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Rapid Communication

First occurrence of the needle-spined urchin *Diadema setosum* (Leske, 1778) (Echinodermata, Diadematidae) in the southern Mediterranean Sea

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Abstract

The first occurrence of *Diadema setosum* in the southern Mediterranean waters is recorded from the shores of Libya and Egypt, through the input by citizens' science. The expansion of this invasive sea urchin in the Mediterranean basin is briefly discussed.

Key words: non-indigenous species, Echinoderms, Libya, Egypt, citizen science

Introduction

Two Diadematidae species inhabit the Mediterranean Sea: the native *Centrostephanus longispinus* (Philippi, 1845) and the non-indigenous *Diadema setosum* (Leske, 1778). The needle-spined urchin *D. setosum* (long-spined sea urchin, black long-spine urchin, porcupine sea urchin) is a tropical venomous sea urchin widely distributed in the shallow-water hard substrates of the Indo-West Pacific Ocean. Molecular studies showed that the *D. setosum* lineage split into two clades 3 to 5 million years ago: the clade *a*, widespread within the Indo-West Pacific and the clade *b*, native to the Red Sea, Arabian Peninsula and the Persian Gulf (Bronstein et al. 2017). The *D. setosum* that is colonizing the eastern Mediterranean belongs to the clade *b* (Bronstein and Kroh 2018).

The species was found for the first time in the Mediterranean Sea along the south-western coast of Turkey in 2006 (Yokes and Galil 2006). Since then, its occurrence has been reported in Lebanon, Cyprus, Israel, Greece (south Aegean Sea, Crete, eastern Ionian Sea) and the Mediterranean and

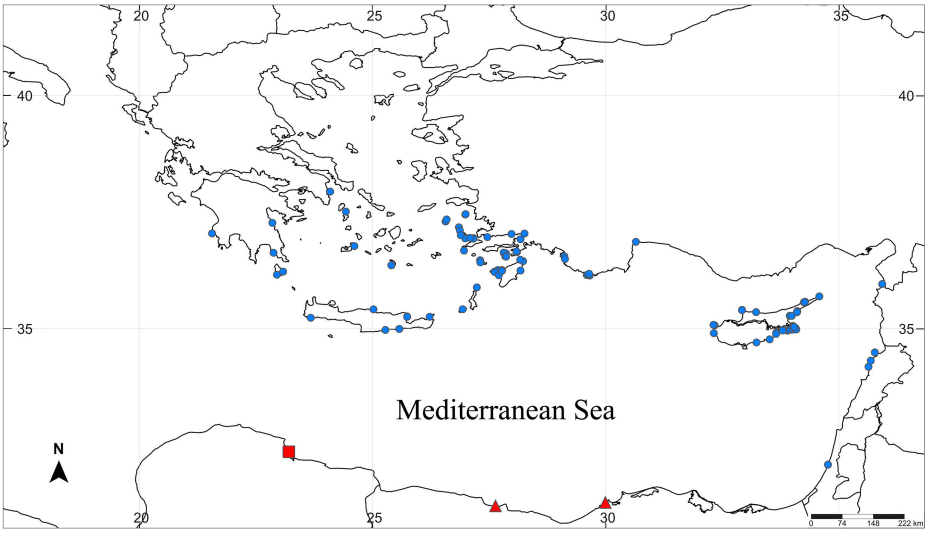

Figure 1. Distribution of *Diadema setosum* in the Mediterranean Sea: published records (blue bullets) [Yokes and Galil 2006; Katsanevakis et al. 2014, and references therein; Mytilineou et al. 2016, and references therein; Bronstein et al. 2017, and references therein; Zenetos et al. 2017; Karachle et al. 2017; Galanos and Kritikos 2019; Vafidis et al. 2021; Bronstein and Kroh 2018; Ragkousis et al. 2020; Katsanevakis et al. 2020] and present study records: Barda'ah Island, Libya (red square), Sidi Haneish and Alexandria, Egypt (red triangles). For record dates and coordinates see Supplementary material Table S1.

south Aegean coasts of Turkey (Karachle et al. 2017; Bronstein and Kroh 2018; Galanos and Kritikos 2019; Ragkousis et al. 2020; Katsanevakis et al. 2020; Çinar et al. 2021). Çinar et al. (2021) considered questionable the records of the species from the northern Aegean Sea and the Sea of Marmara reported respectively by Yapıcı (2018) and Artüz and Artüz (2019). Larval transportation via the Suez Canal, shipping-mediated transport and the aquarium trade are considered the main possible pathways of introduction of the species to Mediterranean waters (Yokes and Galil 2006; Bronstein et al. 2017).

In the present study, the first occurrence of *D. setosum* in Libyan and Mediterranean Egyptian waters is reported. These records also constitute the first records of the invasive needle-spined urchin along the northern African coasts, west of Port Said, Egypt.

