

Outbreak of growth anomalies in coral communities of Qeshm Island, Persian Gulf

Pavriz Tavakoli-Kolour · Javid Kavousi ·
Hamid Rezai

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Abstract Reports on the outbreaks of coral diseases are on the rise, stating that diseases are considered to be one of the main drives in the decline of global coral reefs. In this study, the outbreak of growth anomalies (GAs) in coral communities of the south of Qeshm Island in the Persian Gulf is reported. Despite a previous report on the localized GAs on a few colonies, this is the first report of GA outbreak from the Persian Gulf, in which 28 ± 11 % (\pm SE) and 21 ± 13 % of *P. daedalea* and *Porites* colonies contracted GAs in July 2012. A year later, we recorded GAs on 37 ± 07 % of *P. daedalea* and 23 ± 12 % of *Porites* colonies. Pearson's correlation test showed a strong positive relationship between coral colony size and the number of GAs ($r = 0.907$, $p < 0.05$). Further investigation is needed to understand the cause of GAs, their progress trend, and prospective impacts on the coral communities at our studied site.

Keywords Disease · Growth anomalies · Massive *Porites* · Persian Gulf

Introduction

Coral diseases are known as one of the most prevalent threats to coral reefs worldwide (Sutherland et al. 2004; Weil et al. 2006). In the recent years, reports on coral diseases and subsequent mass mortalities have increased worldwide (Goreau et al. 1998; Green and Bruckner 2000; Sutherland et al. 2004; Weil et al. 2006). Although the Caribbean Sea is considered the main coral disease hot spot with over 66 % of the world's recorded diseases (Green and Bruckner 2000), Indo-Pacific coral reefs are getting more attention due to increasing instances of coral disease outbreaks recently (e.g., Willis et al. 2004; Weil et al. 2012) and the Persian Gulf is no exception (Riegl et al. 2012).

Although coral disease studies in the southern Persian Gulf started about two decades ago (see Riegl et al. 2012), little information was available on coral diseases of the northern part until recently. Except the Yellow Band Disease, which was reported at two Iranian Islands in 2000 and 2002 (Rezai et al. 2004), the other

P. Tavakoli-Kolour (✉)
Young Researchers and Elite Club, Bandar Abbas Branch, Islamic Azad University, PO Box 79159-14 1311, Bandar Abbas,
Iran
e-mail: p.tavakoli@hotmail.com

J. Kavousi
Graduate School of Engineering and Science, University of the Ryukyus, 1 Senbaru, Nishihara, Okinawa 903-0213, Japan

H. Rezai
Iranian National Institute for Oceanography and Atmospheric Sciences, Tehran, Iran

reports on diseases were drawn up only in the last few years (Samimi-Namin et al. 2010; Kavousi and Rezai 2011; Kavousi et al. 2013).

Similarly, serpulid invasions associated with red tides at Qeshm Island (Samimi-Namin et al. 2010) and the White Mat Disease at Hormuz Island (Kavousi et al. 2013) caused mass coral mortalities in the northern Persian Gulf. Other reports included growth anomalies (GAs) only on a few colonies at Larak, Hengam, and southeast of Qeshm Island (Kavousi and Rezai 2011). However, no coral colonies with GAs were observed at the southern part of Qeshm Island. Here, we report the outbreak of GAs in *Platygyra daedalea* and *Porites* spp. colonies as the only coral taxa affected among the southern coral communities of Qeshm Island in 2012 and 2013.

Materials and methods

The study site includes the southern coral communities of Qeshm Island (26°45'N, 55°49'E, Fig. 1) in the Persian Gulf. The present investigation took place during July 2012 and July–August 2013. In total, eight 30 m⁻¹ Line-Intercept transects were established at depth 2–5 m⁻¹ in each year for preliminary assessment of benthic communities including live coral and coral genera cover. Moreover, to study growth anomalies (GAs) dynamic on the affected corals, eight 30 m⁻² belt transects were considered. Coral skeletons in GAs and healthy parts of coral colonies were observed under a focal microscope to check out the microstructural differences.

