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New addition to the fauna of shallow-water hydroid polyps (Cnidaria: Hydrozoa) in the Gulf of Antalya, Türkiye

by

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Abstract

The present study aimed to identify and characterize the hydroid fauna in the Gulf of Antalya, Türkiye. This paper reports 35 taxa belonging to 17 families identified in the region. Among the identified species, *Clytia brevithecata, Clytia noliformis, Turritopsis nutricula, Scandia gigas* and *Acauloides ammisatum* were recorded for the first time on Turkish coasts. Nineteen taxa – *Amphinema rugosum, Coryne eximia, Clytia gracilis, Monotheca obliqua, Eudendrium merulum, Halecium tenellum, Orthopyxis integra, Hydractinia aculeata, Laomedea flexuosa, Laomedea angulata, Dicoryne conferta, Clytia linearis, Eudendrium simplex, Eudendrium capillare, Aglaophenia picardi, Halopteris diaphana, Salacia desmoides, Sertularella ellisii* and *Hydrodendron mirabile* – are new to the Mediterranean coast of Türkiye. With the publication of this paper, the number of hydroid species documented along the Turkish coasts has increased to 132, highlighting the importance of these findings. The discovery of new species and the expansion of their range underscores the need for continued research covering different depths to better understand the ecological importance of these organisms and the biodiversity of the marine environment.

Key words: aquatic invertebrates, benthos, Cnidaria, Hydrozoa, Mediterranean, hydroid polyps

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1. Introduction

The Mediterranean Sea is a biodiversity hotspot, home to some 17,000 marine species (Coll et al. 2010). Therefore, the Mediterranean Sea has a rich history of biodiversity research, making it one of the most extensively studied seas in the world (Gravili et al. 2013). The high biodiversity in the Mediterranean is attributable to both its development over the years and ecological factors (Morri, Bianchi 1999). The biodiversity of the Mediterranean Sea is undergoing significant changes, a phenomenon that is partly linked to the effects of global warming. In particular, rising temperatures are believed to favor the colonization of non-native tropical species in the basin (Coll et al. 2010).

Information on biological diversity enables a better understanding of potential environmental issues. It provides a basis for intervention and facilitates understanding of the ecosystem through the use of indicator species (Puce et al. 2009). Due to their microscopic size, hydroids are often overlooked, but they contribute significantly to the overall biodiversity of a given area (Bouillon et al. 2004). Hydroid species occupy a significant ecological niche as consumers of fish eggs, larvae, and planktic organisms that serve as their prey (Gili, Hughes 1995). As such, they can act as both predators and competitors of commercially important fish species. Moreover, their ability to produce nematocysts, which can cause painful stings, acts as a deterrent to human recreational activities (Gülşahin et al. 2013).

It is important to acknowledge that our current understanding of Mediterranean hydroids is based mainly on research conducted by French, Spanish, and Italian scientists such as Picard, Medel, López-González, Boero, Gravili, Piraino and many other scientists working in the region (Bouillon et al. 2004). In 1958, Picard compiled a list of Anthoathecata (= Anthomedusea) and Leptothecata (= Leptomedusea) species in the Mediterranean, which consisted of 191 species. In 1993, Boero and Bouillon expanded Picard's work by identifying 34 new species. In 1997, Boero and colleagues updated the same list to 379 species (Bouillon et al. 2004; Galea 2007). Following these studies, Bouillon et al. (2004) published "Fauna of the Mediterranean Hydrozoa" and expanded the number of species in the region to 457. Therefore, it can be concluded that the hydroid fauna of only the northwestern Mediterranean and the Adriatic regions has been adequately studied (Boero et al. 1997). While the scarcity of information on the Aegean Sea has been partially addressed by the work of Morri and Bianchi (1999), extensive research on the hydroid fauna of the eastern Mediterranean region is still lacking (Morri et al. 2009).

Although the hydroid fauna of the Mediterranean Sea is one of the best studied in the world, the eastern basin, known as the Levantine Sea, is still relatively unexplored in this regard (Morri et al. 2009). Türkiye is located in the eastern part of the Mediterranean Sea. Until recent years, our knowledge about the hydrozoan fauna of the Turkish coasts in this region has been largely limited or obscure (İşinibilir et al. 2015). Research on hydroid polyps on the Turkish coasts began with the work "Invertebrate benthic fauna of the Bosphorus and island coastline", which identified 22 species and provided diagnostic keys as well as some ecological characteristics (Demir 1952). This study was followed by numerous studies. In 2014, Çınar et al. compiled all the studies and published a comprehensive checklist of hydrozoan species occurring along the Turkish coasts, reporting a total of 106 species. The authors reported 57 species in the Sea of Marmara, eight species in the Black Sea, 69 species in the Aegean Sea, and 56 species on the Mediterranean coasts of Türkiye. This was followed by thirteen species reported from the Aegean Sea (İşinibilir et al. 2014), three new species reported from the Sea of Marmara (İşinibilir et al. 2015), one species from the Sea of Marmara (Yılmaz et al. 2017), one species from the northeastern Aegean Sea (İşinibilir et al. 2019), one species from the Aegean Sea (Gülşahin et al. 2013), one species from the Aegean Sea (Gülşahin et al. 2016) and one species from the Sea of Marmara that were recorded as new to the Turkish coast (İşinibilir et al. 2021).

While recent studies have aimed to reduce the existing information gap, there is still much work to be done regarding the Aegean Sea and the Levantine basin in general (İşinibilir et al. 2015). Furthermore, İşinibilir et al. (2022) reported one new species from the northeastern Aegean Sea, and Mutlu and Özvarol (2022) reported one new species from the Eastern Mediterranean coasts of Türkiye. Following these new discoveries, the total number of hydrozoan species in the Turkish fauna increased to 127. These studies are relatively limited in number compared with the Western Mediterranean and are insufficient to describe the region's biodiversity.

