

## Checklist of Echinodermata from the coasts of Turkey

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Received: 30.05.2014

Accepted: 31.08.2014

Published Online: 10.11.2014

Printed: 28.11.2014

**Abstract:** According to the benthic studies on echinoderms inhabiting the coasts of Turkey, a total of 91 echinoderm species belonging to 5 classes have been reported. The Aegean Sea coast is represented by the highest number of species (76 species), followed by the Sea of Marmara (64 species), the Levantine Sea (51 species), and the Black Sea (17 species). Sixty-six echinoderm species were found on soft substrata, while 8 species were reported on hard substrata and 17 species on both soft and hard substrata. The majority of the echinoderm species (83 species) were found at depths ranging from 11 to 50 m, while a small number of species (8 species) were reported from the deeper bottoms (>600 m). Six echinoderm species (*Asterias rubens*, *Amphiodia (Amphisipina) obtecta*, *Ophiactis macrolepidota*, *Ophiactis savignyi*, *Diadema setosum*, and *Synaptula reciprocans*) were regarded as alien species.

**Key words:** Echinodermata, Turkish seas, biodiversity, alien species

### 1. Introduction

The phylum Echinodermata is represented by almost 7000 living and 13,000 fossil species in the world's oceans and has 5 classes, namely Crinoidea, Asteroidea, Ophiuroidea, Echinoidea, and Holothuroidea (Pawson, 2007). In the Mediterranean Sea, 154 echinoderm species have been reported to date, with high species richness being encountered in the Aegean Sea (107 species) (Coll et al., 2010). Echinoderm species generally live in the marine benthic environment, but some species have adapted to the pelagic zones and the brackish benthic areas.

The echinoderm fauna along the coasts of Turkey was first studied by Forbes (1843, 1844), who reported 8 species from the Aegean Sea. Some echinoderm species were later reported from the Sea of Marmara (Colombo, 1885; Ostroumoff, 1894, 1896; Marion, 1898). More detailed studies on echinoderms in the Sea of Marmara were conducted by Demir (1952), and Tortonese and Demir (1960), who reported 27 and 44 species in the area, respectively. The other contributions to our understanding of the echinoderm diversity in the Sea of Marmara were made by Balkis (1992), Albayrak (1996), Topaloğlu et al. (2004), Özgür and Öztürk (2010), Altuğ et al. (2011), and Aslan-Cihangir and Pancucci Papadopoulou (2012).

After the studies by Forbes (1843, 1844), the echinoderm species on the Aegean coast of Turkey were then reported in some papers (Geldiay and Kocataş, 1972; Kocataş, 1973, 1976, 1978; Ünsal, 1973; Önen, 1983; Özaydın, 1991; Ergen et al., 1994; Özaydın et al., 1995; Çınar and

Ergen, 1998; Zaitsev and Öztürk, 2001; Çınar et al., 2002, 2005, 2006b, 2008, 2012a; Aslan, 2005; Doğan et al., 2005; Öztürk et al., 2005; Yokeş and Galil, 2006; Öztürk, 2006; Aydın et al., 2007; Özgür and Öztürk, 2007; Dağlı et al., 2008; Altuğ et al., 2011; Aslan-Cihangir, 2012). There are a small number of benthic studies on the echinoderm fauna of the Levantine coast of Turkey (Özaydın et al., 1995, Yokeş and Galil, 2006, Çınar et al., 2006a, Özgür et al., 2008; Çınar, 2012b). In the study conducted by Özgür et al. (2008), 42 and 71 echinoderm species were reported from the Levantine and Aegean coasts of Turkey, respectively.

Along the Black Sea coast of Turkey, echinoderms were studied by Jakubova (1948), Bacescu (1961), Bacescu et al. (1971), Caspers (1968), Kiseleva (1969, 1981), Sezgin et al. (2007), Karhan et al. (2008), and Sezgin and Dağlı (2009).

The aims of the present study were to give a checklist of the echinoderm species reported from the coasts of Turkey to date, and to determine the species richness along the coasts by using a grid system and to assess the areas where weak and intensive research efforts have been focused.

### 2. Materials and methods

A checklist of the echinoderm species from the coasts of Turkey was prepared, based on benthic studies performed in the Turkish Exclusive Economic Zone. The first reports of the species in the areas are indicated in the Table. The substratum types and the depth ranges where the species were encountered are also shown in the Table.