Materials and methods

On 29 May 2021, two individuals of *D. setosum* were photographed and video registered during SCUBA diving off Bomba village, near Barda'ah Island, Libya (32°21′35.9″N; 23°12′16.3″E) (Figure 1) at 25 m of depth, on rocky substrate. Photos and video of the same individuals were submitted to the social media citizen science platform for Libyan waters called "Marine Biology in Libya" (https://www.facebook.com/MarineBiologyinlibya). Specimens were not obtained.

On 9 August 2021, two individuals of *D. setosum* were photographed and video registered by one of the authors (MA) during SCUBA diving off Sidi Haneish, Matrouh, Egypt (31°12′03.24″N; 27°38′05.83″E) (Figure 1), at

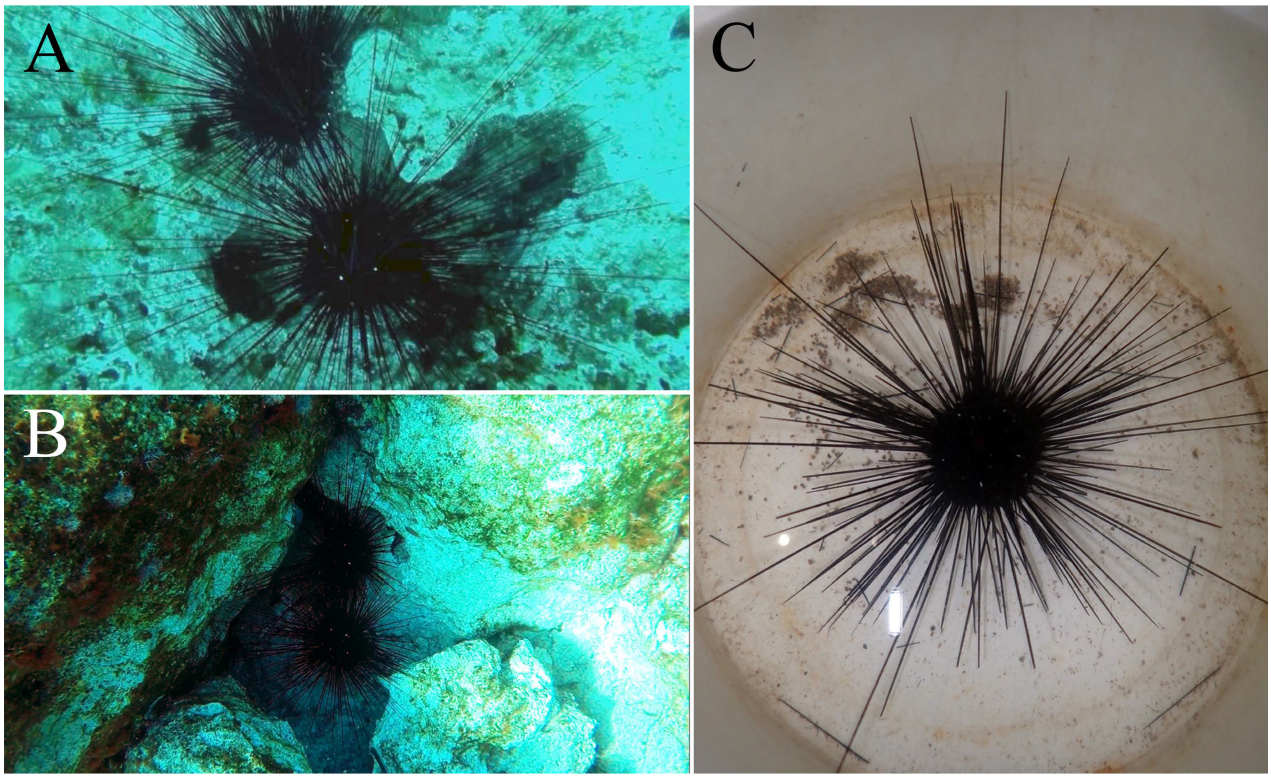

Figure 2. *Diadema setosum*: A, specimens observed near Barda'ah Island, Libya (Photo by A. Bobaker); B, specimens observed at Sidi Haneish, Egypt (Photo by M. Adel); C, specimen collected off Alexandria, Egypt (Photo by O.M. Nour).

5 m of depth, on rocky substrate. The video is available at https://www.youtube.com/watch?v=N6CD7M5Gy_M. On 6 September 2021, an individual was caught by hand net off Miami beach, Alexandria, Egypt (31°16′21.7″N; 29°59′27.0″E) (Figure 1), at 18 m of depth, on rocky substrate. The sample was frozen and deposited within the private collection of one of the authors (OMN).

The distribution map of *D. setosum* records in Figure 1 was prepared using SimpleMappr (https://www.simplemappr.net/).

