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SOME FISH SPECIES SHOWING COMMENSALISM TRAITS WITH LONG-SPINED SEA URCHIN (*Diadema setosum* Leske, 1778) IN GULF OF ANTALYA

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ABSTRACT

This research was carried out with a rocky (Cliffs: 36°53'3.13"N; 30°41'49.78"E) stony and gravelly bottom (Konyaaltı beach: 36°53'0.07"N; 30°40'43.36"E) in two different regions of Gulf of Antalya. This study intended to determine the fish species that use the long-spined sea urchin (*Diadema setosum* Leske, 1778) as a shelter. In this study, the fish that use the sea urchin in the rocky area as a sheltered area was *Chromis chromis*, *Cheilodipterus novemstriatus*, *Thalassoma pavo*, *Coris julis*, *Tripterygion melanurum*, *Gobius bucchichi*. Of these species, only *C. novemstriatus* is exotic. Others are native species of the Mediterranean. *C. chromis* juveniles were the most dense among the sea urchin spines in the rocky region, while *C. novemstriatus* formed the second crowded species. The study that carried out in the second area, which has a stony and gravelly bottom structure, represents fish species that use sea urchins as shelter are *C. novemstriatus*, *Siganus rivulatus*, *Apogonichthyoides pharaonis*, *Pteragogus pelycus*, *Parupeneus forsskali*, *Pterois miles*, *Sargocentron rubrum*, *Epinephelus aeneus* and *C. julis*. Of these species, only *E. aeneus* and *C. julis* were determined to be native species of the Mediterranean. All of the other species are Red Sea species, with Rabbitfish (*S. rivulatus*) fry as the most dense species, *C. novemstriatus* in the second place and *A. pharaonis* in the third place. It was determined that adult and juvenile individuals of *C. novemstriatus*, *A. pharaonis* and *P. pelycus* used sea urchin as shelter, and only juveniles of other species. In addition, among the sea urchin spines, most of the *C. novemstriatus*, *A. pharaonis* individuals were found to carry eggs in their mouths. The results show that the long-spined sea urchin rapidly increases its population in the Mediterranean by creating a shelter for some fish of origin Red Sea that cannot be economically evaluated and invaded.

Keywords: Long-spined Sea Urchin; *Diadema setosum*; Commensalism; Gulf of Antalya

INTRODUCTION

The long-spined sea urchin *D. setosum* is a Lessepsian echinoderm species that migrated from the Red Sea to the Mediterranean. Yokes & Galil (2006) made the first record of this species in the Mediterranean on the shores of the Kap peninsula. One year after this record, the second record of the species from the Mediterranean was found by Gökoglu *et al.* (2007) from Antalya-Konyaaltı beach cliff region. After these notifications, the species rapidly expanded its distribution in the Mediterranean and Notifications have also started to be given from the Aegean Sea (Pirkenseer, 2020). The occurrences of *D. setosum* by many researchers has been reported as follows; Along the Lebanese coastline (Nader & Indary 2011), the Levantine Basin from the Israeli coast (Bronstein

& Kroh, 2018), the southeast coastline of Turkey (Turan *et al.*, 2011), the Aegean Sea (Yapici *et al.*, 2014) and from Rhodes Island (Kondylatos & Corsini-Foka 2015). This sea urchin expanded its distribution to the north on the Turkish coasts and entered the Sea of Marmara (Artüz & Artüz 2019). The rapid distribution of the species and the rapid increase in its population in the regions where it was registered are indicators that it is very well adapted to the Mediterranean ecosystem.

The long-spined sea urchin is an echinoderm species with venomous spines (Yokes & Galil 2006; Gökoglu *et al.*, 2007). It is shown among the dangerous species in the Mediterranean as it can cause various injuries and poisonings for humans. Its excessive proliferation on the Mediterranean and

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Aegean Seas shores and its emergence into shallow waters pose a risk of injury and poisoning for those entering the sea.

