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# Unusual Observation of the Alien Sea Urchin *Diadema setosum* (Leske, 1778) in the Aegean Sea: Recent and Recorded Occurrences

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**Abstract**
The Aegean Sea has been invaded by Indo-Pacific species via the Suez Canal. The needlespined urchin, *Diadema setosum*, was first reported in the Mediterranean in 2006 off southern Turkey. The present study presents its recent northernmost occurrence as well as previous recorded occurrences of *Diadema setosum* in the Mediterranean.

**Keywords** *Diadema setosum* · Echinoidea · Alien species · Aegean sea

## Introduction

The phylum Echinodermata includes 7000 specimens belonging to 5 classes: Crinoidea, Asteroidea, Ophiuroidea, Echinoidea, and Holothuroidea (Öztoprak et al. 2014). The class Echinoidea, known as sea urchins, are considered a very important group because they are keystone species and play a major role in many marine ecosystems (Elmasry et al. 2013). The echinoids of the Turkish coasts are comprised of 20 species, of which one is of lessepsian origin (Öztoprak et al. 2014).

The alien sea-urchin *Diadema setosum* (Leske, 1778) is a species widely distributed in the Indo-West-Pacific Ocean, from the Red Sea and the east coast of Africa, to Japan and Australia (James and Pearse 1971). Although it was first observed in 2006 (Yokes and Galil 2006), its range has subsequently expanded broadly throughout the Mediterranean.

The present study reports an atypical sighting of *D. setosum* in the İbrice Cape and postulates on the northward expansion of this sea urchin in the Aegean Sea.

## Material and Methods

On 25 April 2017, a single *D. setosum* was observed by divers in İbrice Cape (40° 3534′ N, 26° 3046 ′ E) situated on Saros Bay, Turkey at a depth of 6 m. Seawater temperature was 15.1 °C. A single specimen approximately 6 cm in diameter was photographed in a crevice surrounded by rock covered by algae patches.

## Results and Discussion

The specimen was identified by its unique distinctive features: long and slender dark & gray spines, five evident white spots on the mid-lines of the interambulacral, as well as small blue iridiphores, and an orange ring around the periproctal cone (Coppard and Campbell 2006) (Fig. 1).

A total of 9 confirmed occurrences of *D. setosum* including the present finding have been reported in the Mediterranean and the Aegean Sea (Fig. 2). It was reported firstly in the Mediterranean off Kaş Peninsula, southwestern coasts of Turkey (Yokes and Galil 2006). After first report, it has been reported at different locations from the Levant Sea to the Aegean Sea: Lebanon (Nader and Indary 2011), Turkey (Turan et al. 2011; Yapici et al. in Katsanevakis et al. 2014), Greece (Latsoudis in Tsiamis et al. 2015; Kondylatos and Corsini-Foka in Crocetta et al. 2015, Dounas and Krystalas in Mytilineou et al. 2016) and Cyprus (Kapiris and Constantinou in Mytilineou et al. 2016). According to the literature, *D. setosum* has expanded its range, but the sighting reported here is unusual as this tropical sea urchin has previously only been observed in warm-water sectors of the Mediterranean. Por (2009) indicated that *D. setosum* is a historically resilient species. Sarifudin et al. (2017)

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**Fig. 1** Underwater view of the needle-spined urchin *Diadema setosum* within crevice

investigated effects of salinity on fertilization of *D. setosum* in a controlled laboratory condition and stated that *D.setosum* is a stenohaline echinoid that cannot survive and develop if the salinity range is less than 28 or more than 37 ppt. However, it naturally occurs in the Red Sea, where salinity is 41 ppt, and the Gulf of Suez, where salinity is 42.5 ppt. His could be an indication of how *D. setosum* could be observed in some of the highest salinity sectors of both the Mediterranean and Aegean Sea.

