Bioeroding sponge species (Porifera) in the Aegean Sea (Eastern Mediterranean)

Alper Evcen*, Melih Ertan Çınar

Department of Hydrobiology, Faculty of Fisheries, Ege University, 35100 Bornova, İzmir – TURKEY

*Corresponding author: alperevcen@gmail.com

Abstract

In the present study, a total of 11 bioeroding sponge species belonging to 4 families were found on rocky substrata in İldırı Bay (eastern Mediterranean), five of which (Dotona pulchella mediterranea, Volzia albicans, Delectona madreporica, Siphonodictyon infestum and Thoosa mollis) are new records for the eastern Mediterranean fauna. The most abundant and frequent species in the area were Chondrosia reniformis, Spirastrella cuntatrix and Cliona celata. The morphological and distributional features of the species that are new to the Turkish marine fauna are presented. In addition, a checklist of the bioeroding sponge species reported from the Mediterranean coasts to date is provided.

Keywords: Bioerosion, boring sponges, biodiversity, Mediterranean, Aegean Sea, Turkey

Introduction

Bioerosion is the degradation of substrates as a consequence of the drilling and abrasive activities of various marine organisms inhabiting calcareous substrates (Neumann 1966). In the marine ecosystem, various organisms have synergic effects in eroding rocks that enable the introduction of CaCO₃ into the marine environment, which can be later utilized by other organisms (Ruetzler 1975). With a general expression, sponge bioerosion is a result of tissue expansion of the endolithic sponges into rocky formations (Schoenberg 2003). Bioeroding sponges are able to transform all kinds of calcareous substrates into free calcareous particles and mineral elements dissolved in water by chemical and mechanical processes (Schoenberg 2002). Apart from calcareous substrata, Chondrosia reniformis is known to erode quartz formations and later incorporate the etched particles into its body tissue (Bavestrello et al. 1995; 2003). It is still enigmatic what percent of the substrate dissolution results from these chemical and mechanical processes. Ruetzler and Rieger (1973) postulated that only 2-3% of the abraded surface dissolves chemically, while the
rest dissolves mechanically. The amount of the calcium carbonate removed from the substrate due to the annual bioerosion occurring on the coral reefs was estimated to be 50 - 90% (Reis and Leão 2000). The excavating sponges not only cause erosion on the calcareous rocks but also have great impacts on the breakwaters and other concrete structures (Scott et al. 1988).

Rosell and Uriz (2002) published the first comprehensive list of the bioeroding sponges in the western Mediterranean. In the eastern Mediterranean, there is no study specifically dealing with these species. However, Voultsiadou (2005) previously reported 13 boring sponges in the Aegean Sea. Prior to the present study, a total of nine bioeroding sponge species have been reported from the coasts of Turkey, which belonged to Spirastrellidae (Diplastrella bistellata and Spirastrella cunctatrix), Clionidae (Cliona celata, C. vermisfera, C. viridis, C. schmidtii and Clithoosa hancocki), Thoosidae (Alectona millari) and Chondrillidae (Chondrosia reniformis) (see the checklist given by Evcen and Çınar 2012; Topaloğlu and Evcen 2014).

The aims of this study are to determine the diversity of bioeroding sponge species in the eastern Aegean Sea, and to assess their distributional and morphological features.

**Materials and Methods**

Specimens of sponges were collected between 0 and 35 m depths at 15 stations in İldiri Bay (eastern Aegean Sea) in August 2012 by scuba diving and snorkeling (Figure 1). In the field, sponge specimens were collected with a hammer and chisel. The materials were put in jars and fixed with a 4% formaldehyde solution. The estimation of the percentage coverage of the species at stations was approximate and determined by swimming along a 10 m horizontal line put on substrata and considering a swept area which covered 1 m distance from each side of the line.

In the laboratory, sponge specimens were washed under tap water and preserved in 70% alcohol. Sponge tissues were taken from bioerosion chamber by using a fine-tipped forceps. Permanent preparations of spicules were made following the standard procedure proposed by Ruetzler (1978). A minimum of 20 spicules of each type were measured with an ocular micrometer. The classification used in this work was that proposed by Hooper and Van Soest (2002), with the amendments given in the World Porifera Database (Van Soest et al. 2015).

