</i> (Schmidt, 1862)		2, 3		I	Hs
<i>Dysidea tupha</i> (Martens, 1824)		15		I	Hs
<i>Pleraplysilla spinifera</i> (Schulze, 1879)			26	II	Hs
Family: Thorectidae					
<i>Cacospongia mollior</i> Schmidt, 1862	3			I	Hs
<i>Fasciospongia cavernosa</i> (Schmidt, 1862)	1, 3			I–II	Hs
<i>Hyrtios collectrix</i> (Schulze, 1880)			27	II	Hs
<i>Scalarispongia scalaris</i> (Schmidt, 1862)	3	15	26, 27	I–II	Hs
Family: Spongiidae					
<i>Hippospongia communis</i> (Lamarck, 1814)	3	13, 15		II–III	Hs
<i>Spongia (Spongia) officinalis</i> Linnaeus, 1759	3, 14, 15, 17, 21	13, 15, 18	4, 26	I–III	Hs
<i>Spongia (Spongia) virgultosa</i> (Schmidt, 1868)		15		I	Hs
Family: Aplysinidae					
<i>Aplysina aerophoba</i> Nardo, 1843	3, 16	11, 15, 18, 23	26, 28	I–III	Hs
Family: Chondrillidae					
<i>Chondrilla nucula</i> Schmidt, 1862			26	II	Hs
<i>Chondrosia reniformis</i> Nardo, 1847	13	15, 18, 23	26, 28	I	Hs

1: Colombo (1885), 2: Ostroumoff (1894), 3: Ostroumoff (1896), 4: Gruvel (1931), 5: Demir (1952–1954), 6: Casper (1968), 7: Sarıtaş (1972), 8: Sarıtaş (1973), 9: Sarıtaş (1974), 10: Pınar (1974), 11: Geldiay and Kocataş (1972), 12: Kocataş (1978), 13: Yazıcı (1978), 14: Okuş (1986), 15: Ergüven et al. (1988), 16: Bayhan et al. (1989), 17: Balkıs (1992), 18: Ergen et al. (1994), 19: Ergen and Çınar (1994), 20: Çınar and Ergen (1998), 21: Kocak et al. (1999), 22: Topaloğlu (2001), 23: Topaloğlu (2001b), 24: Çınar et al. (2002), 25: Uysal et al. (2002), 26: Gözcelioğlu (2011), 27: Gözcelioğlu et al. (2011), 28: Evcen and Çınar (2012), 29: Topaloğlu et al. (2013).

