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First spawning record of the widespread Indo-Pacific *Pavona maldivensis* observed in the Red Sea

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Information on coral reproductive biology and coral spawning times is crucial to advance basic and applied research and inform strategies for coral reef conservation and restoration. Important efforts have been made to collate coral spawning times and reproductive patterns in global and regional datasets. Here, we report and document the first *in situ* spawning of *Pavona maldivensis* Gardiner, 1905, observed in the Red Sea. A medium size colony was observed releasing sperm on the full moon night on 23 May 2024, at sunset time. Our observations suggest that the widespread Indo-Pacific *P. maldivensis* is likely gonochoric. This first report on the *in situ* spawning timing for *P. maldivensis* contributes to expanding coral spawning databases and provides valuable data on its reproductive biology, which is relevant for coral restoration and conservation efforts.

KEYWORDS

coral reproductive biology, coral gametes, broadcast spawners, coral sperm release, Red Sea

Introduction

The current global coral crisis has pushed forward the development of a wide range of strategies to improve coral resilience to withstand the pressing anthropogenic impacts (Voolstra et al., 2021). Some of these interventions rely on successfully collecting gametes to sexually propagate corals. Therefore, detailed information on coral spawning is crucial to advance basic and applied research and inform strategies for coral reef conservation and restoration. Currently, reproduction data is available for over 300 scleractinian species in 61 genera in the Indo-Pacific (Harrison, 2011; Baird et al., 2021), where over 600 hard coral species are reported (Veron et al., 2015). In the Red Sea, where research on coral reproduction historically started in the Gulf of Aqaba (Rinkevich and Loya, 1979; Shlesinger and Loya, 1985; Shlesinger et al., 1998; Rapuano et al., 2017), synchronous spawning of scleractinian corals at central latitudes has been observed around full moon nights in spring (Bouwmeester et al., 2015; Osman et al., 2024). In the Indo-Pacific region,

most spawning observations are on species of the genus *Acropora*, with 38% of the total spawning records, while information on other coral genera is relatively scarce (Baird et al., 2021).

Pavona Lamarck, 1801, is commonly observed in shallow Indo-Pacific coral reefs, including the Red Sea (Terraneo et al., 2017), but few studies have described its reproductive biology. Species of *Pavona* are almost exclusively gonochoric and broadcast spawners (Shlesinger et al., 1998; Harrison, 2011). *In situ* spawning has been reported two and three days after the full moon of November in *Pavona cactus* Forskål, 1775, in the Great Barrier Reef (Marshall and Stephenson, 1933), of March in *Pavona gigantea* Verrill, 1869, in the Galapagos Islands, Ecuador (Glynn et al., 1996), from January to April for *Pavona varians* Verrill, 1864, and *Pavona* sp. (later formally described as *Pavona chiriquiensis* Glynn, Maté & Stemann, 2001) in the Gulf of Chiriquí, Panama (Glynn et al., 2000), and in October for *Pavona clavus* Dana, 1846, in Contadora Island,

Panama (Glynn et al., 2011). *In situ* spawning was observed six days after full moon of August in *Pavona decussata* Dana, 1846, in Kochi Prefecture, Japan (Mezaki et al., 2014). In the Red Sea, no *in situ* spawning observations have been reported so far for *Pavona*; however, April has been inferred as the spawning month in *P. varians*, based on the oocyte maturity (Bouwmeester et al., 2015). Here, we report the first *in situ* spawning observation of *Pavona maldivensis* Gardiner, 1905.