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

Bioeroding sponge species in Ildırı Bay
A total of 11 bioeroding sponge species belonging to the families Clionidae, Thoosidae, Phloeodictyiidae and Chondrillidae were encountered in Ildırı Bay. Five species (Dotona pulchella mediterranea, Volzia albicans, Delectona madreporica, Siphonodictyon infestum, Thoosa mollis) are new records for the eastern Mediterranean fauna and six species (Cliona janitrix, Dotona pulchella mediterranea, Volzia albicans, Delectona madreporica, Thoosa mollis, Siphonodictyon infestum) for the marine fauna of the eastern part of the Aegean sea (Turkey). The morphological and ecological features of the species are as follows.

Clionaidae d’Orbigny, 1851
Cliona Grant, 1826
Cliona celata Grant, 1826
Cliona celata Grant 1826: 78; Ackers et al. 1992: 69.
Material examined: Station 1, 5–10 m (ESFM–POR/2011–130); Station 2, 5–10 m (ESFM–POR/2011–131); Station 3, 0–5 m (ESFM–POR/2011–132); Station 4, 0–5 m (ESFM–POR/2011–133); Station 5, 5–10 m (ESFM–POR/2011–134); Station 6, 5–10 m (ESFM–POR/2011–135); Station 7, 5–10 m (ESFM–POR/2011–136); Station 8, 5–10 m (ESFM–POR/2011–137); Station 9, 0–10 m (ESFM–POR/2011–138); Station 10, 0–5 m (ESFM–POR/2011–139); Station 11, 0–5 (ESFM–POR/2011–140); Station 12, 0–5 m (ESFM–POR/2011–141); Station 13, 0–5 m (ESFM–POR/2011–142); Station 14, 0–5 m (ESFM–POR/2011–143); Station 15, 3–5 m (ESFM–POR/2011–144).

Description: It has a shiny and yellow appearance under water (Figure 2A), but it becomes brownish in alcohol. It builds galleries by constituting spherical and interconnecting chambers, having a diameter of 1-8 mm within the substrate. Its development has three different stages, namely alpha (=papillae), beta (encrusting) and gamma (developed form). Colonies observed in the study area were at the alpha stage. There is no any structural differentiation between the ectosomal and choanosomal skeletons. Its spicules are only composed of tylostyles (270–450 x 2–9 µm) (Figure 3; 1).

Habitat and distribution: This species were found at all stations in the study area. Its highest coverage (20%) was encountered at station 9, while the lowest coverage (2-5%) at stations 6, 7, 10, 12, 13 and 14. It was previously reported from the Sea of Marmara (Topaloğlu 2001a; 2001b) and Mediterranean Sea (Schmidt 1862; Schmidt 1864; Lendenfeld 1898; Babic 1922; Vatova 1928; Volz 1939; Sarà and Melone 1963; Ruetzler 1965; Grubelić 2001; Pansini and Longo 2008; Demir and Okus 2010; Bakran-Petricioli et al. 2012; Evcen and Cinar 2012) This species was reported on calcareous substrata from shallow waters up to a depth of 200 m in the world’s oceans (Rosell and Uriz 2002; Voultsiadou 2005; Xavier et al. 2010).

*Cliona janitrix* Topsent, 1932

*Cliona janitrix* Topsent 1932: 575; Rosell and Uriz 2002: 72, Figure. 11.

Material examined: Station 1, 0–5 m (ESFM–POR/2011–145); Station 5, 5–10 m (ESFM–POR/2011–146); Station 6, 5–10 m (ESFM–POR/2011–147); Station 8, 0–5 m (ESFM–POR/2011–148).

Description: It has a light yellow appearance under water (Figure 2B), but it becomes white in alcohol. It remains always in the alpha stage of growing (Rosell and Uriz 2002). This sponge does not have any significant papillae space sticking out of the substrate. It builds 2-3 mm wide spherical galleries within the substrate (Figure 2B). The galleries are filled up with soft sponge tissue. The skeletal elements are only tylostyles (150–200 × 3–20 µm) (Figure 3; 2), and these form small groups and spread into the choanosome.
Habitat and distribution: This species was previously reported in association with the bivalve shells (Topsent 1932), but we found it on calcareous rocks at stations 1, 5, 6 and 8, as well as in the shady areas of the rocky walls. Its coverage percentage is less than 1% at all stations. It is a new record for the coasts of Turkey. It was previously reported from the Adriatic Sea (Pansini and Longo 2008), western Mediterranean (Topsent 1932) and Caribbean coasts (Miloslavich et al. 2010).