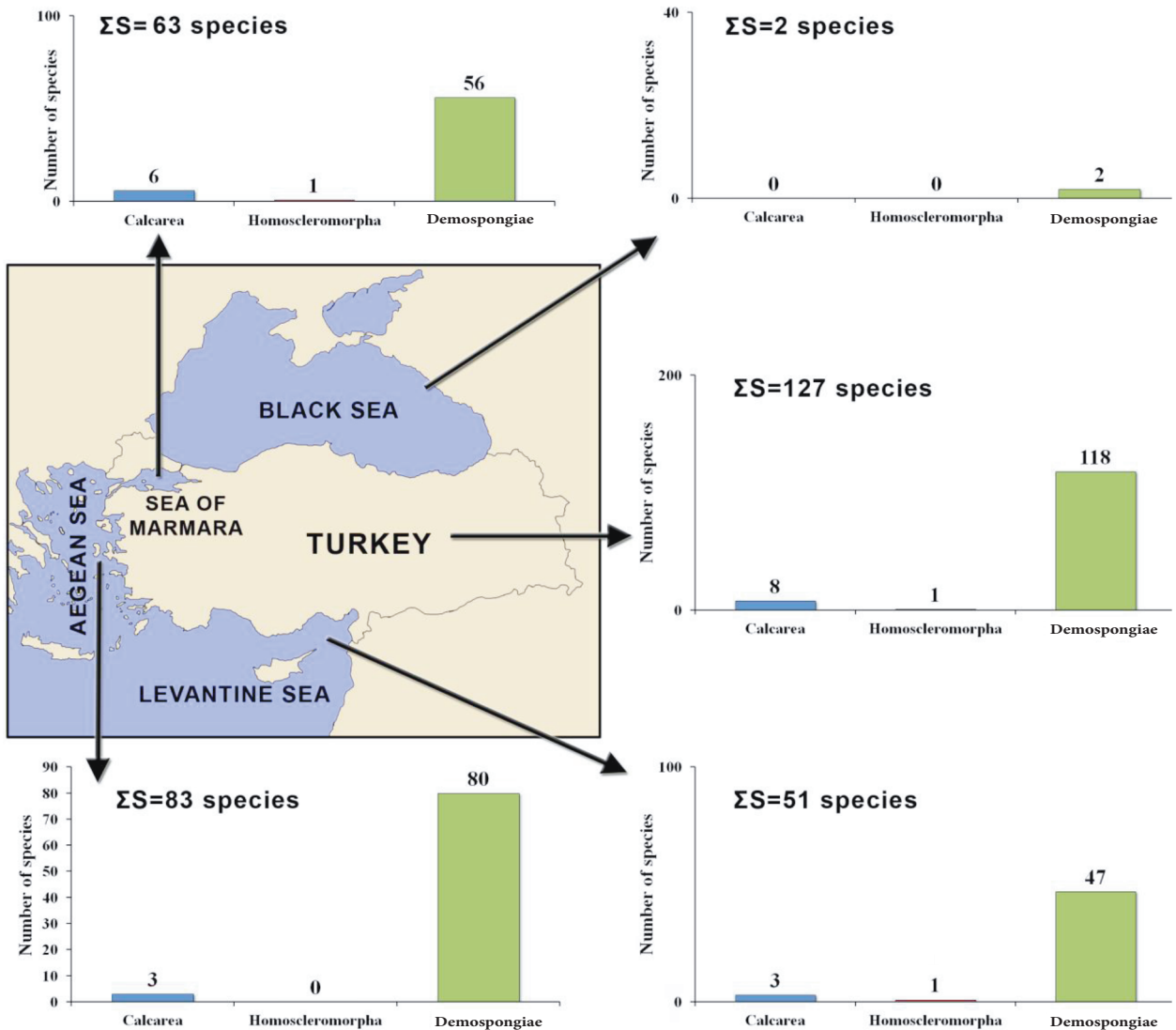


Figure 2. The number of sponge species according to seas.

*Rhizaxinella elongata* (Ridley and Dendy, 1886)

**Material examined:** One specimen from Saros Bay (station 1), 100–200 m depth, bottom-trawling (see Figure 1).

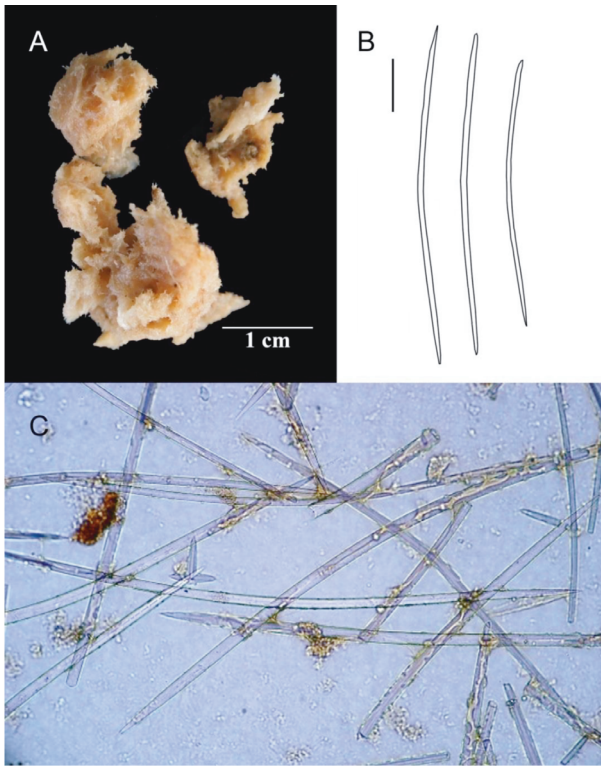
**Description:** The species is a yellowish gray, stalked, oval, solid sponge. It has fine hispid surface and firm consistency. The body is solid, elongated, up to 6 cm long. Spicules: Styles and tylostyles, long, smooth, in 3 categories: long styles: 1750–2000 × 14–16 μm, intermediate styles: 500–2000 × 5–6 μm, and small tylostyles: 200–400 × 3–6 μm (Figure 4). Previously it has been reported from the eastern Mediterranean Sea (Carteron, 2002).