Several studies are currently underway to investigate the hydrozoan fauna of the eastern Mediterranean Sea. With global warming, the temperature and other physicochemical parameters of the sea are changing, and new species are entering the Mediterranean Sea through the Suez Canal (Puce et al. 2009). Furthermore, since the Turkish coast is geographically close to the Lessepsian migration area, new species are expected to migrate to the region. Given these factors, new research is needed to add to the information on the marine fauna of Turkish coasts and gain a comprehensive understanding of biodiversity in the region. The sampling area, the Gulf of Antalya, is located in the eastern part of the Mediterranean Sea and on the southern coast of Türkiye, which is home to a diverse range of marine life, including hydroids.

This study aims to shed light on the distribution of hydrozoan species in the Gulf of Antalya and contribute to the knowledge of the hydrozoan fauna and fill the gap in research on the hydrozoan fauna in Türkiye.

2. Materials and methods

A total of 32 samples were collected seasonally at eight selected sites located throughout the Gulf of Antalya (Fig. 1) between February 2016 and October 2016. The length of the bay's coastline where the study was conducted is nearly 300 km.

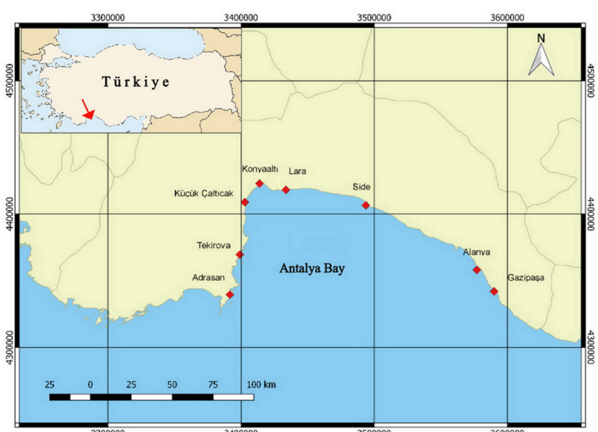

Figure 1

Study area and sampling sites.

The sampling sites were characterized by a substrate consisting of a mixture of rocks, algae, hard-shelled invertebrates and *Posidonia* meadows. To collect data from each site, the researchers carried out apnea dives in each shallow-water zone (0–10 m) and collected benthic hydroid colonies from the bottom, as well as fragments of various substrates that were or could be suitable for settlement of hydrozoan colonies, such as algae, seagrasses, and hard-shelled invertebrates. During the dives, the researchers scanned an area of 50 m^2, observing a meter on either side of a line that included stones, rocks, and other objects on the line (Piraino et al. 2013). The researchers carried out a visually oriented collection to create a faunistic inventory.

Site 1 is a small bay with a sandy beach 2 km wide and a maximum depth of 6 m, with hotels and guesthouses. Site 2 is a beach of a five-star hotel without any treatment system, where all waste, including pool water, is discharged into the sewage system. Site 3 is a coastal recreational area and picnic spot located about 800 m from the Port of Antalya and Mediterranean port operations. Site 4 is located at the beginning of a 7-km rocky beach located at the end of the cliffs in the city center of Antalya province. Site 5 is located east of the city center, in a rocky area where the beaches begin, in a region of high population density. Site 6 is located in an area with a small port and a high concentration of tourist facilities. Site 7 is located in a small fishing port, approximately 20 km east of the city center, in an area with intensive agricultural activity. Site 8 is located in an area heavily exposed to waves, making it unsuitable for tourism and fishing. The surrounding area is characterized by agricultural activities. The coordinates of the sampling sites are given in Table 1.

Table 1

Coordinates of the sampling sites.

	Sites	Latitude	Longitude
1	Adrasan	36°17′49″N	30°28′21″E
2	Tekirova	36°30′37″N	30°32′38″E
3	Küçük Çaltıcak	36°47′36″N	30°34′30″E
4	Konyaaltı	36°53′01″N	30°40′45″E
5	Lara	36°50′43″N	30°47′58″E
6	Side	36°46′01″N	31°23′06″E
7	Alanya	36°25′55″N	32°08′47″E
8	Gazipaşa	36°18′19″N	32°15′26″E

To preserve taxonomic identity of the collected specimens, they were immediately fixed in 4% formaldehyde in the field and sorted in the laboratory. Low- and high-power microscopes were used to confirm the taxonomic identity of the specimens. Species were identified on the basis morphological characters based on literature sources, including Riedl (1983), Morri and Boero (1986), Svoboda and Cornelius (1991), Morri and Bianchi (1999), Bouillon et al. (2004), Schuchert (2001a,b, 2003, 2004, 2006), Nawrocki et al. (2010), and Schuchert and Geneve (2010). The classification used in this study is based mainly on the work of Bouillon et al. (2004), although in some cases updates to species names and terminology from the World Hydrozoa Database (Schuchert 2023) were also included.

The Sorensen similarity index was used to demonstrate the similarity of the selected sites in terms of biodiversity (Sorenson 1948). The formula for calculating the Sorensen index is as follows:

$$S = \frac{2C}{A + B}$$

where:

S – Sorensen index (similarity)
C – number of common species between two sites
A – number of species at site 1
B – number of species at site 2

The percentage of occurrence of a species in the study area is expressed by frequency analysis. The frequency value at a given site is calculated by dividing the number of samples containing the species by the total number of samples collected:

Frequency (F) = *Na*/*Nn* × 100, where *Na* is the number of samples for species 'a' and *Nn* is the total number of samples collected.

