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Aims and scope: The *Western Indian Ocean Journal of Marine Science* provides an avenue for the wide dissemination of high quality research generated in the Western Indian Ocean (WIO) region, in particular on the sustainable use of coastal and marine resources. This is central to the goal of supporting and promoting sustainable coastal development in the region, as well as contributing to the global base of marine science. The journal publishes original research articles dealing with all aspects of marine science and coastal management. Topics include, but are not limited to: theoretical studies, oceanography, marine biology and ecology, fisheries, recovery and restoration processes, legal and institutional frameworks, and interactions/relationships between humans and the coastal and marine environment. In addition, *Western Indian Ocean Journal of Marine Science* features state-of-the-art review articles and short communications. The journal will, from time to time, consist of special issues on major events or important thematic issues. Submitted articles are subjected to standard peer-review prior to publication.

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Word from the Editor

The last couple of years have been a time of change for the Western Indian Ocean Journal of Marine Science. The journal has a new and more modern layout, published online only, and the editorial Board was increased to include more disciplines pertaining to marine sciences. While important challenges still lie ahead, we are steadily advancing our standard to increase visibility and dissemination throughout the global scientific community. The central objective of the journal continues focused on the Western Indian Ocean region and serving its growing scientific community.

We are pleased to start the publication of special issues of the journal, launched here with the publication of manuscripts from the University of Mauritius Research Week 2016. The special issues aim to contribute for advancing marine science in the WIO by focusing on specific themes, geographical areas or assembling contributions from scientific meetings. The editorial processes are exactly the same as for regular issues, with double peer-review, and guest editors are considered.

José Paula
Chief Editor

Editorial Note · Coral reefs of Mauritius in a changing global climate

The University of Mauritius Research Week (UoM RW) has been held on an annual basis since 2007 and was organized for the 9th time from 19-23 September 2016. The Research Week is geared towards dissemination of knowledge generated through research activities at the University and by relevant stakeholders in accordance with the UoM's vision of "*Excellence in Research and Innovation*". In line with national priorities, the UoM organizes this event to provide insightful research outcomes not only for the advancement of academic knowledge, but for the benefit of the community at large, through robust policy recommendations.

Out of the multiple submissions made during the UoM RW 2016, a number of manuscripts in the field of ocean/marine sciences were selected to be published in the Western Indian Ocean Journal of Marine Science (WIOJMS), as a special issue entitled "Coral reefs of Mauritius in a changing global climate". This issue is presented in the context of Mauritius being surrounded by a beautiful but delicate coral reef ecosystem, which provides ample ecosystem services contributing to the national economy, but which is subjected to extreme climatic events. Hence, in this special issue several contributions advancing our scientific understanding for sustainable use and management of marine resources in a globally changing marine environment are articulated. The original article by Mattan-Moorgawa *et al.* investigates the photo-physiology of diseased and non-diseased corals. Coral diseases are becoming more common on reefs worldwide due to both local and global stressors. Ramah *et al.* then present a short communication related to substrate affinity by two giant clam species found on the Mauritian coral reefs. Giant clams are under threat worldwide and information on their substrate affinity and habitat aims at providing insightful information towards their sustainable management. In addition, Nandoo *et al.*, in an effort to optimize nucleic acid extraction protocols from marine gastropods, present an original article based on a comparative study using the gastropod genera *Planaxis*, *Cypraea* and *Drupella*. These marine gastropods are ecologically important for coral reefs, especially the coral-eating *Drupella*. Moreover, given the importance of intertidal molluscs, Kaullysing *et al.* document the density and diversity of the benthic molluscs while comparing sheltered and exposed coastal habitats. Appadoo & Beeltah report on the biology of *Platorchestia* sp. (Crustacea, Amphipoda) at Poste La Fayette, Mauritius. Studies on Amphipod diversity and distribution are important especially since studies on marine biodiversity are scarce around Mauritius. Another original article by Ragoonaden *et al*. analyses the recent acceleration of sea level rise in Mauritius and Rodrigues. Such studies are more important than ever in the light of a globally changing marine environment with small island states faced with issues related to rising sea level. Two field notes, based on field observations, are presented by Bhagooli *et al.*, documenting a variety of coral diseases, and *Stylophora pistillata*-like morphotypes occurring around Mauritius Island, respectively. Kaullysing *et al.* also present a field note on coral-eating gastropods observed around Mauritius.