*Terpios gelatinosa* (Bowerbank, 1866)

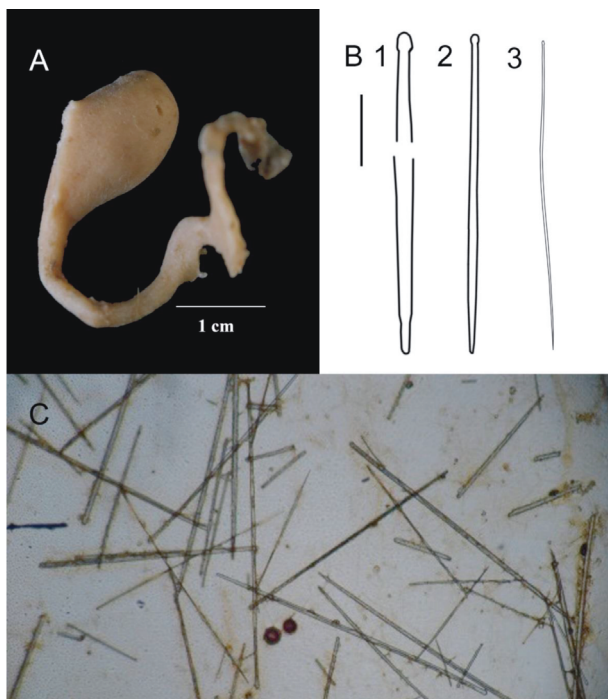
**Material examined:** Many specimens from Ildırı Bay, Çeşme (station 2), 0–10 m, scuba diving (see Figure 2).

**Description:** It is recognizable by its blue colors. The blue or orange-yellow color persists in alcohol and in dried specimens. Oscules are minute, not distinct to the naked eye. Surface is smooth and hispid, quite thin. Spicules: only tylostyles (200–480 × 4–8 μm), have well-developed head. Tylostyle's apex of the lobes is divided in various ways. Lobate swellings are a characteristic feature of the genus *Terpios*. Forming the skeleton, spicules are connected to each other in the form of a brush (Figure 5). *Terpios gelatinosa* is very common on rocky substrata and the undersides of boulders. In the Mediterranean it occurs on algae and other sponges, and it occurs on the Aegean coasts and islands, where it has been recorded in various habitat types by several authors (Pérès and Picard, 1958; Voultsiadou, 2005; Gerovasileiou and Voultsiadou, 2013).

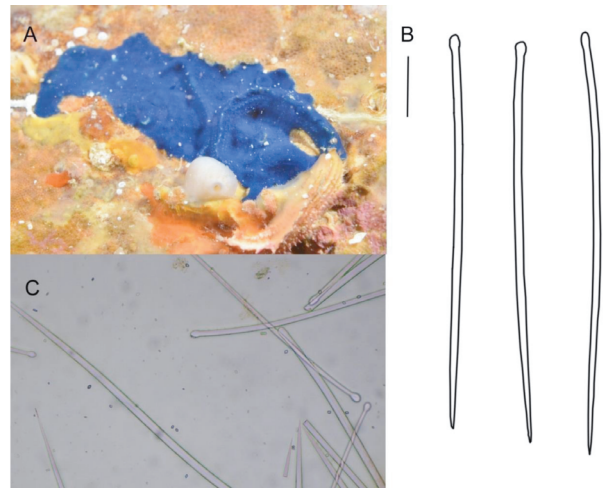




**Figure 3.** A) Photograph of *Axinyssa digitata*. B) Spicules of *Axinyssa digitata*: oxeas. Scale: 100  $\mu$ m. C) Overview of spicules.



