Oceanological and Hydrobiological Studies

International Journal of Oceanography and Hydrobiology

Volume 47, Issue 4, December 2018
pages (337-344)

ISSN 1730-413X
eISSN 1897-3191

Decapod crustaceans in benthic habitats of the Turkish Straits System with new records

by

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DOI: **10.1515/ohs-2018-0032**
Category: **Original research paper**
Received: **March 6, 2018**
Accepted: **April 27, 2018**

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Abstract

The objective of this study was to investigate decapod species occurring in the Turkish Straits System. For this purpose, benthic samples were collected from six different biotopes (photophilic algae, *Cystoseira barbata*, meadows, *Posidonia oceanica*, mussel, *Mytilus galloprovincialis*, meadows, *Zostera marina*, serpulid reef, and rocks) at depths ranging from 10 to 1000 m. A total of 60 species of decapod crustaceans were identified, including new records for the Turkish Straits System: *Processa elegantula*, *P. modica*, *Richardina fredericii*, *Callianassa subterranea*, *Gourretia denticulata*, *Inachus parvirostris* and *Macropodia linaresi*. In addition, some information about the spatial and bathymetric distribution as well as biotope preferences of the decapod community is provided.

Key words: Decapoda, Crustacea, deep water, the Turkish Straits System

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Introduction

The Turkish Straits System includes the straits of Istanbul (Bosphorus), Canakkale (the Dardanelles) and the Sea of Marmara. It is a combination of biological, physiographic, meteorological and hydrological characteristics that form a distinctive ecosystem between the Mediterranean and the Black Sea (Öztürk & Öztürk 1996). Reviews of research on marine decapod crustaceans from the Turkish coast were performed by Ateş et al. (2010) and Bakır et al. (2014). The Turkish Straits System is a region that has been the subject of many studies but has not yet been fully researched. To date, 144 decapod crustaceans have been identified in the Turkish Straits System and most of them were identified during coastal surveys (Ostroumoff 1896; Bakır 2012; Bakır et al. 2014). However, there were also a few studies related to deep-water species (Topaloğlu 2014). Research on deep-water decapod crustaceans from the Turkish Aegean Sea coast was also carried out by Gönülol et al. (2014) off Gokceada (Imbros) Island. The objective of this study was to present the species of decapods found in coastal and deeper waters with new records and to show their distributions in various biotopes.

Materials and methods

This study was carried out in the Turkish Straits System between October 2012 and June 2013. Samples were collected by a box corer of 0.1 m^2 area at depths of 10, 25, 50, 100, 200, 500, and 1000 m where available and by a metal square frame of 400 cm^2 from 26 coastal sites covered with various biotopes such as *Cystoseira barbata* (Stackhouse) C. Agardh, 1820, *Posidonia oceanica* (Linnaeus) Delile, 1813, *Zostera marina* Linnaeus, 1753, serpulid reefs [*Spirobranchus triqueter* (Linnaeus, 1758), *Vermiliopsis striaticeps* (Grube, 1862)] and *Mytilus galloprovincialis* Lamarck, 1819. Quantitative samples (*Cystoseira barbata, Posidonia oceanica, Zostera marina, Mytilus galloprovincialis,* and all box-corer samples) were collected in three replicates. Qualitative samples including small bare stones, rocks with filamentous algae, gravel or sand were also collected to increase the number of species at the coastal sites (Fig. 1). All physicochemical parameters of seawater were measured by a YSI Probe in situ. A 0.5 mm mesh size sieve was used to sieve the benthic samples and 4% formaldehydeseawater solution was used to preserve the retained material. In the laboratory, the decapod specimens were sorted, counted and preserved in 70% ethanol. All decapod individuals at the level of the genus and species were identified based on studies by Zariquiey Alvarez (1968), Lagardere (1971), Fischer et al. (1987), and Falciai and Minervini (1996). Individuals after identification were deposited at the Museum of the Faculty of Fisheries, Ege University (ESFM). Collection numbers for *Macropodia linaresi* are as follows: ESFM-MAL/2012-1, 2, 3, 4, 5, 6, 7, 8; *Processa elegantula* ESFM-MAL/2013-1; *Processa modica* ESFM-MAL/2013-2; *Richardina fredericii* ESFM-MAL/2013-3; *Callianassa subterranea* ESFM-MAL/2013-4, 5, 6, 7, 8, 9, 10; *Gourretia denticulata* ESFM-MAL/2013-11; *Inachus parvirostris* ESFM-MAL/2013-12.

