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Determination of Fish Diversity in The Rocky Habitat Around Mersin Boğsak Island (Northeast Mediterranean) by Visual Census Method

Mersin Boğsak Adasi (Kuzeydoğu Akdeniz) Çevresinde Yer Alan Kayalık Habitattaki Balık Çeşitliliğinin Görsel Sayım Yöntemiyle Belirlenmesi

Türk Denizcilik ve Deniz Bilimleri Dergisi

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ABSTRACT

The study was carried out in the rocky bottom habitat of Boğsak Island in Mersin Bay in November, March and July 2022-2023, using visual census method between 0-18 m depth and the survey was conducted along a transect. In the study, the structure of the fish community of the rocky bottom habitat of Boğsak Island was determined and the seasonal availability, abundance, feeding status and distribution of native and non-native fish species were determined. Shannon-Weiner Diversity Index (H') was used to determine species diversity and multidimensional scaling analysis was used to determine the relationship between the data. A total of 29 fish species, including 28 bony fish species belonging to 15 families and 1 cartilaginous *Gymnura altavela* (Linnaeus, 1758) were identified in the study area. The richest family in terms of species diversity was Sparidae (6), followed by Mullidae (3), Serranidae (3), Tetraodontidae (2), Soleidae (2), Labridae (2) and other families with 1 species each. It was determined that 52% of the fish species found in the study area throughout the year were Atlantic, 37% were Indo-Pacific and 11% were cosmopolitan. It was determined that 41% of the fish species were invertivores, 22% were carnivores (feeding on fish and invertebrates), 18% were omnivores, 11% were planktivores, 4% were herbivores and 4% were piscivores. The most abundant species were *Torquigener flavimaculosus* in summer, *Cheilodipterus novemstriatus* in spring and *Chromis chromis* in fall. Shannon species diversity (H'=2.956), richness (d=4.804) and homogeneity (J=0.800) were highest in the fall, followed by spring and summer.

Keywords: Rocky habitat, Fish communities, Underwater observation, Mersin Bay, Türkiye.

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ÖZET

Araştırma, Mersin Körfezi Boğsak Adasık kayalık habitatında, 2022-2023 yılı Kasım, Mart ve Temmuz aylarında, 0-18 m derinlik arasında görsel sayım yöntemi kullanılarak gerçekleştirilmiş ve araştırma doğrusal bir hat boyunca yapılmıştır. Çalışmada, Boğsak Adası'nın kayalık dip habitatının balık topluluğunun yapısı belirlenmiş, yerli ve yerli olmayan balık türlerinin mevsimsel bulunabilirliği, bolluğu, beslenme durumu ve dağılımı tespit edilmiştir. Tür çeşitliliğin belirlenmesinde Shannon-Weiner Çeşitlilik İndeksi (H'), veriler arasındaki ilişkinin belirlenmesinde çok boyutlu ölçeklendirme analizi kullanılmıştır. Çalışma alanında 15 familyaya ait 28 kemikli balık türü ve 1 kıkırdaklı *Gymnura altavela* (Linnaeus, 1758) olmak üzere toplam 29 balık türü tespit edilmiştir. Tür çeşitliği açısından en zengin familya Sparidae (6) olup, bunu Mullidae (3), Serranidae (3), Tetraodontidae (2), Soleidae (2), Labridae (2) ve 1'er türle diğer familyalar takip etmektedir. Çalışma alanında yıl boyunca tespit edilen balık türlerinin %52'sinin Atlantik, %37'sinin Hint-Pasifik ve %11'inin kozmopolit olduğu belirlenmiştir. Balık türlerinin %41'inin invertivor, %22'sinin karnivor (balık ve omurgasızlarla beslenen), %18'inin omnivor, %11'inin planktivor, %4'ünün herbivor ve %4'ünün piscivor olduğu tespit edilmiştir. Yaz aylarında *Torquigener flavimaculosus*, ilkbaharda *Cheilodipterus novemstriatus* ve sonbaharda *Chromis chromis* en bol bulunan türlerdir. Shannon tür çeşitliliği (H'=2.956), zenginliği (d=4.804) ve homojenliği (J=0.800) sonbahar mevsiminde en yüksek olup ilkbahar ve yaz mevsimi bunu izlemiştir.

Anahtar sözcükler: Kayalık habitat, Balık toplulukları, Sualtı gözlemi, Mersin Körfezi, Türkiye.

