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Short communication

Does Symbiosis of invasive species become common phenomena for the Mediterranean? *Cheilodipterus novemstriatus* (Rüppell 1838) and *Diadema setosum* (Leske 1778) is observed together in the Gulf of Iskenderun

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Abstract

Cheilodipterus novemstriatus (Rüppell 1838), is native to the Indo-Pacific region. These species can be found mostly around the spines of *Diadema setosum* (Leske 1778) between 0-40 m in depth. During a scientific diving survey in the Gulf of Iskenderun, a shoal of *C. novemstriatus* was sighted around a *D. setosum*. Some photographs of the fish and sea urchins were taken. This is the second study that reports these two species in a symbiotic relationship in Turkish waters. Also, these records show that the Mediterranean coasts are in a rapid tropicalization process, and the Lessepsian species quickly adapt to the Mediterranean.

Keywords: Adaptation, Cardinalfish, Lessepsian, Non-indigenous, Porcupine sea urchin

Introduction

Cheilodipterus novemstriatus Rüppell, 1838, also known as Indian Ocean two-spot cardinalfish, is one species of cardinal fishes belonging to the Apogonidae family. (Froese and Pauly 2019). They are native to tropical Indo-Pacific waters. Like most cardinalfish species, *C. novemstriatus* inhabits rocky or reef-associated habitats to depths of 40 m for better protection. Also, some branched corals, crevices, or sea urchins [*Diadema setosum* (Leske 1778)] are known to provide shelter for this family (Gon and Randall 2003). Members of Apogonidae feeds on crustaceans and small fishes (Hiatt and Strasburg 1960, Bell and Galzin 1984).

D. setosum is an Indo-South Pacific native sea urchin belonging to the Diadematidae family (James and Pearse 1971, Lessios *et al.* 2001, Yokes and Galil 2006). This species can be found in the reef and rocky areas. *D. setosum*, which is an omnivore scavenger sea urchin, feeds mostly on detritus (Yokes and Galil 2006) and can be found from 0-70 m in depth (Palomares and Pauly 2019). Invasive species can be defined as; a non-native species which makes harmful effects on the environment and/or economy while entering a new region (Beck *et al.* 2008). According to this definition, it can be said that *D. setosum* is an invasive species for the Mediterranean Sea.

In the Mediterranean Sea, *D. setosum* was first recorded in the Kaş (Antalya) region of Turkey in 2006 (Yokes and Galil 2006), and in Lebanon in 2009 (Nader and El Indary 2011). In 2010, it was recorded from Antakya Bay, Turkey (Turan *et al.* 2011). Afterward, it started to be seen all over the Eastern Mediterranean until the Aegean Sea and the Sea of Marmara (Yapici *et al.* 2014, Kondylatos *et al.* 2015, Artüz and Artüz 2019).

A symbiotic relationship between *D. setosum* and *C. novemstriatus* was first noticed and reported in 2018 from Kaş (Antalya region) of Turkey (Bilecenoğlu *et al.* 2019). In this study, another symbiosis was observed in not too distant past, in Iskenderun Bay, where is another location from the north-eastern Levantine Sea. The present paper highlights the increasing of symbiosis after a decade that they introduce into the Mediterranean Sea; therefore, an idea raises that Lessepsian migration starts a new phase.

Material and methods

The Gulf of Iskenderun, which is the third-largest Gulf of the southern side of Turkey, is

found in the northern-eastern Mediterranean (Bilim *et al.* 2017). When compared to other regions in the Eastern Mediterranean, the Gulf of İskenderun and Mersin have shallow depths that show the characteristics of a continental shelf. This bathymetric structure provides an important settlement area for Lessepsian species. Change of ichthyofaunal character of the Gulf into dominance of Lessepsian migrants is well known fact (Gücü *et al.* 2010). Mavruk *et al.* (2017) defined the Gulf as a natural laboratory to test the hypotheses on Lessepsian migrants due to these unique characteristics that provide high success in the settlement.

On 29 November 2019, a small group of *C. novemstriatus* was observed around a *D. setosum* in an artificial rocky area in the Gulf of Iskenderun at 6 m depth around 5 pm (Fig. 1). Photos were taken with the Canon EOS 600D using SEA&SEA underwater housing digital camera without flash. Identification for *C. novemstriatus* was confirmed from the meristic information given in Gon and Randall (2003) and for *D. setosum* Coppard and Campbell (2006).