*Cliona viridis* (Schmidt, 1862)


*Cliona viridis* Rosell and Uriz 2002: 78-82, Figure 17-19.

Material examined: Station 1, 5–10 m (ESFM–POR/2011–149); Station 2, 0–10 m (ESFM–POR/2011–150); Station 3, 5–10 m (ESFM–POR/2011–151); Station 4, 0–5 m (ESFM–POR/2011–152); Station 6, 5–10 m (ESFM–POR/2011–153); Station 8, 5–10 m (ESFM–POR/2011–154); Station 9, 0–10 m (ESFM–POR/2011–155); Station 10, 0–5 m (ESFM–POR/2011–156); Station 12, 0–5 m (ESFM–POR/2011–157); Station 13, 0–5 m (ESFM–POR/2011–158) Station 14, 0–5 m (ESFM–POR/2011–159).

Description: This species has globular and oval papillae of 0.8-12 mm in diameter, sticking out of the substrata. They abrade substrata in the form of small chambers. They develop in three different stages, namely alpha, beta and gamma. The specimens observed were at the alpha stage. Their spicules include tylostyles (400–550 x 10–12 µm) (Figure 3a) and spirasters (15-45 x 1-2 µm) (Figure 3b). While tylostyles are in the form of palisades within the ectosome, their distribution is hardly visible in the choanosome. On the other hand, the spirasters are seen only in the choanosome.

Habitat and distribution: It generally inhabits coralligenous substrata and half-dark cave entrances (Rosell and Uriz 2002). It was found at nine stations in the study area. Its highest coverage (6-8%) was encountered at station 8, while the lowest coverage (1%) at stations 6, 7, 12, 13 and 14. It was previously reported from the Sea of Marmara (Ostroumoff 1896) and the Aegean Sea (Sartaş 1972; 1973; 1974; Kocatas 1978). This species was reported in the Mediterranean Sea (Schmidt 1862; Lendenfeld 1898; Topsent 1925; Vatova 1928; Volz 1939; Sarà and Melone 1963; Labate 1964; Ruetzler 1965; Pulitzer-Finali 1983; Grubelić 2001; Pansini and Longo 2008; Bakran-Petricioli et al. 2012) and the North Atlantic, Pacific and Indian Oceans (Rosell and Uriz 2002), from the shallow waters up to a depth of 367 m (Van Soest et al. 2015).

*Dotona* Carter, 1880

*Dotona pulchella mediterranea* Rosell and Uriz, 2002


Material examined: Station 11, 0–5 m (ESFM–POR/2011–161).
Description: This sponge species has a soft and fragile tissue, which can be easily distinguished from the substrata (Figure 2E). It always grows in the alpha stage. It forms spherical excavation chambers with a width of 3-5 mm and filled up with sponge tissue. Its spicules include styles, which are straight (90–280 x 2–3 μm) or slightly bent in the form of palisades within the skeleton (280–420 x 5–13 μm) (Figure 4a, b), oxeas bent in the middle (115–311 x 6–12 μm) (Figure 4c, d), spiral-spined microstrongyles (40–82 x 5–11 μm) (Figure 4e), and small amphistriers (10–15 x 1–3 μm).

Habitat and distribution: This species was only found on calcareous rocks at station 11. Its coverage percentage was below 1%. It is a new record for the coasts of the eastern Mediterranean and Turkey, while it was previously reported from the western Mediterranean (Rosell and Uriz 2002).

Volzia Rosell and Uriz, 1997
Volzia albicans (Volz, 1939)
Material examined: Station 7, 0–5 m (ESFM–POR/2011–171).

Description: This sponge species always exhibits growth in the alpha stage. Papillae are very small (1-2 mm), and have brown-white color (Figure 4D). This species forms small (2 mm) chambers at an average depth of 25 mm beneath the substrate surface. The interior of such chambers are filled up with whitish fragile sponge tissue. The skeletal elements comprises tylostyles (290–350 x 4–8 μm) (Figure 3; 6a) and oxeas (90–110 μm) (Figure 3; 6b), localized in the excavation chambers of the sponge in the form of palisades in the papillae.