1. INTRODUCTION

Habitats formed by rocky substrates are rich in biodiversity, despite the fact that coastal ecosystems are known to be the harshest ecosystems in terms of abiotic environmental impact. Rich biodiversity is possible through adaptation to harsh environmental conditions. Rocky ecosystems are more affected by tides in the mediolittoral zone, while bottom habitats are less affected. In addition to natural factors such as interspecific interactions, competition, prey-predator relationships, invasive species pressure, negative impacts of direct human activities such as uncontrolled or unintentional hunting, pollution, unintentional urbanization / development and tourism have an impact on the biodiversity of rocky ecosystems (Golani, 1999; Molnar *et al.,* 2008; Bonaviri *et al.,* 2009; Satyam and Thiruchitrambalam, 2018).

Rocky ecosystems may dominate along the littoral zone starting from the coast, but may also be surrounded regionally by dune ecosystems or reefs (Satyam and Thiruchitrambalam, 2018). This has implications for biodiversity. Every surface is a habitat for aquatic organisms. The existence of suitable habitats, especially for sessile species that can survive by clinging to a place and mobile species such as fish, seaslug and cephalopods, plays an important role in enriching biodiversity. Since each species has a different function in the ecosystem, the preservation of the ecological balance is only possible through the regular maintenance of their relationships with each other and their environment.

Rocky bottom habitats support a large number of vertebrate and invertebrate species, are rich in nutrients and oxygen, and the burrows created by the impact of rough waves between the rocks provide shelter from predation for many species (Planes *et al.,* 2000). On the other hand, the abundance and diversity of food attract predators (Hindell *et al.,* 2000, Hyndes *et al.,* 2003, Ornellas and Coutinho, 1998) and the suitable breeding environment attracts many non-native fish species (Cocheret de la Morinière *et al.,* 2002; García-Rubies and Macpherson, 1995; Lloret *et al.,* 2002; Nagelkerken and van der Velde, 2004).

Regional and seasonal changes are observed in the structure of fish communities in rocky habitats. This change is influenced by competition between species for food, shelter, reproduction and habitat, the dominance of non-native species, the structure of algal communities and anthropogenic factors (Fishelson *et al.,* 2002; Guidetti and Boero, 2004; Guidetti *et al.,* 2002; Hughes *et al.,* 2003; Kucuksezgin *et al.,* 2006; Letourneur *et al.,* 2001; Pinnegar and Polunin, 2004; De Raedemaecker *et al.,* 2010).

Depth, wave exposure, bottom slope and abundance of seagrass meadows have been considered in studies of fish communities in rocky ecosystems in the Mediterranean (Colloca *et al.,* 2003; Gust *et al.,* 2001; Kallianiotis *et al.,* 2000; Valesini *et al.,* 2004) and it has been reported that the highest fish abundance was found in seagrass meadows and shallow rocky habitats (De Raedemaecker *et al.,* 2010).

It has been emphasized that many vertebrate and invertebrate species such as pufferfish and lionfish, poisonous sea urchins (*Diadema setosum*), jellyfish (*Rhopilema nomadica*) have caused changes in the biodiversity of the northeastern Mediterranean (Öztürk and İşinibilir, 2010; Bariche *et al.,* 2013; Bilecenoğlu *et al.,* 2019; Dağhan and Demirhan, 2019). Underwater visual census (UVC) studies in the Mediterranean are generally conducted in coastal and sensitive areas (marine protected areas, marine reserves, national parks). In Turkey, on the other hand, it is noteworthy that UVC studies are limited in number and mainly conducted in artificial reef areas (Horosan, 2016).

Uncontrolled fishing activities have contributed more to this change in the biodiversity of the northeastern Mediterranean than non-native migratory pressure. Artificial reefs, designed to increase fish populations in decline, have also created new habitats, especially for species with no or limited predators. Therefore, artificial reefs may be one of the anthropogenic factors that have a negative impact on biodiversity change in the Northeast Mediterranean.

The Turkish coast in the Northeastern Levantine has natural rocky bottom habitats. One of these habitats is located around Boğsak Island in the Gulf of Mersin and the main objective of this study is to investigate the changes caused by changing biodiversity and alien species impact on this special ecosystem. The study area is a protected area away from sport, amateur and professional hunting pressure and has the ability to reflect the natural biodiversity. The aim of this study was to determine the seasonal distribution, abundance and species diversity of fish species distributed in the rocky bottom habitat of Boğsak Island and to investigate the effect of non-indigenous species on biodiversity.

