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RESEARCH ARTICLE

Pelagic gastropods of the Finike Seamounts region, the eastern Mediterranean Sea

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Abstract

The present study addresses the distribution of pelagic gastropods species in the Finike Seamounts region, which is a Special Environmental Protection Area. The material was sampled from different depths in 12 stations by nets and beam trawl. In total, seven species belonging to six families were identified, namely, *Janthina globosa* Swainson, 1822; *Atlanta peronii* Lesueur, 1817; *Cavolinia gibbosa* (d'Orbigny, 1835); *Cavolinia inflexa* (Lesueur, 1813); *Clio pyramidata* Linnaeus, 1767; *Styliola subula* (Quoy & Gaimard, 1827) and *Hyalocylis striata* (Rang, 1828). Here we present some ecological and distributional characteristics of the determined species with their photographs.

Keywords: Finike, seamounts, pelagic gastropods, Türkiye

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Introduction

Hydrothermal vents and their communities were discovered for the first time in the Galapagos Rift in 1976 (Lonsdale 1977; Georgieva *et al.* 2021). Since that time new deep-sea habitats with rich biodiversity have continued to be discovered and studied (Sibuet and Olu 1998; Vanreusel *et al.* 2009; Ürkmez 2021). Cold seeps and mud volcanoes are also seen in various seafloor structures besides hydrothermal vents (Paull *et al.* 1984). Like that formations were identified by Cita *et al.* (1981) for the first time in the south of Crete in the Mediterranean, various mud volcanoes were also determined (Ritt *et al.* 2012).

The Finike Seamounts are situated at the intersection between the Hellenic and Cyprus Arcs in the eastern Mediterranean, to the south of Türkiye. They consist of Anaximander in the west (summit 1250m depth), Anaximenes in the centre (summit 680m depth), Anaxagoras in the east (summit 930m depth) seamounts, and five mud volcanoes (Amsterdam, Kazan, Kula, Athina and Thessaloniki) (Zitter *et al.* 2003, 2006; Aksu *et al.* 2009; Raineault *et al.* 2013; Ürkmez 2021). The studies carried out in the region showed that these mountains with a complex structure are separated from the Turkish continental margin (Zitter *et al.* 2003, 2006; Aksu *et al.* 2009).

Ecosystems of deep sea such as seamounts, canyons, hydrothermal vents, cold seeps, and mud volcanoes have unique benthic and pelagic biodiversity and understanding their biological and ecological roles are very important (Sibuet and Olu 1998; Öztürk *et al.* 2012; Würtz 2012). With the aim of understanding and protecting biodiversity of seamounts, therefore, many studies have been carried out on the benthic and pelagic communities in the Finike Seamounts (Salas and Woodside 2002; Olu-Le Roy *et al.* 2004; Öztürk 2009; Vanreusel *et al.* 2009; Öztürk *et al.* 2010; Shank *et al.* 2011; Ürkmez 2021), which were then declared as a Special Environment Protection Area by the Turkish government in 2013.

Among the invertebrate organisms inhabiting these special regions such as deep seas and seamounts, molluscs are abundant taxa, especially those of the classes Gastropoda, Bivalvia and Cephalopoda. The phylum Mollusca comprises species belonging to eight classes known to distribute at different depths and habitats. The phylum consists of nearly 50,000 marine species (Bouchet 2006) of which the gastropods are dominant (Ponder and Lindberg 2008; Öztürk *et al.* 2014).

Materials and Methods

The samples were collected in the Finike Seamounts known as "Special Environmental Protection Area" in the Mediterranean Sea by using plankton net, pelagic net and beam trawl on board R/V YUNUS-S in May and September 2021 (Figure 1) in the framework of the project "Cetacean Diversity in the Finike Seamounts Special Environmental Protection Area" supported by Turkish Ministry of Environment, Urbanisation and Climate Change. The pelagic net (not closing) used for sampling was a simple conical of 3.2m fitted with a 5mm mesh size and cod end. A plankton net also used had 300µ mesh size, 1.3m in diameter and 2.8m in length. The pelagic and plankton nets were hauled from depths mentioned in Table 1 to surface as vertically. Besides, a beam trawl with 3m length and a vertical net opening of 0.6m was used along 1 h and towing speed between 2.2 and 2.5 nautical miles at one station.