The sea surface temperature (SST) gradient of the whole Aegean sub-basin is significantly controlled by water exchange between cold/fresh Black Sea water entering through the Dardanelles Strait and warm/saline Levantine basin water entering through the Cretan Arc Straits (Poulain et al. 2012). However, increases in the average SST of the Mediterranean have increased the inflow of warmer Levantine waters into the Aegean. Reaching the warm and highly saline Levantine waters (Levantine Surface Water (LSW) and Levantine Intermediate Water (LIW)) into Saros Bay were reported by various authors (Uçkaç 2005; Tokat and Sayın 2007, Sayın et al. 2011, Eronat and Sayın 2014). Therefore, warm-water native/non-native species belonging to different taxa occur in this area (Tunçer and Önal in Katsanevakis et al. 2014; Daban et al. 2016). Sarifudin et al. (2016) stated that the critical lower and higher temperature for embryonic development of *D. setosum* are 16 and 34 °C respectively, whilst its critical lower temperature for survival was reported as 12 °C (Oki et al. 2004). Temperature of surface waters in the Saros Bay vary seasonally between 16 and 25 °C because of LSW and LIW (İşler et al. 2016). Favorable temperature condition of Saros Bay could indicate that this sea urchin will be able to persist and even reproduce in the area. In conclusion, further observation and monitoring of this area is required to determine whether *D. setosum* is able to persist.

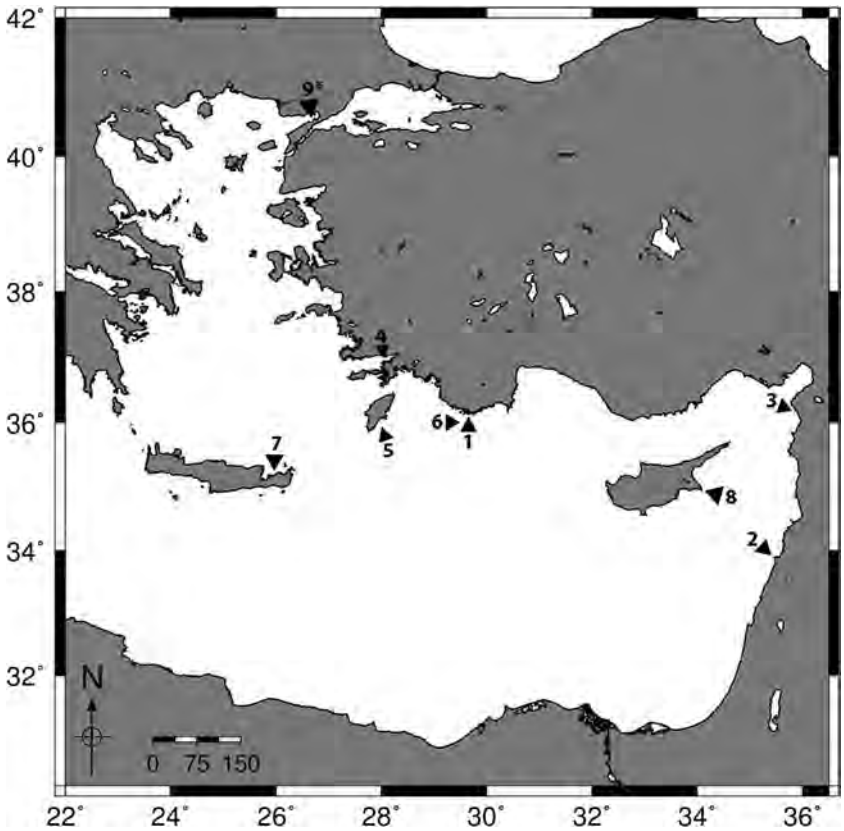


**Fig. 2** Locations in the Mediterranean and Aegean Sea where *Diadema setosum* have been reported are indicated chronologically from 1 to 9. Yokes and Galil (2006)[1], Nader and Indary (2011)[2], Turan et al. (2011)[3], Yapici et al. in Katsanevakis et al. (2014)[4], Kondylatos & Corsini-Foka in Crocetta et al. (2015)[5], Latsoudis in Tsiamis et al. (2015)[6], Dounas and Krystalas in Mytilineou et al. (2016)[7], Kapiris and Constantinou in Mytilineou et al. (2016)[8], Present study[9]

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