2. MATERIALS AND METHODS

The research was carried out in the rocky habitat of Boğsak Island in Mersin Bay, Mersin Bay in November, March and July, representing the fall, spring and summer periods of 2022-2023, by making underwater observations between 0-18 m depths. Coordinates of the study area: 36.268621 N, 33.828460 DE. The map of the study area is shown in Figure 1, and the maximum depth of the bottom dominated by rocky substrate structure was measured to be 18 m.

Diving and visual census techniques were used in the study. To obtain the data in the study, an underwater visual census was conducted using the scanning technique over a transect in the study area. An underwater camera (GoPro 12 Black) was used for underwater video recording. A total of 24 dives of approximately 40 hours were made, with video recording continued for 10-15 minutes depending on the behavior of the fish. Dives were conducted during the day before noon.

In this visual census-based study conducted by scuba diving along a linear line, the entire area was videotaped and the species observed and their numbers were determined. Describes the methodology and application used in this study and does not identify the possible effects of the choice of methodology on the data obtained. This study was not designed to determine the possible effects of the UVC method and its application on the data obtained. Therefore, even though the time spent in the scanned area was recorded, it was not considered sufficient to standardize the method due to the large scanned area chosen.

In the study, the fish communities in the rocky habitat of Boğsak Island were determined by using video recordings made during dives with the scanning method on a single transect within the area shown in Figure 2. The recordings observed and visualized during the dives in the field were analyzed in a computer environment. Akşiray (1987), Eschmeyer (2003), Fricke *et al.,* (2007) and Bilecenoğlu *et al.,* (2014) were used for the identification of local and non-native fish species.

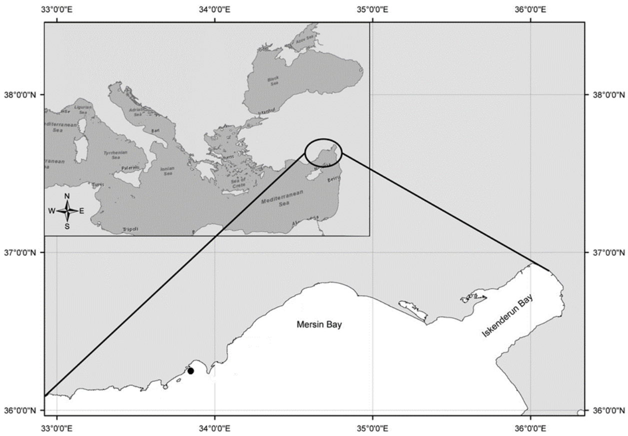

Figure 1. The area indicated by the black dot (●) is the Boğsak Island rocky bottom habitat sampling site

Figure 2. The red line shows the scanned area at the study site

The Shannon-Weiner diversity index (H'), the homogeneity and relative diversity index Evennes (J), the Dominance Index (D) and the species richness index Margalef Rhichnes (d) were used to determine species diversity (Zar, 1984). Biodiversity and statistical analyses were performed using the PAST version 4.09 package. Non-metric multidimensional scaling (N-MDS) analysis was used to visualize the relationship between the number of individuals in seasonal dives. The Euclidean formula was used to calculate the distances between coordinates in the N-MDS scaling. The stress value for N-MDS analysis was set to 0.04. To accurately represent the data, the final stress values should ideally be less than 10% and no greater than 30%. The ellipse indicates similarity between species 95% confidence intervals. Principal component analysis (PCA) was used to determine the effect of seasonal variation on species diversity and abundance.

3. RESULTS

In this study, the structure of fish communities in the rocky bottom habitat of Boğsak Island was investigated by underwater visual census technique in the fall, spring and summer. As the sea conditions were not favorable in winter, the study was planned for three seasons. The identified species were systematically classified and their distribution areas, feeding patterns and seasonal changes in the structure of the fish community were determined.

A total of 28 bony fish species belonging to 15 families and one cartilaginous fish species belonging to the family Gymnuridae were identified in a total of 24 dives conducted in November, March and June in 2022-2023 in the rocky bottom habitat of Boğsak Island. The richest family in terms of species diversity was Sparidae (6), followed by Mullidae (3), Serranidae (3), Tetraodontidae (2), Soleidae (2), Labridae (2) and other families with 1 species each.

