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First Record of the Stony Coral *Paracyathus stokesii* Edward and Haime, 1848 (Caryophylliidae) in the Eastern Breakwater of the New Al-Faw Grand Port, Basrah, Iraq

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Abstract: The Arabian Gulf is home to dense coral communities. The occurrence of coral reefs in the coastal water of Iraq is not common. In the current study, several monthly surveys were conducted from November 2021 to March 2022 to investigate the biodiversity in the area surrounding the eastern breakwater recently established in Al-Faw Grand Port, south of Basrah, Iraq. Water temperature ranged between 16.0 °C in December 2021 and 33.0 °C in June 2021. Salinity ranged between 39.6 and 44.0 psu. The scleractinian coral species, *Paracyathus stokesii*, was recorded for the first time in this region. The occurrence of the coral reefs in a region of the breakwaters as artificial reef provided a good condition for coral larvae to settle and growing as colony will open doors for more environmental studies to follow up on the effects of climate change on biodiversity in this area.

Keywords: Al-Faw Grand Port, breakwater, *Paracyathus stokesii*, Scleractinian coral

Introduction

Coral reefs are fascinating and biodiversity-rich ecosystems (Bowen et al., 2013). They represent the tropical rainforests in the oceans. In these habitats, various invertebrate families and hundreds of fish species live in integral food webs (Brainard et al., 2011; Richard et al., 2020). Coral reefs are also essential to social economies, providing food, medical products, tourism, and coastal production in several warm regions of the world (Venkataraman & Satyanarayana, 2012). Coral reefs are limited to tropic and sub-tropic marine environments, and their life and distribution are affected by three main environmental factors: temperatures, salinity and transparency of waters (Guan et al., 2015). The optimum temperature range in which these organisms live is 21.1-29.6 °C, and they are unable to grow and build their reefs at a temperature below 18.0 °C. With regard to salinity, the optimum range for its tolerance is between 28.7 and 40.4 psu. The

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third limiting factor is turbidity as most coral species depend on algae that grow within their tissues, which provide them with oxygen and food through photosynthesis and therefore coral reefs need transparent waters that help in the penetration of light (Sirilak et al., 2011).

Historically, apart from Iraq, many coral complexes were well-established in the Arabian coastal water (Rezai et al., 2004). In 2012, a unique large living coral reef was discovered by a joint scientific team from the Marine Science Centre, University of Basrah, Iraq and the Scientific Diving Centre (SDC) Freiberg, Germany (Phol et al., 2014; Al-Handal et al., 2018; Gutekunst et al., 2018). Due to the sedimentary nature of the region, the tidal flats comprise silts, clays and sands (Aqrawi, 1994; Ali et al., 2021), causing a highly turbid seawater regime on the coast of Iraq. This was the reason behind keeping these corals undetected by satellite observations (Rezai et al., 2004). In addition to the high turbidity, the area exposed to rapid changes in temperature and salinity due to the influence of the strong currents of the Shatt Al-Arab River. Therefore, the area is considered the most extreme for coral life (Pohl et al., 2014).

Recently, a number of reports and studies were published on the impacts of global climate warming and other environmental stressors such as ocean acidification and plastic pollution on the coral reefs ecosystems worldwide, leading to a principal loss of these productive ecosystems (Sheppard & Obura, 2005; Obura et al., 2008, Adam et al., 2021). From this viewpoint, the existence of a living coral reef in an extreme environment of Iraqi coastal waters represents an ideal opportunity to conduct further studies on the future of the coral reefs in global seas in light of the warming of the global oceans (Phol et al., 2014; Dixon et al., 2022).

This paper aims to diagnose and identify the species of coral that has recently settled in the waters adjacent to the breakwater established in the new port of Al-Faw Grand Port.

The Study Area

Al-Faw Grand Port is located on the eastern side of Al-Faw Peninsula, south of Basrah, specifically in the Ras Al-Beshah area at the end of the continental shelf of Iraq. The port has a total area of 54 km^2 and a depth of 19 m. The port design includes an eastern breakwater with a length of 8 km (Figure 1), and a western breakwater with a length of 16 km.