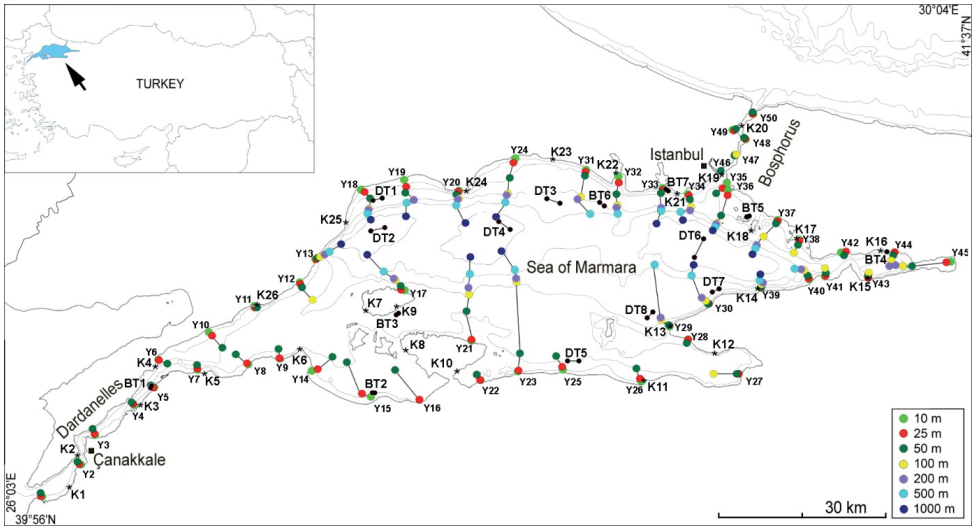

Figure 1

Map of the Turkish Straits System with 20, 50, 100, 500, 1000 m isobaths. Abbreviations: K – coastal sites; Y – box-corer sites; BT, DT – trawls

Results

As a result of salinity measurements made at the study sites, a halocline was observed at a depth of about 25 m. While the salinity of the waters above this layer was low, the salinity of the waters below was high (Fig. 2).

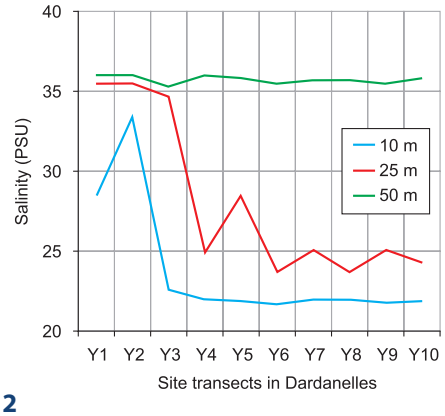

Figure 2

Salinity values at sites Y1–Y10 in relation to depth

The faunistic examination of decapod individuals captured from various biotopes and depths in the study area revealed a total of 12 952 specimens belonging to 60 species (Table 1). Seven of them were new records for the sampling area: *Processa elegantula* Nouvel and Holthuis, 1957, *Processa* modica *modica* Williamson and Rochanaburanon, 1979, *Richardina fredericii* Lo Bianco, 1903, *Callianassa subterranea* (Montagu, 1808), *Gourretia denticulata* (Lutze, 1937), *Inachus parvirostris* (Risso, 1816), *Macropodia linaresi* Forest and Zariquiey Alvarez 1964).

Samples of hard bottoms in the coastal areas and box-core samples, which were heterogeneous soft-bottom biotopes, contained an equal number (28) of decapod species (Fig. 3). In some locations, the box-corer sampling points along the transects had a large depth range (10–1000 m). Along these transects, the mean number of species generally decreased below the depth of 50 m and the thalassinid, *Calocaris macandreae* Bell, 1853 was usually a common species below this depth (Fig. 4). The polychelid, *Polycheles typhlops* C. Heller, 1862 and the sergestid shrimp, *Sergestes robustus* Smith, 1882 were yet another decapods at the sampling depths below 50 m. In addition to these species, deep-sea (below 500 m) decapods – the crangonid shrimp, *Aegaeon lacazei* (Gourret, 1887), the sergestid shrimp, *Eusergestes arcticus* (Krøyer, 1855), the penaeoid shrimp, *Gennadas elegans* (Smith, 1882), the caridean shrimp, *Pasiphaea sivado* (Risso, 1816) and the stenopodid shrimp, *Richardina fredericii* Lo Bianco, 1903 – were also caught during this study.