In our study, Sparidae was found to be the richest family in terms of species diversity in the rocky bottom habitat of Boğsak Island.

Of the fish species identified throughout the year in the study area, 52% were Atlantic, 37% Indo-Pacific, and 11% cosmopolitan species.

The distribution of the fish community in the study area was determined according to their diet. Invertebrate-eating fish species constituted 41% of the community, followed by carnivores (feeding on fish and invertebrates) with 22%, omnivores with 18%, planktivores with 11%, herbivores with 4% and psychivores with 4%.

T. flavimaculosus in the summer season, *C. novemstriatus* in the spring season and *C. chromis* in the fall season were determined as the species with the highest abundance in the structure of the rocky bottom habitat fish community of Boğsak Island.

Table 1 shows the seasonal standardized

abundance of species observed during the November, March, and June dives in the study area and the average number of individuals of each species observed. As shown in Table 1, 22 fish species were observed in the fall season, 20 in the summer season and 17 in the spring season. Since the study area was determined by scanning on a transect, the results show the number of species and individuals encountered at the time of the dive. According to the similarity index scatter plot of the multidimensional scaling analysis, the number of individuals of *T. flavimaculosus*, *C. chromis* and *C. novemstriatus* showed a statistically significant difference from other species. In the N-MDS analysis, the value of the correlation coefficient was R^2=0.8772 for spring, R^2=0.5224 for summer and R^2=0.0668 for fall, with a stress value of 0.04, which was found to be significant ($P<0.01$). Principal component analysis results show that *C. novemstriatus* in March, *T. flavimaculosus* in June, and *C. chromis* in November have a statistically significant difference in abundance from other species (Figure 3). Principal component analysis has 80.03% variation in PC1 and shows similar results with N-MDS analysis, which shows seasonal separation in the abundance of fish species. The distance between taxa observed during the sampling period by visual census was determined. Ward's method algorithm was used to calculate the distance between taxa and the Euclidean similarity index was used. Although the observation results do not emphasize a sharp separation between the groups, it is seen that the groups can be separated from each other. *T. flavimaculosus*, *C. chromis* and *C. novemstriatus* appear to cluster separately from the other species observed (Figure 4).

Seasonal changes in fish community structure in the rocky bottom habitat of Boğsak Island were determined by diversity index analysis. Shannon diversity index refers to the diversity and abundance of fish species, Margalef richness (d) refers to the species richness, i.e. the number of species in the community, and evenness (J) value refers to the homogeneity of species distribution in the community. According to Shannon's diversity index (H'), the highest species diversity and evenness (J) were found in the fall (H' =2,956; J=0.801), followed by spring (H' =2.501; J=0.642) and summer (H' =2.458; J=0.531), while the Margalef D index of species richness was highest in fall (d=4.804), summer (d=3.917) and spring (d=3.632) (Table 2).

The analysis of the Shannon Diversity Index shows the seasonal separation of the fish species diversity found in the study area. It can be seen that the diversity is higher in the fall (November) season than in the spring (March) and summer (June) seasons. In terms of species richness, November was the highest followed by June and March observations. In the study, it was found that the similarity of March and June observations in terms of species richness in the fish community of Boğsak Island was high, while November observations showed a difference.

It was determined that 52% of the fish species observed in the study area were local species and 37% were Indo-Pacific species. The abundance of Indo-Pacific species clearly indicates competition with local species.