A breakwater is a coastal structure projecting into the sea to protect vessels from waves and currents and prevent a navigation channel’s siltation. A breakwater typically comprises various stone layers that can stabilize the coast by preventing erosion. The current study samples were obtained from the eastern breakwater area, as shown in the map of the study area (Figure 2). On the other hand, the area is part of eastern coast of Khor Abdullah, which formed tidal muddy flat extending for several kilometers towards the land, and it represents the link between Khor Al-Zubair in the north and Arabian Gulf in the south (Issa et al., 2009). The mudflat intertidal area constitutes a suitable habitat for many species of

burrowing benthic animals, in particular the crabs and mudskippers of high abundance populations (Ali et al., 2021).

Figure 1: The eastern breakwater of Al-Faw Grand Port. Photograph by Hanaa H. Mohammed.

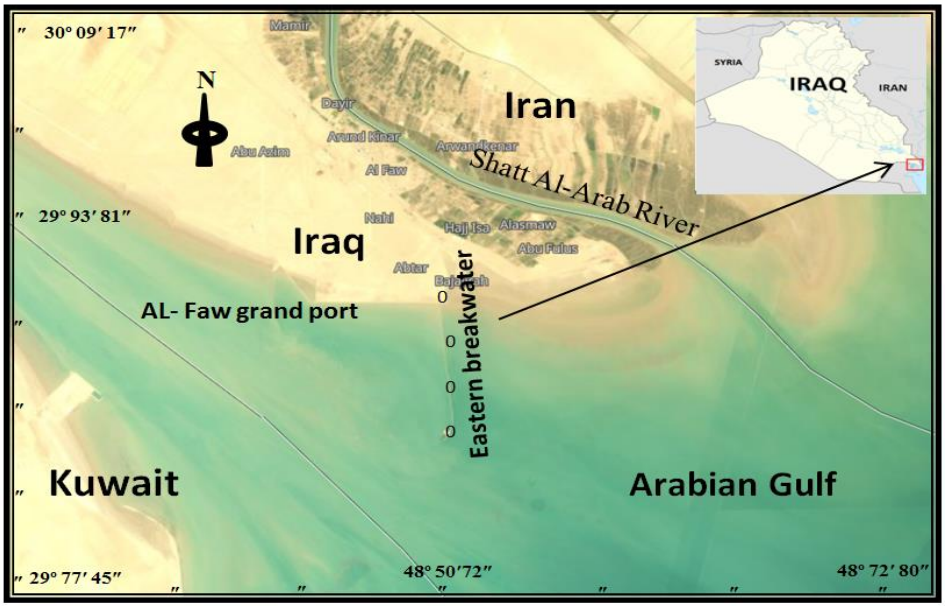

Figure 2: The location of the eastern breakwater of Al-Faw Grand Port.

Material and Methods

Many surveys were conducted on a monthly basis (one day/ month) from November 2021 to March 2022 to investigate the area surrounding the newly constructed breakwater in Al-Faw Grand Port. The surveys are usually made at low tide, a suitable time for benthic invertebrate observation. The collection of macro-invertebrates was made by hand with a 1.0 mm mesh size sieve. Specimens were preserved in 85% alcohol for further laboratory examination. Many coral individual were found attached to rocks of the artificial breakwater, in the low intertidal zone, but the studied coral sample was collected from the shallow subtidal zone that follows it, and it includes most growth of coral.

Coral samples were obtained from the subtidal water by a grab sampler, picking up solid bodies from the sea bottom. *P. stokesii* identification was made following Carpenter et al. (1997) and Hoeksema & Cair (2022). The size of the corallum was estimated by measuring the diameter of *P. stokesii* corollite using a vernier caliper to the nearest 0.01 mm. The taxonomic characteristics were examined with the aid of a dissecting microscope. Water temperature and salinity within the breaker area were measured monthly by using Multimetre 350i.

The size distribution of 85 individuals of *P. stokesii* was analyzed by plotting the numerical frequency against the size classes of the corals samples. Each normal size distribution represents a year age class of the *P. stokesii* population or a cohort of the multi-generation population (Ali et al., 1995).