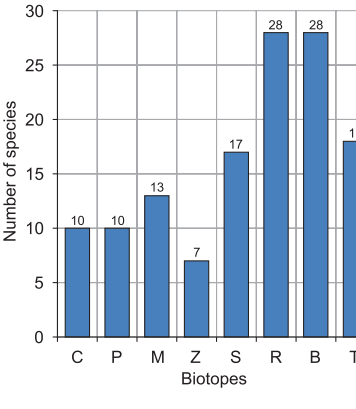

Figure 3

Biodiversity of decapod species in different biotopes

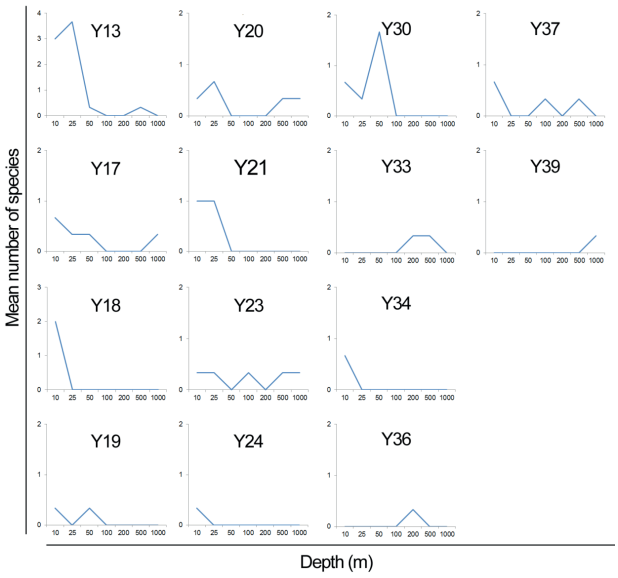

Figure 4

The mean number of decapod species along the deepest transects

Trawl samples contained the largest number of individuals. The penaeid shrimp, *Parapenaeus longirostris* (2898 ind.), the pandalid shrimp, *Plesionika heterocarpus* (2433 ind.), the portunid crab, *Liocarcinus depurator* (735 ind.) and the thalassinid, *Calocaris macandreae* (206 ind.) were very abundant in these samples. The serpulid reefs and coastal rocky substrata were the next populated biotopes following the trawls in the sampling area (Fig. 5).

Spatial differences in the number of species and individuals were large between sites within a biotope. At sites covered with photophilic algae, *Cystoseira barbata* had higher values toward the Dardanelles,

Table 1

The list of decapod species present in the Turkish Straits System. Abbreviations: C – *Cystoseira barbata*; P – *Posidonia oceanica*; M – *Mytilus galloprovincialis*; Z – *Zostera marina*; S – serpulid reef; R – rock, stone, gravel; B – box-core samples; T – trawl, * – new records for the sampling area