Many organisms migrate from the Red Sea to the Mediterranean (Zenetos 2019). Migration from the Red Sea to the Mediterranean is not limited to sea urchins. Fish are also among the migratory species. Various researchers have reported that more than 100 Red Sea origin fish species have crossed into the Mediterranean until now (Golani, 2021). On the coasts of Turkey, this number has approached about 100. The number of Red Sea origin fish species are reached about 67 in Gulf of Antalya. The last reported fish species was *Epinephelus fasciatus*, also called Red grouper (Gökoglu *et al.*, 2022). Some fish species such as *A. pharaonis*, *C. novemstriatus*, *P. pelycus*, *P. forsskali*, *P. miles*, *S. rivulatus*, *S. rubrum* migrated from the Red Sea to the Mediterranean which these fish species adapted very well to the coastal areas of the new ecosystem and increased their populations rapidly.

Some fish species use the long and poisonous spines of *D. setosum* as a shelter against their enemies. Commensalism is a type of life in which one of the two organisms benefits and the other is not affected by this partnership. Fish that use the poisonous and long spines of *D. setosum* as a shelter and do not harm the sea urchin constitute a good example of commensalism behavior. Among the fish that show commensal behavior, there are some native fish species of the Mediterranean, as well as lesepian species.

In this article, lesepian and native fish species that show commensalism behavior by using the poisonous and long spines of *D. setosum* as a shelter against their enemies will be given.



Figure 1. *D. setosum* colony and refugee fish individuals encountered during dives in rocky cliff areas.

MATERIALS AND METHODS

This research was carried out in the rocky (Cliffs; 36°53'3.13"N; 30°41'49.78"E), stony and pebbly bottom (Konyaalti beach; 36°53'0.07"N; 30°40'43.36"E) areas of the Gulf of Antalya. The observation was carried out by scuba diving to the depth between 3-22 m from June to September 2021. Canon Power Shot G12 camera and housing were used to take underwater photography and video shooting.

In this study, an underwater writing tablet and pencil were used to record the amount of fish and the number of species observed. In order to determine the number of fish, besides the direct visual counting technique, the counts were made on underwater photographs and video footage. While the counts of the fish species were made through photographic and video footage, the counting of the species that were few in number was conducted through visual observation.

RESULTS AND DISCUSSION

Results

This research was carried out in two different bottom types substrates of Gulf of Antalya. The first substrate type is located near Antalya Kaleiçi Marina that has rocky bottom structure.

The three meters rocky area, which starts from the cliff, which is in the form of a steep wall, continues to a depth of 28-29 m. In this region, sea urchins start to be seen from a depth of 2 m. *D. setosum* juveniles have been seen rarely, at 1-2 m depths in cliffs with steep walls (Fig. 1). It has been determined that sea urchins come together between 1-7 individuals and form single or colonies in rock cavities and holes after a depth of 3 meters.

In the observations and counts we made in this region, the fish that use sea urchin as a shelter are species such as *C. chromis* juveniles (length 1-2 cm), *C. novemstriatus*, *T. pavo*, *C. julis*, *T. melanurum*, *G. bucchichi*. Of these species, *C. novemstriatus* that originates from the Red Sea. According to our countings, the number of damselfish (*C. chromis*) juveniles using sea urchins that used them as a shelter ranged between 80-140 with an average of 126 individuals.

The second most crowded species that uses the sea urchin as a shelter in the rocky area is *C. novemstriatus*, a cardinalfish species. In our study conducted during the summer months, it was seen

that the adults and young individuals of this species use sea urchin as a shelter. This fish species was counted between 20-60 individuals among the spines of the sea urchin and it was found that 32 individuals could be hidden on average. It has been observed that some of the *C. novemstriatus* individuals who use sea urchins as a shelter during the summer months carry eggs in their mouths. The aggregation of other fish species among sea urchin spines was limited to a few individuals.

D. setosum colonies on the floors of the stony and gravelly bottom type in eastern part (36°53'0.07"N; 30°40'43.36"E) of Konyaaltı beach (Fig. 2, 3).