Furthermore, during 2013, 11 colonies of *Platygyra daedalea* with GAs were measured in three dimensions (length, width, and height) and the frequency of GAs were counted followed by the Pearson's correlation test to assess whether there was any relationship between coral colony size and the number of GAs in coral colonies. *Porites* colonies were not considered due to the negligible difference in their size.

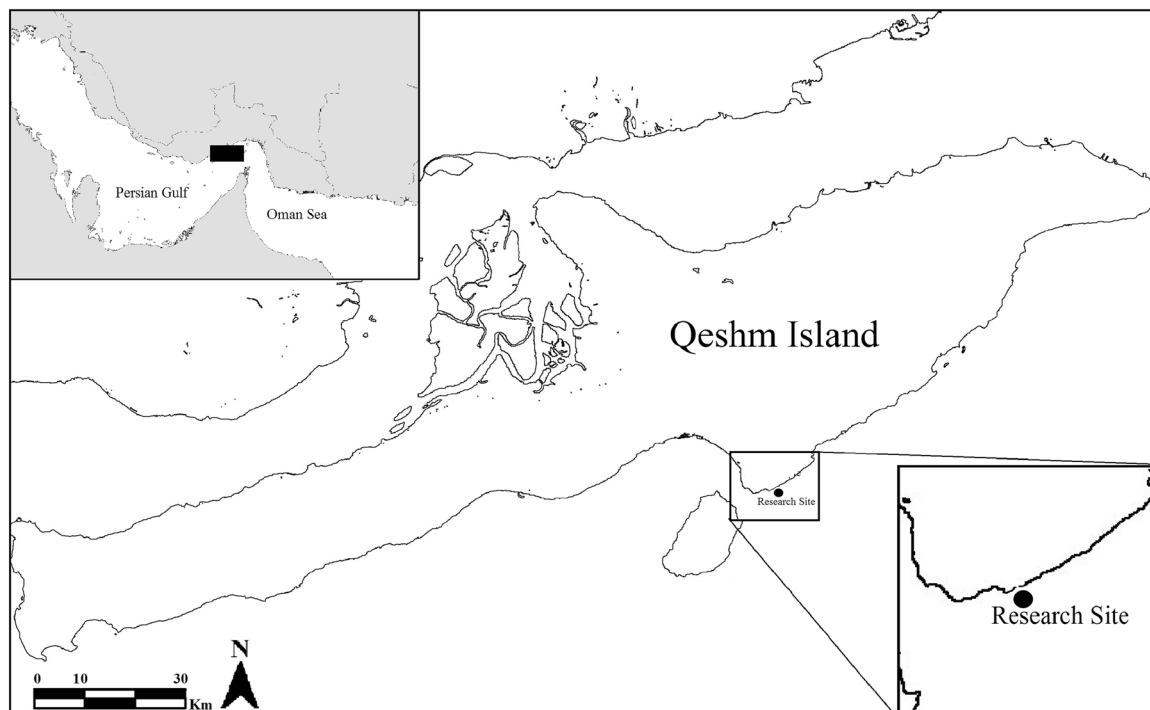


Fig. 1 Map of the site studied in this research



Results and discussion

Live coral cover

Live coral constituted 20 % of the substrate of the studied site at Qeshm Island (Fig. 2), which is higher than that reported for 2009, 14.03 ± 4.8 % (Kavousi et al. 2011). *Platygyra daedalea*, as the dominant coral taxa, accounts for approximately 50 % of the live coral cover in the area (~53 % in 2012 and ~49 % in 2013; Fig. 3). In contrast, *Porites* spp. as dominant genus in the southeast of Qeshm Island constituting 89 ± 12.2 % (Kavousi et al. 2011) accounts for about 6 % of the coral cover at the current studied site (Fig. 3).