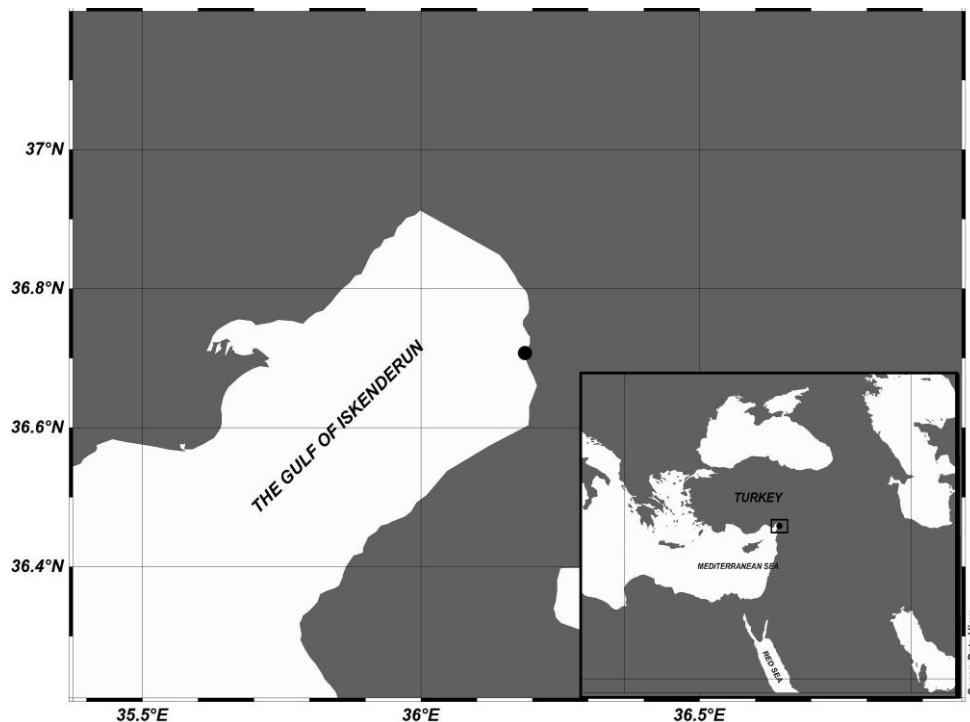


Figure 1. The approximate location of the symbiotic relationship indicated with a dot

Results and Discussion

During a scientific survey, a symbiotic relationship between approximately 30 *C. novemstriatus*, and one *D. setosum* were randomly observed (Fig. 2). In order to clarify identification, the species detected in this observation, *C. novemstriatus*, the body was silvery-gray. There were four distinct black stripes on the body. The fifth stripe passed through the anal and pectoral fin bases and was folded towards the dorsal at the end of the

pectoral fin. There was a large yellow spot on both sides of the caudal fin, with a prominent black mark in the middle. There was another black spot on the dorsal part of the caudal peduncle. *D. setosum* was black with very long spines, but sometimes its color can vary to grey or white, or a combination of black, grey and white spines. This species has a red balloon-like bubble around the anus on its dorsal side (Coppard and Campbell 2006). It also has five white spots above the periphery of the test and blue spots arranged in lines.



Figure 2. The symbiotic relationship between *C. novemstriatus* and *D. setosum* in the Gulf of Iskenderun

The symbiosis between several species of cardinal fishes and sea urchins is a well-known phenomenon, especially from the Red Sea, where they have been reported several times (Tamura 1982, Dafni and Diamant 1984, Gon and Randall 2003). The type of symbiotic relationship between these organisms is known as “commensalism,” where one species benefits but does not harm the host, cardinalfish hide between the spines of sea urchin for protection,

and the sea urchin does not get harmed by the relationship (Coppard and Campbell 2004). This relationship can be established between two indigenous species or non- and indigenous species (Lockwood *et al.* 2009). Attempts to understand the mechanism and reasoning of such a relationship indicate affection of the ecological level might be dispersed from individual to ecosystem level (Jeschke and Heger 2018). It is encouraged to increase

understanding on behavior since a competition among Lessepsian migrants in communal level may have gained more importance considering advantages of the area on settlement and increasing biomass,

All over the world, the sea surface waters' temperature increasing with the accumulation of CO₂ in the atmosphere (Nagelkerken *et al.* 2015). Among the seas in the world, the Mediterranean, called semi-closed sea, is known as the region most affected by global warming (Béthoux *et al.* 1990, Lionello *et al.* 2012). These changes, caused by the effects of global warming, put the Mediterranean in the process of tropicalization (Bianchi and Morri 2003). In a study conducted in İskenderun Bay, sea surface water temperatures showed an increase in the last three decades (Gucel and Sakalli 2018, Bengil and Mavruk 2019). A direct relationship between seawater temperature and Lessepsian biomass was also defined in the Gulf of Iskenderun (Mavruk *et al.* 2017). As pointed out Mavruk *et al.* (2017), the Gulf can be used as a natural laboratory to not only monitor Lessepsian biomass but also observe their behaviors in order to increase understanding on adaptation level.

In Turkey, *D. setosum* and *C. novemstriatus* were reported individually from various regions; however, these two species together were first reported in the Kaş region of Antalya (Bilecenoğlu *et al.* 2019). *C. novemstriatus* and *D. setosum* are two organisms, which are generally not caught from commercial fishing activities such as longlines, trammel nets, and purse seining due to their benthic nature but can be caught by bottom trawlers. Frequent efforts on visual census method can provide advantages to increase such behavior to increase understanding on adaptation.

Conclusion

Increase observations of symbiotic relationships between two Lessepsian migrants raised a question on initialization of a new phase in the migrations. Therefore, it is suggested to focus on more observational

efforts in further studies for increasing understanding of the mechanism. Such adaptations might be the reason a severe changes in the characteristics of the ecosystem in the Mediterranean. For instance, *D. setosum* species are found in high amounts in a particular area; It has been found to have destructive effects on coral reefs and algae compositions (Qiu *et al.* 2014, Ishikawa *et al.* 2016). Such symbiosis can increase success in settlement and increment in biomass of the species, which may limit other native herbivore species food sources considering the high grazing capacity of *D. setosum*.

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