Table 1. Seasonal availability of species and number of individuals observed

Family	Species	Spring	Summer	Autumn	Origin	Feeding type (Froese and Pauly, 2024)
Gymnuridae	*Gymnura altavela*	-	1	0	Atlantic	Omnivore
(Mullidae	*Mullus barbatus*	1	1	0	Atlantic	Invertivore
	Upeneus moluccencis	13	7	3	Indo-Pasific	Invertivore
	Parupeneus forskalii	9	12	7	Indo-Pasific	Invertivore
Haemulidae	*Pomadasys stridens*	0	2	0	Indo-Pasific	Carnivore
Sparidae	*Spicara flexuosa*	3	1	3	Atlantic	Planktivore
	Spicara smaris	1	6	1	Atlantic	Planktivore
	Boops boops	2	6	1	Atlantic	Omnivore
	Diplodus vulgaris	12	14	10	Atlantic	Invertivore
	Sparus aurata	1	1	0	Atlantic	Omnivore
	Diplodus annularis	3	2	2	Atlantic	Invertivore
	Dussumeria elopsoides	0	0	2	Indo-Pasific	Carnivore
Scorpaenidae	*Pterois miles*	2	4	0	Indo-Pasific	Piscivore
Siganidae	*Siganus rivulatus*	0	0	2	Indo-Pasific	Herbivore
Serranidae	*Epinephelus aeneus*	0	0	7	Circumglobal	Invertivore
	Serranus cabrilla	10	8	6	Atlantic	Carnivore
	Serranus hepatus	2	13	8	Atlantic	Carnivore
Mugilidae	*Mugil cephalus*	0	0	1	Cosmopolitian	Carnivore
	Chelon ramada	4	0	11	Cosmopolitian	Omnivore
Apogonidae	*Cheilodipterus novemstriatus*	35	22	10	Indo-Pasific	Planktivore
Sphyraenidae	*Sphyraena chrysotaenia*	0	0	2	Indo-Pasific	Invertivore
Carangidae	*Trachurus trachurus*	0	1	6	Atlantic	Carnivore
Labridae	*Coris julis*	1	4	5	Atlantic	Invertivore
	Thalassamo pavo	9	10	8	Atlantic	Invertivore
Pomacentridae	*Chromis chromis*	20	25	18	Atlantic	Omnivore
Soleidae	*Monochisrus hispidus*	0	2	2	Atlantic	Invertivore
	Solea solea	0	0	1	Atlantic	Invertivore
Tetradontidae	*Lagocephalus sceleratus*	2	3	1	Indo-Pasific	Carnivore
	Torquigener flavimaculosus	12	68	3	Indo-Pasific	Invertivore

Table 2. Diversity Index Analysis values of fish species observed in the study area

	Month		
Index	**March**	**June**	**November**
Shannon_H	2.501	2.458	2.956
Evenness_$e^{H/S}$	0.642	0.531	0.800
Margalef	3.632	3.917	4.804