Apart from the local contributors, international collaborators also contribute two original articles in this special issue. Casareto *et al.* characterize the chemical and biological aspects of a coral reef of Mauritius focusing on benthic carbon and nitrogen fixation. These studies related to benthic productivity are important for understanding sustainability of coral reefs and/or lagoonal fisheries. On the other hand, Tokumoto *et al.* document the first detection of membrane progestin receptor (mPR)-interacting compounds from Mauritian coral reef and lagoonal seawater. They used cutting-edge technology to detect key regulators of reproduction in seawater. These contributions in terms of original articles, short communications, and field notes generate new scientific knowledge that may better inform policy and decision making in the field of coral reef studies and management in Mauritius, while contributing to the understanding of coral reefs in the wider Western Indian Ocean region.

Prof. Sanjeev K. Sobhee
Pro-Vice Chancellor (Academia)
The University of Mauritius

Differential substrate affinity between two giant clam species, *Tridacna maxima* and *Tridacna squamosa*, around Mauritius

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Abstract

Giant clams have been mostly reported in the South Pacific and Indian Ocean. The aim of this study was to compare the substrate affinity between two species of giant clams, *Tridacna maxima* and *T. squamosa*. Field surveys were carried out in April and May 2016 within the reef areas of three geographically different sites around Mauritius Island: Black-River; Ile D'Ambre; and Belle Mare. Using triplicate (n=3) belt transects of 50m × 10m (500m^2), giant clams were identified, quantified and the substrata to which they were attached were noted. Results indicated that 90% of *T. maxima* bore partially in colonies of *Porites* spp., potentially making them less vulnerable to natural and anthropogenic pressures. *T. squamosa* individuals, on the other hand, were more exposed as they were attached to flat substrata such as dead plate corals or rubble. This difference may be attributed to the shape of the giant clam shells. For instance the bottom section of *T. squamosa*'s shells are scaly as compared to that of *T. maxima.* This morphological difference may be one of the factors that influences the choice of substrate. Further investigations at additional sites will provide more information on the preference of substratum by these highly valued Tridacnid species and inform appropriate conservation and management approaches.

Keywords: Giant clams, *Tridacna maxima, Tridacna squamosa,* Mauritius Island, substrate affinity

Introduction

Tridacnids are known to live in close association with coral reefs (Lucas, 1988). Neo *et al.* (2015) found that giant clams play a crucial role in the ecological functioning of coral reefs by acting as a food source for numerous predators and scavengers, providing substratum to other organisms, contributing to reef structure, as well as acting as reservoirs for *Symbiodinium*, the dinoflagellates symbionts commonly known as zooxanthellae. Similar to corals, giant clams provide shelter to zooxanthellae by protecting them from predators and facilitate their photosynthesis by exposing the tissues hosting the algae to sunlight. In return, the giant clams receive some of the photosynthates produced by the symbionts (Blidberg *et al.,* 2000). Additionally, these cryptic organisms obtain their daily intake of nutrients by filter feeding on plankton from sea water.

The two most commonly found species of giant clams recorded in Indo-Pacific waters are *T. maxima* and *T. squamosa* (Fauvelot *et al.,* 2016). *T. maxima*, also known as the small giant clam, reaches sizes of <40cm (Gilbert *et al.*, 2006) and *T. squamosa*, also known as the fluted or scaly giant clam can reach a size of 35cm to 40cm (Calumpong, 1992). Both *T. maxima* and *T. squamosa* are classified as "Least Concern with a designation of Lower Risk/conservation dependent" in the IUCN Red List (UNEP, 2014).