Growth anomalies (GAs) on corals

P. daedalea and *Porites* spp. were the only coral taxa with GAs (Fig. 4). GAs accounted for 28 ± 11 % (\pm SE) and 21 ± 13 % in *P. daedalea* and *Porites* colonies, respectively, during July 2012, whereas they were 37 ± 07 % and 23 ± 12 % in *P. daedalea* and *Porites* spp., respectively (Fig. 5). These results show a 9 % increase in GAs on *P. daedalea* colonies, but the increase in *Porites* spp. is negligible. Although localized GAs on *P. daedalea* and *Dipsastraea* (formerly *Favia*) were recorded at Iranian Islands (Kavousi and Rezai 2011), GA outbreak has never been previously reported for the Persian Gulf.

There is a highly positive correlation between the coral colony size and the number of GAs ($r = 0.907$, $p < 0.05$, Fig. 6). In other words, the bigger the colony, the greater the chances of GAs. Irikawa et al. (2011) also found that *Acropora cytherea* colonies larger than 120 cm in diameter had more GAs at some Japanese reefs. Loya et al. (1984) studying GAs in two species of *Platygyra* at some Australian reefs found that the larger the colony, more likely it is to have GAs.

Microscopic photographs of the coral skeletons show that calices of the affected areas are irregular, destructed, and bigger than those of normal coral skeletons (Fig. 7). Similar results are reported in other studies (McClanahan et al. 2009; Irikawa et al. 2011; Stimson 2011).

Fig. 2 Percentages of biotic and abiotic objects at the studied site. LC live coral, DC dead coral, Rb rubble, Sd sand, Rc rock, Al algae, Sp sponge

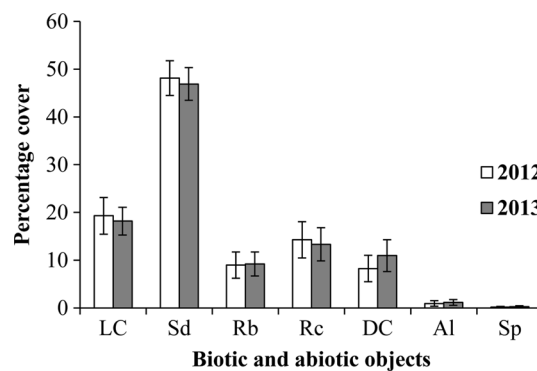


Fig. 3 Coral genera coverage at the studied site

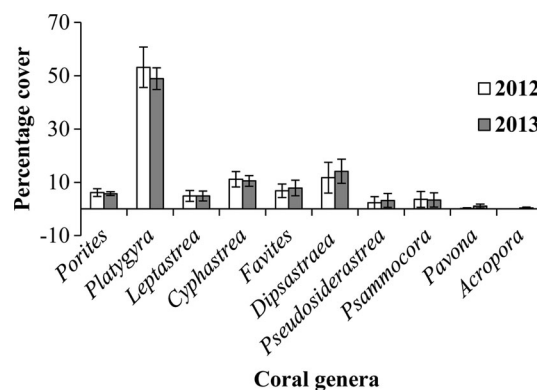


Fig. 4 Growth anomalies on *Platygyra daedalea* (a) and on *Porites* spp. (b)