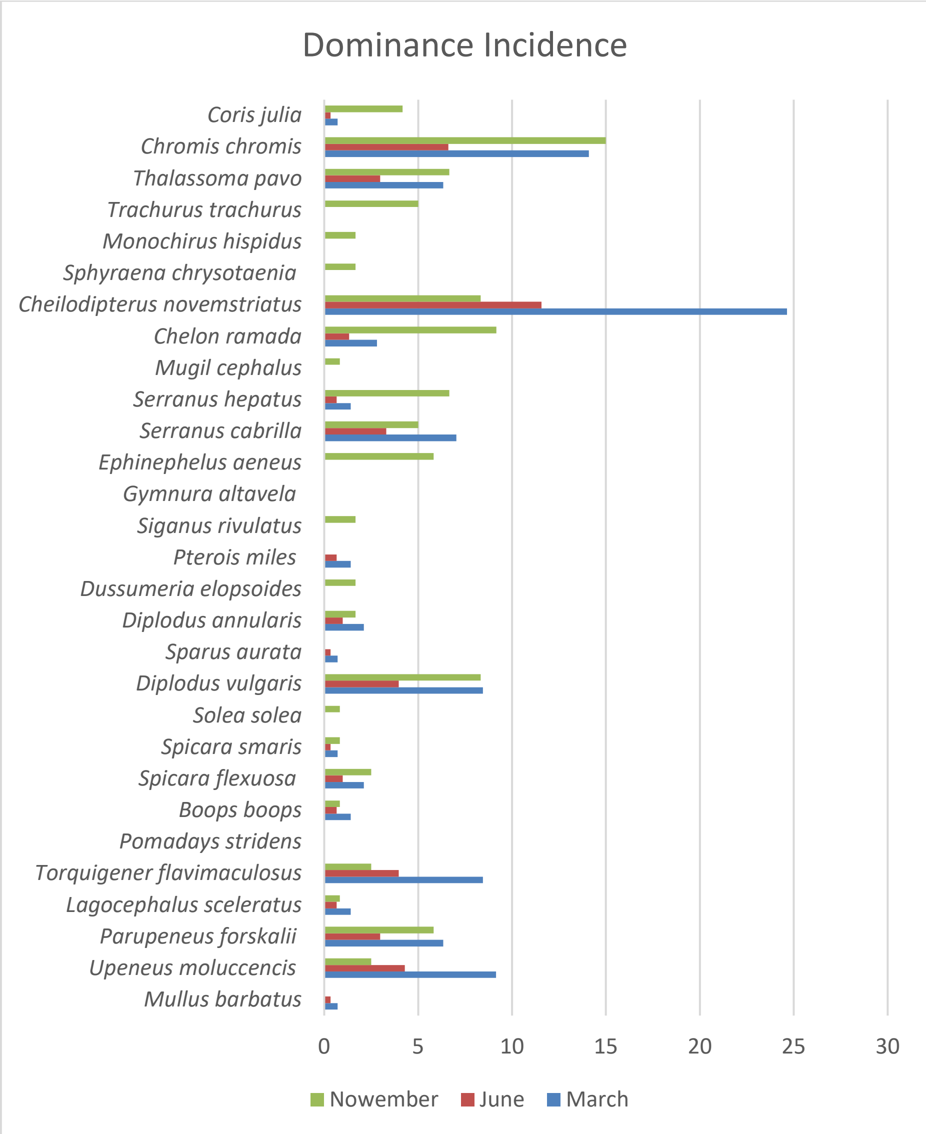

Figure 3. Dominance incidence of fish

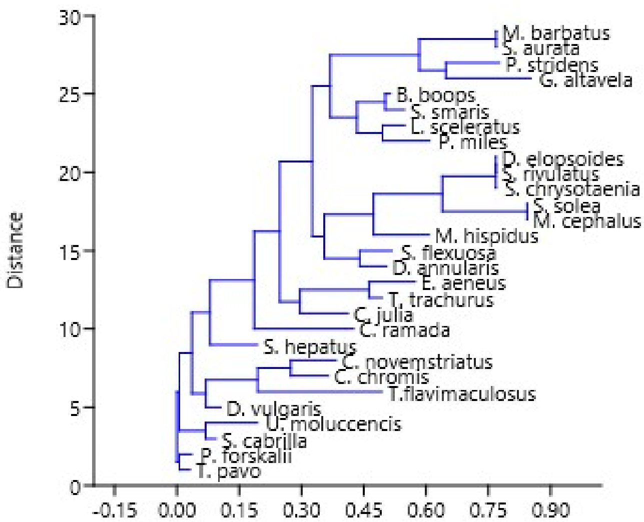

Figure 4. Dendrogram of distance between taxa with Bray-curtis similarity index

4. DISCUSSIONS

Boğsak Island a suitable habitat for many aquatic organisms including vertebrates and invertebrates. Due to its rich biodiversity, it is one of the special area that have ecological importance and should be protected.

In addition to fishes, *Spondylus gaederopus* Linnaeus, 1758, a spiny clam belonging to the phylum Mollusca, and *D. setosum* (Leske, 1778), a long spiny sea urchin belonging to the phylum Echinodermata, have been observed in the study area. *Halophila stipulaceae* (Forsskål) Ascherson, 1867, a tropical seagrass, and *Padina pavonica*, a brown algae, were also observed in the study area.

Among the findings of previous studies investigating fish communities in rocky bottom habitats in the eastern Mediterranean, the presence of 62 species belonging to 27 families between 0-32 m depths in the Lebanese rocky bottom habitat (Harmelin-Vivien *et al.,* 2005), 79 species belonging to 31 families in 3 different study sites in Israel rocky bottom habitat (Golani *et al.,* 2007); 61 fish species belonging to 21 families in 14 different rocky bottom habitats around the island of Arki in the Aegean Sea (De Raedemaecker *et al.,* 2010); 54 species belonging to 21 families in 26 islands in the rocky bottom habitat of the Cyclades Archipelago (Northeast Mediterranean) (Giakoumi and Kokkoris, 2013) were reported.

In similar studies conducted in the northwestern Mediterranean, 38 species belonging to 17 families were reported in shallow rocky reef areas in Sardinia, Italy (Pais *et al.,* 2007), and 68 species belonging to 22 families in rocky coastal habitats of Cape Portofino in the Ligurian Sea (Tunesi *et al.,* 2006).

In our country, Horosanlı (2016) investigated the distribution of fish species in *Posidonia oceanica* habitats between 0-15 m between April and September 2016 in a study conducted by underwater visual census method in Yıldız Bay in Gökçeada Underwater Park by Horosanlı (2016). A total of 64 fish species belonging to 20 families were identified in the study area.