Species	C	P	M	Z	S	R	B	T
Aegaeon lacazei (Gourret, 1887)	–	–	–	–	–	–	–	4
Alpheus macrocheles (Hailstone, 1835)	–	20	8	–	185	20	3	1
Athanas nitescens (Leach, 1813)	5	76	382	1	1062	45	111	–
Crangon crangon (Linnaeus, 1758)	–	–	–	–	–	–	–	1
Eualus cranchii (Leach, 1817)	–	31	2	–	173	–	–	–
Eusergestes arcticus (Krøyer, 1855)	–	–	–	–	–	–	–	16
Gennadas elegans (Smith, 1882)	–	–	–	–	–	–	–	10
Hippolyte inermis Leach, 1816	115	–	–	5	–	2	–	–
Hippolyte leptocerus (Heller, 1863)	10	–	–	–	–	–	–	–
Hippolyte sp.	92	–	13	–	–	43	8	–
Nepinnotheres pinnotheres (Linnaeus, 1758)	–	–	–	–	–	1	–	–
Palaemon adspersus Rathke, 1837	–	–	–	–	–	21	–	–
Palaemon elegans Rathke, 1837	–	–	1	–	–	765	–	–
Palaemon longirostris H. Milne Edwards, 1837	–	–	–	–	–	–	–	25
Palaemonetes sp.	–	–	–	–	–	5	–	–
Parapenaeus longirostris (Lucas, 1846)	–	–	–	–	–	–	–	2898
Pasiphaea sivado (Risso, 1816)	–	–	–	–	–	–	–	10
Philocheras sp.	–	–	–	–	–	–	1	–
Plesionika heterocarpus (A. Costa, 1871)	–	–	–	–	–	–	–	2433
Processa edulis (Risso, 1816)	1	9	3	21	211	29	14	–
**Processa elegantula* Nouvel and Holthuis, 1957	–	–	–	–	–	–	4	–
**Processa modica* Williamson in Williamson and Rochanaburanon, 1979	–	–	–	–	–	–	1	–
**Richardina fredericii* Lo Bianco, 1903	–	–	–	–	–	–	–	10
**Callianassa subterranea* (Montagu, 1808)	–	–	–	–	–	–	10	–
Calocaris macandreae Bell, 1853	–	–	–	–	–	–	18	206
**Gourretia denticulata* (Lutze, 1937)	–	–	–	–	–	–	1	–
Pestarella tyrrhena (Petagna, 1792)	–	–	–	6	–	–	–	–
Polycheles typhlops Heller, 1862	–	–	–	–	–	–	–	1
Upogebia pusilla (Petagna, 1792)	–	–	–	–	–	–	104	–
Anapagurus bicorniger A.Milne-Edwards and Bouvier, 1892	–	1	–	–	1	–	4	–
Cestopagurus timidus (Roux, 1830)	–	–	–	–	–	1	–	–
Clibanarius erythropus (Latreille, 1818)	1	7	–	–	1	24	–	–
Diogenes pugilator (Roux, 1829)	–	–	–	13	–	128	20	–
Galathea intermedia Liljeborg, 1851	–	5	–	–	–	4	6	1
Galathea squamifera Leach, 1814	–	–	–	–	–	21	–	–
Paguristes syrtensis de Saint Laurent, 1971	–	–	–	–	–	–	7	–
Pagurus cuanensis Bell, 1846	–	–	–	–	1	–	–	–
Pagurus prideaux Leach, 1815	–	–	–	–	–	1	–	–
Pisidia bluteli (Risso, 1816)	–	32	165	–	637	226	37	–
Pisidia longimana (Risso, 1816)	–	–	22	–	–	–	–	–
Porcellana platycheles (Pennant, 1777)	–	–	–	–	–	1	–	–
Brachynotus sp.	–	–	–	–	–	1	1	–
Carcinus aestuarii Nardo, 1847	1	–	1	1	4	126	2	10
Dromia personata (Linnaeus, 1758)	–	–	–	–	–	3	–	–
Ebalia edwardsii Costa, 1838	–	–	–	–	–	–	1	–
Eriphia verrucosa (Forskål, 1775)	–	–	–	–	1	178	–	–
Eurynome aspera (Pennant, 1777)	–	–	–	–	–	–	3	–
Goneplax rhomboides (Linnaeus, 1758)	–	–	–	–	–	–	2	1
**Inachus parvirostris* (Risso, 1816)	–	–	–	–	–	–	1	–
Jaxea sp.	–	–	–	–	–	–	1	–
Liocarcinus arcuatus (Leach, 1814)	–	–	–	–	4	–	35	–
Liocarcinus depurator (Linnaeus, 1758)	–	–	–	–	5	55	15	735
Liocarcinus maculatus (Risso, 1827)	–	–	–	6	–	–	13	–
Liocarcinus vernalis (Risso, 1816)	–	–	–	–	1	4	–	16
**Macropodia linaresi* Forest and Zariquiey Alvarez, 1964	6	–	1	–	6	7	–	–
Maja squinado (Herbst, 1788)	–	–	–	–	26	84	–	–
Pachygrapsus marmoratus (Fabricius, 1787)	–	–	3	–	–	259	–	–
Pilumnus hirtellus (Linnaeus, 1761)	4	7	105	–	105	145	9	1
Pisa muscosa (Linnaeus, 1758)	1	–	–	–	–	–	–	–
Xantho poressa (Olivi, 1792)	–	1	18	–	31	278	8	–
Total number of species	10	10	13	7	17	28	28	18
Total number of individuals	236	189	724	53	2454	2477	440	6379