3. Results

The present study reports a total of 35 taxa from the Gulf of Antalya, including five species (*Clytia brevithecata, Clytia noliformis, Turritopsis nutricula, Scandia gigas* and *Acauloides ammisatum*) recorded for the first time for the Turkish coast, and together with the previous five species, twenty-four species (*Amphinema rugosum, Coryne eximia, Clytia gracilis, Monotheca obliqua, Eudendrium merulum, Halecium tenellum, Orthopyxis integra, Hydractinia aculeata, Laomedea flexuosa, Laomedea angulata, Dicoryne conferta, Clytia linearis, Eudendrium simplex, Eudendrium capillare, Aglaophenia picardi, Halopteris diaphana, Salacia desmoides, Sertularella ellisii* and *Hydrodendron mirabile*) were recorded for the first time for the western Mediterranean coast of Türkiye (Table 2). The study attributes the large number of newly recorded taxa to a significant lack of prior research in the region.

Table 2 shows the number of taxa identified at the sampling sites throughout the year (4 seasons). The largest number of taxa was identified at site 5 (18), followed by site 6 (17), site 2 (16), site 4 (16), site 7 (11), site 8 (11), site 3 (8), and site 1 (8).

Frequency analysis showed that *Clytia hemisphaerica* is scattered throughout all sampling sites, and was most common at site 8 (75% of the time). *Pennaria disticha* was consistently present at sites 2, 3, 4 and 5; most frequently observed at sites 1 and 6, and was not observed at site 7. *Scandia gigas*, *Coryne eximia*, *Sertularella ellisii*, *Eudendrium merulum* and *Laomedea angulata* are very rare at the sampling sites. Figures 2–9 show the frequency values of all species encountered by site. When the similarity between the sites in terms of species diversity was compared using the Sorensen index, sites 3 and 8 were found to be similar at 0.63, followed by sites 6 and 7 at 0.59, sites 2 and 5 at 0.58 and sites 1 and 7 at 0.55.

As for the substrate preferences of hydroid polyps, it was found that the highest percentage of them, 37%, preferred epiphytic substrate, followed by 23.08% that preferred epilithic substrate and 21.68% that preferred epizoic substrate. When conducting research on the fauna of hydroid polyps, it is important to consider the substrate preferences of species during sampling (Table 2).

When examining the seasonality of species occurrence, it was determined that only *Eudendrium* sp. and *P. disticha* occurred in all seasons (Table 2). Frequency graphs of the species given in figure 2-9.

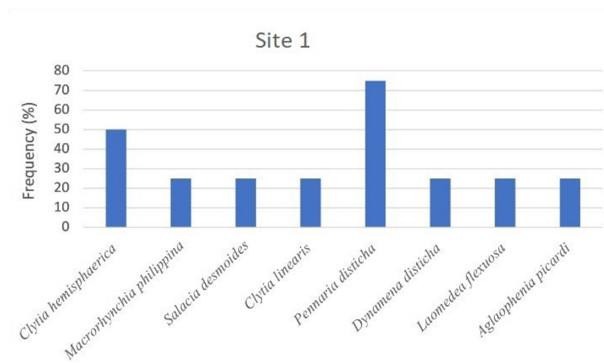

Figure 2

Species frequency graph for site 1.

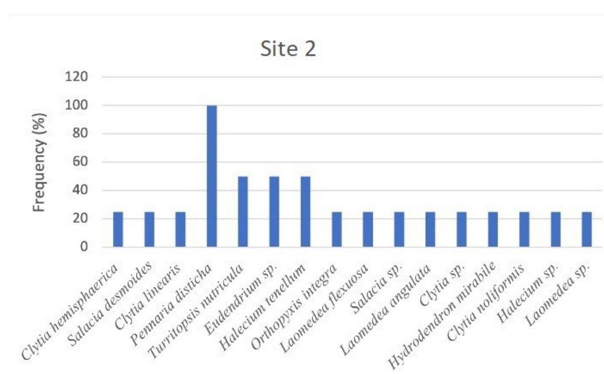

Figure 3

Species frequency graph for site 2.

Table 2

List of Hydrozoa taxa recorded in the Gulf of Antalya during this study. Substrate: EZ – epizooic; EL – epilytic; EP – epiphytic. The southern Mediterranean coasts of Türkiye, the Aegean Sea, the Sea of Marmara and the Black Sea are denoted as Smed, AS,SM and BS. 'All' means all substrate types. St.1 – Adrasan, St.2 – Tekirova, St. 3 – Küçük Çaltıcak, St.4 – Konyaaltı, St.5 – Lara, St.6 – Side, St.7 – Alanya, St.8 – Gazipaşa. New records for the southern Mediterranean coasts of Türkiye are marked with *. New records for Turkish coasts are marked with #. Abbreviations used for seasons are as follows: 'sp.' for spring, 'su.' for summer, 'wi.' for winter, and 'au.' for autumn, 'All' for all seasons.