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In order to determine the hotspots of echinoderm diversity and the areas where weak and intensive research efforts have been focused to date, the coasts of Turkey were divided into grids of squares 15 × 15 km. All distribution data of each species were entered into an Excel file and then imported and digitized using ArcGIS 9.3.

### 3. Results and discussion

The compilation of papers regarding the echinoderm fauna along the coasts of Turkey yielded a total number of 91 species belonging to 5 classes (Crinoidea, Asteroidea, Ophiuroidea, Echinoidea, and Holothuroidea) (Table).

**Table.** Checklist of echinoderm species from the coasts of Turkey [\*: Alien species; **BS**: Black Sea; **SM**: Sea of Marmara; **AS**: Aegean Sea; **LS**: Levant 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
<b>ECHINODERMATA</b>						
<b>Crinoidea</b>						
<i>Antedon mediterranea</i> (Lamarck, 1816)		3	2	21	I–V	Ss
<i>Leptometra phalangium</i> (Müller, 1841)		5	18		II–VI	Ss
<b>Asteroidea</b>						
<i>Anseropoda placenta</i> (Pennant, 1777)		3	11	11	I–V	Ss
* <i>Asterias rubens</i> Linnaeus, 1758	28	22			II, III	Hs, Ss
<i>Asterina gibbosa</i> (Pennant, 1777)		7	11	11	I–III	Hs
<i>Asterina pancerii</i> (Gasco, 1870)		3	11	11	I–IV	Ss
<i>Astropecten aranciacus</i> (Linnaeus, 1758)		9	11	11	I–IV	Ss
<i>Astropecten bispinosus</i> (Otto, 1823)		3	11	11	I–V	Ss
<i>Astropecten irregularis</i> (Pennant, 1777)		11	11	11	I–V	Ss
<i>Astropecten irregularis pentacanthus</i> (Delle Chiaje, 1827)		5	17		I–V	Ss
<i>Astropecten jonstoni</i> (Delle Chiaje, 1827)		7	11		I, II	Ss
<i>Astropecten platyacanthus</i> (Philippi, 1837)		4	17		I–III	Ss
<i>Astropecten spinulosus</i> (Philippi, 1837)		7	11	11	I, II	Ss
<i>Chaetaster longipes</i> (Retzius, 1805)			11	11	II–V	Ss
<i>Coscinasterias tenuispina</i> (Lamarck, 1816)		19	11	11	I–III	Hs
<i>Echinaster (Echinaster) sepositus</i> (Retzius, 1783)		3	11	11	I–V	Ss
<i>Hacelia attenuata</i> Gray, 1840		7	11		I–V	Ss
<i>Hymenodiscus coronata</i> (Sars G.O., 1872)			17		I–VII	Ss
<i>Luidia ciliaris</i> (Philippi, 1837)		7	11	11	I–IV	Ss
<i>Luidia sarsii</i> Düben & Koren, in Düben, 1845			11	11	II, III	Ss
<i>Marthasterias glacialis</i> (Linnaeus, 1758)	29	4	11	11	I–V	Hs, Ss
<i>Odontaster mediterraneus</i> (Marenzeller, 1893)			17	21	II–VI	Ss
<i>Ophidiaster ophidianus</i> (Lamarck, 1816)			21	11	III–V	Hs
<i>Peltaster placenta</i> (Müller & Troschel, 1842)		7	11	11	II–VI	Ss
<i>Tethyaster subinermis</i> (Philippi, 1837)			11	21	II–V	Ss

Table. (Continued).