Despite a number of strategies designed to protect and conserve giant clam populations worldwide, especially for the Indo-Pacific region, most species of giant clams have been over-exploited over the past decades for their meat and shells (Mingoa-Licuanan & Gomez, 2002; Van Wynsberge *et al.,* 2015). *T. maxima* has remained relatively untargeted by fishermen in areas where comparatively larger species occur due to the higher catch per unit effort obtained from harvesting larger species (Lewis *et al.,* 1988). According to Van Wynsberge *et al.* (2015), it is still unclear whether various densities of giant clams reported worldwide result from the combined effects of exploitation and environmental factors, or solely from fishing activities. Dumas *et al.* (2013) assumed that the life cycle of giant clams may be affected by environmental conditions at global (e.g. sea temperature, hurricanes) and local scales through habitat and micro-habitat parameters (e.g. substratum, depth, nutrients).

Giant clams absorb dissolved nutrients directly from seawater, by filter-feeding, to obtain major nutrients (nitrogen and phosphorus), particularly during the juvenile stage (Trench *et al.,* 1981; Fisher *et al.,* 1985; Klumpp *et al.,* 1992). Several studies have shown that high dissolved inorganic nitrogen (DIN) levels enhanced the population density of zooxanthellae in the mantle and the overall growth rate of giant clams in culture (Fitt *et al.,* 1993; Ambariyanto & Hoegh-Guldberg, 1997). However, Toonen *et al.* (2012) reported species-specific differences in growth response of tridacnids to varying levels of nutrient, substrate type, feeding effects and ocean acidification.

While the distribution range of giant clams is continuously being reviewed, *T. maxima* and *T. squamosa* are reported to be the most commonly distributed species in the waters of Eastern Africa and the Central Pacific (Othman *et al.,* 2010). However, their choice of substrata for attachment has not yet been well-studied and documented. Thus, the aim of this study is to provide additional information on giant clams from this part the Western Indian Ocean to better understand their selection of substrata for attachment, a factor which may be contributing to their rapid decline.

Materials & methods

Study Area

The study was carried out in the months of April and May 2016, at three reef sites around Mauritius Island: Black River (BR); Ile D'Ambre (IDA); and Belle Mare