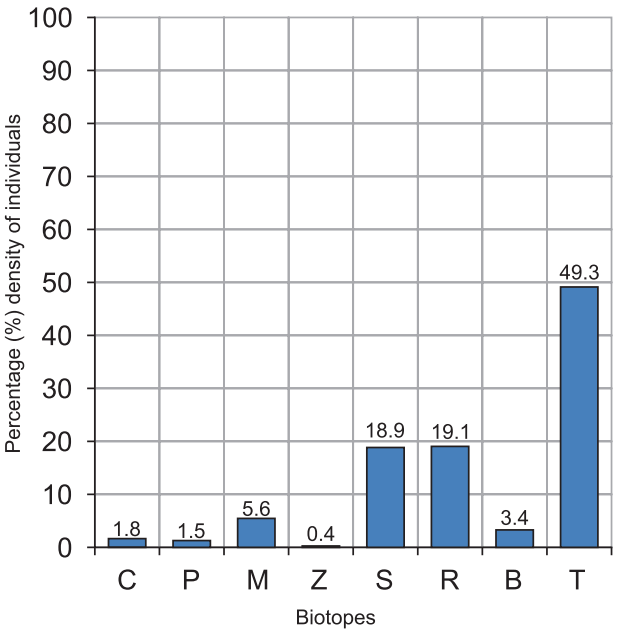

Figure 5

Density of decapod individuals in different biotopes

while the sites with *Mytilus galloprovincialis* and the serpulid reef were more homogeneous in terms of species density. Furthermore, the box-corer sites in the coastal zone were characterized by a large number of species and dense populations compared to the deeper sites. The rocky and trawling sites did not show a pattern in terms of depth, but they showed regional differences (Fig. 6).

Discussion

Most of the new records can only be considered as new if the boundaries of the sampling area are taken into consideration. In other words, *Processa elegantula*, *P. modica*, *Gourretia denticulata*, *Inachus parvirostris*, *Macropodia linaresi* were all known in the Aegean Sea (Bakır et al. 2014) and sampled only at the sites in the Dardanelles. As presented in Figure 2, the salinity changes in the Dardanelles create a barrier for some species between the Aegean Sea and the Sea of Marmara. One of these species is *Processa elegantula* known from the Turkish Aegean and Levantine coasts (Kocataş 1981). *P. elegantula* was recorded at only one site (Y1) at a depth of 25 m at the entrance of the Aegean Sea to the Dardanelles. This species seems to have no further distribution in the Sea of Marmara. Another species, *Processa modica*, was also known from the Turkish Aegean and Levantine coasts (Kocataş 1981) and was recorded, such as the previous one, at only one site (Y6) at a depth of 25 m in the Dardanelles.

Gourretia denticulata was previosuly reported from the Aegean and Levantine coasts of Turkey (Kocataş & Katağan 2003; Özcan 2007). This species also appears to be a Mediterranean species, as the above-mentioned *Processa* species, the presence of which was only observed at Y2 (depth of 50 m) at the entrance of the Dardanelles toward the Aegean Sea.

Inachus parvirostris was previously reported from the Aegean coast by Ateş et al. (2008). A single specimen of this species was found at a depth of 50 m at site Y1.

Richardina fredericii was reported for the first time on silty seabed at a depth of 720 m off the eastern Mediterranean shores of Turkey (Kocataş & Katağan 2003). A total of 10 individuals belonging to this species were collected in DT4 at a depth of 1200 m.

Callianassa subterranea is known from the Aegean Sea and Levantine coasts of Turkey (Adensamer 1898; Özcan 2007) and was rarely observed in the study area at seven sites with soft bottom (Y3, Y13, Y15, Y27, Y28, Y30, Y32) at depths between 50 and 100 m.

Macropodia linaresi was also known from the Aegean Sea and Levantine coasts of Turkey (Kocataş 1981). This species was observed in the study area on serpulid reefs, which are unique structures in the Sea of Marmara, and on rocks covered with photophilic algae at depths between 0 and 25 m (sites: K2, K4, K20, K23, K24, K25).