**Figure 4.** A) Photograph of *Rhizaxinella elongata*. B) Spicules of *Rhizaxinella elongata*: 1- long tylostyles, 2- intermediate tylostyles, 3- small tylostyles. Scale: 1- 300  $\mu$ m, 2- 100  $\mu$ m, 3- 50  $\mu$ m. C) Overview of spicules.



**Figure 5.** A) Photograph of *Terpios gelatinosa*. B) Spicules of *Terpios gelatinosa*: tylostyles. Scale: 100  $\mu$ m. C) Overview of spicules.

The pioneer studies on sponges along the coasts of Turkey were carried out by Colombo (1885), Ostroumoff (1894, 1896), and Demir (1952–1954). The species *Geodia baretti* was listed in the Sea of Marmara in the previous checklist by Evcen and Çınar (2012), based on reports by Colombo (1885), Ostroumoff (1894, 1896), and Demir (1952–1954). The global distribution of the species is in the Arctic, Norway, Sweden, and North Atlantic (according to World Porifera Database, 2014). The orthotrien spicules that Demir (1952–1954) mentioned in the description of the species are characteristic to *Geodia cydonium*. Topaloğlu (1999) also pointed out this fact after personal communication with RVM Van Soest. However, *Geodia gigas* and *Geodia placenta* are considered synonyms of *Geodia cydonium* (Jameson, 1811) (Cárdenas, 2010; Cárdenas et al., 2013). Therefore, *G. baretti*, *G. gigas*, and *G. placenta* were eliminated from the checklist.

Ostroumoff (1896) reported 2 new species from the Sea of Marmara. These [*Cometella stolonifera* (Ostroumoff, 1896) and *Suberites appendiculatus* (Ostroumoff, 1896)] are actually considered to be nomen nudum (Evcen and Çınar, 2012). According to the World Porifera Database, however, *Oceanapia robusta* (Bowerbank, 1866) (given by Ostroumoff, 1896) has not been recorded from the Mediterranean Sea. Therefore, *O. robusta* was removed from the checklist.

The highest number of species was reported from the Aegean Sea (Sarıtaş, 1972, 1973, 1974; Kocataş, 1978; Yazıcı, 1978; Ergüven, 1988; Ergen and Çınar, 1994; Ergen et al. 1994; Kocak et al., 1999; Topaloğlu, 2001; Çınar et al., 2002). While the Mediterranean records of

*Lissodendoryx isodictyalis* and *Rhabderemia indica* (given by Saritaş, 1972, 1973, 1974) are considered invalid, *Clathrina coriacea* (Ergüven, 1988) has not been recorded in the Mediterranean Sea according to the World Porifera Database (2014). The number of publications on sponges in the Aegean Sea is relatively high compared to the other coasts of Turkey. The area also has many suitable habitats for sponges, like rock reefs and islands. Three new records of sponges are also being reported from the Aegean Sea in the present study.

The sponge species from the Levantine Sea were reported by Gruvel (1931), Gözcelioğlu (2011), and Evcen and Çınar (2012). According to Evcen and Çınar (2012), the biodiversity of sponges has rarely been a subject of study in the Levantine Sea. The authors reported 29 sponge species in the area, 8 of which were new records for the marine fauna of Turkey. Gözcelioğlu (2011) reported 27 sponge species from the Aegean and Mediterranean coasts of Turkey and 5 of those species were new records for the marine fauna of Turkey. In total, 49 sponge species have been reported from the Levantine Sea coast of Turkey.