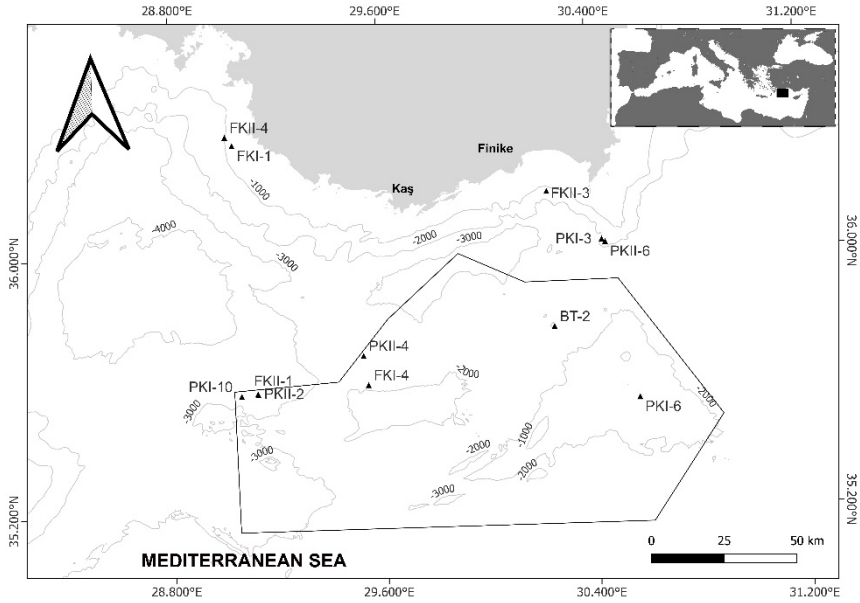

Figure 1. The sampling stations in the Finike Seamounts study area

Table 1. Coordinates, sampling dates, depth and sampling methods at sampling stations

Stations	Coordinates	Date	Depth (m)	Sampling methods
PKI-3	36°2'6.90" N 30°26'35.04" E	14.05.2021	1884	Plankton Net
PKI-6	35°32'32.40" N 30°34'8.40" E	19.05.2021	1422	Plankton Net
PKI-10	35°34'32.04" N 29°3'33.39" E	25.05.2021	3399	Plankton Net
FKI-1	36°21'14.40" N 29°2'23.88" E	11.05.2021	625	Pelagic Net
FKI-4	35°36'11.58" N 29°32'28.50" E	15.05.2021	2062	Pelagic Net
PKII-2	35˚34'47.39" N 29˚7'22.43" E	18.09.2021	3277	Plankton Net
PKII-4	35°41'37.40" N 29°31'30.21" E	25.09.2021	2363	Plankton Net
PKII-6	36°1'37.08" N 30°27'21.78" E	27.09.2021	1610	Plankton Net
FKII-1	35°34'55.14" N 29°7'16.23" E	18.09.2021	3277	Pelagic Net
FKII-3	36°11'20.40" N 30°14'20.10" E	28.09.2021	1305	Pelagic Net
FKII-4	36°22'49.56" N 29°0'46.26" E	01.10.2021	1002	Pelagic Net
BT-2	35˚46'8.52" N 30˚15'12.72" E	19.05.2021	1800	Beam Trawl

The sampled material was fixed in seawater-formalin solution (4%) at the field. In the laboratory, the materials were sorted into taxonomic groups under a stereomicroscope and preserved in 70% ethanol. The studied materials were deposited in the museum collection of the Faculty of Fisheries (ESFM) at Ege University, Izmir.