Results

During the study months, water temperature within the breakwater ranged between 16.0 °C in December and 33.0 °C in June, and the salinity ranged from 39.6 psu in December and 44.0 psu in November. The observed specimens are a scleractinian coral *Paracyathus stokesii* corallum first observed attached to solid pieces of scrap materials and rocks accumulated on the seafloor near the eastern breakwater. There were 85 individuals of different sizes of *P. stokesii* growing on a small area (1000 cm^2) of a solid plate. Plotting the size distribution of the coral's number reveals two normal distributions that indicate two generations or a two-year class population of *P. stokesii* (Figure 3). The sizes (diameters) of the corals ranged from 0.15 cm to 1.15 cm., the mean of the first normal size distribution X_1 was 0.31 cm and the mean of the second normal size distribution X^2 was 0.64 cm. The present scleractinian species (*Paracyathus stokesii*) was identified as a new record to Al-Faw Grand Port sea area, and the Iraqi marine waters in general, belonging to the phylum Cnidaria, class Anthozoa, order Scleractinia and family Caryophylliidae according to both GBIF (2022) and WoRMS (2022).

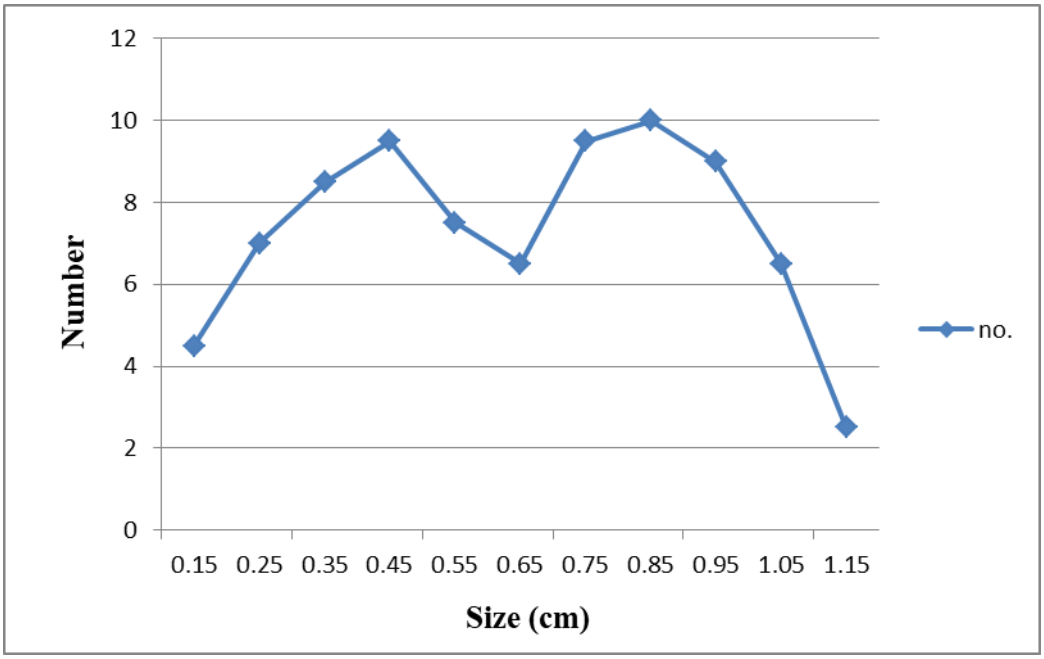

Figure 3: The normal sizes distribution of the coral sample.

Description

A zooxanthellate, solitary and sticky coral, with a flat base and cylindrical stalk up to 16 mm high was tapering internally with the animal's maturity and ending with an oval shaped corallite and pinched along the central line and septa edges entirely granulated.

The walls of the corallite are higher in the middle. There are 84 septa in four orders pail, prominent and merged with the columella. The columella is long and narrow. The granules aligned to form fan-like edges, and all septa descend steeply into the calice. The edges of the outer septa have light granules and they stand out more as they approach the septa (Figure 4). The examined materials of *P. stokesii* were conserved in alcohol and placed in the marine collection at the Aquatic Museum Laboratory of the Marine Science Centre, University of Basrah.