Taxa	Biogeographical distribution	Previously documented from Türkiye	References	Sites	Seasonality
Phylum: Cnidaria					
Class: Hydrozoa					
Subclass: Hydroidolina					
Order: Anthoathecata					
Suborder: Aplanulata					
Family: Acauliadae					
Genus:*Acauloides* Bouillon, 1965					
Acauloides ammisatum (Bouillon, 1965)	Mediterranean	#,*		4,5,7	sp., su.
Suborder: Filifera					
Family: Pandeidae					
Genus*: Amphinema* Haeckel, 1879					
Amphinema rugosum (Mayer, 1900)	Atlantic, Indo-Pacific, Mediterranean	*,AS,	1	6	su.
Amphinema sp.				6	au.
Family: Bougainvillidae					
Genus: *Dicoryne* Allman 1859					
Dicoryne conferta (Allman, 1864)	North- Eastern Atlantic, Mediterranean	*,SM,	2	4	au.
Family: Eudendriidae					
Genus: *Eudendrium* Ehrenberg, 1834					
Eudendrium sp.				2,3,4,5,6,7	All
Eudendrium capillare (Pallas, 1776)	Cosmopolitan	*,SM, AS	2	3,4,8	wi.
Eudendrium merulum (Watson, 1985)	Mediterranean	*,SM, AS	2	8	sp.
Eudendrium simplex (Pieper, 1884)	Mediterranean	*,AS	2	4	au.
Family: Hydractiniidae					
Genus: *Hydractinia* Van Beneden,1844					
Hydractinia aculeata (Wagner, 1833)	Mediterranean	*,SM	3	4,6,7	au., wi.
Family: Oceaniidae					
Genus: *Turritopsis* Mc crady, 1857					
Turritopsis nutricula (McCrady, 1857)	Atlantic, Mediterranean	#,*		2,4,5	sp., su.
Suborder: Capitata					
Family: Corynidae					
Genus: *Coryne* Gaertner, 1774					
Coryne eximia (Allman, 1859)	Atlantic, Indo-Pacific, Mediterranean, Arctic	*SM	2	4	sp.
Family: Pennaridae					
Genus: *Pennaria* Goldfus, 1820					
Pennaria disticha **(Goldfus, 1820)**	North-East Atlantic, Mediterranean	Smed	2	1,2,3,4,5,6,7,8	All
Order: Leptothecata					
Family: Campanulariidae					
Genus: *Clytia* Lamoroux, 1812					
Clytia sp.				2,3,6,8	su., au., wi.
Clytia gracilis (Sars, 1850)	Cosmopolitan	*SM, AS	2	4,5	sp.
Clytia hemisphaerica (Linnaeus,1767)	Cosmopolitan	SM, AS, Smed	1, 2	1,2,3,4,5,6,7,8	sp., su., au.
Clytia brevithecata (Thorneley,1900)	South Atlantic, Mediterranean	#,*		6,7	au., wi.
Clytia linearis (Thorneley, 1900)	Circumtropical	*AS	1,2	1,2,4,5,8	sp., au., wi.
Clytia noliformis (McCrady, 1859)	Central Atlantic, Mediterranean	#, *		2,5,6	au., wi.
Genus: *Laomedea* Lamouruox, 1812					
Laomedea angulata (Hincks, 1861)	Atlantic, Mediterranean, Adriatic	*AS, SM, BS	2	2,5	su., au.
Laomedea flexuosa (Alder, 1857)	Atlantic, Mediterranean	*AS, SM	2	1,2,5,7	su., au.
Laomedea sp.				2,5	su., wi.
Genus: *Orthopyxis* L. Agassiz, 1862					
Orthopyxis integra	Atlantic, Indo-Pacific, Mediterranean	*AS, SM	2	2,8	sp., su., au.
Family: Haleciidae					
Genus: *Halecium* Oken, 1815					
Halecium tenellum (Hincks, 1861)	Atlantic, Mediterranean, Indo-Pacific, Boreal	*, AS	1	2,5,6	sp., su., au.
Halecium sp.				2	wi.
Family: Habellidae					
Genus: *Scandia* Fraser, 1912					
Scandia gigas (Pieper, 1884)	Atlantic, Mediterranean	#,*		4,5	sp., au.
Süper family: Plumularioidea					
Family: Plumulariidae					
Genus: *Plumularia* Lamarck, 1816					
Monotheca obliqua (Johnston,1847)	Circumtropical	*AS, SM	1,2,3	6,7,8	sp., au., wi.
Family: Aglaopheniidae					
Genus: *Macrorhynchia* Kirchenpauer, 1872					
Macrorhynchia philippina Kirchenpauer, 1872	North Atlantic, Mediterranean	Smed	2	1,3,5,8	sp.
Genus: *Aglaophenia* Lamoroux, 1812					
Aglaophenia picardi Svoboda,1979	Atlantic, Mediterranean	*, AS, BS	1,2	1,5,6	wi.
Family: Halopteriidae					
Genus: *Halopteris* Allman,1877					
Halopteris diaphana (Heller, 1868)	Atlantic, Mediterranean	*, AS	1,2	3,4,6,8	sp., su., au.
Family: Phylactothecidae					
Genus: *Hydrodendron* Hincks, 1874					
Hydrodendron mirabile (Hincks, 1866)	Atlantic, Mediterranean, Pacific Ocean	*, AS	2	2,6	au.
Super Family: Sertularioidea					
Family: Sertulariidae					
Genus: *Dynamena* (Fraser, 1938)					
Dynamena disticha (Bosc, 1802)	Atlantic, Mediterranean, Red sea,	AS, Smed	2	1,5,6,7,8	sp., su., wi.
Genus: *Salacia* Haeckel, 1888					
Salacia desmoides (Torrey,1902)	Circumtropical	*, AS	2	1,2,3,4,6,7	sp., su.
Salacia sp.				2	su.
Family: Sertularellidae					
Sertularella sp.				5	wi.
Sertularella ellisii	North Atlantic Ocean, North Pacific Ocean, Mediterranean	*, AS, SM	1,2	4,5,6,7	sp., su., wi.