Habitat and distribution: It was previously found on rocks in the shallow waters (Volz 1939). This species is one of the rare species in the present study, occurring solely at station 7. Its coverage percentage is below 1%. It is a new record for the marine fauna of the eastern Mediterranean and Turkey. It is a species endemic to the Mediterranean Sea, previously known from the Adriatic Sea (Volz 1939; Ruetzler 1965; Ruetzler 2002a; Bakran-Perticioli et al. 2012; Pansini and Longo 2008).

Remarks: The Aegean Sea specimen does not have any microsclerites, but Volz (1939) questionably reported the presence of this kind of spicule in this species. The size range of oxeas (90-110 μm) we found was slightly larger than that (88–95 m) given for the Adriatic specimens (Volz 1939).

Spirastrellidae Ridley and Dendy, 1886
Spirastrella Schmidt, 1868
Spirastrella cunctatrix Schmidt, 1868
Material examined: Station 1, 0–10 m (ESFM–POR/2011–174); Station 2, 5–10 m (ESFM–POR/2011–175); Station 3, 0–10 m (ESFM–POR/2011–176); Station 4, 0–5 m (ESFM–POR/2011–177); Station 5, 0–5 m (ESFM–POR/2011–178); Station 7, 5–10 m (ESFM–POR/2011–179); Station 8, 0–10 m (ESFM–POR/2011–180); Station 9, 0–10 m (ESFM–POR/2011–181); Station 10, 0–10 m (ESFM–POR/2011–182); Station 11, 0–10 (ESFM–POR/2011–183); Station 12, 0–10 m (ESFM–POR/2011–184); Station 13, 0–5 m (ESFM–POR/2011–185); Station 14, 0–5 m (ESFM–POR/2011–186); Station 15, 3–5 m (ESFM–POR/2011–187).

Description: It has a shiny orange and red color under the water (Figure 2G). The excavation rooms they form by invading calcareous substrata have various shapes, but their excavation tendency is less than other bioeroding species. There are apparent canals connected to raised osculum above the sponge tissue. The skeletal system comprises small spirasters (10–20 x 5–15 µm) (Figure 3; 5) and tylostyles (400–500 x 8–10 µm). While spirasters are placed in wide gaps, tylostyles are located within smaller spaces and less in number.

Habitat and distribution: This species is common in sea caves, subsurface of the rocks and shady sites. It also occurs in many tropical and subtropical shallow water habitats including coral reefs in particular (Calcinai et al. 2000). It is a common species in İldırı Bay. The high coverage of this species (5%) was observed at stations 2, 4, 5, 10 and 11. It was previously reported from the Levant coast of Turkey (Demir and Okus 2010; Evcen and Cinar 2012). It is a cosmopolitan species (Calcinai et al. 2000; Voultsiadou 2005).

Phloeodictyidae Carter, 1882
Siphonodictyon Bergquist, 1965
Siphonodictyon infestum (Johnson, 1889)
Acca infesta Johnson 1899: 211; Schoenberg and Beuck 2007: 149–1476
Lev.1–3.

Material examined: Station 5, 0–5 m (ESFM–POR/2011–172).

Description: The papillae of this species have white-greenish pale color under water, and the endolithic tissue (within the substrate) has more creamy white or yellowish color (Figure 2F). The tiny papillae stick out of substrata through holes, which are smaller than 1 mm at various distances. Papillae are fragile; the endolithic tissue is weak and soft. The skeletal system comprises monotype, smooth oxeas (110–50 x 10–2 µm) (Figure 3; 8), which are widely bent.

Habitat and distribution: This species lives on sea shells and calcareous rocks. It was found in the Mediterranean at depths down to 679 m (Schoenberg and Beuck 2007). This species was only encountered at station 5, and its coverage percentage was below 1%. It is a new record for the coasts of Turkey. It was
previously reported from the Ionian Sea (Johnson 1899; Schoenberg and Beuck 2007) and North Atlantic Coast (Van Soest 1993).

Remarks: Schoenberg and Beuck (2007) reported strongyles in the chaonosom, but we did not observe this spicule in our sample.