Furthermore, several species identified in previous studies were not found in this study. For example, *Pandalina brevirostris* (Rathke, 1843), which was previously reported around Marmara Island by Balkıs (1992), was not found in this survey. Balkıs et al. (2002) reported a total of 36 species of decapod crustaceans from the Bosphorus, several of which could not be reported in this study. In addition, the decapod fauna of the Turkish Straits System was studied by Balkıs (2003) and a total of 46 species (18 from the Bosphorus, 42 from the Sea of Marmara, and 20 from the Dardanelles) were reported. A checklist of crustaceans from the Turkish Seas has been recently prepared by Bakır et al. (2014). This list includes 144 decapod species reported from the Turkish Straits System. However, only 60 of them were identified from the same region in this study. In addition, differences in the number of species were also determined in the study, as well as varying biotope preferences of the species. Among other biotopes in the study area, such as *Cystoseira*, *Posidonia*, *Zostera*, and *Mytilus*, the serpulid reefs were found to be the richest ones in terms of decapod diversity (Fig. 3). This biotope was similar to the biotopes of calcareous algae, which are known to have high biodiversity in the Mediterranean ecosystem (Ballesteros 2006).

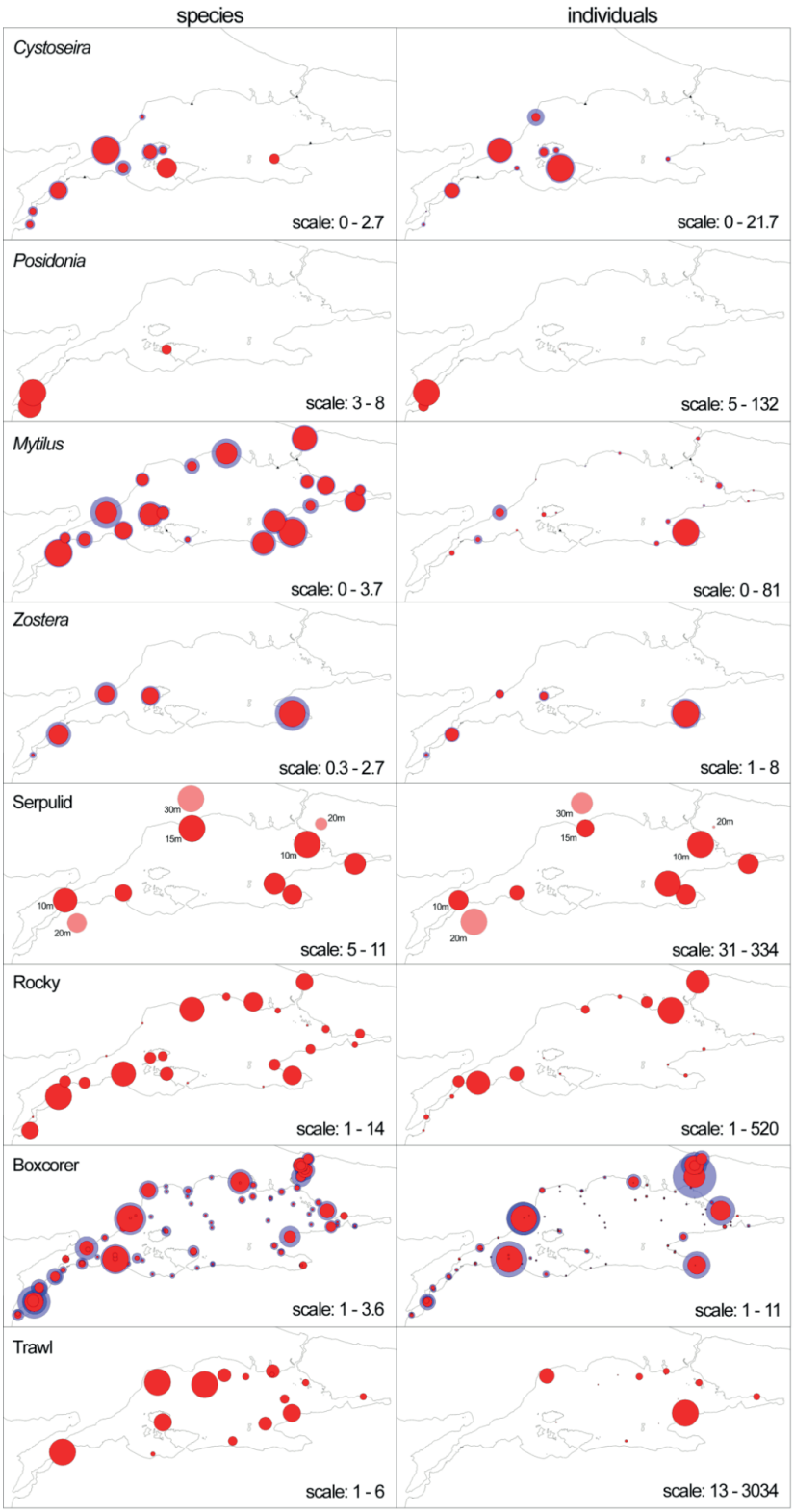

Figure 6

The number of species and individuals determined at different sites. Outer blue circles indicate the standard error of the mean. Black triangles indicate sites without decapod individuals in Cystoseira and Mytilus biotopes. Circles with lower opacity indicate values at different depths of the same site in serpulid reef biotopes.