References: 1 – İşinibilir et al. 2014; 2 – Çınar et al. 2014; 3 – İşinibilir et al. 2015

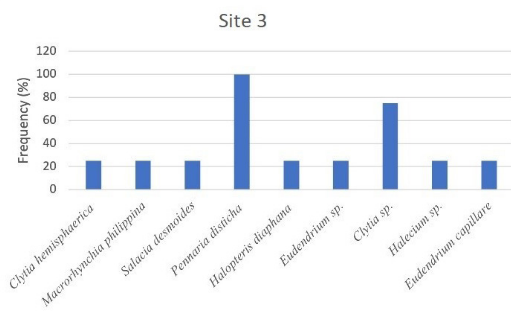

Figure 4

Species frequency graph for site 3.

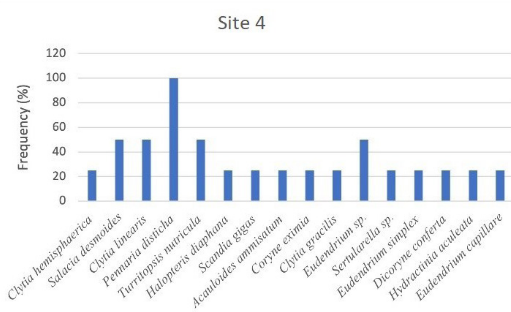

Figure 5

Species frequency graph for site 4.

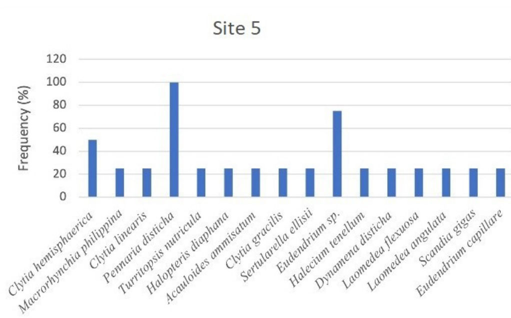

Figure 6

Species frequency graph for site 5.

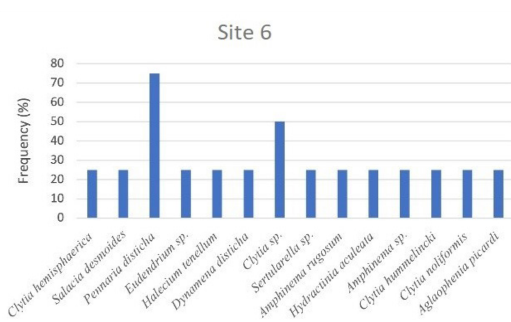

Figure 7

Species frequency graph for site 6.

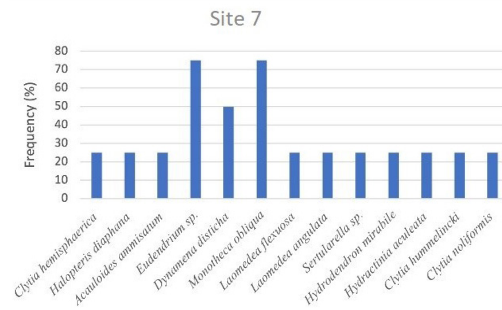

Figure 8

Species frequency graph for site 7.

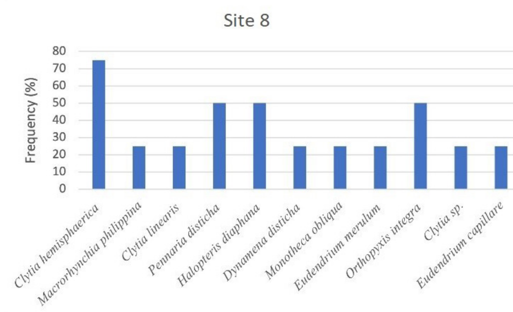

Figure 9

Species frequency graph for site 8.

4. Discussion

Over the past three decades, the count of Hydrozoa taxa documented in the Mediterranean Sea has nearly doubled and the number of newly reported species continues to increase. Boero et al. (1997) reported 379 species, whereas Bouillon et al. (2004) documented 457 species. The number of Hydrozoa species in the eastern Mediterranean region has increased in recent years due to studies conducted in the area (Bouillon et al. 2004).

Hydroid polyp species are expected to be more abundant in the area, but the gap in the literature indicates the need for further studies on this issue in the region. As a result of subsequent scientific research, the number of hydrozoan species in Türkiye has also increased to 127 species (Gülşahin et al. 2013; İşinibilir et al. 2015 a, b; Gülşahin et al. 2016; Gülşahin, Türker 2017; Yılmaz et al. 2017; İşinibilir et al. 2019; İşinibilir et al. 2021; İşinibilir et al. 2022). With the results of the present study, the total number of hydrozoan taxa recorded on the Mediterranean coasts of Türkiye increased to 85, and those distributed along the coasts of Türkiye increased to 132 species.

The total number of hydroid species recorded on the Mediterranean coasts of Türkiye until 2014 was 56 (Çınar et al. 2014). The higher number of species found by Çınar et al. than in the present study is believed to be due to the fact that they sampled a wide range of depths, periods and locations along the entire Mediterranean coast. Of these, 18 species were recorded both in the present study and in the 2014 study conducted by Çınar et al. A comparison of the data obtained in 2014 and 2019 showed that the total number of species was slightly higher in 2019 (85) than in 2014 (56). The increase in the number of species can be explained by gaps resulting from a lack of previous research, as well as hypotheses regarding the arrival of Lessepsian species, the effects of global warming, and the movement of species due to shipping activities.