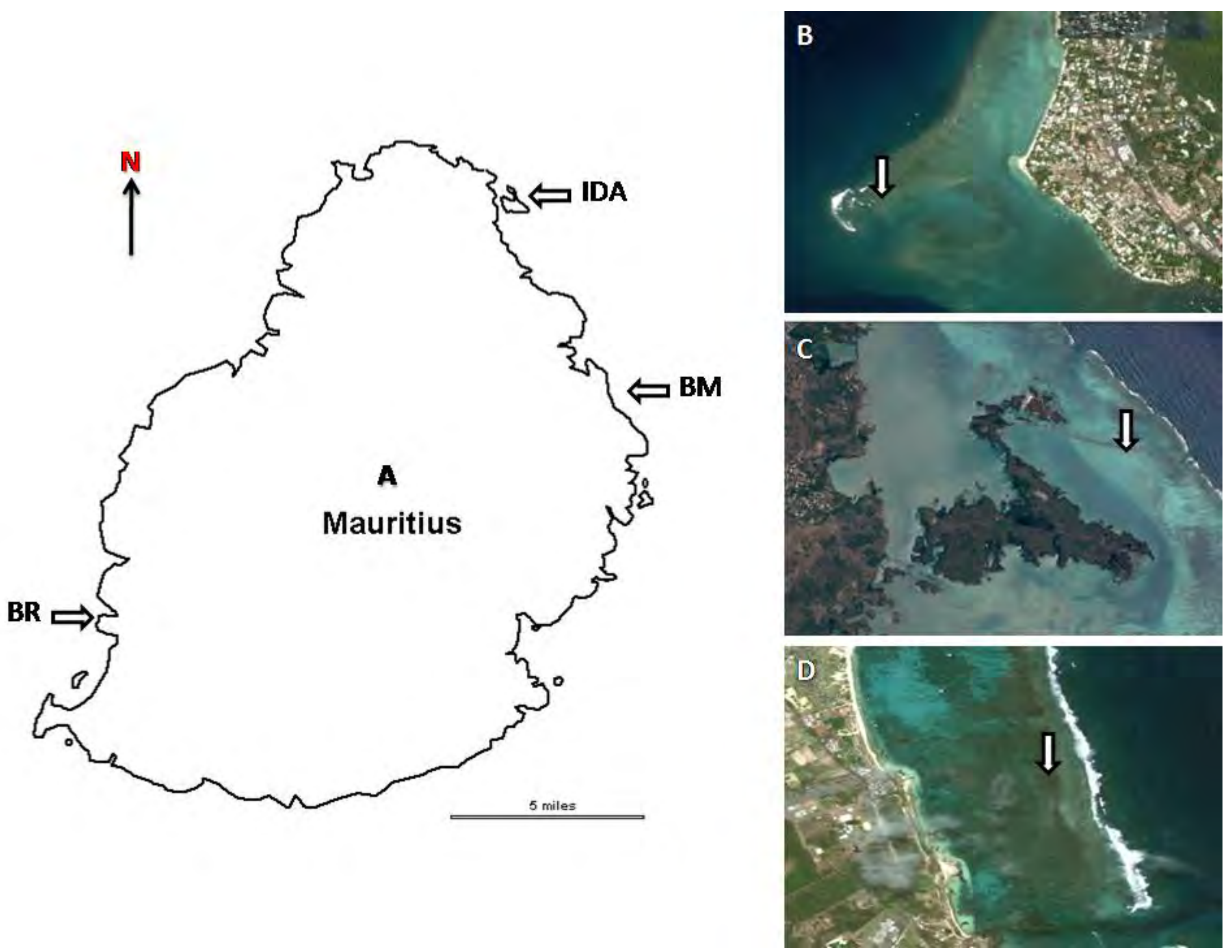

Figure 1. Map of Mauritius (A) showing the three sites: Black River (B); Ile D'Ambre (C); and Belle Mare (D). The arrows indicate the survey area. (Source: Enchanted Learning, 2016 and Google Earth, 2016 for A and B, C, D, respectively.)

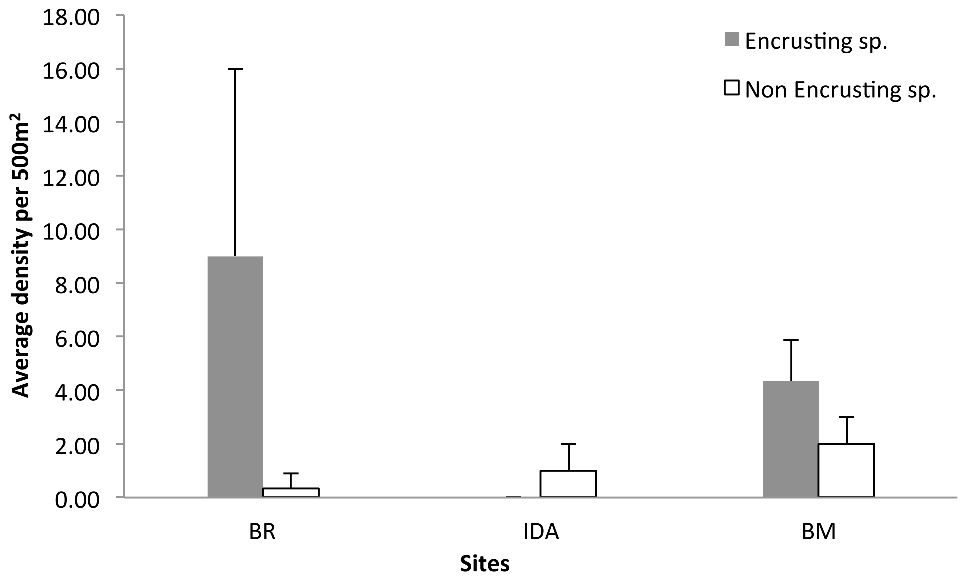

Figure 2. Mean density of encrusting and non-encrusting species of Tridacnids per site at Black River (BR), Ile D'Ambre (IDA) and Belle Mare (BM). Data represent Mean ± SD (n=3).