**Ophiuroidea**

<i>Acrocnida brachiata</i> (Montagu, 1804)				21	I, II	Ss
* <i>Amphiodia (Amphispina) oblecta</i> Mortensen, 1940				31	I–III	Ss
<i>Amphipholis squamata</i> (Delle Chiaje, 1828)	15	4	17	29	I–III	Hs, Ss
<i>Amphiura cherbonnieri</i> Guille, 1972		33			II, III	Hs, Ss
<i>Amphiura chiajei</i> Forbes, 1843	29	3	1	29	I–VII	Hs, Ss
<i>Amphiura filiformis</i> (O.F. Müller, 1776)	30	5	17	29	I–V	Hs, Ss
<i>Amphiura lacazei</i> Guille, 1976		33			I	Ss
<i>Amphiura (Ophiopeltis) securigera</i> (Düben & Koren, 1846)		33			I	Ss
<i>Amphiura stepanovi</i> Djakonov, 1954	6				IV, V	Hs
<i>Ophiacantha setosa</i> (Bruzelius, 1805)		3	17		III, IV	Ss
* <i>Ophiactis macrolepidota</i> Marktanner-Turneretscher, 1887				31	I–III	Ss
* <i>Ophiactis savignyi</i> (Müller & Troschel, 1842)			25		I, II	Ss
<i>Ophiactis virens</i> (M. Sars, 1857)			23	21	I, II	Ss
<i>Ophiocten abyssicolum</i> (Forbes, 1843)		5			II–V	Ss
<i>Ophioderma longicauda</i> (Bruzelius, 1805)		3	17		I–III	Ss
<i>Ophiomyxa pentagona</i> (Lamarck, 1816)		3	17	29	I–III	Hs
<i>Ophiopsila annulosa</i> (M. Sars, 1859)			17		II, III	Ss
<i>Ophiopsila aranea</i> Forbes, 1843		5	17	29	II, III	Hs, Ss
<i>Ophiothrix fragilis</i> (Abildgaard, in O.F. Müller, 1789)	6	5	1	21	I–IV	Hs, Ss
<i>Ophiothrix quinquemaculata</i> (Delle Chiaje, 1828)		21	17	29	II–IV	Ss
<i>Ophiura albida</i> Forbes, 1839	15	3	17	21	I–V	Ss
<i>Ophiura grubei</i> Heller, 1863		9	17		I–III	Ss
<i>Ophiura ophiura</i> (Linnaeus, 1758)	15	3	2	21	I–VII	Ss
<i>Pectinura vestita</i> Forbes, 1843			1	29	II, III	Ss
<b>Echinoidea</b>						
<i>Arbacia lixula</i> (Linnaeus, 1758)		4	12	12	I–III	Hs
<i>Brissopsis atlantica mediterranea</i> Mortensen, 1913				21	V	Ss
<i>Brissopsis lyrifera</i> (Forbes, 1841)		5	12	12	I–VII	Hs, Ss
<i>Brissus unicolor</i> (Leske, 1778)		19	29		I, II	Ss
<i>Centrostephanus longispinus</i> (Philippi, 1845)		7	12	21	II–IV	Ss
<i>Cidaris cidaris</i> (Linnaeus, 1758)		5	2	12	II–VII	Hs, Ss
* <i>Diadema setosum</i> (Leske, 1778)				26	II	Ss
<i>Echinocardium cordatum</i> (Pennant, 1777)		5	16	29	I–V	Ss
<i>Echinocardium mediterraneum</i> (Forbes, 1844)		9	17		I, II	Ss
<i>Echinocyamus pusillus</i> (O.F. Müller, 1776)	29	4	12	12	I–III	Hs, Ss
<i>Echinus melo</i> Lamarck, 1816		7			II–IV	Hs