The seasonal distribution of the species indicates that the findings of this study are mostly consistent with the literature (Bouillon et al. 2004). However, it was found that some species showed discrepancies with their distribution reported in the literature (Bouillon et al. 2004; İşinibilir et al. 2014) – in this study, *E. capillare* and *A. picardi* were observed only in winter, while in the literature they were reported to occur throughout the year. *E. merulum* was recorded in spring in this study, but was reported in the literature to occur year-round. *C. linearis* was found in spring, autumn, and winter in this study, but was reported to have a year-round distribution. Although *L. angulata* was reported to occur in winter and autumn, it was also observed in summer in this study. *L. flexuosa* was reported to occur in spring and summer, but in this study it was also found in autumn. *O. integra* was found to occur year-round, but in this study it was not found in winter. *S. gigas* was recorded in spring and autumn, but not in summer in this study. Contrary to other literature sources, *H. diaphana* was not observed in the winter season. *D. disticha* was reported to occur year-round, but in this study it was observed in spring, summer and winter, but not in autumn. *S. ellisii* was reported to occur year-round, but in this study it was not found in autumn. The distribution of other species was seasonal, consistent with the literature. The above differences in seasonal distribution of the species may be due to the limited depth of the study, which was restricted to 0–10 m. In addition, with sampling conducted mainly in coastal areas, the variation may be due to the fact that organisms do not show a homogeneous distribution.

Morri & Bianchi (1999) reported in their study that macroalgae were the most frequently used substrate by hydroid polyps. In the present study, the largest number of taxa was recorded at site 5, where intensive development of macroalgae was observed. The presence of sessile organisms, such as hydroids, in marine environments depends on their ability to attach to substrates. The availability and density of different substrates in the environment directly affects the occurrence of species (Boullion et al. 2004).

Of all the other species found, only *C. hemisphaerica* and *P. disticha* occurred at all sampling sites throughout the study, as shown in Table 2. Although these two species are common in the region, *C. hemisphaerica* is a cosmopolitan species, while *P. disticha* is a circumtropical species (Gravili et al. 2008; Houliston et al. 2010; Schuchert 2023). The analysis of the species distribution in relation to seasonal variations revealed that *Eudendrium* sp. and *P. disticha* were the only species that occurred consistently across all seasons.

Table 3 shows the similarity between the sampling sites in terms of Sorensen index values. Sites 3 and 8 are characterized by the highest similarity ratio. These two sites are the most similar in terms of partial distance from the city center and have similar rocky benthic structures. They are followed by sites 6 and 7, both of which have artificial structures such as a small harbor and fishing port. Sites 2 and 5 are both tourist spots exposed to human impact, with a rocky and stony structures. Sites 1 and 7 are located at the eastern and western ends of the bay, respectively.

According to the frequency results, *Pennaria disticha* and *Clytia hemisphaerica* were frequently encountered at site 1, *Pennaria disticha* was most common at site 2, and *Clytia* sp. and *Pennaria disticha* were frequently found at site 3. *Pennaria disticha*, *Salacia desmoides*, *Clytia linearis*, *Eudendrium* sp., and *Turritopsis nutricula* were common species at site 4. *Pennaria disticha* and *Eudendrium* sp. were the most prevalent species at site 5. Similarly, *Pennaria disticha*

Table 3

Sorensen similarity index values of the sampling sites (‘St.’ is used as an abbreviation for ‘site’).

	St.1	St.2	St.3	St.4	St.5	St.6	St.7	St.8
Site 1	1							
Site 2	0.41	1						
Site 3	0.5	0.41	1					
Site 4	0.33	0.37	0.33	1				
Site 5	0.53	0.58	0.3	0.52	1			
Site 6	0.53	0.48	0.48	0.42	0.45	1		
Site 7	0.55	0.38	0.44	0.46	0.50	0.59	1	
Site 8	0.52	0.37	0.63	0.37	0.34	0.42	0.38	1

and *Clytia* sp. were common at site 6. *Monotheca obliqua* and *Eudendrium* sp. were regularly observed at site 7. *Clytia hemisphaerica, Pennaria disticha*, *Halopteris diaphana* and *Orthopyxis integra* were abundant at site 8 (Figs 2–9).

Analysis of frequently observed species can reveal whether they are tolerant species in terms of distribution at sites with different habitat characteristics.

Species that are transported to different regions from their natural habitats through various means (such as ballast water, fouling, human impact, etc.) can cause significant problems in the areas where they become newly adapted. With global warming and human impact, hydroid polyps are disappearing from their areas of occurrence or may appear in areas where they were not previously present (Puce et al. 2009). Therefore, it is important to know the distribution and ecology of alien invasive species that are present along our coasts (Çınar et al. 2014).

It is believed that *C. linearis*, one of the identified species in this study, is the first hydroid species to successfully colonize and adapt to the Mediterranean system through the Suez Canal (Boero et al. 2005). In addition, *C. hummelincki*, *M. philippina*, *C. eximia* and *E. merulum* were identified as other species exhibiting characteristics of alien invasive species on the Turkish coasts (Çınar et al. 2014; Gravili et al. 2015).

The study "Risk screening of potential invasiveness of non-native jellyfishes in the Mediterranean Sea" conducted by Killi et al. (2020) reported that *C. brevithecata* (syn. *C. hummelincki*) has high risk of invasiveness for Türkiye, as well as the Mediterranean system. This paper confirms the findings of the previous study and reports that the species is new for the Turkish coasts. The same study reports that both *C. linearis* and *C. eximia* have a high risk of invasiveness, in line with previous reports. From this perspective, risk screening studies have a certain degree of accuracy.