Results

The investigation of the pelagic molluscan specimens in the Finike Seamounts region of Türkiye revealed seven species belonging to six families: *Janthina globosa* Swainson, 1822; *Atlanta peronii* Lesueur, 1817; *Cavolinia gibbosa* (d'Orbigny, 1835); *Cavolinia inflexa* (Lesueur, 1813); *Clio pyramidata* Linnaeus, 1767; *Styliola subula* (Quoy & Gaimard, 1827) and *Hyalocylist striata* (Rang, 1828).

The systematics and photographs of the determined species are presented below together with the remarks and their distribution. The depths were also submitted as a characteristic of stations in the material notes and quantitative evaluation has not been made because the used sampling nets were not closing nets and were hauled from the starting depths to the surface vertically in the stations.

Class : Gastropoda Cuvier, 1795
Family : Epitoniidae Berry, 1910
Genus : *Janthina* Röding, 1798

***Janthina globosa* Swainson, 1822**
(Figure 2)

Janthina globosa Swainson, 1822: Vol. 2, plate 85.

Material: St. PKI-6, 19.05.2021, 1422m (ESFM-GAS /2021-46); St. PKII-4, 25.09.2021, 2363m (ESFM-GAS /2021-52); St. PKII-6, 27.09.2021, 1610m (ESFM-GAS /2021-62).

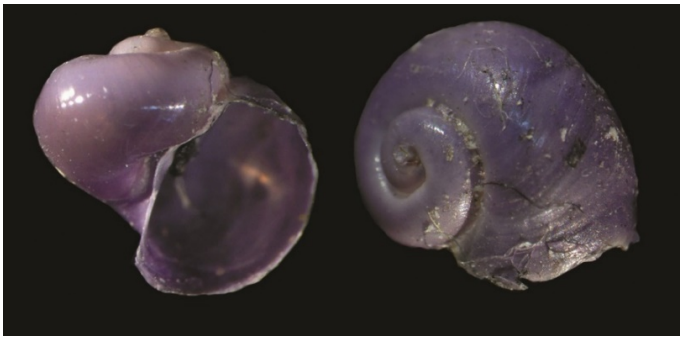

Figure 2. *Janthina globosa* (ventral and dorsal views of a specimen, h=2.8mm)

Remarks: The species is with globose, convex, thin and fragile shell, which is consisted nearly of the body whorl. Sutur small. Aperture large with columellar side a bit turned over the umbilicus. Colour violet. The species is characteristic with its more globose last whorl compared to the other *Janthina* species distributed in the Mediterranean Sea. *Janthina globosa* is an epipelagic and pleustonic species but it is difficult to say from which depths both its individuals and/or empty shells were obtained because of the sampling methods used in this study.

Distribution: Levantine Sea (Demir 2003; Öztürk *et al.* 2014; Teker *et al.* 2017).

Family : Atlantidae Rang, 1829
Genus : *Atlanta* Lesueur, 1817

***Atlanta peronii* Lesueur, 1817**
(Figure 3)

Atlanta peronii Lesueur, 1817: 390, plate 2, fig. I (1-2).

Material: Sta. FKI-4, 15.05.2021, 2062m (ESFM-GAS /2021-42); Sta. PKII-2, 18.09.2021, 3277m (ESFM-GAS /2021-53); Sta. FKII-1, 18.09.2021, 3277m, (ESFM-GAS /2021-54).

