



## Status of the Sea Urchin, *Diadema setosum* (Echinodermata, Echinoidea, Diadematidae) along the Egyptian Red Sea Coasts

Ahmed Ghallab<sup>1\*</sup>, Rashad E.M. Said<sup>2</sup>, Aldoushy Mahdy<sup>2\*</sup>

<sup>1</sup>Director Manager of the Red Sea Northern Islands, Nature Conservation Sector EEAA, State Ministry of Environment, Cairo, New Administrative Capital

<sup>2</sup>Zoology Department, Faculty of Science, Al-Azhar University, Assiut Branch (71524), Egypt

\*Corresponding Author: [ahmedghallab968@yahoo.com](mailto:ahmedghallab968@yahoo.com), [aldoushy@azhar.edu.eg](mailto:aldoushy@azhar.edu.eg)

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### ABSTRACT

To the best of our knowledge, this study is the first to track and demonstrate the mortality event in *Diadema setosum* (Leske, 1778) along the Egyptian Red Sea coasts. The diadematid is a group of echinoid echinodermites that play an important ecological role in marine ecosystems. However, the current global mass mortality events in *Diadema setosum* have the potential to significantly change the fundamental structure of the ecosystem. This report was based on the 2023-summer observations of a *D. setosum* die-off during an ecological investigation in the northern Red Sea, Egypt. To determine the entirety of the event, a group from the Red Sea protectorates carried out an extensive survey simultaneously. The current survey covered the coastal regions of the Elba protectorate in the south, the Wadi El Gemal protected area in the middle, and Hurghada in the north. A diverse population of *D. setosum* was found dead on the bottom during both snorkeling and scuba diving. Representative photographs were taken at each explored site. Several features were noticed in the dead *D. setosum*, including a frail body, sand-covered body parts, spines distributed on the bottom, and inactive tube feet. The current findings, therefore, recommend crucially the performance of regular monitoring for the status of *D. setosum*. In addition, biological and ecological investigations are needed as soon as possible to interpret the causative and potential factors responsible for *D. setosum* loss.

### INTRODUCTION

Events involving marine infectious diseases, harmful algal blooms (HABs), climatic changes, pollution, ocean acidification, and anthropogenic activities can all have significant impacts on the structure of ecosystems, leading to changes in species dominance, biodiversity, and ecosystem function. The sea urchin *Diadema setosum* (Leske, 1778) (Family: Diadematidae, Class: Echinoidea, Phylum: Echinodermata) is one of the most conspicuous and important species of the echinoids and is an important constituent of the nearshore marine biota. It is adapted to occur in a very wide range of conditions, extending from the intertidal zone downward to a depth of 50 meters and