Results

The specimens were identified from photos and the available videos as *D. setosum* having delicate, long, uniform, black spines of approximately 30 cm in maximum length, and five white spots evident dorsally on the interambulacra (Figure 2) (Yokes and Galil 2006). Specimens were distinguishable from the only species of Diadematidae native to the Mediterranean, *C. longispinus*, given that the latter is characterized by large spines banded brown and white. The test of the sample collected off Alexandria, not completely free from tissues, had a horizontal diameter of 39.5 mm and a vertical diameter of 18 mm.

Discussion

The depth range and type of substrate (rocky) characterising the *D. setosum* reports included in the present study agreed with the range and the

substrate reported in native and invaded regions (Muthiga and McClanahan 2020; Vafidis et al. 2021).

Although the Libyan coasts present suitable habitats for the species, the distribution model developed by Bronstein et al. (2017) failed to predict its invasion/arrival. The first, almost contemporary, records of *D. setosum* reported in this study from Libyan and Egyptian Mediterranean waters could indicate a rapid expansion of the species along the north African coastline and could represent a harbinger of an imminent large-scale invasion and establishment, as observed in other areas of the eastern Mediterranean (Vafidis et al. 2021).

Diadema species are mainly omnivorous grazers and detritus feeders, ingesting substrate and scraping algae off hard substrata. In the Red Sea, the needle-spined urchin, although usually nocturnal, has also been observed to be active diurnally (Young and Bellwood 2011). The most notable predators of *Diadema* in the tropical Indo-Pacific are finfish species such as balistids, carangids, diodontids, labrids, ostraciids, pomadasyids, sparids, and tetraodontids, as well as some invertebrates (gastropods, spiny lobsters and starfish) (Muthiga and McClanahan 2020). Recently, the needle-spined urchin has been observed among the prey items of the invasive tetraodontid *Lagocephalus sceleratus* (Gmelin, 1789) in the southeastern Aegean waters of Turkey (Ulman et al. 2021).

Populations of *D. setosum* play an important ecological role, since their relative numbers can greatly affect the population dynamics of coral, reef fish and algae (Yokes and Galil 2006; Karachle et al. 2017; Muthiga and McClanahan 2020; Vafidis et al. 2021). Variations in the population density of *D. setosum* and other sea-urchins and reef-associated fauna depend on natural biological and physical fluctuations as well as on disturbances of anthropogenic origin, such as removal of predators due to overfishing on coral reefs (Muthiga and McClanahan 2020; Vafidis et al. 2021). Although the further proliferation of *D. setosum* has potential deleterious implications for native benthic communities (Vafidis et al. 2021), to date, this potential impact has not materialized (Karachle et al. 2017).

The fish-sea urchin association has long been reported, between the cardinalfishes (Apogonidae) and clingfishes (Gobiesocidae) families with sea urchins from the family Diadematidae (Giglio et al. 2018). *Diadema setosum* provide anti-predator refuges for Mediterranean native fish species and for the non-indigenous apogonid *Cheilodipterus novemstriatus* (Rüppell, 1838) (Bilecenoğlu et al. 2019; Çiçek et al. 2020; Al Mabruk et al. 2021), frequently seen sheltering among the spines of sea-urchins of the genus *Diadema* in its native range (Gon and Randall 2003; Debelius 2011). Given that the shallow Mediterranean coastal waters of Egypt and Libya are suitable for the introduction and establishment of NIS fish of Red Sea origin (Nour et al. 2021), the occurrence of the Indian Ocean two-spot cardinalfish *C. novemstriatus*, a fish species which is intrinsically associated

with *D. setosum* through a symbiotic relationship, within the same waters is imminently expected, following the pattern observed in the eastern Mediterranean (Rothman et al. 2013).

Social media platforms and the increasing contribution of citizen science are becoming important tools all over the world for supplementing knowledge on undocumented elements of marine biodiversity (Gerovasileiou et al. 2016; Garcia-Soto et al. 2021). This is particularly evident in Libya, where their input is rapidly developing, allowing researchers in recent years to collect a growing repository of information on native species and to detect the occurrence of alien species inhabiting the poorly-known communities of the coastal waters of the country.

These first observations of *D. setosum* increase the further number of non-indigenous taxa recorded recently along the coasts of Libya and Egypt (cf. Shakman et al. 2019; Abdulrraziq et al. 2021; Corsini-Foka et al. 2021, and references therein; Nour et al. 2021, and references therein).

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Supplementary material

The following supplementary material is available for this article:

Table S1. Geo-referenced records of *Diadema setosum* in the Mediterranean Sea.

This material is available as part of online article from:
http://www.reabic.net/journals/bir/2022/Supplements/BIR_2022_Nour_etal_SupplementaryMaterial.xlsx