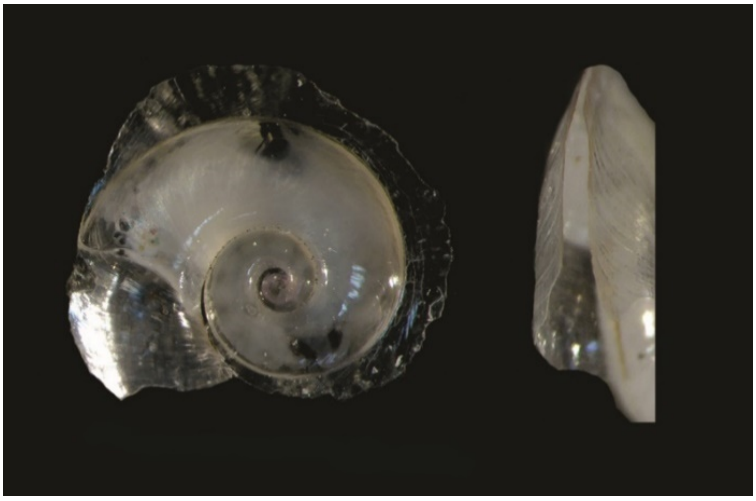

Figure 3. *Atlanta peronii* (two different views of a specimen, d=3.9mm)

Remarks: Shell smooth, calcareous and flatly coiled with up to six whorls. A high keel surrounds the entire shell circumference. The spire is flat, with sharp apex and it is very small, with four whorls. The suture is moderately deep, the umbilicus is relatively wide and deep. Out of seven species distributed in the

Mediterranean Sea (Coll *et al.* 2010), the genus *Atlanta* is represented by two species (*A. brunnea* and *A. peronii*) along the Turkish coasts, of which *A. peronii* is the commonest one.

Distribution: Sea of Marmara (Ostroumoff 1896; Öztürk *et al.* 2014), Aegean Sea (van Aartsen and Kinzelbach 1990; Demir 2003; Öztürk *et al.* 2014), Levantine Sea (Çevik *et al.* 2006; Öztürk *et al.* 2014).

Family : Cavoliniidae Gray, 1850
Genus : *Cavolinia* Abildgaard, 1791

***Cavolinia gibbosa* (d'Orbigny, 1835)**
(Figure 4)

Hyalaea gibbosa d'Orbigny, 1835: 95-96, plate 5, fig. 16-20.

Material: Sta. PKI-3, 14.05.2021, 1884m (ESFM-GAS /2021-45); Sta. PKI-10, 25.05.2021, 3399m (ESFM-GAS /2021-49); FKI-1, 11.05.2021, 625m (ESFM-GAS /2021-38); St. FKII-3, 28.09.2021, 1305m (ESFM-GAS /2021-55); Sta. BT-2, 19.05.2021, 1800m (ESFM-GAS /2021-56).

Figure 4. *Cavolinia gibbosa* (different lateral views of a specimen, h=9.8mm)

Remarks: The species is characteristic with its gibbous shell and truncated inferior valve in front with transversal striae on it. Lateral spines obtuse, median spine short and strongly hooked. All of the *Cavolinia* species known to be distributed in the Mediterranean Sea were also collected from the Turkish coasts (Coll *et al.* 2010; Janssen 2012; Öztürk *et al.* 2014).

Distribution: Aegean Sea (Aker *et al.* 2007; Öztürk *et al.* 2014); Levantine Sea (Forbes 1844; Öztürk *et al.* 2014).

***Cavolinia inflexa* (Lesueur, 1813)**
(Figure 5)

Hyalaea inflexa Lesueur, 1813: 281-285, plate 5, fig. 4.

Material: Sta. PKI-6, 19.05.2021, 1422m (ESFM-GAS /2021-61); Sta. PKII-4, 25.09.2021, 2363m (ESFM-GAS /2021-57).

Figure 5. *Cavolinia inflexa* (ventral views of a specimen, h=5.3mm)

Remarks: The species has a long hyaline shell with ventral flat side. There is a large caudal part with undistinguishable spine. Shell dorsally convex and lateral spines are slightly developed and are not elongated. Only growth striae are visible on the ventral and dorsal side. Aperture small. Shell size up to 7mm long. *C. inflexa* is one of the commonest pteropod species in the worldwide (van der Spoel 1967).