This study was conducted seasonally in the rocky bottom habitat of Boğsak Island in the Gulf of Mersin, and the number and abundance of fish species observed cannot be compared because no similar study has been conducted in the same area. However, the number and abundance of fish species are lower compared to previous studies conducted in the eastern Mediterranean. It is thought that this difference may be due to differences in methodology. Fish abundance and richness may vary depending on depth and substrate structure, as well as anthropogenic pressures such as fishing activities, pollution, etc. Previous similar studies conducted in the Levant Basin reported that Labridae was the richest family in terms of species diversity, followed by Sparidae in second place (De Raedemaecker *et al.,* 2010; Giakoumi and Kokkoris, 2013; Sini *et al.,* 2019). In the Ligurian Sea in the western Mediterranean, the Sparidae family was reported to be richer in species diversity than the Labridae family (Tunesi *et al.,* 2006).

While *C. chromis*, *Oblado melanura*, *Spicara smaris*, *Coris julis* and *Thalassamo pavo* were reported to be the dominant fish species along the Lebanese coast (Harmelin-Vivien *et al.,* 2005), *T. pavo*, *C. julis* and *C. chromis* were similarly reported in the rocky habitats of Arki Island (De Raedemaecker *et al.,* 2010). *C. chromis*, *Boops boops*, *T. pavo*, *S. smaris*, *C. julis*, and *Diplodus vulgaris* have been reported in rocky habitats in the Aegean (Sini *et al.,* 2019). Yalgın and Türker (2023) reported that *C. chromis*, *Sparisoma cretense*, *Siganus luridus*, *Siganus rivulatus*, *T. pavo*, *S. smaris*, *C. julis*, and *D. vulgaris* were the most abundant species in terms of abundance in a visual census study conducted on the northern coast of Cyprus. In this study conducted in the rocky habitat of Boğsak Island, *T. flavimaculosus* was the most abundant species followed by *C. chromis*, *C. novemstriatus*, *D. vulgaris*, *Parupeneus forsskalii*, *T. pavo*, *Serranus cabrilla*, *U. mollucensis* and *Serranus hepatus*.

The fact that the species with the highest abundance in the rocky bottom habitat of Boğsak Island are species that entered the Mediterranean through species migration originating from the Indo-Pacific suggests that non-native species are more dominant in the study area. *C. novemstriatus* is associated with *D. setasum* and both species coexist. *C. novemstriatus* is protected from predators by the long spines of *D. setasum*. The increase in the abundance of *C.*

novemstriatus in the rocky bottom habitat of Boğsak Island can be seen as a natural consequence of the increase in the sea urchin population. The dwarf pufferfish *T. flavimaculosus* is a species of pufferfish found in the northeastern Mediterranean Sea. This species also exerts pressure on the fish communities in the rocky bottom habitat of Boğsak Island by competing for food. *C. chromis* was observed as the second most abundant species in the rocky bottom fish community of Bogsak Island. With the exception of *T. flavimaculosus* and *C. novemstriatus*, the rocky bottom fish assemblage of Bogsak Island is similar to the native dominant species reported in previous studies conducted in the Levant Basin.

Harmelin-Vivien *et al.,* (2005) reported that 13% of the fish species diversity and 19% of the abundance in the rocky habitat of the Lebanese coast were Indo-Pacific species. Golani *et al.,* (2007), in their study of rocky habitat ichthyofauna in different regions of the Israeli coast, identified 79 species, of which 29% (23 species) were local, 44% (35 species) were area dependent, and 27% (21 species) were migratory species from the Red Sea. The researchers stated that the low number of migratory species may be due to the lack of a continuous rocky habitat connecting the northern Gulf of Suez, the Suez Canal, and the southern Mediterranean coast of Israel. Yalgın and Türker (2023) determined the distribution of 72 different fish species, belonging to 26 families, in a visual monitoring study between 0 and 40 m depth along the coast of Northern Cyprus. They reported that 56 of the species were native to the Mediterranean, and 14 of them were of Indo-Pacific origin. The rocky bottom habitat of Boğsak Island, where this study was conducted, seems to have a higher value in terms of Indo-Pacific species diversity than the results of previous studies conducted on the coasts of Lebanon, Israel and Northern Cyprus. This can be explained by the abundance of nutrients and oxygen, clarity and, most importantly, interspecific competition. The high abundance of *T. flavimaculosus* and *C. novemstriatus*, which are Indo-Pacific species, in this study conducted in the rocky bottom habitat of Boğsak Island may indicate non-local species pressure on local species. Among the Indo-Pacific species, *P. forsskali* is an economically important demersal species. This species can compete for the habitat of local demersal species such as *M. barbatus* and *M. surmuletus*. *U. mollucensis*, another Indo-Pacific species of the Mullidae family, is another species that creates competition for local species, as does *P. forsskalii*.