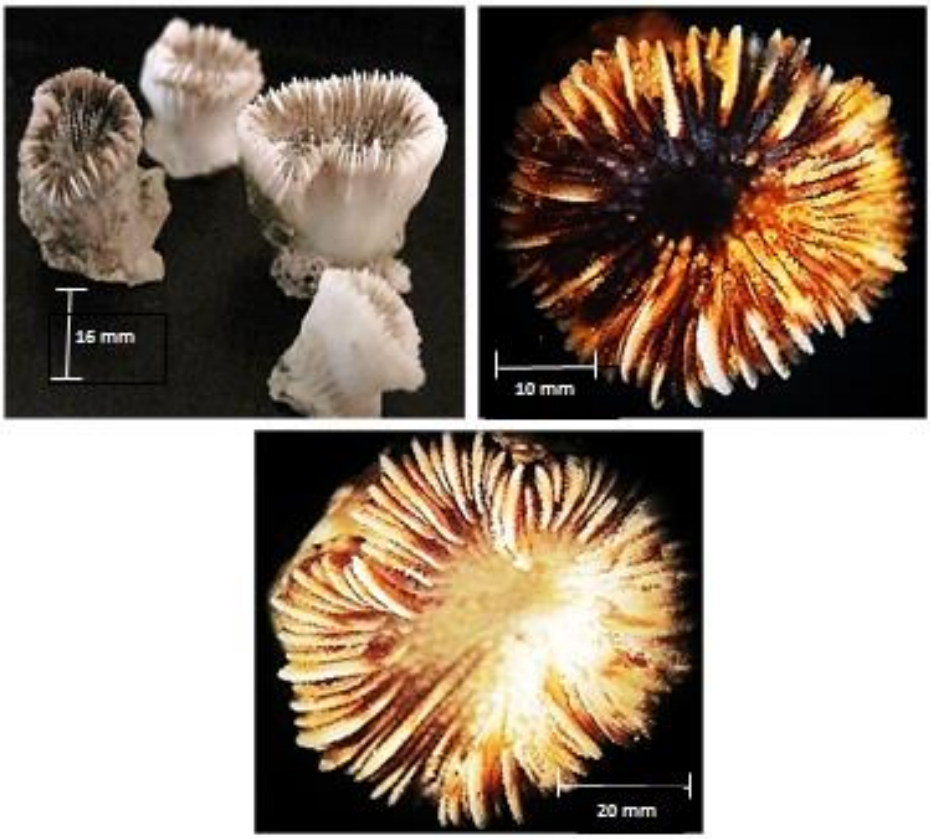

Figure 4: *Paracyathus stokesii* in marine waters from the eastern breakwater of Al-Faw Grand Port: lateral view of an adult individual (top left photo), juvenile (top right photo) and adult (down photo). Photographs by Hanaa H. Mohammed.

Discussion

The coast of Al-Faw Peninsula is characterized by a vast mudflat intertidal zone of high sedimentation nature comprising muds and sandy silts sourced from the Shatt Al-Arab River and causing high turbidity of seawater (Issa et al., 2009; Ali et al., 2021). These conditions are not suitable for coral reef growth, as confirmed by many studies (Roy & Smith, 1971; Risk & Edinger, 2011). However, it appears that the existence of breakwaters helped create a suitable condition for coral growth in the area. Many studies show an example of the positive effects of artificial breakwaters in the development of the settlement growth of new coral reefs (Burt et al., 2010; Wen et al., 2013).

The results of the current study showed two peaks in the size distribution of the coral, which indicates either two annual age groups or two generations for the same year. Many studies on the estuarine invertebrates in Basrah indicated that these species produce several generations during the breeding season due to the rapid growth in a high-temperature range (Ali et al., 1995).

P. stokesii is a corallum belonging to Caryophlliidae, the biggest scleractinian corals family comprising 43 genera and 301 species (Venkataraman & Satyanarayana, 2012). The species is widely distributed in the Indian Ocean and the endo-Pacific area (Moazzam & Moazzam, 2016). However, the nearest location recorded for *P. stokesii* is in the water of Kuwait coasts at N: 29° 15' 00; E: 48° 15' 00, nearly 70 km south of Al-Faw Grand Port, in which 35 coral species were recorded (Carpenter et al., 1997). On the other hand, the species was not recorded in the Palinurus Rock (PR) coral reef at N: 29° 37’ 00; E: 48° 40’ 00, southeast of Al-Faw Grand Port. However, other samples previously collected from the PR have not yet been examined. As a result, we assume that the new settlement of *P. stokesii* observed in this investigation came from the neighboring colonies throughout their planktonic larvae (Mangubhai, 2007).

Taxonomically, the closest species to *P. stokesii* found in the region is *P. marigondoni* Verheij & Best, 1987. The colony of this species is flat and creeping, round or oval, consists maximum of 46 septa (Carpenter et al., 1997), and can be easily discriminated from *P. stokesii*.

In conclusion, the establishment of the breakwater has provided appropriate conditions for the settlement of coral that had not previously existed in the studied area. It gives hope for the emergence of a second coral colony in the marine water of Iraq.

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