Faunistic studies in the European region have typically focused on well-studied areas and on easy-to-spot, popular species and economically important fish species. However, research on invertebrate fauna in regions with high biodiversity, which have not been sufficiently explored so far, can provide important information on species diversity and faunal richness (Costello, Wilson 2011). Therefore, more comprehensive and geographically extensive surveys are necessary to fill the knowledge gaps on invertebrate diversity in the Mediterranean region. Such studies would improve our understanding of the distribution, ecology, and conservation of invertebrate species and could provide valuable information for biodiversity conservation efforts in the region.

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References

Boero, F., Di Camillo, C., & Gravili, C. (2005). Phantom aliens in Mediterranean waters. Aquatic Invasions. MarBEF Newsletter, 3, 21-22.

Boero, F., Gravili, C., Denitto, F., Miglietta, M. P. & Bouillon, J. (1997). The rediscovery of *Codonorchis octaedrus* (Hydroidomedusae, anthomedusae, pandeidae), with an update of the mediterranean hydroidomedusan biodiversity. *Italian Journal of Zoology*, *64*(4), 359–365. https://doi.org/10.1080/11250009709356223

Bouillon, J., Medel, M. D., Pagès, F., Gili, J., Boero, F. & Gravili, C. (2004). Fauna of the Mediterranean Hydrozoa. *Biologia*, *68*, 5–438.

Coll, M., Piroddi, C., Steenbeek, J., Kaschner, K., Lasram, F., Aguzzi, J., et al. (2010) The Biodiversity of the Mediterranean Sea: Estimates, Patterns, and Threats. *PLoS ONE 5*(8), e11842. https://doi.org/10.1371/journal.pone.0011842 PMID:20689844

Costello, M.J. & Wilson S.P. (2011). Predicting the number of known and unknown species in Europe seas using rates of description. *Global Ecology and Biogeography*, *20*, 319-330. https://doi.org/10.1111/j.1466-8238.2010.00603.x

Çınar M. E., Yokeş, M.B., Açık, Ş. & Bakır, A.K. (2014). Checklist of Cnidaria and Ctenophora from the coasts of Turkey. *Turkish Journal of Zoology*, *38*, 677-697. https://doi.org/10.3906/zoo-1405-68

Demir, M. (1952). Invertebrate Benthic Fauna of the Bosphorus and the Islands Coastline. Istanbul University Faculty of Science Hydrobiology Research Institute Publications, 3, 615 pp.

Galea, H.R., Häussermann, V. & Försterra, G. (2007). Hydrozoa, fjord Comau, Chile. C*heck List, 3*(2). https://doi.org/10.15560/3.2.159

Gili, J.M., & Hughes, R. G. (1995). The Ecology of Marine Benthic Hydroids, *Oceanography and Marine Biology - an Annual Review*, *33*, 351- 426.

Gravili, C., Boero, F., & Licandro, P. (2008). Hydrozoa. *Biologia Marina Mediterranea 15(suppl.)*,71- 91.

Gravili, C., Di Camillo, C. G., Piraino, S. & Boero, F. (2013). Hydrozoan species richness in the Mediterranean Sea: past and present. *Marine Ecology*, *34*, 41–62. https://doi.org/10.1111/maec.12023

Gravili, C., De Vito, D., Di Camillo, G., Martell, L., Piraino, S. & Boero, B. (2015). The non-Siphonophoran Hydrozoa (Cnidaria) of

Salento, Italy with notes on their life-cycles: An illustrated guide. Zootaxa, *Monograph*, *3908*, 1-187. https://doi.org/10.11646/zootaxa.3908.1.1 PMID:25661429

Gülşahin, N., Tarkan, A.N. & Bilge, G. (2013) The hydrozoan *Geryonia proboscidalis* (Forskål, 1775), new for Turkey (Hydrozoa). *Zoology in the Middle East*, *59*(1), 93- 94. doi: 10.1080 / 09397140. 2013. 795077

Gülşahin, N., Çelik, M., Turan, C. & Ateş, C. (2016). First record of the hydrozoan *Oceania armata* Kölliker, 1853 from Turkey. *Zoology in the Middle East*, *62*(2), 187-188. doi:10.1080/09397140.2016.1182782

Gülşahin, N., Türker, A. (2017) A New Ctenophora Species for Turkey – *Leucothea multicornis* (Quoy Gaimard, 1824) (Order: Lobata). 2. Workshop on Invasive Species, Global meeting on invasion ecology, 27-29 September 2017, Bodrum, Muğla, TURKEY.

Houliston E., Momose, T. & Manuel, M. (2010). *Clytia hemisphaerica*: A jellyfish cousin joins the laboratory. *Cell Press*, *26*(4), 59-67. https://doi.org/10.1016/j.tig.2010.01.008 PMID:20227783

İşinibilir, M., Martell, L., Topçu, E.N., Yilmaz, I.N. & Piraino, S. (2014) First inventory of the shallow-water benthic hydrozoan assemblages of Gökçeada Island (northern Aegean Sea). *Italian Journal of Zoology*, *82*(2), 281-290. doi:10.1080/11250003.2014.977970

İşinibilir, M., Yilmaz, I.N. & Demirel, N. (2015). New records of jellyfish species in the Marmara Sea. *Italian Journal of Zoology*, *82*(3), 425-429. https://doi.org/10.1080/11250003.2015.1040858

İşinibilir, M., Ulucam, K. & Yüksel, E. (2019) First record of *Physophora hydrostatica* Forskål, 1775 (Cnidaria, Hydrozoa) for the Turkish seas. *Journal of the Black Sea/Mediterranean Environment*, *25*(2), 160 -165.