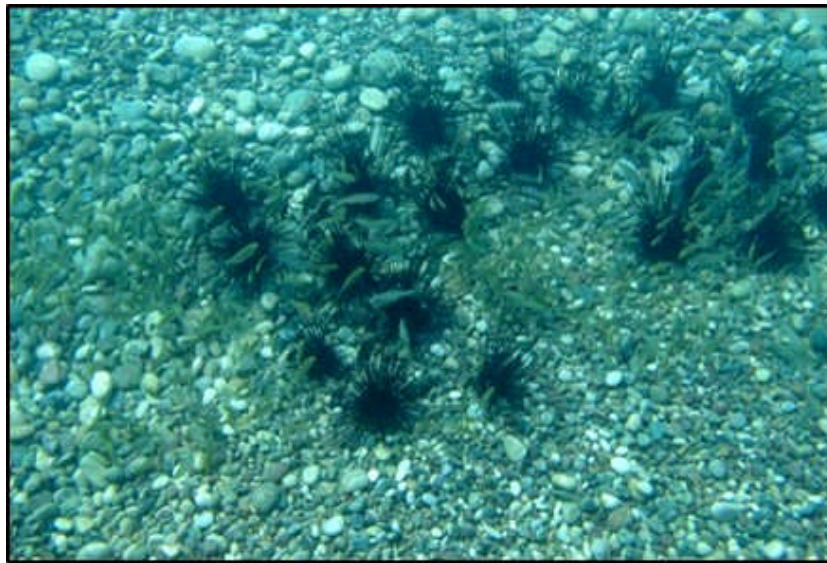


Figure. 2. Sea urchins and juvenile *S. rivulatus* colonized in the stony and gravelly areas of Konyaaltı beach.



Figure. 3. Sea urchins and individuals of *P. forskalli* colonized in the stony and gravelly areas of Konyaaltı beach.

In this region, sea urchins between 2-100 individuals (Average 24.35 individuals, 20 colonies) come together to form colonies. In this study, it was determined that the distances between the sea urchin colonies ranged between 5-20 m showing that many colonies inhabit this region. In our research conducted

here, it was determined that some fish species use sea urchins as shelters such as *C. novemstriatus*, *S. rivulatus*, *A. pharaonis*, *P. pelycus*, *P. forsskali*, *P. miles*, *S. rubrum*, *E. aeneus*, and *C. Julis*. All of these species used *D. setosum* as a shelter in stony and gravelly areas (Fig. 4, 5).

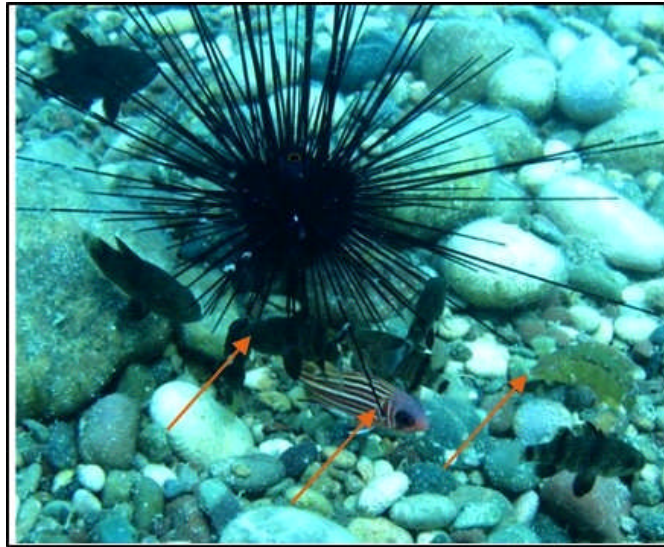


Figure. 4. *A. pharaonis*, *S. rubrum* and *P. pelycus* individuals, respectively, around a sea urchin.