Distribution: Aegean Sea (Aker *et al.* 2007; Öztürk *et al.* 2014); Levantine Sea (Forbes 1844; Öztürk *et al.* 2014).

Family : Cliidae Jeffreys, 1869
Genus : *Clio* Linnaeus, 1767

***Clio pyramidata* Linnaeus, 1767**
(Figure 6)

Clio pyramidata Linnaeus, 1767: 1094.

Material: Sta. PKI-6, 19.05.2021, 1422m (ESFM-GAS /2021-47); Sta. PKI-10, 25.05.2021, 3399m (ESFM-GAS /2021-41); Sta. BT-2, 19.05.2021, 1800m (ESFM-GAS /2021-58).

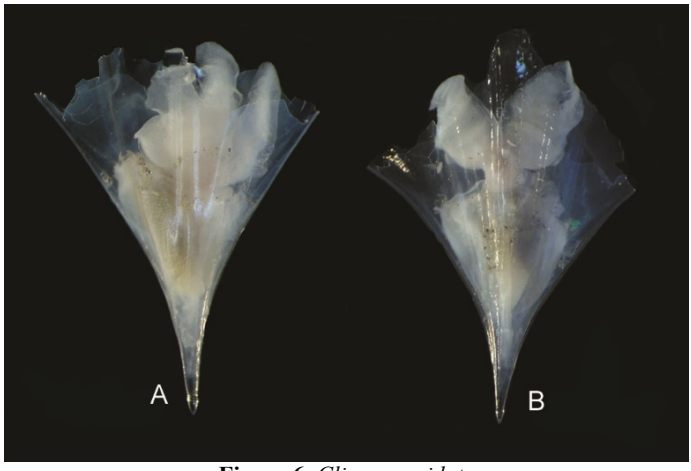

Figure 6. *Clio pyramidata*
(dorsal views of two different specimens, **A.** h=8.4mm and **B.** h=7.8mm)

Remarks: Shell thin, slender, straight and with uncoiled pyramidal shell. The two lateral ribs are thickened and slightly diverging and bent. They are rounded, especially near the embryonic shell. Transverse striation and growth lines are distinct. Although two species are known to be distributed in the Mediterranean Sea, only *Clio pyramidata* was reported from the Turkish coasts (Janssen 2012; Öztürk *et al.* 2014).

Distribution: Aegean Sea (van Aartsen and Kinzelbach 1990; Öztürk *et al.* 2014); Levantine Sea (Forbes 1844; Çevik *et al.* 2006; Öztürk *et al.* 2014).

Family : Creseidae Rampal 1973
Genus : *Styliola* Gray, 1847

***Styliola subula* (Quoy & Gaimard, 1827)**
(Figure 7)

Cleodora subula Quoy & Gaimard, 1827: 233-234, plate 8 D, fig. 1-3.

Material: Sta. PKI-6, 19.05.2021, 1422m (ESFM-GAS /2021-40); Sta. PKI-10, 25.05.2021, 3399m (ESFM-GAS /2021-48); Sta. FKI-4, 15.05.2021, 2062m (ESFM-GAS/2021-43); Sta. FKII-1, 18.09.2021, 3277m (ESFM-GAS /2021-59); Sta. FKII-4, 01.10.2021, 1002m (ESFM-GAS /2021-60).

Figure 7. *Styliola subula*
(dorsal views of two different specimens, **A.** h=3.3mm and **B.** h=2.9mm)

Remarks: Shell small, long, tubular and not curved, round in cross-section, with faint transverse striation on the surface. Between striae, there are longitudinal striations visible under magnification. Aperture small. A triangular tooth may be found dorsally and a triangular incision ventrally at the aperture border can be visible. *Styliola subula* is the single species of the genus known from the Mediterranean Sea (Coll *et al.* 2010; Janssen 2012).

Distribution: Levantine Sea (Forbes 1844; Buzzurro and Greppi 1996; Öztürk *et al.* 2014).