(BM) (Fig. 1). The surveys were conducted at depths ranging between 1.5m to 3m.

BR, situated along the west coast, is a fishing reserve (Marine Protected Areas (Amendment) Act, 2007) with clear water and an average coral cover of 42% in 2010. IDA, situated along the northern coast, has turbid water and an average coral cover of 45% in 2010 and BM, located along the eastern coast of Mauritius Island, is a highly frequented beach with clear water and an average live coral cover of 47% in 2011 (Annual Report (Fisheries), 2010; 2011).

Survey Method

Underwater field surveys were carried out using an adapted methodology from Tisera *et al.* (2011). Three 50m x 10m belt (500m^2 area) transects were laid parallel to the coast at each reef site by snorkeling. Presence of giant clams was determined and the identified organisms were categorised as encrusting (EN) and non-encrusting (NEN) to their substrata. *In-situ* morphological identification was done according to Norton & Jones (1992) and Knop (1996). Coral communities within the 500m^2 surveyed areas were recorded and categorised as massive (MC), and non-massive corals (NMC) such as *Porites* spp. and *Acropora* spp., respectively.

Determination of nitrate and phosphate levels

The Greenberg *et al.* (1992) protocol was used to determine nitrate and phosphate variations at each site by the cadmium reduction and ascorbic acid methods, respectively. Triplicate samples of 250ml seawater were collected and processed in the laboratory accordingly.

Statistical analyses

STATISTICA software (version 10.0) was used for statistical analyses. One-way ANOVA was carried out to test the percentage significance of EN and NEN giant clams at the three study sites. Upon lack of normality, the data were log transformed prior to ANOVA analyses. Correlations between the coral (MC or NMC) and giant clam categories (EN or NEN) were tested using Pearson correlation and the data was presented as Mean ± SD (n=3).

Results

A total of 75 individuals of giant clams was recorded at the three sites during the survey, of which 49 (65%) were categorised as EN and identified as *T. maxima*. 26 (35%) were reported as NEN and identified as *T. squamosa*. A higher density of EN and NEN specimens was encountered at BR and IDA, respectively, as compared to BM (Fig. 2).

The survey also showed a significantly ($P < 0.01$) higher density of MC, especially *Porites* spp., which positively correlated with a higher density of EN giant clams as compared to NEN specimens. A higher density of NEN was also encountered on reef sections where NMC was higher (Fig. 3). This was also observed at BR where a higher percentage of MC (95%) was recorded resulting in a higher percentage of EN individuals