De Raedemaecker *et al.,* (2010) reported that among the fish species distributed in the rocky habitats of the islands around Arki Island in the Aegean Sea, invertebrate-feeding fish species were dominant, followed by planktivores, carnivores, herbivorous invertebrates, and omnivores. Similarly, invertebrate-feeding fishes were found to be dominant in the fish communities of the rocky bottom habitat of Boğsak Island compared to species with other feeding types. The low number of herbivorous species may be related to the vegetation.

Previous research provides limited information on the temporal distribution of fish assemblages. De Raedemaecker *et al.,* (2010) emphasized that temporal segregation of fish assemblages can be interpreted through more comprehensive studies. Indeed, the fact that seasonal temperature differences are lower in tropical and temperate rocky coastal habitats than in cold climate habitats suggests that more sensitive studies may be needed to interpret this distinction.

Most quantitative estimates of fish abundance in rocky habitats in the Mediterranean are based on underwater visual surveys. The results of fisheries surveys may not provide accurate data for such estimates, mainly due to problems of fishing efficiency and selectivity (Katsanevakis *et al.,* 2012). In addition, underwater visual surveys are usually conducted in protected areas to monitor marine protected areas (Rius, 2007), and information on the status of fish populations in Mediterranean rocky habitats is very limited (Sala *et al.,* 2012; Guidetti *et al.,* 2014).

Of the fish species observed, 41% were species that feed only on marine invertebrates. This was followed by carnivorous and omnivorous species. There are *H. stipulacea* beds in dune habitats around the study area. Studies report that this species is consumed by the green sea turtle *Chelonia mydas* (Becking *et al.,* 2014).

In previous studies conducted to determine the fish species composition of rocky bottom habitats in the east (Golani *et al.,* 2007), west (De Raedemaecker *et al.,* 2010) and south (Harmelin-Vivien *et al.,* 2005) of the Levant Basin, the results obtained are higher than the number determined in this study. This can be explained by the variation in area, number of stations, depth, observation frequency, environmental conditions, food abundance and anthropogenic factors. In addition, David *et al.,* (2024) emphasized that the diver effect may prevent some species from being observed due to escape from the environment. In this study, the reason why some species known to be present in the study area (species belonging to families such as Blenniidae, Gobiidae, Holocentridae, Pempheridae) could not be observed may be related to the effect of factors such as diving time and diver effect.

5. CONCLUSIONS

The rocky bottom habitat is a biologically rich environment. Often found where land and sea meet, rocky bottom habitats provide a unique habitat for some special fauna. Fauna living in rocky bottom habitats are exposed to daily and seasonal changes such as currents and temperature. Common animal groups found in rocky bottom habitats include sea urchins, sponges, sea anemones, molluscs and some fish communities. Today, this habitat type and its flora and fauna, which are of great importance for the health of marine ecosystems, are threatened by climate change caused by anthropogenic activities. In addition, the fish communities of rocky bottom habitats in this part of the Mediterranean are changing due to the migration of Indo-Pacific species to the eastern Mediterranean. This study, which is the first to examine the structure of rocky habitat fish communities in the northeastern Mediterranean coast of Turkey, is expected to contribute to the literature for the Levant Basin, which shows a dynamic structure in terms of biodiversity.

AUTHORSHIP CONTRIBUTION STATEMENT

Mert ATEŞ: Sampling **Nuray ÇİFTÇİ:** Conceptualization, Methodology, Writing-Original Draft, Writing-Review and Editing, **Deniz ERGÜDEN:** Data Curation, Review and Editing, **Deniz AYAS:** Conceptualization, Visualization, Writing-Review and Editing.

CONFLICT OF INTERESTS

The authors declare that for this article they have no actual, potential or perceived conflict of interests.

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