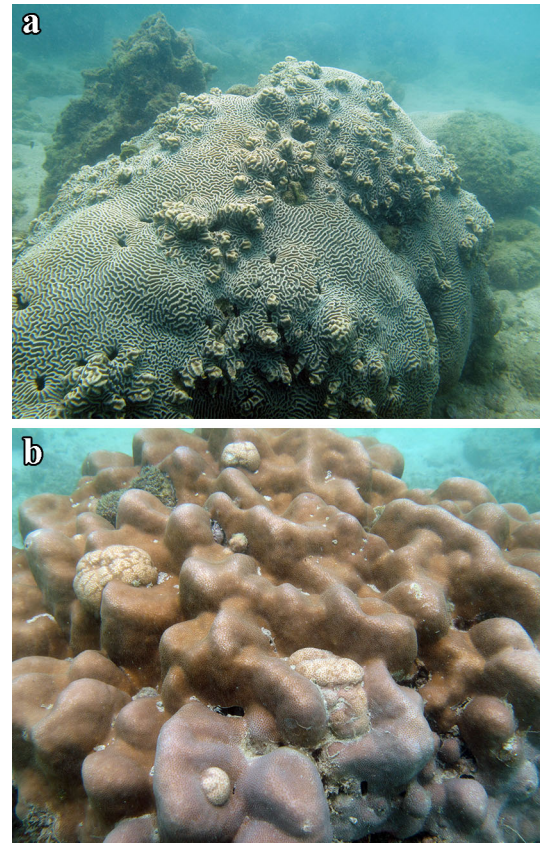


Fig. 5 Percentage of coral colonies contracting growth anomalies in 2012 and 2013

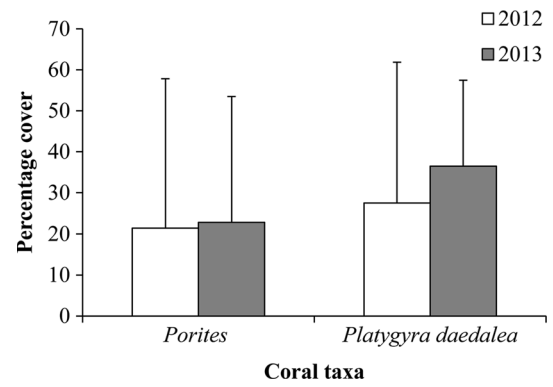
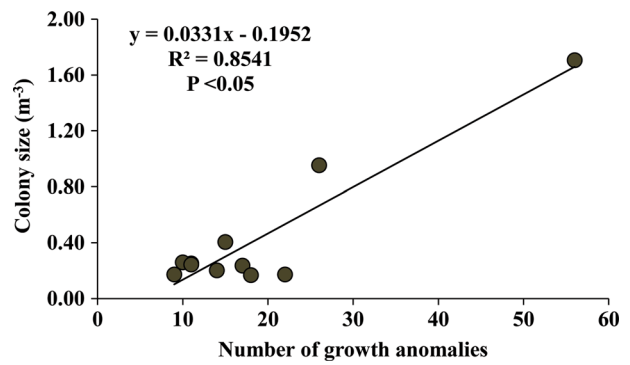


Fig. 6 The relationship between *Platygyra daedalea* colony size and the frequency of growth anomalies in 2013