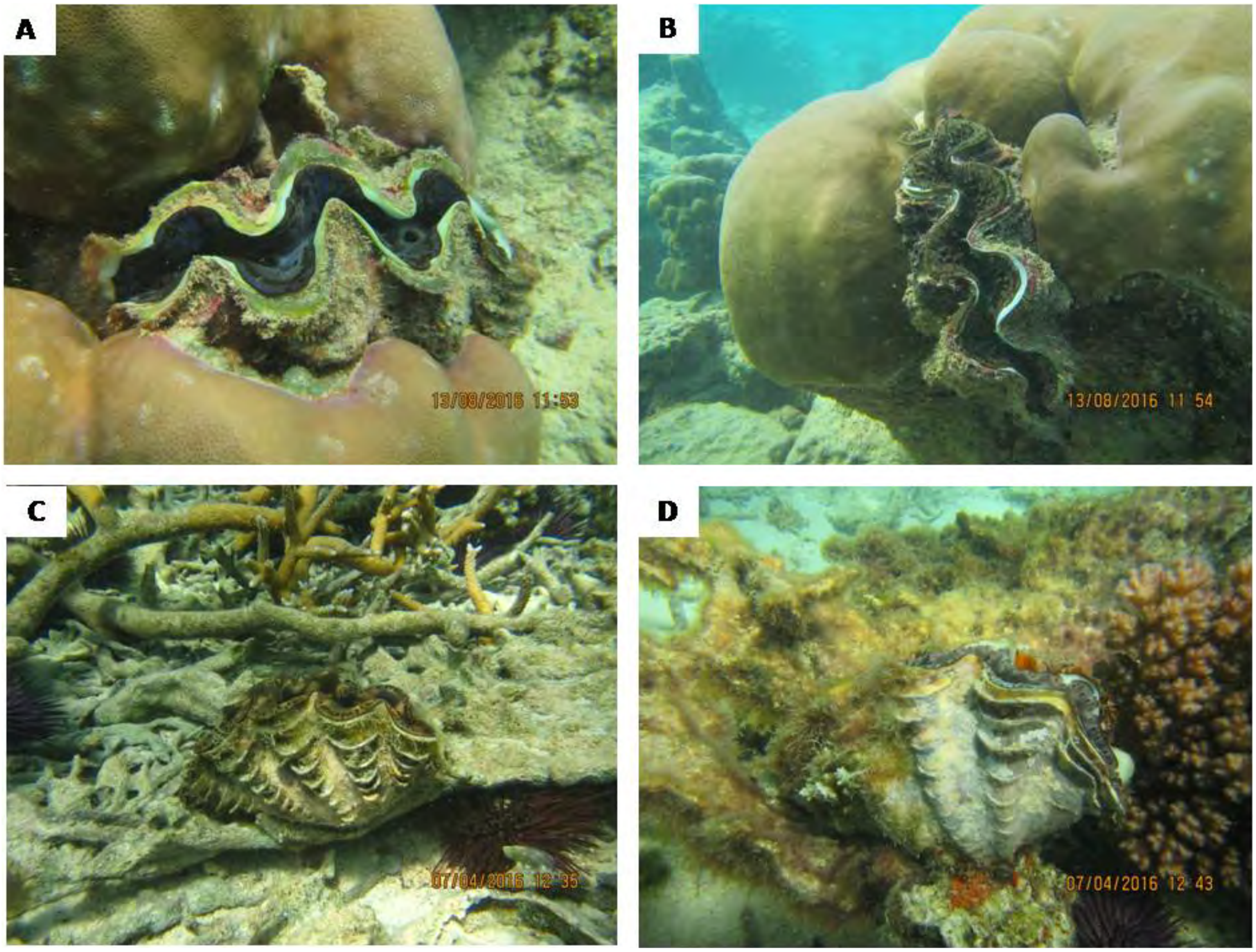

Figure 3. *T. maxima*, partly encrusted in massive corals at Black River (A and B) and *T. squamosa* attached to dead plate corals at Belle Mare (C and D).

(96%) embedded into the corals. Likewise, a higher percentage of NMC resulted in a higher percentage of NEN giant clams (Fig. 4).

A positive relationship between percentages of EN giant clams and MC (r=0.470, p=0.01), and NEN and NMC (r=0.333, p=0.01) indicated that a decrease in MC and NMC is likely to have a direct impact on the different giant clam categories (EN and NEN).

Nitrate and phosphate levels

No significant spatial variation in nitrate and phosphate concentrations was observed at the three sites, except at BM. The highest phosphate concentration was at BR (0.004 ± 0.002mg/L) and the lowest record was at both BM and IDA (0.002 ± 0.000mg/L). The trend was opposite for nitrate concentration where the highest was recorded at BM (0.025 ± 0.002 mg/L) and the lowest at BR and IDA, both having the same concentration (0.003 ± 0.001 mg/L). Figure 5 summarises the variation in nitrate and phosphate concentrations at the three sites during the survey period.