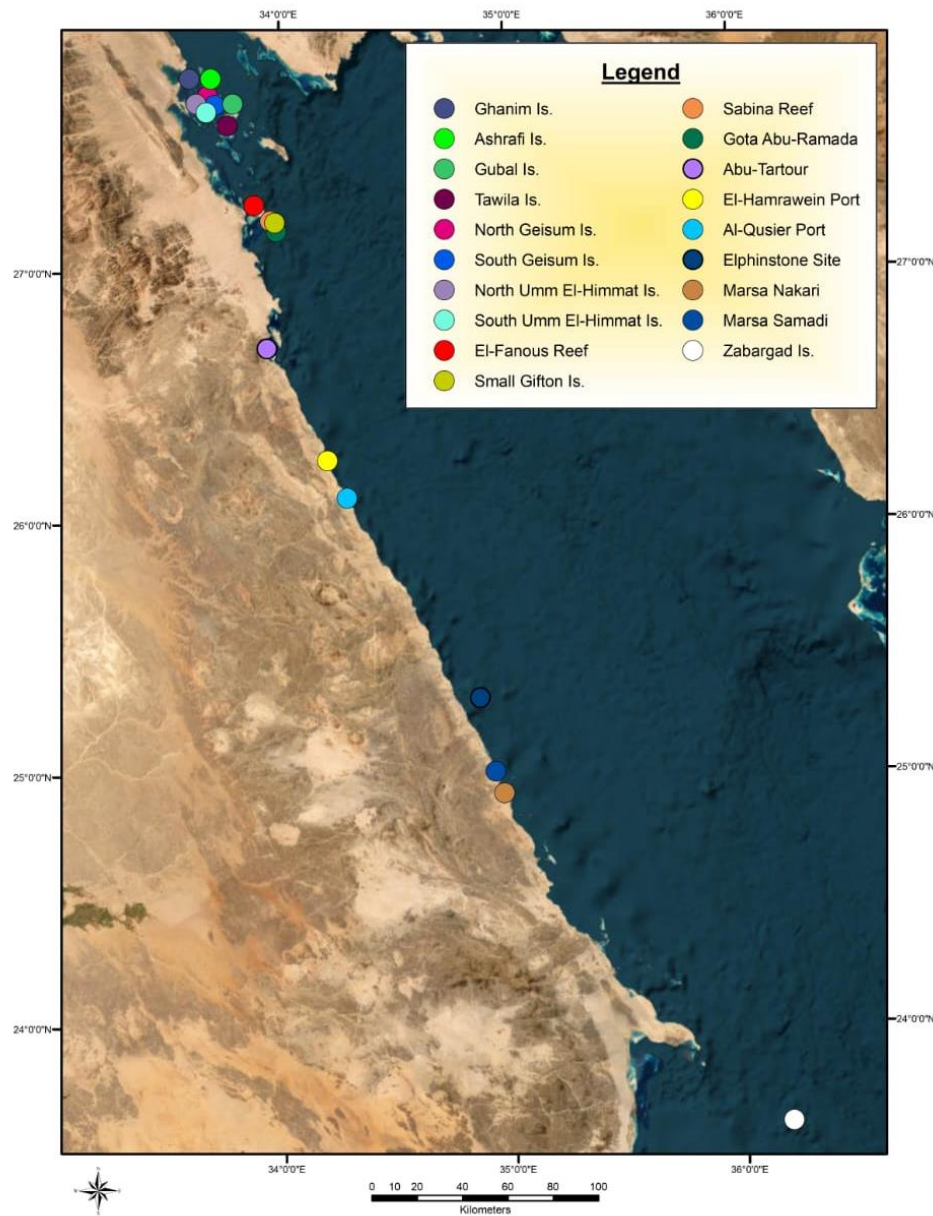
from subtropical to tropical regions. It ranges from hard substrates to those that live in sandy and seagrass habitats (**Hasan, 1995**).

*D. setosum* is also one of the most important species in the coral ecosystem since it contributes significantly to the food chain and to the modification of the substrate (**Lirman, 2001**). It is one of the most important benthic fauna effects and is affected by the other fauna and by the substrate. It is considered one of the major biological factors that protect corals from competition, as algal grazing by the echinoids is recognized as being crucial in restoring and maintaining coral recolonization (**Lirman, 2001**). **Fishelson (1971)** declared both *D. setosum* and *Echinometra mathaei* as the most dominant species in subtidal live and dead coral habitats for the former and subtidal rocky and dead coral habitats in the Red Sea. In the northern Red Sea, **Hasan (2019)** reported that live and dead corals were the most suitable habitats for *D. setosum*. In contrast, sand, seagrasses, and rocky habitats were unfavorable for the populations of *D. setosum*, while the abundance of individuals was 30ind/ m<sup>2</sup> at live corals.

Globally, some studies reported the mass mortality of other echinod diadima. For example, **Lessios *et al.* (1984a)** reported the mass mortality of *Diadema antillarum* on the Caribbean coast in Panama. Moreover, **Zirler *et al.* (2023)** recorded the mass mortality of invasive *D. setosum* in the Mediterranean Sea, and they expected that the mortality would cross to the endemic species in the Red Sea. Moreover, during 1983–1984, *D. antillarum* exhibited notable mortality, which was described as a catastrophic marine event due to its negative impact on coral reefs in the Caribbean (**Hylkema *et al.*, 2023**). The purpose of the current assessment was to evaluate the status of the echinoderm *D. setosum* on the Egyptian coasts of the Red Sea.

## MATERIALS AND METHODS

A large population of dead *D. setosum* and bottom-aggregated spines were observed in the northern Red Sea during a routine underwater survey as part of continuing studies on coral reefs (**Ghallab *et al.*, 2024**). Therefore, we decided to conduct the current assessment. The current survey was carried out during the summer months of the year 2023 (between June and September). According to the depth, which varied from 1 to 10m, snorkeling and scuba diving were the survey methods used along the coast of the chosen areas (Fig.1). Three sectors of the Red Sea (including points at each site) were selected as common areas for *D. setosum* during the extensive investigation: the northern, center, and southern portions. The northern part includes diving points and other islands in Hurghada; the second is the middle part including Wadi El Gimal islands; and the third is the coast of Elba protectorate at the south (Fig. 1).