**Table.** (Continued).

<i>Genocidaris maculata</i> A. Agassiz, 1869	8	2		II	Hs, Ss	
<i>Gracilechinus acutus</i> (Lamarck, 1816)	7	12		I–IV	Ss	
<i>Ova canaliferus</i> (Lamarck, 1816)	5	17		I–IV	Ss	
<i>Paracentrotus lividus</i> (Lamarck, 1816)	4	12	12	I–IV	Hs, Ss	
<i>Psammechinus microtuberculatus</i> (Blainville, 1825)	3	17	12	I–VII	Hs, Ss	
<i>Spatangus purpureus</i> O.F. Müller, 1776	5	12	12	II–V	Ss	
<i>Spatangus subinermis</i> Pomel, 1887		17		II–V	Hs	
<i>Sphaerechinus granularis</i> (Lamarck, 1816)	3	12	12	I–III	Ss	
<i>Stylocidaris affinis</i> (Philippi, 1845)	7	12	12	II–V	Ss	
<b>Holothuroidea</b>						
<i>Holothuria (Panningothuria) forskali</i> Delle Chiaje, 1823			20	I	Ss	
<i>Holothuria (Thymiosycia) impatiens</i> (Forskål, 1775)			29	I, II	Ss	
<i>Holothuria (Holothuria) mammata</i> Grube, 1840			21	I–IV	Ss	
<i>Holothuria (Rowethuria) poli</i> Delle Chiaje, 1824			16	I–III	Ss	
<i>Holothuria (Platyperona) sanctori</i> Delle Chiaje, 1823			32	32	I, II	Ss
<i>Holothuria (Holothuria) tubulosa</i> Gmelin, 1791	29	3	16	29	I–III	Hs, Ss
<i>Leptopentacta elongata</i> (Düben & Koren, 1846)		5	2		I–III	Hs, Ss
<i>Leptopentacta tergestina</i> (M. Sars, 1857)		9	17		I–IV	Ss
<i>Leptosynapta inhaerens</i> (O.F. Müller, 1776)	14	7	29		I–III	Ss
<i>Leptosynapta makrankyra</i> (Ludwig, 1898)				21	I, II	Ss
<i>Mesothuria (Allantis) intestinalis</i> (Ascanius, 1805) Östergren, 1896			21		II, III	Ss
<i>Ocnus koellikeri</i> (Semper, 1868)		21	17		II–VII	Ss
<i>Ocnus planci</i> (Brandt, 1835)	10	5	16		I–III	Ss
<i>Ocnus syracusanus</i> (Grube, 1840) Panning, 1949			17	29	I, II	Ss
<i>Oestergrenia digitata</i> (Montagu, 1815)	15	4	17	29	I–VII	Hs, Ss
<i>Panningia hyndmanni</i> (W. Thompson, 1840)	13				I–III	Ss
<i>Parastichopus regalis</i> (Cuvier, 1817)		3	17	21	I–VI	Ss
<i>Phyllophorus (Phyllophorus) urna</i> Grube, 1840		5	16		I–III	Ss
<i>Stereoderma kirchsbergii</i> (Heller, 1868) Panning, 1949	13	4	17		I–III	Ss
<i>Synapta hispida</i> Heller, 1868	14	5			?	Ss
* <i>Synaptula reciprocans</i> (Forskål, 1775)			24	27	I, II	Ss
<i>Thyone fusus</i> (O.F. Müller, 1776)		33			II	Ss

**References in the Table:**

**1:** Forbes (1843); **2:** Forbes (1844); **3:** Colombo (1885); **4:** Ostroumoff (1894); **5:** Ostroumoff (1896); **6:** Jakubova (1948); **7:** Demir (1952); **8:** Tortonese (1959); **9:** Tortonese and Demir (1960); **10:** Bacescu (1961); **11:** Artüz (1967); **12:** Artüz (1968); **13:** Caspers (1968); **14:** Kiseleva (1969); **15:** Bacescu et al. (1971); **16:** Geldiay and Kocataş (1972); **17:** Ünsal (1973); **18:** Özyayın et al. (1991); **19:** Balkıs (1992); **20:** Ergen et al. (1994); **21:** Özyayın et al. (1995); **22:** Albayrak (1996); **23:** Çınar and Ergen (1998); **24:** Zaitsev and Öztürk (2001); **25:** Çınar et al. (2002); **26:** Yokeş and Galil (2006); **27:** Çınar et al. (2006a); **28:** Karhan et al. (2008); **29:** Özgür et al. (2008); **30:** Sezgin and Dağlı (2009); **31:** Stöhr et al. (2010); **32:** Gözcelioğlu (2011); **33:** Aslan Cihangir and Pancucci Papadopoulou (2012).

The Aegean Sea is represented by the highest number (76 species) of species, followed by the Sea of Marmara (64 species), the Levantine Sea (51 species), and the Black Sea (17 species) (Figure 1). Among the classes, Ophiuroidea had the highest number of species (24 species), 16 of which were reported from the Sea of Marmara and the Aegean Sea (Figure 1). Asteroidea were also represented by a high number of species (23 species), of which 22 species were determined from the Aegean coasts of Turkey.

The Marmara and Levantine coasts of Turkey possessed low asteroid diversity (17 species) (Figure 1). Only one echinoid species (*Echinocyamus pusillus*) is known from the Black Sea coast of Turkey, whereas the Aegean Sea, the Sea of Marmara and the Levantine Sea were represented by 18, 17, and 14 echinoid species, respectively (Figure 1).