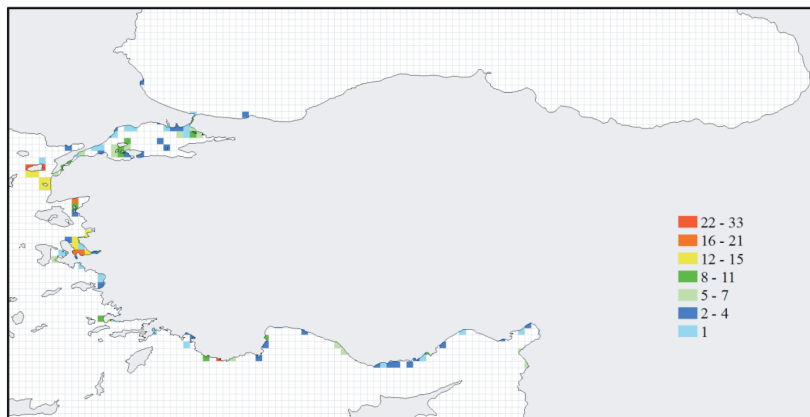
Only 2 species [*Dysidea fragilis* (Montagu, 1814) and *Suberites domuncula* (Olivi, 1792)] were reported from the western Black Sea coast of Turkey by Topaloğlu et al. (2013). Kaminskaya (1968) reported 26 sponge species, of which 5 species were endemic, for all of the Black Sea. The western part of the Black Sea may be more diverse than the eastern part for sponge species due to Mediterranean-originated currents that flow to the Black Sea via the İstanbul Strait.

The highest number of sponge species was reported from the Aegean Sea (83), where many suitable habitats for sponges exist, like rock reefs and islands. This is followed by the Sea of Marmara (63), where the sponge species were mostly sampled from the islands. The Sea of Marmara is

called the Turkish Straits System (TSS) together with the Çanakkale and İstanbul Straits. This area also represents a biological corridor, a barrier, and a transitional zone between the Mediterranean and Black sea basins. On the other hand, the straits allow the acclimatization of certain species of Mediterranean origin such as decapod crustaceans, anthozoans, and sponges penetrating to the Sea of Marmara and Black Sea (Öztürk and Öztürk, 1996). Therefore, many benthic species were not able to pass through the TSS and populated in the Black Sea. According to Oğuz and Öztürk (2011), one-third of benthic and pelagic taxa were able to migrate and settle successfully in the Black Sea.

According to data available, the hotspot area in terms of sponge species richness is Gökçeada, where more than 27 species were found in 2 grids (15 × 15 km) (Figure 6). The other areas with relatively high numbers of sponge species are Edremit Bay, İzmir Bay, and Kaş. Almost all areas of the Black Sea (except for 2 grids) and the majority of areas of the other seas remain unexplored in terms of sponge species.

This study compiled the diversity of sponge studies for the Turkish marine fauna. Some authors reported sponge species in some specific areas, such as Ergüven et al. (1988) for Gökçeada, Topaloğlu (2001) for the Sea of Marmara, and Evcen and Çınar (2012) for the Levantine Sea. Evcen and Çınar (2012) presented a checklist for sponge fauna of Turkey with 116 species. The present study has increased the number of sponge species known from the coasts of Turkey to 128. We think that sponges are actually more diverse. More studies are needed, especially for the Black Sea coast. In this way, the actual number of sponge species in Turkey will be available, and their function in the marine ecosystem will become clearer.



**Figure 6.** The number of sponge species along the coasts of Turkey. Each grid is 15 × 15 km in dimension.

## Acknowledgments

We are grateful to 2 anonymous referees for their constructive comments. This work was partially supported by TÜBİTAK (Project Number: 111Y141). We thank Prof

Bayram Öztürk and Prof Melih Ertan Çınar for their great supervising, Assoc Prof Dr Kerem Bakır and Unsal Karhan for great help, and Dr Ayaka Amaha Öztürk for the correction of the English of the text.