Family : Hyalocylidae Janssen, A. W., 2020
Genus : *Hylolocylis* Fol, 1875

***Hyalocylis striata* (Rang, 1828)**
(Figure 8)

Cleodora (Creseis) striata Rang, 1828: 315-316, plate 17, fig. 3.

Material: St. FKI-4, 15.05.2021, 2062m (ESFM-GAS /2021-44).

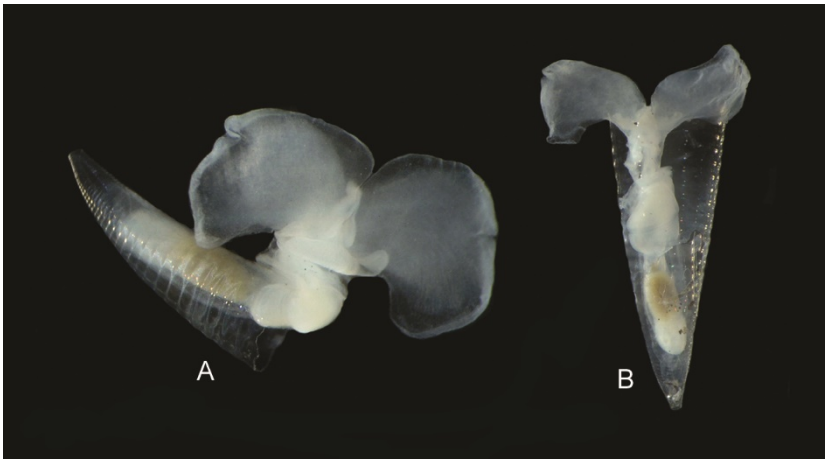

Figure 8. *Hyalocylis striata*
(views of two different specimens, **A.** h=6.8mm and **B.** h=6.5mm)

Remarks: Shell conical, with slightly curved apical part. It is distinctly annulated and slightly oval in transverse section. Aperture simple. Protoconch usually absent and the apical opening presumably closed with organic tissue. Shell length up to 9mm. The genus is represented by a single species in the Mediterranean Sea.

Distribution: Aegean Sea (Aker *et al.* 2007; Öztürk *et al.* 2014); Levantine Sea (Forbes 1844; Öztürk *et al.* 2014). According to Rampal (2011), *H. striata* is more frequently found in the eastern Mediterranean than in the western region.

Discussion and Conclusion

Pelagic gastropods are holoplanktonic organisms living at different depths in the water column, which have undergone some adaptations for feeding, swimming and buoyancy. Due to different diagnostic characteristics of the pelagic gastropods, some of them are placed under the order Pteropoda (Cavoliniidae, Cliidae, Creseidae, Hyalocylidae, etc.) and the others are included in the order Littorinimorpha (Atlantidae, Carinariidae, Pterotracheidae, etc.). While the distribution of the pelagic gastropods within the order Littorinimorpha are usually

between surface and 700m depth, the representatives of the order Pteropoda are with wider distribution. Most of the pteropods, although, are distributed in surface waters, some are distributed in deeper waters (1000-2000m or deeper). Pelagic gastropods are frequently encountered in zooplankton samples (Suárez-Morales *et al.* 2009). Members of the family Janthinidae were revised by molecular phylogeny studies and included in the family Epitonidae (Churchill *et al.* 2011a, b; Beu 2017). In fact, the jantinids are an evolutionary member of the Epitoniidae being adapted to pelagic life (Beu 2017).

Pelagic gastropods being food for many organisms from zooplankton to fish, cephalopods, mammals and sea turtles in the food chain, it is important to know their distribution due to the fact that they are bioindicator organisms in monitoring environmental variables. They are also important organisms for the biochemical cycles in the oceans (Lalli and Gilmer 1989; Beu 2017; Moreno-Alcántara *et al.* 2017; León *et al.* 2020).