İşinibilir, M., Yuksel, E. & Guresen, O. (2021) The first record of *Geryonia proboscidalis* (Forskål, 1775), (Cnidaria: Hydrozoa) on the coasts of Gökçeada, the Aegean Sea, Turkey. *Aquatic Science and Engineering*, *36*(4), 215-217. https://doi.org/10.26650/ASE2021962514

İşinibilir, M., Yuksel, E., Turkeri, E.E., Dogan, O., Karakulak, F.S., Uzer, U., Dalyan, C., Furfaro, G. & Piraino, S. (2022) New Additions to the Jellyfish Fauna of the Sea of Marmara. *Aquatic Science and Engineering*, *37*(1), 53-57. https://doi.org/10.26650/ASE2021981468

Killi, N., Tarkan, A.S., Kozic, S., Copp, G., Davison, P. I. & Vilizzi, L. (2020). Risk screening of the potential invasiveness of non-native jellyfishes in the Mediterranean Sea. *Marine Pollution Bulletin*, Volume 150, 110728, ISSN 0025-326X

Morri, C. & Boero, F. (1986). Catalogue of Main Marine Fouling Organisms. *Office d'Etudes Marines et Atmospheriques ODEMA*, *7*, 1–91.

Morri, C., Bianchi, C. N. (1999). Hydroids (Cnidaria : Hydrozoa) from the Aegean Sea, mostly epiphytic on algae. *Cahiers de Biologie Marine*, *40*, 283–291

Morri, C., Puce, S., Bianchi, C. N., Bitar, G., Zibrowius, H. & Bavestrello, G. (2009). Hydroids (Cnidaria: Hydrozoa) from the Levant Sea (mainly Lebanon), with emphasis on alien species. *Journal of the Marine Biological Association of the United Kingdom*, *89*(1), 49–62. https://doi.org/10.1017/S0025315408002749

Mutlu, E., Özvarol, Y. (2022). Recent Record of *Oceania armata* and Near-Past Records of Other Gelatinous Organisms in the Turkish Waters Presumably Derived by Basin-Scale Current. *Çanakkale Onsekiz Mart University Journal of Marine Sciences and Fisheries*, *5*(1), 48–55 . https://doi.org/10.46384/jmsf.1083023.

Nawrocki, A. M., Schuchert, P. & Cartwright, P. (2010). Phylogenetics and evolution of Capitata (Cnidaria: Hydrozoa), and the systematics of Corynidae. *Zoologica Scripta*, *39*(3), 290–304. https://doi.org/10.1111/j.1463-6409.2009.00419.x

Piraino, S., de Vito, D., Brodbeck, E., Di Camillo, C. G., Fanelli, G. & Boero, F. (2013). Destructive standard squares or low-impact visually driven collection? A comparison of methods for quantitative samplings of benthic hydrozoans. *The Italian Journal of Zoology*, *80*(3), 424–436. https://doi.org/10.1080/11250003.2013.787461

Puce, S., Bavestrello, G., Di Camillo, C. G. & Boero, F. (2009). Long-term changes in hydroid (Cnidaria, Hydrozoa) assemblages: Effect of Mediterranean warming? *Marine Ecology (Berlin)*, *30*(3), 313–326. https://doi.org/10.1111/j.1439-0485.2009.00283.x

Riedl, R., (1983). Fauna und Flora des Mittelmeeres: Ein systematischer Meeresführer für Biologen und Naturfreunde. P. Parey, 836s, Deutschland.

Schuchert, P., (2001a). Survey of the family Corynidae (Cnidaria, Hydrozoa). *Revue Suisse De Zoologie*, *108*, 739-878. https://doi.org/10.5962/bhl.part.80165

Schuchert, P., (2001b). Hydroids of Greenland and Iceland (Cnidaria, Hydrozoa). Meddelelser om Grønland, Bioscience 53. Copenhagen, the Danish Polar Center, 185s.

Schuchert, P., (2003). Hydroids (Cnidaria, Hydrozoa) of the Danish expedition to the Kei Islands. *Steenstrupia, (Copenhagen)*, *27*(2), 137–256.

Schuchert, P., (2004). Revision of the European athecate hydroids and their medusae (Hydrozoa, Cnidaria): Families Oceanidae and Pachycordylidae, *Revue Suisse de Zoologie*, *111*(2), 315-369. https://doi.org/10.5962/bhl.part.80242

Schuchert, P., (2006). The European athecate hydroids and their medusae (Hydrozoa, Cnidaria) Capitata Part 1, *Revue Suisse De Zoologie*, *113*(2), 325–410. https://doi.org/10.5962/bhl.part.80356

Schuchert, P. & Genève, C. (2010). The European athecate hydroids and their medusae (Hydrozoa, Cnidaria): Capitata Part 2. *Revue Suisse De Zoologie*, *117*(3), 337–555. https://doi.org/10.5962/bhl.part.117793

Schuchert P. 2023. World Hydrozoa database. Available: https://www.marinespecies.org/aphia.php?p=taxdetails&id=1337 Accesed 16.05.2023.

Sorenson, T. (1948) A Method of Establishing Groups of Equal Amplitudes in Plant Sociology Based on Similarity of Species Content and Its Application to Analyses of the Vegetation on Danish Commons. Kongelige Danske Videnskabernes Selskab, *Biologiske Skrifter*, *5*, 1–34.

Svoboda, A., Cornelius P.F.S. (1991). The European and Mediterranean species of *Aglaophenia* (Cnidaria: Hydrozoa). Zoologische verhandelingen Leiden, 274, 1–72.

Yılmaz, I.N., Isinibilir, M., Vardar, D. & Dursun, F. (2017). First record of *Aequorea vitrina* Gosse, 1853 (Hydrozoa) from the Sea of Marmara: a potential invader for the Mediterranean Sea. *Zoology in the Middle East*, *63*(2), 1–3. https://doi.org/10.1080/09397140.2017.1299334

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