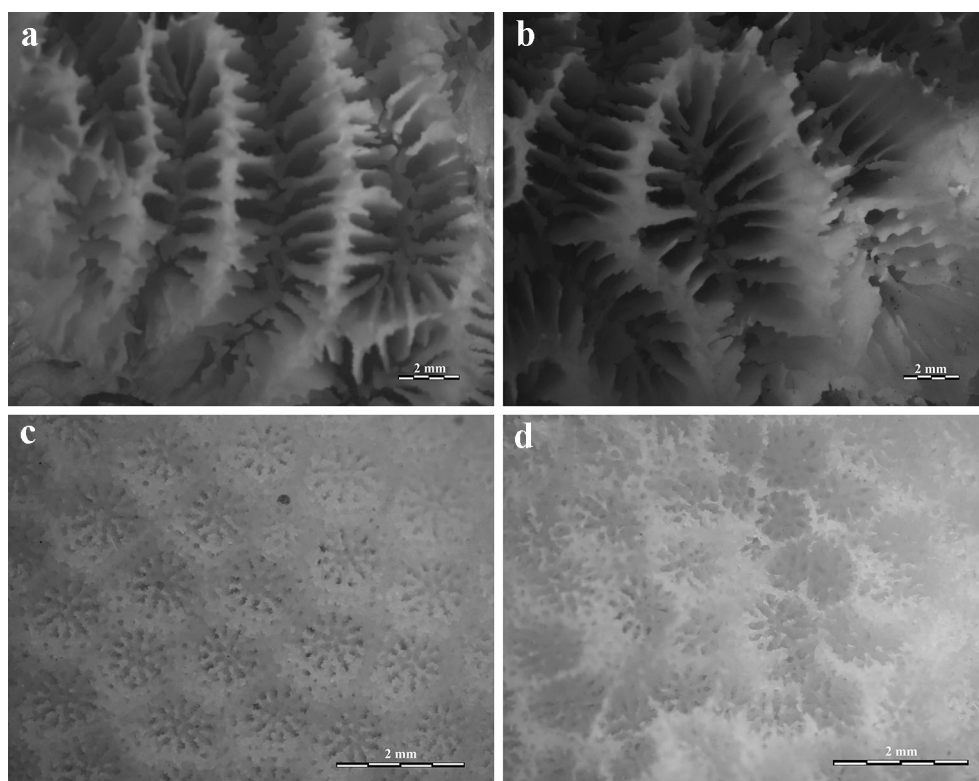


Fig. 7 Microscopic photographs of the coral skeletons of **a** healthy and **b** GA parts of *Platygyra daedalea*, **c** healthy, and **d** GA parts of *Porites* spp.

Although the etiology of GAs, like the majority of coral diseases, is understudied, environmental factors have been suggested as the main cause. For example, McClanahan et al. (2009) found a strong relationship between *Porites* growth anomalies and coral bleaching at Kenyan coral reefs. As a massive bleaching happened in the northern Persian Gulf, extending to our studied site in 2012 (Kavousi et al. 2014), high temperatures might have been a cause of GAs in this area. However, it is unlikely that anomalous temperatures alone could be the cause of the GA outbreak because no GAs were observed at other sites encountering mass bleaching in the area at the same time.

Irikawa et al. (2011) monitoring some Japanese reefs for 10 years suggested that GAs on *Acropora cytherea* were a resultant of aging amplified by temperature anomalies. Some studies also suggested biotic factors such as viruses, fungi, and endolithic algae as the cause of GAs (see Weil et al. 2012). McClanahan et al. (2009) mentioned that altered calice structure in GA areas is due to some microbioeroders including fungi causing the unusual growth.

Another study found that environmental conditions together with the human population size as well as the abundance of host coral communities strongly influence *Acropora* and *Porites* GA prevalence in the Indo-Pacific (Aeby et al. 2011). Our research site, however, encompasses a local community with a few boats, which are used for limited fishing and transportation, it is not close to ports, industrial complexes, or urban areas. The suggestion by Aeby et al. (2011) may not hold true for our studied zone as not only the stressors including human pressure are relatively greater in number at the southeast of Qeshm Island but also *Porites* spp. are dominant (~89 %) at that site (Kavousi et al. 2011). However, no GA outbreak was discerned in that site (pers. obs.). We hypothesize that a compulsory combination of environmental conditions, host corals' physiological conditions, and microbial invasions may determine occurrence and development of GAs on corals. Partial involvement of the mentioned factors may explain why some studies report transition of GAs to healthy colonies (Kaczmarek and Richardson 2007), whereas others do not (Irikawa et al. 2011). However, the certain cause of the observed outbreak of the GAs at the south of Qeshm Island remains unknown for the time being.



Although GAs do not kill coral colonies, they can decrease fecundity in the affected parts (Irikawa et al. 2011). Therefore, if an increasing trend in the outbreak of GAs on coral colonies is observed for a long term, so that GAs can cover most of the coral colony surface, it may decline coral recovery after disturbances because of insufficient recruits. The case may be more serious for our studied site as it encounters continuous stressors (Kavousi et al. 2011, 2014). Therefore, it is necessary to conduct field experiments to understand the dynamics and future impacts of GAs on coral communities of the south of Qeshm Island.

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