Thoosidae Cockerell, 1925
*Alectona* Carter, 1879
*Alectona millari* Carter, 1879
*Alectona millari* Carter, 1879: 495, Fig. 1–7; Pulitzer–Finali 1983: 501 Fig. 29.

Material examined: Station 1, 0–5 m (ESFM–POR/2011–128).

Description: It has pale rose, small papillae (1-1.5 mm) and brownish endolithic tissue. It always grows in the alpha stage. It has very distinctive diactines (oxeas) and amphister. Oxeas are divided into two categories: aconthoxeas (heavily spined or warty tuberculated) (200-320 x 12-18 µm) and smooth oxeas (64–132 x 6–16 µm), which were sharply bent in the center (Figure 3; 7a). Microscleres are amphister (35–50 x 8–12 µm) (Figure 3; 7b), with slender or conical rays.

Habitat and distribution: This species was found only at station 1 and its coverage percentage was below 1%. In Turkey, it was previously reported from the coasts of Levant (Evcen and Çınar 2012) and Aegean Seas (Sarıtaş 1972). It was also reported from the Indo-Pacific, Atlantic, and the Mediterranean Sea (Ruetzler 2002a).

*Delectona* de Laubenfels, 1936
*Delectona madreporica* Bavestrello, Calcainai, Cerrano, Sarà, 1997

Material examined: Station 6, 5–10 m (ESFM–POR/2011–125).

Description: This species has greyish color in alcohol. It does not have any significant papillae on the exterior part of the specimen. The boring chambers are spherical and ovoid (2–4 mm). The main skeletal system includes tangled, thick rhabds (15–25 x 5–7 µm) (Figure 3; 9a). However, it rarely has toxiform oxeas (60 x 0,5–1 µm) (Figure 3; 9b) and thin amphister (18–20 x 1–2 µm) (Figure 3; 9c).

Habitat and distribution: This species inhabits semi-dark caves with *Leptopsammia pruvoti* Lacaze-Duthiers 1897 and *Madracis pharensis* (Heller 1868) (Bavestrello et al. 1997). It was only found at station 6, with a low (1%) coverage percentage. It is a new species for the marine fauna of the eastern Mediterranean and Turkey. It is a species endemic to the Mediterranean Sea and
was previously reported from the western Mediterranean (Ligurian Sea) (Bavestrello *et al.* 1997).

*Thoosa* Hancock, 1849

*Thoosa mollis* Volz, 1939


Material examined: Station 1, 0–5 m (ESFM–POR/2011–126); Station 2, 5–10 m; (ESFM–POR/2011–127).

Description: This species has a shiny white color under the water; creamy color in alcohol. The individuals we observed did not have any significant papillae. The sponge tissue penetrates into calcareous rocks. Boring chambers have 3–5 mm width. The skeletal elements comprises smooth tylostyles (210–330 x 3–4 μm), oxiaster (20–1 μm) (Figure 3; 10a) and amphiasters (5–0.5 μm) (Figure 3; 10b).

Habitat and distribution: This species was previously found on calcareous rocks between 0–10 meters (Pulitzer–Finali 1983). This species was encountered at two stations in Ildırı Bay, with coverage below 1%. It is a new record for the coasts of Turkey. It is a species endemic to the Mediterranean Sea and was previously reported from the Adriatic (Volz 1939) and Ionian Seas (Pulitzer–Finali 1983).

Chondrillidae Gray, 1872

*Chondrosia* Nardo, 1847

*Chondrosia reniformis* Nardo, 1847

*Chondrosia reniformis* Nardo, 1847: 267.

Material examined: Station 1, 0–5 (ESFM–POR/2011–271); Station 2, 0–10 (ESFM–POR/2011–272); Station 3, 0–5 m (ESFM–POR/2011–273); Station 4, 0–5 m (ESFM–POR/2011–274); Station 5, 0–5 m (ESFM–POR/2011–275); Station 6, 5–10 m (ESFM–POR/2011–276); Station 7, 0–10 m (ESFM–POR/2011–277); Station 8, 5–10 m (ESFM–POR/2011–278); Station 9, 5–10 m (ESFM–POR/2011–279); Station 10, 0–10 m (ESFM–POR/2011–280); Station 11, 0–10 (ESFM–POR/2011–281); Station 12, 0–10 m (ESFM–POR/2011–282); Station 13, 0–5 m (ESFM–POR/2011–283); Station 14, 0–5 m (ESFM–POR/2011–284)

Description: This species was found either alone or in colonies. It has a brownish color under water and in alcohol (Figure 2H). It has a cortex developed by the adhesion of collagenous fibers. The individuals were maximally 20 cm in length, while they reached up to 3 cm in thickness. It does not have any spicules. It etches the substrate by releasing ascorbic acid, and lets
various minerals such as quartz mix in the ectosomal structure (Bavestrello et al. 1995).