Materials and methods

In April and May 2024, *in situ* surveys to document coral spawning were conducted in Al Fahal Reef (22°18'21" N; 38°57'44" E), a midshore reef located in the central Red Sea (Garcias-Bonet et al., 2024). Underwater surveys took place by SCUBA divers

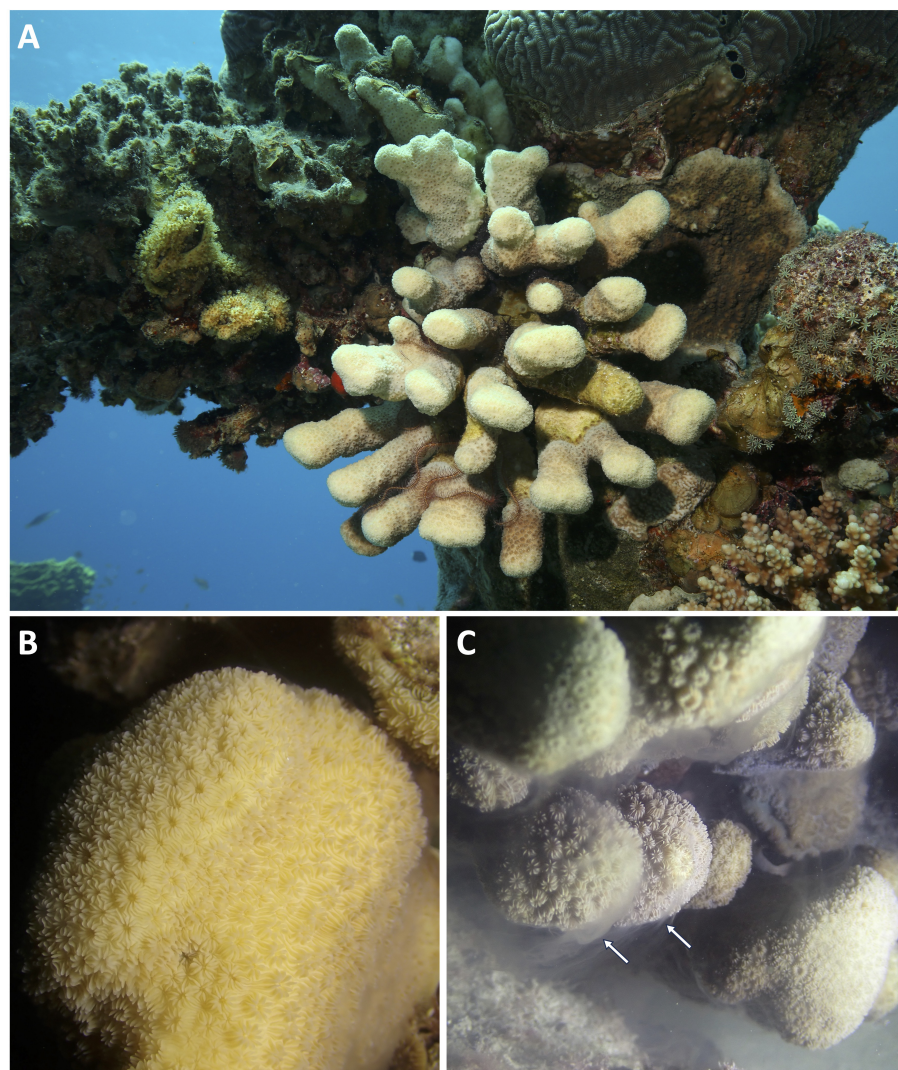


FIGURE 1

(A) Picture of a *Pavona maldivensis* colony in the Red Sea. Image by Francesca Benzoni. (B) Detail of a *P. maldivensis* colony *in vivo*. The colony exhibits the characteristic knob-shaped structure, with corallites defined by the species' distinct raised, rounded, and well-defined wall. The corallite septa are alternating in height and thickness. Image by Marco Casartelli. (C) *In situ* spawning observation, with a dense cloud of sperm being released (arrows), from *P. maldivensis* in Al Fahal Reef in central Red Sea. Image by Neus Garcias-Bonet.

during two consecutive months on 21–25 April 2024 and 20–24 May 2024, covering the full moon nights on 24 April and 23 May 2024. Surveys were conducted from 17:30 to 19:00 and from 21:30 to 23:00 at depths from 8–10 meters using red light torches to minimize the negative impact of light on coral spawning. Spawning observations and timing were noted and pictures and videos were taken with an Olympus TG-6 camera equipped with an Olympus PT-059 underwater housing (OM System). *In situ* seawater temperature was monitored using a Multiparameter CTD probe (Ocean Seven 310, Idronaut) as part of a sustained environmental data observation platform (Garcias-Bonet et al., 2024).