Özgür et al. (2008) reviewed the echinoderm fauna of Turkey and reported 80 species from the coasts. Afterwards, 11 species (*Astropecten irregularis pentacanthus*, *Amphiodia*

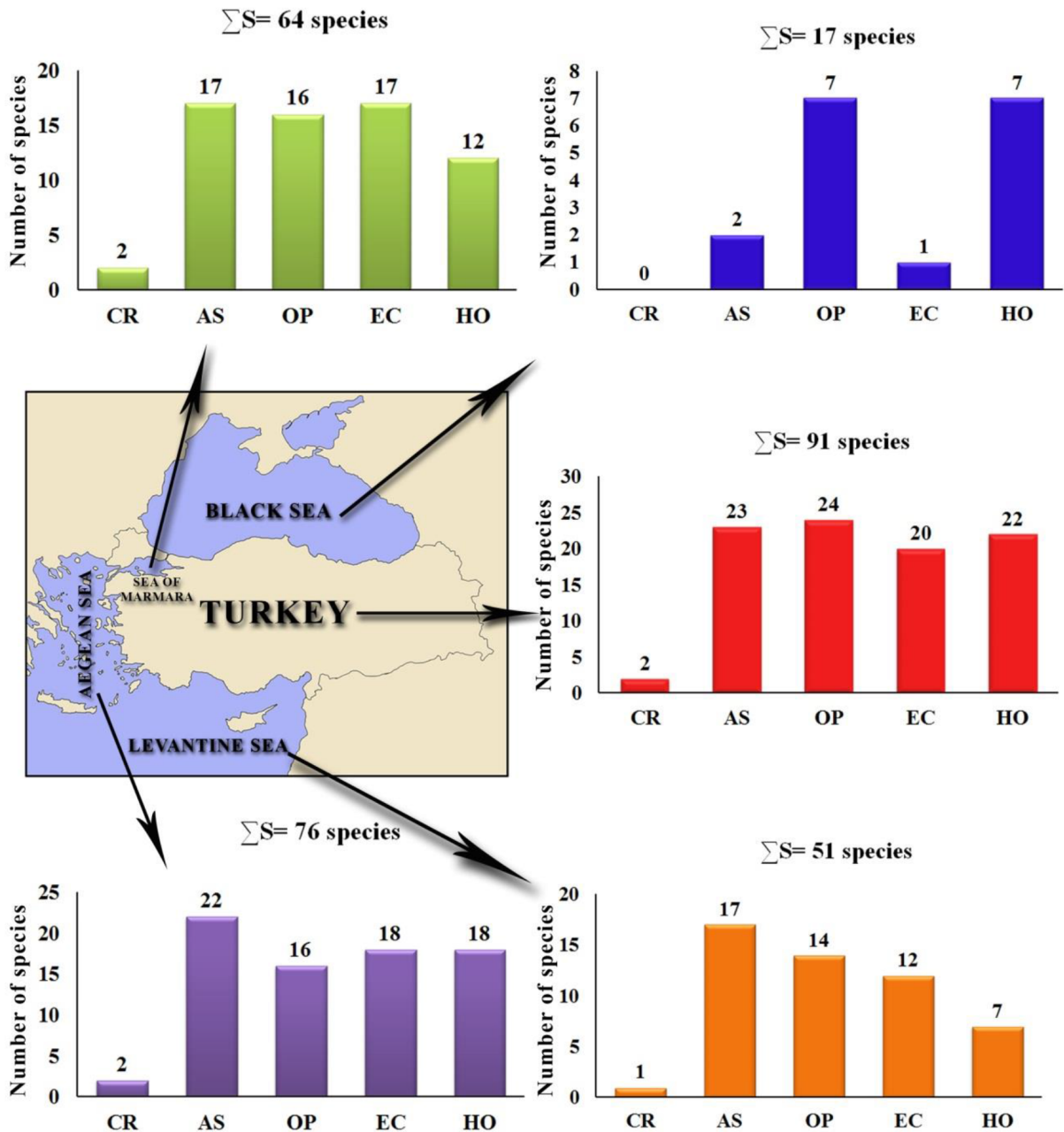


Figure 1. Number of echinoderm species along the Turkish coasts with respect to the classes (CR: Crinoidea, AS: Asteroidea, OP: Ophiuroidea, EC: Echinoidea, HO: Holothuroidea).

(*Amphispina*) *obtecta*, *Amphiura cherbonnieri*, *Amphiura lacazei*, *Amphiura* (*Ophiopeltis*) *securigera*, *Ophiactis macrolepidota*, *Ophiacten abyssicolum*, *Holothuria* (*Panningothuria*) *forskali*, *Holothuria* (*Platyperona*) *sanctori*, *Synapta hispida*, and *Thyone fusus*) were reported along the coasts of Turkey (see Table). The holothuroid echinoderm *Ocnus orientalis*, which was reported from the Sea of Marmara by Ostroumoff (1894, 1896), was considered as *Stereoderma kirchsbergii* by Cherbonnier (1960). In the Sea of Marmara, *Arbacia lixula* was reported by Ostroumoff (1894, 1896) and no other record of this species has been noted in the area to date. Therefore, the presence of *A. lixula* in the Sea of Marmara seems to be questionable.