Figure 2. Some bioeroding sponge species found in Ildiri Bay. A. Cliona celata, B. Delectona madreporica, C. Cliona viridis, D. Cliona janitrix, E. Dotona pulchella mediterranea, F. Siphonodictyon infestum, G. Spirastrella cunctatrix, H. Chondrosia reniformis
Habitat and distribution: This species was a common species in Ildırı Bay, inhabiting rocky substrata and having a high coverage percentage (generally >%20) at all stations. It was also found at the entrance of submarine caves, and on the vertical walls of caves (Burton 1956). It was previously reported from the Aegean (Yazici 1978; Erguven et. al. 1988; Topaloğlu 2001b) and Levantine (Demir and Okus 2010; Evcen and Cinar 2012) Seas. It seems to be a cosmopolitan species (Boury–Esnault 2002).


Bioeroding sponge species in the Mediterranean Sea
Rosell and Uriz (2002) reported a total of 22 bioeroding sponge species from the Mediterranean Sea. However, almost 39 sponge species belonging to five
families Clionidae, Thoosidae, Phloeodictyidae, Chondrosiidae and Spirastrellidae are known to take part in bioeroding processes in the Mediterranean so far (see Table 1, compiled with the help of Dr. Schoenberg). The bioeroding activity of the families Chondrosiidae and Spirastrellidae is disputable (Bavestrello et al. 1995, Hutchings 2011). Chondrosia reniformis is known to embed sediment, shell fragments, but has not been generally accepted as a bioeroding sponge. However, according to Bavestrello et al. (1995), it has an ability to transform quartz into free silica particles by utilizing the ascorbic acid. According to Calcinai et al. (2000; 2006), spirastrellids have bioerosion capabilities and appear to erode a bit its attachment area. In this respect, we included these two species in the list of bioeroding sponge species in the Mediterranean Sea.

The family Clionidae ranked first in terms of the number of bioeroding species (20 species) in the Mediterranean Sea, followed by Thoosidae (6 species) and Spirastrellidae (3 species).

The boring sponge species are generally reported from the Western Mediterranean (33 species) and the Adriatic Sea (23 species), whereas only 14 species are found in the Aegean Sea, 12 species in the Ionian Sea and eight species in the Levantine Sea (Table 1). In the Sea of Marmara and Black Sea, a total of four (Chondrosia reniformis, Cliona celata, Cliona viridis, Diplastrella bistellata) and three (Cliona lobata, Pione stationis, Pione vastifica) species have been reported up to date, respectively (Topaloğlu and Evcen 2014; Nassonow, 1883; Kaminskaya 1968; Bacescu et al. 1971). Among them, 17 species (Cliona adriatica, C. parenzani, C. burtoni, C. rhodensis, C. topsenti, Volzia albicans, V. rovignensis, Spiroxya sarai, S. heteroclita, S. corallophila, Thoosa mollis, T. tortonesei, Delectona alboransis, D. ciconiae, D. madreporica, Diplastrella ornata, D. bistellata) are endemic to the Mediterranean Sea, the other species are of the Atlantic origin or cosmopolitan. No alien bioeroding sponge species have been reported up to date in the Mediterranean Sea, whereas a spinculan worm, Aspidosiphon elegans (Chamisso and Eysenhardt 1821), which is a Lessepsian invader, is known as a bioeroding alien species (Acik 2008).