Results and discussion

We report and document the first *in situ* spawning observation of *Pavona maldivensis* Gardiner, 1905 (Figure 1) in the central Red Sea (Al Fahal Reef) on the full moon night, on 23 May 2024 at 18:49h, ten minutes before sunset time (18:59h), when *in situ* daily mean seawater temperature was 29.68°C. A medium size *P. maldivensis* colony (80 cm in diameter) at a depth of 9 m was observed releasing sperm in a dense cloud surrounding the entire colony for seven minutes (Figure 1, Supplementary Movie 1). No eggs seemed to be released from the colony, suggesting that *P. maldivensis* is likely gonochoric, in agreement with reproductive data available for other *Pavona* species. For instance, *Pavona varians* has been reported as gonochoric in the Red Sea (Bouwmeester et al., 2015; Shlesinger et al., 1998) and mostly gonochoric with some hermaphrodite colonies in Eastern Pacific (Glynn et al., 2000).

Contrary to the spawning synchrony observed in many scleractinian corals (Baird et al., 2009, 2021), spawning times in *Pavona* genus doesn't seem to be synchronized, with *in situ* observations ranging from midday to few hours before sunrise around full moon nights across different months. Similarly to our spawning observation at sunset time in *P. maldivensis*, *Pavona* sp. spawning was reported shortly after sunset in Panamá (Glynn et al., 2000), *P. gigantea* spawning was reported in the late afternoon (two hours before sunset) in Galapagos Islands, Ecuador (Glynn et al., 1996), and the release of eggs in *Pavona explanulata* was observed three hours after sunset in Taiwan (Lin and Nozawa, 2017). Contrary, *Pavona* sp. spawning was reported at midday in Thailand (Plathong et al., 2006), male and female colonies of *P. varians* were observed spawning two hours before sunrise in Panamá (Glynn et al., 2000) and *P. decussata* was observed spawning about one hour before sunrise in Japan (Mezaki et al., 2014).

The spawning observation of *P. maldivensis* reported here is based on a single male colony; therefore, further research, increasing the observation time window and number of monitored colonies, is needed to fully describe the spawning patterns, characterize the reproductive biology and confirm the gonochorism of *P. maldivensis* in the Red Sea. *P. maldivensis* is known to be widespread from the Red Sea to the East Pacific Region

(Sheppard, 1991; Veron, 2000; Salvat et al., 2016). In the Red Sea, it can be commonly observed from very shallow to upper mesophotic low-light environments such as under reef crest ledges and underhangs (Al Tawaha et al., 2019), with *Pavona* genus accounting on average for less than 1% of the benthic cover in the central Red Sea (Monroe et al., 2018). This first report on the *in situ* spawning timing for *P. maldivensis* in the Red Sea contributes to expanding global coral spawning databases and provides valuable data on its reproductive biology, which is relevant for coral restoration and conservation efforts.

Data availability statement

The original contributions presented in the study are included in the article/Supplementary Material. Further inquiries can be directed to the corresponding author/s.

Ethics statement

The manuscript presents research on animals that do not require ethical approval for their study.

Author contributions

NG-B: Conceptualization, Methodology, Writing – original draft. MC: Conceptualization, Methodology, Writing – review & editing. SV: Methodology, Writing – review & editing. FB: Conceptualization, Writing – review & editing. RP: Conceptualization, Funding acquisition, Writing – review & editing.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Supplementary material

The Supplementary Material for this article can be found online at: <https://www.frontiersin.org/articles/10.3389/fmars.2025.1514216/full#supplementary-material>

SUPPLEMENTARY MOVIE 1

In situ spawning observation from a *Pavona maldivensis* colony in Al Fahal Reef in central Red Sea on the full moon night in May, on the 23rd of May 2024, after sunset time (18:50h). File format: Apple QuickTime Movie (MOV).

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