Topaloğlu & Kihara (1993) reported three species of decapods during their research on the *Mytilus galloprovincialis* community in the Bosphorus. In addition to their work, *Pisidia longimana* (Risso, 1816), *Pachygrapsus marmoratus* (Fabricius, 1787) and *Xantho poressa* (Olivi, 1792) were encountered at the sampling sites (K19, K20) of the Bosphorus.

Kocataş et al. (2004) carried out a study on crustaceans associated with the *Cystoseira* spp. distributed along the Aegean coast of Turkey and found a total of 19 decapod species at nine sites. We recorded a total of 10 species of decapod crustaceans in *Cystoseira barbata* samples collected from 14 sites (Fig. 3). Kocataş et al. (2004) also indicated that the majid crab, A*canthonyx lunulatus* (Risso, 1816), was the most common decapod observed in the *Cystoseira* facies along the Aegean coast. However, this species was not found in the study area. Its occurrence is likely limited by salinity changes.

The distribution of the *Posidonia oceanica* biotope is very limited in the Sea of Marmara due to a narrow salinity range (36.5 to 39.5 PSU) (Meinesz et al. 2009). *P. oceanica* assemblages were observed at only three sites. Two of these three sites were located in the Dardanelles and the samples included a total of 10 decapod species (Fig. 3). Yurdabak (2004) reported that only *Pilumnus hirtellus* (Linnaeus, 1761) and *Pisidia bluteli* (Risso, 1816) were found near our sampling sites in the Dardanelles. In addition to these two species, alpheids, *Alpheus macrocheles* (Hailstone, 1835), *Athanas nitescens* (Leach, 1813), the hippolyt shrimp, *Eualus cranchii* (Leach, 1817), the caridean shrimp, *Processa edulis* (Risso, 1816), and paguroid, *Clibanarius erythropus* (Latreille, 1818) were also found at the sites in the Dardanelles. However, the alpheid shrimp, *Athanas nitescens*, the caridean shrimp, *Processa edulis*, and the xanthid crab, *Xantho poressa* were the only decapods at the *Posidonia* site (K8) located in the Sea of Marmara. On the other hand, 102 decapod species have so far been identified in *Posidonia* studies carried out on the Aegean Sea coast of Turkey (Katağan & Bakır 2013).

Zostera marina was more common in the study area than *Posidonia oceanica*. Seven decapod species were encountered at five sites at depths ranging from 0.5 m to 2 m (Fig. 3). Yurdabak (2004) reported only *Pisidia bluteli* at the *Zostera* site in the Dardanelles, taking monthly samples for a year. In addition, three species were reported from the Aegean coast and nine species were identified from the Black Sea coast of Turkey. The last two studies were carried out during four sampling seasons. The irregularity in the number of species was due to the structure of *Zostera* beds in the regions.

Gönülal et al. (2014) carried out a study to determine deep-sea decapod species in the north of the Aegean Sea and reported 23 decapod species in a much smaller area compared to our sampling area. According to the above-mentioned study, some parts of the deep-sea decapod fauna of the Aegean Sea are likely to be more diverse than that of the Sea of Marmara. Topaloğlu (2014) also indicated that thalassinid, *Calocaris macandreae*, was the dominant species in the same region.

Consequently, this study has shown, in particular, that differences in salinity in the Dardanelles were a limiting factor in the distribution of some Mediterranean species toward the Sea of Marmara. Nevertheless, the serpulid reefs in the Sea of Marmara are characterized by high decapod diversity, like the coralligenous algae. Also, the deep-sea decapod fauna in the Sea of Marmara was composed of fewer species compared to the Aegean and Mediterranean Seas. These results are considered useful for better designing future works.

Acknowledgements

This research (project No. 111Y268) was financially supported by TUBITAK (the Scientific and Technological Research Council of Turkey).

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