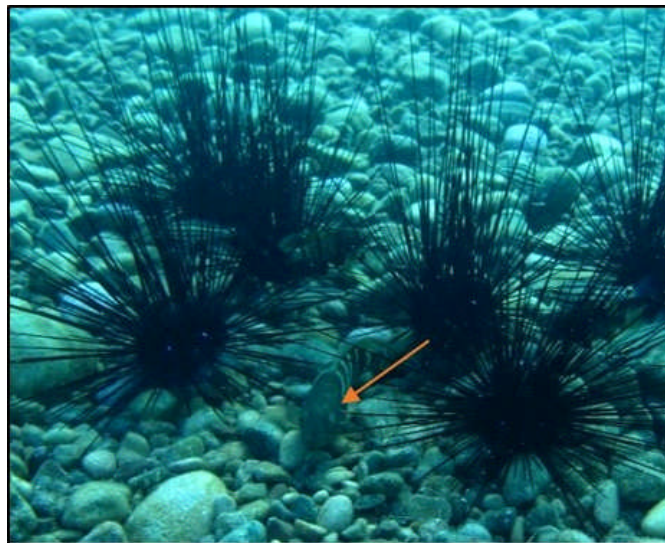


Figure. 5. A hidden *E. aeneus* among *D. setosum* individuals.

All of these species, except for *E. aeneus* and *C. julis*, are exotic for the Mediterranean and originating from the Red Sea. *C. novemstriatus* and *A. pharaonis* are cardinal fish species. Some individuals of both

cardinal fish species that use sea urchins as a shelter during the summer months were observed their mouth filled with full of eggs (Fig. 6).

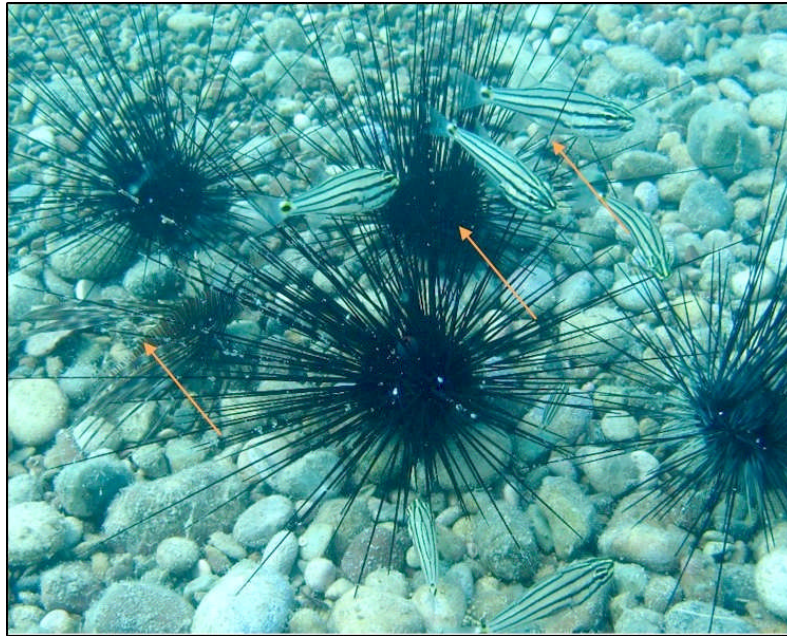


Figure. 6. An individual of *P. miles* found under the spines of sea urchin and cardinal fish carrying eggs in its mouth.

It has been observed that nocturnal species such as *C. novemstriatus*, *A. pharaonis*, *P. pelycus* and *S. rubrum* use the sea urchin in the Konyaalty beach during the daytime, while other species use it as a shelter in case of danger. The average number of individuals by fish species in the counts of fish using

D. setosum as a shelter, *S. rivulatus* 62, *C. novemstriatus* 53, *A. pharaonis* 0.75, *P. pelycus* 0.5, *P. forskalli* 0.3, *C. julis* 0.20, *S. rubrum* 0.041, *P. miles* 0.02, *E. aeneus* 20 (total number of individuals counted under sea urchins is 20) were found (Fig. 7, 8).



Figure. 7. *C. novemstriatus* and *C. julis* individuals found around the sea urchin colony.