**Fig. 1.** Map showing the surveyed areas, including sites for the presence of *D. setosum* in the northern, middle, and southern Red Sea protectorates (Ghallab *et al.*, 2024)

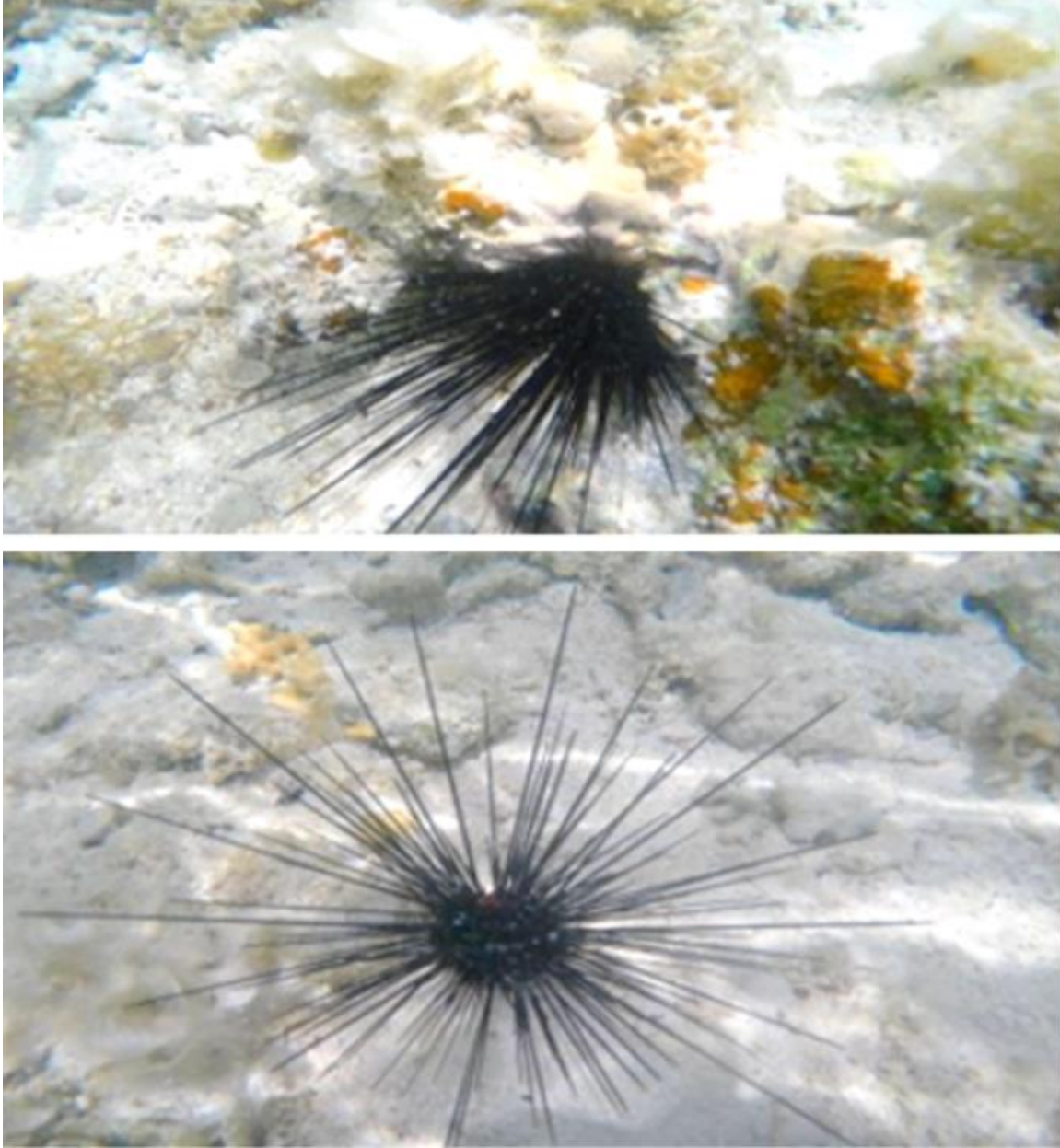
## RESULTS AND DISCUSSION

The current survey began in Hurghada in the northern Red Sea and extended to Wadi El Gemal and Elba protectorates in the southern Red Sea. At the selected sites, where common diving sites were surveyed, the species of *D. setosum* was totally absent from all sites, particularly in the north (Figs. 2, 3). In addition, at the surveyed sites in the northern, middle, and southern Red Sea, lots of spines and parts of the skeleton belonging to *D. setosum* were observed at the bottom of the natural habitats of this species. Dead *D.*