According to Coll et al. (2010), 107 echinoderm species occur in the Aegean Sea, of which 76 species were reported from the Turkish part of the Aegean Sea (present study). Seventy-three echinoderm species are known to occur in the Levantine Sea, whereas 51 species have been reported from the Levantine coast of Turkey to date.

The hotspot areas for echinoderm diversity and the areas where intensive or weak scientific efforts have been focused to date along the Turkish Exclusive Economic Zone are shown in Figure 2. The highest species richness (24–28 species in 1 grid square) was determined to the south of İstanbul, to the west of Gökçeada, and İzmir Bay. The other hotspots for echinoderm diversity (18–23 or 15–17 species in 1 grid square) were areas near İzmir Bay, Bozcaada, İstanbul, and the western part of Kapıdağ Peninsula. The differences in species richness are mostly attributed to the intensity of the studies performed in the areas and the hydrographical conditions of the seas surrounding Turkey.

The highest number of echinoderm species (83 species) was encountered at depths ranging from 11 to 50 m, and the lowest (8 species) at depths of 600 m and greater (Figure 3). The species that inhabited the deepest parts of the areas (>600 m) are *Hymenodiscus coronata*, *Amphiura chiajei*, *Ophiura ophiura*, *Brissopsis lyrifera*, *Cidaris cidaris*, *Psammechinus microtuberculatus*, *Ocnus koellikeri*, and *Oestergrenia digitata*.

The increase in new species reports from the coasts of Turkey in a time scale between 1843 and 2014 is shown in Figure 4. Authors that made significant contributions to our understanding of the Turkish echinoderm fauna were Forbes (1843, 1844), Colombo (1885), and Ostroumoff (1894, 1896) between 1843 and 1910; Demir (1952) between 1940 and 1955; and Ünsal (1973) between 1970 and 1985 (Figure 4).

Among the echinoderms determined, 66 species were found on soft substrata, while 8 species were reported on hard substrata and 17 species on both soft and hard substrata.

Six echinoderms (*Asterias rubens*, *Amphiudia* (*Amphispina*) *obtecta*, *Ophiactis macrolepidota*, *Ophiactis savignyi*, *Diadema setosum*, and *Synaptula reciprocans*) were regarded as alien species (Table). According to Karhan et al. (2008) and Dalgıç et al. (2009), *A. rubens* was introduced from the northeast Atlantic Ocean to the Sea of Marmara via the ballast waters of ships. *Amphiudia* (*Amphispina*) *obtecta* is an Indo-Pacific species and might have migrated from the Red Sea via the Suez Canal or an Indo-Pacific area via ballast water of ships (Stöhr et al., 2010). It was postulated that larval transport through the Suez Canal, shipping, and the aquarium trade are the