## References

- Balkıs H (1994). Marmara Adası littoralinin makrobentosu üzerine bir ön araştırma. Bülten 9: 309–327 (in Turkish).
- Bayhan H, Tunçdilek N, Şakar S (1989). Avşa Adası littoral zonu üzerine gözlemler. In: Çevre 89. 1. Ekoloji ve Çevre Kongresi, Çukurova, Turkey, pp. 580–591 (in Turkish).
- Burton M (1936). The fishery grounds near Alexandria. IX. Sponges. Notes Mem Fish Res Cairo 17: 1–28.
- Cárdenas P (2010). Phylogeny, taxonomy and evolution of the Astrophorida (Porifera, Demospongiae). PhD, University of Bergen, Bergen, Norway.
- Cárdenas P, Pérez T, Boury-Esnault N (2012). Sponge systematics facing new challenges. Advan Mar Biol 61: 79–209.
- Cárdenas P, Rapp HT, Klitgaard AB, Best M, Thollesson M, Tenda OS (2013). Taxonomy, biogeography and DNA barcodes of *Geodia* species (Porifera, Demospongiae, Tetractinellida) in the Atlantic boreo-arctic region. Zool Jour Linn Soc 169: 251–311.
- Carteron S (2002). Etude taxonomique des spongiaires du Liban. Stage de Maîtrise. Marseille, France: Centre d'Océanologie de Marseille (in French).
- Caspers H (1968). La macrofaune benthique du Bosphore et les problèmes de l'infiltration des éléments méditerranéens dans la mer Noire. Rapp Comm Int Mer Medit 19: 107–115 (in French).
- Çınar ME, Ergen Z (1998). Polychaetes associated with the sponge *Sarcotragus muscarum* Schmidt, 1864 from the Turkish Aegean coast. Ophelia 48: 167–183.
- Çınar ME, Katakın T, Ergen Z, Sezgin M (2002). Zoobenthos inhabiting *Sarcotragus muscarum* (Porifera: Demospongiae) from the Aegean Sea. Hydrobiologia 482: 107–117.
- Coll M, Piroddi C, Steenbeek J, Kaschner K, Lasram FBR, Aguzzi J, Ballesteros E, Bianchi CN, Corbera J, Dailianis T et al. (2010). The biodiversity of the Mediterranean Sea: estimates, patterns, and threats. PLoS One 5: 1–36.
- Colombo A (1885). Raccolte Zoologiche Eseguite dal R. Pirascafa Washington nella campagna abissale Talassografica dell'anno. Riv Mar 18: 22–53 (in Italian).
- Dalkılıç N (1982). Sünger Kültür Çalışmaları. Bodrum, Turkey: Tarım ve Orman Bakanlığı Sünger Geliştirme – İşleme İstasyonu ve Eğitim Merkezi Müdürlüğü (in Turkish).
- Demir M (1952–1954). Boğaz ve Adalar sahillerinin omurgasız dip hayvanları. Hidrobiyol Araş Enst Yay 3: 1–615 (in Turkish).
- Devedjian K (1926). Pêche et pêcheries en Turquie. İstanbul, Turkey: Imprimerie de l'Administration de la Dette Publique Ottomane (in French).
- Ergen Z, Çınar ME (1994). Ege Denizinde dağılım gösteren *Cystoseria* fasiesinin kalitatif ve kantitatif yönden araştırılması. In: XII. Ulusal Biyoloji Kongresi, Edirne, Turkey, pp. 138–149 (in Turkish).
- Ergen Z, Kocataş A, Katakın T, Çınar ME (1994). Gencilim Limanı (Aliğa – İzmir) bentik faunası. EÜ Fen Fak Derg 16: 1047–1059 (in Turkish).
- Ergüven H, Ulutürk T, Öztürk B (1988). Gökçeada'nın Porifera (sünger) faunası ve üretim imkanları. İst Üniv Su Ürün Der 2: 173–189.
- Evcen A, Çınar ME (2012). Sponge (Porifera) from the Mediterranean coast of Turkey (Levantine Sea, eastern Mediterranean), with a checklist of sponges from the coasts of Turkey. Turk J Zool 36: 460–464.
- Geldiay R, Kocataş A (1972). İzmir Körfezinin bentosu üzerine preliminary bir araştırma. Ege Üniv Fen Bil Monogr Ser 12: 3–33 (in Turkish).
- Gerovasileiou V, Voultziadou E (2013). Marine caves of the Mediterranean sea: a sponge biodiversity reservoir within a biodiversity hotspot. PLoS One 7: e39873.
- Gökalp N (1974). Türkiyede ilk sünger yetiştirme tecrübeleri. Teknik rapor. İstanbul, Turkey: İ.Ü. Fen Fakültesi Hidrobiyoloji Enstitüsü (in Turkish).
- Gözcüoğlu B (2011). Denizlerimizin Sakinleri. Ankara, Turkey: Gökçe Ofset (in Turkish).
- Gözcüoğlu B, Van Soest RWM, Proksh P, Konuklugil B (2011). Contribution to the knowledge of the Demospongiae (Porifera) fauna of Turkey. Zool Middle East 54: 149–152.
- Gruvel A (1931). Les états de Syrie. Richesses marines et fluviales, Exploitation actuelle- Avenir. Paris, France: Bibliothèque de la faune des colonies françaises (in French).
- Ilan M, Ben-Eliahu MN, Galil BS (1994). Three deep water sponges from the Eastern Mediterranean and their associated fauna. Ophelia 39: 45–54.
- Ilan M, Gugel J, Galil BS, Janussen D (2003). Small bathyal sponge species from East Mediterranean revealed by a nonregular soft bottom sampling technique. Ophelia 57: 145–160.
- Kaminskaya LD (1968). Klass gubok-Porifera (Sponge-Porifera). In: Opredelitel' fauny Chernogo i Azovskogo morey. Kiev, Ukraine: Naukova Dumka, pp. 35–55 (in Russian).
- Katakın T, Kocataş A, Bilecik N, Yılmaz H (1991). Sünger ve Süngercilik. Trabzon, Turkey: Tarım Orman ve Köy İşleri Bakanlığı Su Ürünleri Araştırma Enstitüsü Müdürlüğü Yayın No: 560 (in Turkish).