*setosum* exhibits multiple features, such as debris accumulating on spines, a lack of tube foot movement, and spine loss (Fig. 2). Additionally, there were crumbs and spine remnants visible on the bottom (Fig. 3). In many regions of the world, the reason for the widespread death of the echinoid *Diadema* is still being debated. The health anomalies documented in the years preceding the Northeast Pacific wasting mass mortality in the echinoids, which occurred from 2013 to the present time, were evaluated by **Hewson *et al.* (2019)**. Additionally, **Lessios *et al.* (1984b)** concluded that characteristics of the natural environment were the primary cause of the mass mortality that occurred between 1983 and 1984. The study by **Hylkema *et al.* (2023)** may be the first to raise concerns regarding *D. antillarum* deaths, which may have been caused by pathogen infection.

Other echinodermates were observed healthy during surveying *D. setosum*, suggesting that the dead seurchins are most likely the result of pathogenic or parasitic infections. Consistent with the current investigation, other studies attributed mortality events and altered health of different marine species to infectious diseases. Echinoderm disease occurrences are spreading to the polar areas (**Núñez-Pons *et al.*, 2018**). A similar survey (**Pratchett, 1999**) documented numerous lesions of the dermal tissue, collapsed spines, and a completely debilitated water-vascular system in the crown-of-thorns starfish, *Acanthaster planci*, from the northern Great Barrier Reef. The authors attributed their observation to bacterial infection, in accordance with similar symptoms (**Sutton *et al.*, 1988**). In Hurghada, **Hashiem *et al.* (2016)** identified bacteria-caused infections in some of the Red Sea fish.

Another study (**Ahmed *et al.*, 2024**) documented the incidence of *Sarcocystis* infection in the Red Sea shortfin mako shark, *Isurus oxyrinchus*. Ship biofouling is a primary channel for the introduction, establishment, and subsequent spread of marine non-indigenous macro-organisms (**Georgiades *et al.*, 2021**). Moreover, vessel biofouling can transfer infections and parasitic invertebrates (**Davidson *et al.*, 2016**). Due to its northern and southern connections to the Mediterranean Sea and Indo-Pacific waters, respectively, the Red Sea has experienced numerous invasions in this regard. For animals whose reproductive patterns are regulated by seasonal cues, the future is uncertain owing to the rapid acceleration of climate change and global warming (**Bronstein *et al.*, 2016**). On the other hand, it has been noted that regional variability, rising sea surface temperatures, and climatic changes all have an effect on biodiversity in terms of migration, mortality, production, and distribution (**El Kafrawy *et al.*, 2020**; **Mahdy *et al.*, 2020**; **Fitori *et al.*, 2021**; **Mahdy *et al.*, 2022**; **Khaled *et al.*, 2023**; **Said *et al.*, 2024**). Sudden mortality in different marine taxa was reported in the southern Red Sea, Egypt, in the coastal area off Elba protectorae (**Mahdy *et al.*, 2022**). The authors (**Mahdy *et al.*, 2022**) demonstrated that the event appeared due to the algal bloom (Red Tide) caused by *Noctiluca scintillans*. Overall, the current survey verified the high mortality of *D. setosum* along the Egyptian Red Sea coasts, and the pathogen or other agents causing this event are being researched.



**Fig. 2.** Debris accumulation on spines and some spine loss of *D. setosum* on the bottom of the surveyed areas at the Red Sea coasts



**Fig. 3.** Spines and skeletal parts of dead *D. setosum* are on the bottom of the surveyed areas along the Red Sea coasts

### CONCLUSION AND RECOMMENDATIONS

Our work is, as far as we know, the first to track and record the *D. setosum* mortality event along the Egyptian Red Sea coasts. The dead sea urchins share similarities in dormant tube feet, missing spines, spatial mortality, and death symptoms. Unfortunately, the population may be significantly impacted by this occurrence, which may deteriorate the Red Sea ecology. We hope that this brief survey will serve as a starting point and encourage more research and work to properly identify and manage this diverse and fascinating group of marine Echinodermata.

Consequently, the following recommendations have been suggested: studying the potential reasons for the mass mortality of the sea urchin *Diadema setosum*, conducting monitoring surveys of the coral community in the Red Sea to investigate the impact of the disappearance of this species, establishing a regional committee of international experts to implement restoration and recovery efforts for *D. setosum* in the Red Sea, developing suitable aquaculture programs for the sea urchin, investigating the DNA barcode for the endemic sea urchin in the Red Sea, and facilitating information exchange between regional countries.

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