In present study, the material was sampled at depths between 625m (FKI-1) and 3399m (PKI-10), and the highest number of pelagic gastropods (four species) was found at the station PKI-6, followed by the stations PKI-10 with three identified species. Except for the stations FKI-4, FKII-1, PKII-4 and BT-2, where two species were identified, one species was found at the rest of the stations.

Janthina globosa and *C. inflexa* were collected from the stations where the material was sampled with a plankton net only. *Atlanta peronii, C. gibbosa* and *S. subula* were sampled from the stations where both plankton and pelagic nets were applied. *Cavolinia gibbosa* and *C. pyramidata* were also sampled in the station BT-2 at 1800m depth, where beam trawl sampling was applied. Among the pelagic gastropods, *C. pyramidata* was the most abundant species known to have distribution in deeper waters (Janssen *et al.* 2018). *Hyalocylis striata* was collected from a single station where a pelagic net was used.

Janthina globosa is one of the well-known species in the Mediterranean Sea (Coll *et al.* 2012), but no detailed information on its distributional depths along the Turkish coasts, from where its presence was reported only (Demir 2003; Öztürk *et al.* 2014), except for the study carried out by Teker *et al.* (2017) in which study the species was sampled in Antalya Bay at depths between 20-30m.

Among *Atlanta* species, *A. peronii* is the most abundant and cosmopolitan species distributed in epilelagic and mesopelagic zones of tropical and subtropical waters (Wall-Palmer *et al.* 2014; Moreno-Alcántara 2019*).* The species is one of the well-known pelagic gastropod species from the Turkish coast. It is known to be distributed in the Levantine Sea (Çevik *et al.* 2006; Öztürk *et al.* 2014), Aegean Sea (van Aartsen and Kinzelbach 1990; Demir 2003; Öztürk *et al.* 2014) and Sea of Marmara (Ostroumoff 1896; Öztürk *et al.* 2014). There is no information, however, on its distribution in terms of depth.

Out of four *Cavolinia* species known from the Turkish coasts, *C. inflexa* is one of the commonest pteropod species worldwide (van der Spoel 1967). Both species of the genus *Cavolinia* identified in the present study are known from seamounts (OBIS 2022). Along the Turkish coasts, *C. gibbosa* and *C. inflexa* were reported from the Aegean Sea (Aker *et al.* 2007) and the Levantine Sea (Forbes 1844). *Cavolinia tridentata* is distributed in the Sea of Marmara (Ostroumoff 1896) and Levantine Sea (Forbes 1844; Çevik *et al.* 2006), and *C. uncinata* was reported from the Levantine Sea only (Yokeş 2009).

Although there have been reports of pelagic gastropods along the Turkish coasts, lack of detailed information especially on their depth range distribution is evident. In this study as well, closing nets were not used, thus the information on the depth where the specimens were collected was not available. Therefore, it would be very important to use closing nets by which it would be possible to sample materials from certain depths only, which will contribute to determine the distributional depth range of pelagic gastropods.

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Doğu Akdeniz'deki Finike Denizaltı Dağları'nın pelajik gastropodları

Öz

Bu çalışmada, Özel Çevre Koruma bölgesi olan Finike Denizaltı Dağları'nın pelajik gastropodları araştırılmıştır. 12 istasyonun farklı derinliklerinden alınan materyalin incelenmesi sonucu, 6 familyaya ait 7 tür *Janthina globosa* Swainson, 1822; *Atlanta peronii* Lesueur, 1817*; Cavolinia gibbosa* (d'Orbigny, 1835); *Cavolinia inflexa* (Lesueur, 1813); *Clio pyramidata* Linnaeus, 1767; *Styliola subula* (Quoy & Gaimard, 1827) and *Hyalocylis striata* (Rang, 1828) tespit edilmiştir. Çalışmada, tespit edilen türlerin ekolojik ve dağılım özelliklerinin yanı sıra, fotoğraflarına da yer verilmiştir.

Anahtar kelimeler: Finike, denizaltı dağları, pelajik Gastropoda, Türkiye

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