- Kocak F, Ergen Z, Çınar ME (1999). Fouling organisms and their developments in a polluted and an unpolluted marina in the Aegean Sea (Turkey). *Ophelia* 50: 1–20.
- Kocataş A (1978). İzmir Körfezi kayalık sahillerinin bentik formları üzerinde kalitatif ve kantitatif araştırmalar. *Ege Üniv Fen Bil Monog Ser 12*: 1–93 (in Turkish).
- Lévi C (1956). Spongiaires des côtes d'Israel. *Bull Res Counc Isr B* 6: 201–212.
- Oğuz T, Öztürk B (2011). Mechanisms impeding natural Mediterraneanization process of Black Sea fauna. *J. Black Sea/Mediterr Environ* 17: 234–253.
- Okuş E (1986). Marmara Adası (Kuzey) littoralinde yapılan araştırmalar. *Bült İÜ Deniz Bil Coğ Enst* 6: 143–166 (in Turkish).
- Ostroumoff A (1894). Dal'neishie materialyi k estestvennoi istoriyii Bosfora. *Bull Acad Imp Sci Saint Petersb* 74: 1–46 (in Russian).
- Ostroumoff A (1896). Otchet o dragirovkax i planktonnyix ulovax ekspeditsii "Selyanika". *Bull Acad Imp Sci Saint Petersb* 5: 33–92 (in Russian).
- Öztürk B, Öztürk AA (1996). On the biology of the Turkish Straits System. *Bulletin de l'Institut oceanographique, Monaco* 17 (special issue): 205–221.
- Pansini M, Longo C (2003). A review of the Mediterranean Sea sponge biogeography with, in appendix, a list of the demosponges hitherto recorded from this sea. *Biogeographia* 24: 251–262.
- Péres J, Picard JM (1958). Recherches sur les peuplements benthiques de la Méditerranée nord-orientale. *Ann Inst Oceanogr* 34: 213–291 (in French).
- Perez T, Vacelet J, Bitar G, Zibrowius H (2004). Two new lithistids (Porifera: Demospongiae) from a shallow Eastern Mediterranean cave (Lebanon). *J Mar Biol Assoc* 84: 15–24.
- Pınar E (1974). Türkiye'nin bazı limanlarında Fouling-Boring organizmalar ve Antifouling-Antiboring boyaların bular üzerine etkisi. *EÜ Fen Fak İlmî Rap Ser* 170: 1–67 (in Turkish).
- Rützler K (1978). Sponges in coral reefs. In: Stoddart DR, Johannes RE, editors. *Coral Reefs: Research Methods*. Paris, France: UNESCO, pp. 209–313.
- Sarıtaş MÜ (1972). Engeceli Limanı'nın silisli sünger (Porifera) faunası hakkında preliminar bir çalışma. *Ege Üniv Fen Bil İlmî Rap Ser* 143: 3–22 (in Turkish).
- Sarıtaş MÜ (1973). Edremit, Altınoluk Sahilinde *Posidonia oceanica* (L.) üzerinde tesbit edilen bazı sünger türleri. *Ege Üniv Fen Bil İlmî Rap Ser* 168: 3–21 (in Turkish).