The present study sheds more light on the knowledge of bioeroding sponge species diversity in the eastern Mediterranean and increased the number of bioeroding species in the region. Future studies would focus on understanding the diversity of bioeroding sponge species in the eastern Mediterranean and their ecological requirements.
### Table 1. A list of bioeroding sponge species in the Mediterranean Sea

<table>
<thead>
<tr>
<th>Group/Species</th>
<th>Western Mediterranean</th>
<th>Ionian Sea</th>
<th>Adriatic Sea</th>
<th>Aegean Sea</th>
<th>Levantine Sea</th>
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<td><strong>Clionidae</strong></td>
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<td><em>Cliona adriatica</em></td>
<td>Calcmai, et al. 2011</td>
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<td><em>Cliona amphilacava</em></td>
<td>Rützler, 1974</td>
<td>Rosell and Uriz 2002</td>
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<td><em>Cliona burtoni</em></td>
<td>Topsent, 1932</td>
<td>Rützler 1973</td>
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<td><em>Cliona carteri</em> (Ridley, 1881)</td>
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<td><em>Cliona celata</em></td>
<td>Grant, 1826</td>
<td>Boury-Esnault 1971; Pulitzer-Finali 1983; Bertolino <em>et al.</em> 2013</td>
<td>Schmidt 1862; Lendenfeld 1898; Topsent 1925; Volz 1939; Vatova 1928; Volz 1939; Sarà and Melone 1963; Labate 1964; Rützler 1965; Pulitzer-Finali 1983; Grubelić 2001; Pansini and Longo 2008; Bakran-Petricioli <em>et al.</em> 2012</td>
<td>Voultsiadou 2005</td>
<td>Evcen and Çınar 2012</td>
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<td><em>Cliona janitrix</em></td>
<td>Topsent, 1932</td>
<td>Rosell and Uriz 2002; Mustapha <em>et al.</em> 2003</td>
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<td><em>Cliona lobata</em></td>
<td>Hancock, 1849</td>
<td>Rosell and Uriz 2002</td>
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<td><em>Cliona parenzani</em></td>
<td>Corriero and Scalera-Liaci, 1997</td>
<td>Rosell and Uriz 2002; Mustapha <em>et al.</em> 2003</td>
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<td>Rützler &amp; Rützler 1898</td>
<td>Rosell and Uriz 2002; Mustapha <em>et al.</em> 2003</td>
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<td><em>Cliona thosinna</em></td>
<td>Topsent, 1888</td>
<td>Rosell and Uriz 2002</td>
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<td><em>Cliona topsenti</em> (Lendenfed, 1898)</td>
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<td><em>Cliona vermifera</em></td>
<td>Hancock, 1867</td>
<td>Rosell and Uriz 2002</td>
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<td><em>Clotho hancockii</em> (Topsent, 1888)</td>
<td>Rützler 1973; Rosell and Uriz</td>
<td>Pulitzer-Finali 1983</td>
<td>Lendenfeld 1898; Rützler 1965; Pansini</td>
<td>Voultsiadou 2005</td>
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</tr>
<tr>
<td>Group/Species</td>
<td>Western Mediterranean</td>
<td>Ionian Sea</td>
<td>Adriatic Sea</td>
<td>Aegean Sea</td>
<td>Levantine Sea</td>
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<td><strong>Dotona pulchella mediterranea</strong></td>
<td>2002; Mustapha et al. 2003</td>
<td>Rosell and Uriz 2002</td>
<td>and Longo 2003</td>
<td>Schmidt 1862</td>
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<td><strong>Rosell and Uriz, 2002</strong></td>
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<td><strong>Pione hancocki</strong> (Schmidt, 1862)</td>
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<td><strong>Pione vastifica</strong> (Hancock, 1849)</td>
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<td>Pulitzer-Finali 1983</td>
<td>Schmidt 1862; Lendenfeld 1898; Topsent 1925; Volz 1939; Vatova 1928; Volz 1939; Sarà and Melone 1963; Ruetzler 1965; Pulitzer-Finali 1983; Pansini 1987; Grubelić 2001; Pansini Longo 2003; Pansini and Longo 2008</td>
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<td><strong>Spiroxya corallophila</strong> (Calcinai, Cerrano and Bavestrello, 2002)</td>
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<td><strong>Spiroxya sarai</strong> (Melone, 1965)</td>
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<td><strong>Thoosa armata</strong> Topsent, 1888</td>
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Acknowledgments

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Ege Denizi’ndeki (Doğu Akdeniz) delici sünger (Porifera) türleri

Özet


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