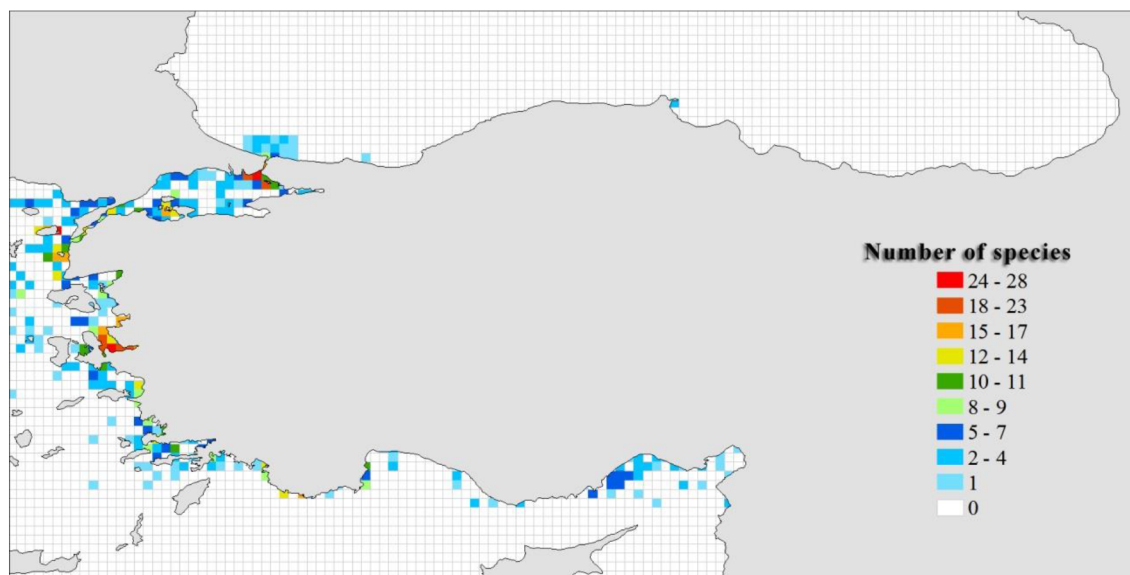


Figure 2. The hotspots for echinoderm diversity along the coasts of Turkey.

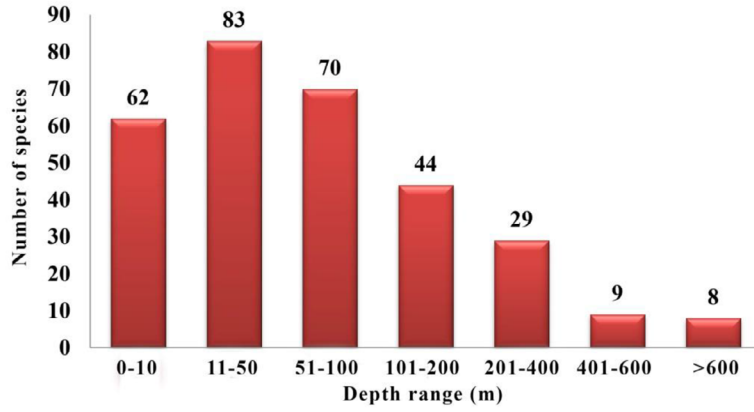


Figure 3. The number of echinoderm species with respect to the depth ranges where they were encountered.

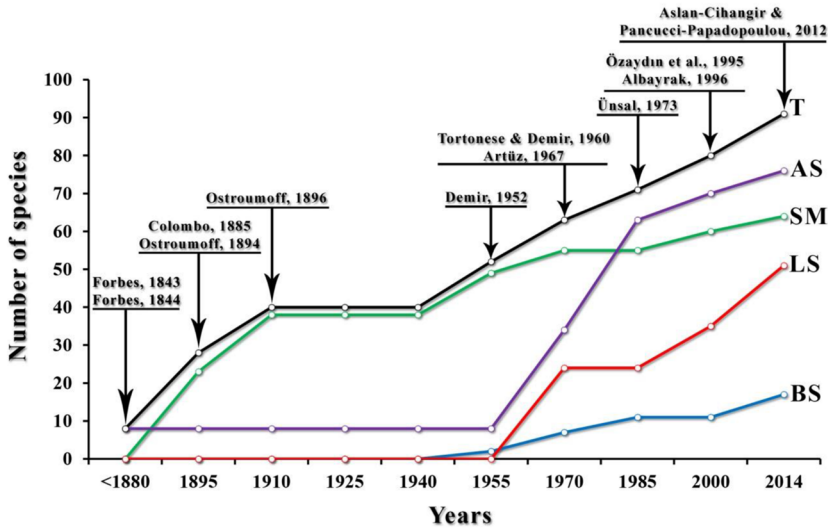


Figure 4. Yearly changes in the number of new records of Echinodermata along the coasts of Turkey.

possible vectors for the introduction of *D. setosum* (Yokeş and Galil, 2006). The other alien species (*O. macrolepidota*, *O. savignyi*, and *S. reciprocans*) are lessepsian migrants (Çinar et al., 2002, 2006a; Stöhr et al., 2010).

In conclusion, the coasts of Turkey are represented by low echinoderm diversity in comparison with the adjacent seas. This could be attributed to the small number of studies carried out along the coasts of Turkey. Therefore,

more scientific efforts, especially in deep-sea areas and some specific habitats including coralligenous ones, are required to better understanding of the echinoderm fauna of Turkey.

**Acknowledgment**

Some of data in the present study were obtained from a TÜBİTAK project (Number: 111Y268).

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