- Sarıtaş MÜ (1974). İzmir Körfezi'nde yaşayan silisli süngerler (Porifera) üzerinde sistematik araştırmalar, PhD, Diyarbakır University, Diyarbakır, Turkey (in Turkish).
- Topaloğlu B (1999). Marmara littoralinde sünger (Porifera) populasyonları üzerine araştırmalar. PhD, İstanbul University, İstanbul, Turkey (in Turkish).
- Topaloglu B (2001). Sponge fauna in the littoral zone of the Marmara Sea. *Rapp Comm Int Mer Medit* 36: 421.
- Topaloğlu B (2001). Gökçeada kuzey sahili sünger faunası üzerine bir ön çalışma. In: Öztürk B, Aysel V, editors. *Ulusal Ege Adaları 2001 Toplantısı Bildiriler Kitabı*. İstanbul, Turkey: Türk Deniz Araştırmaları Vakfı, pp. 97–102 (in Turkish).
- Topaloglu B, Sezgin M, Bat L, Zengin M, Karakulak S (2013). First documented report of two sponge species in the Black Sea Coast of Turkey. *CIESM Rapp Comm Int Mer Medit* 40: 899.
- Tsurnamal M (1967). *Chelonaplysilla erecta*, n. sp. (Demospongiae, Keratosa) from Mediterranean coast of Israel. *Isr J Zool* 16: 96–100.
- Tsurnamal M (1969). Sponges of Red Sea origin on the Mediterranean coast of Israel. *Isr J Zool* 18: 149–155.
- Uysal A, Yuksek A, Okus E, Yilmaz N (2002). Benthic community structure of the Bosphorus and surrounding area. *Wat Scien Techn* 46: 37–44.
- Vacelet J, Bitar G, Carteron, S, Zibrowius H, Perez T (2007). Five new sponge species (Porifera: Demospongiae) of subtropical or tropical affinities from the coast of Lebanon (eastern Mediterranean). *J Mar Biol Assoc* 87: 1539–1552.
- Vacelet J, Perez T (2008). *Phorbas topsenti* and *Phorbas tailliezi* (Demospongiae, Poecilosclerida), new names for the Mediterranean '*Phorbas paupertas*' and '*Phorbas coriaceus*'. *Zootaxa* 1873: 26–38.
- Van Soest RWM, Boury-Esnault N, Hooper JNA, Rützler K, de Voogd NJ, Alvarez de Glasby B, Hajdu E, Pisera AB, Manconi R, Schoenberg C et al. (2014) World Porifera Database. Available at <http://www.marinespecies.org/porifera>.
- Voultsiadou E (2005) Sponge diversity in the Aegean Sea: Check list and new information. *Ital J Zool* 72: 53–64.
- Voultsiadou E (2009). Reevaluating sponge diversity and distribution in the Mediterranean Sea. *Hydrobiologia* 628: 1–12.
- Voultsiadou-Koukoura, Van Soest RWM (1993). Suberitidae (Demospongiae, Hadromerida) from the North Aegean Sea. *Beaufortia* 43: 176–186.
- Yazıcı M (1978). Gökçeada ve Bozcaada civarında saptanan Porifera türleri. *Biyol Der* 28: 109–121.