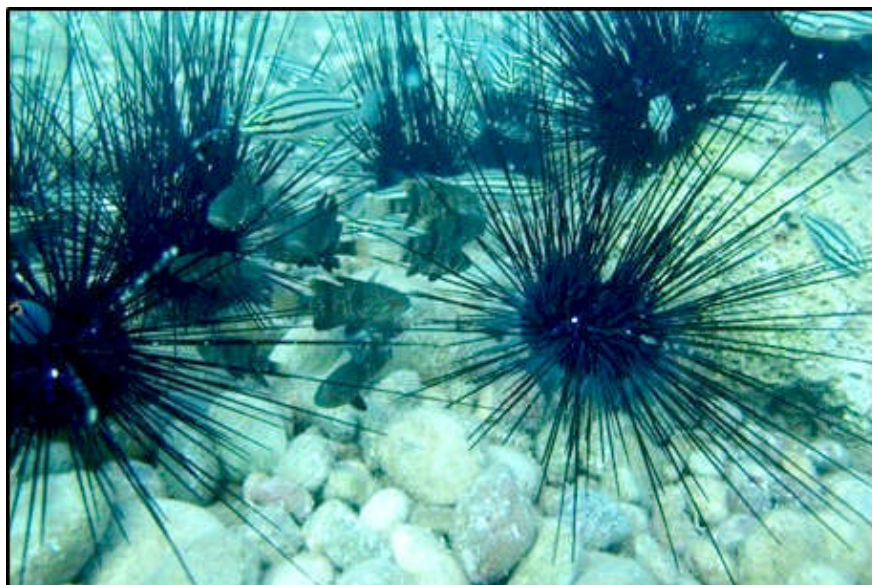


Figure. 8. *C. novemstriatus* and *A. pharaonis* individuals and *D. setosum* colony.

It was determined that adult and juvenile individuals of *C. novemstriatus*, *A. pharaonis* and *P. pelycus* used sea urchin as shelter, on the other hand the other species only juveniles use it.

Discussion

When the number of individuals of the species that use the sea urchin as a shelter is high, the counting technique from photographs and videos was used to determine the number, while the direct counting technique was used to determine the species with a low number of individuals. These methods are not consume nature and harmless to the ecosystem. Our research was carried out in rocky and non-rocky gravelly and stony regions. When the fish species in two different environments using the sea urchin as a shelter were compared, only *C. novemstriatus* was found as the common species. This fish is a species of cardinalfish and is one of the fish species that pass from the Red Sea to the Mediterranean.

According to this study we have done and the findings we have obtained, while the native fish species of the Mediterranean Sea use the sea urchin as a shelter in the rocky region, the Red Sea species are dominant in the gravelly and stony environment. According to Bilecenođlu *et al.* (2019) found the fish species and numbers using sea urchins as shelters close to the species and values we detected in the rocky region. In another study conducted in the Iskenderun Bay, it was pointed out that *D. setosum* and *C. novemstriatus* have a symbiotic life (Ali Çiçek *et al.*, 2020), indicating that the Mediterranean is in a rapid tropicalization process and that lessepsian species are rapidly adapting to the Mediterranean.

It was determined that adult and juvenile individuals of *C. novemstriatus*, *A. pharaonis* and *P. pelycus* used sea urchin as shelter, otherwise the other species only juveniles and young individuals are use it. *C. novemstriatus* and *A. pharaonis* are cardinalfish and it has been observed that they carry eggs in their mouths while they hiding between the spikes of sea urchin. Thus, it is thought that they protecting both themselves and their juveniles to be hatched, and also they have high reproductive ability. Cardinalfish are small and colorful fish of the seas and are generally nocturnal (Habib *et al.*, 2020).

In our research, nine species of fish were identified that use sea urchins as shelter in gravelly and stony environments. Seven of these fish are immigrant Red Sea species. In the rocky environment, this number was determined as 6. When the numbers of the detected fish species are compared, it is seen that the numbers in the rocky environment are low.

In our research, there is an increase in fish species and numbers that use sea urchins as shelter in gravelly and stony areas compared to the rocky area. This is due to the existence of environments where fish can be protected and sheltered in rocky areas in order to be protected from their enemies, and the absence of these environments in other areas, and that fish show hiding behavior between the spines of sea urchins in case of danger.

CONCLUSION

As a result; In this study, the majority of the fish that use the poisonous spines of the sea urchin as a shelter are species originating from the Red Sea. The

rapidly increase of sea urchins in the Mediterranean and the shelter for these fish also contribute to the increase in fish species originating from the Red Sea.

DECLARATIONS

Conflict of Interest On behalf of all authors, the corresponding author states that there is no conflict of interest.

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