Discussion

The results indicated a higher percentage of EN giant clams in areas of high MC density and a high percentage of NEN giant clams in reefs that had higher NMC. Apte *et al.* (2010a) explains that historical and eco-geographical data, coral quality and cover are the crucial factors that explain this type of distribution. This was congruent to the present study where *T. maxima* was mostly observed at sites encrusted in healthy massive corals (mainly *Porites* spp.), while *T. squamosa* was encountered at sites with higher NMC density and were mainly exposed and attached to plate corals, dead corals or rubble. Neo *et al.* (2009) found that juvenile fluted giant clams had a higher affinity for tiles which had a higher concentration of crustose coralline algae (CCA) covered coral rubble (CCACR). CCA is known to induce settlement and metamorphosis of many marine invertebrates. In this study, CCA was noted on the dead corals and rubble to which *T. squamosa* was attached. Some of the shells of the *T. squamosa* were also covered with CCA. However, the study of Neo *et al.* (2009) revealed that CCA

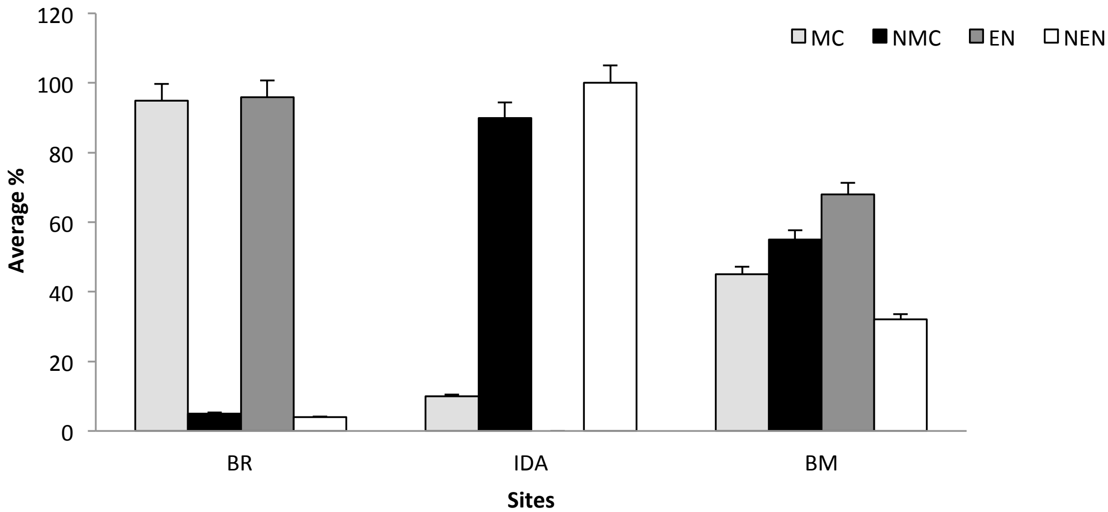

Figure 4. Average percentage of massive corals (MC), non-massive corals (NMC), encrusting species (EN), and non-encrusting species (NEN) at the three sites: Black River (BR); Ile D'Ambre (IDA); and Belle Mare (BM) per 500m² area. Data represent Mean ± SD (n=3).

may have an impact on the larvae at an earlier stage, but does not affect juvenile settlements of *T. squamosa.* The rich *Acropora* spp. and *Porites* spp. observed at the sites in this study could explain the higher density of *T. maxima* over that of *T. squamosa* as it has been reported that *T. maxima* prefers both MC and NMC as substrate (Arthur, 2000).

Dumas *et al.* (2014) reported that one substratum type and depth range may be characteristic of one particular type of lagoon configuration, yet both are likely to influence the life cycle of giant clams. They further suggested that biological factors such as growth, reproduction, mortality and aggregation behaviour also affect tridacnid density. The overall low population of both *T. maxima* and *T. squamosa* found during the present study as compared to Pacific countries could be attributed to different factors (Apte *et al.,* 2010b) such as anthropogenic pressure on small giant clams, density dependency, individual/micro environmental variables and mortality (disease and bleaching). All of these factors have a great influence on the survival of giant clams. In their study, Apte *et al.* (2010b) also found a strong negative effect of human population size (which is one of the indicators of anthropogenic disturbances on the coastal and marine ecosystem in the world) on small giant clam survival rate. However, this result may vary geographically.

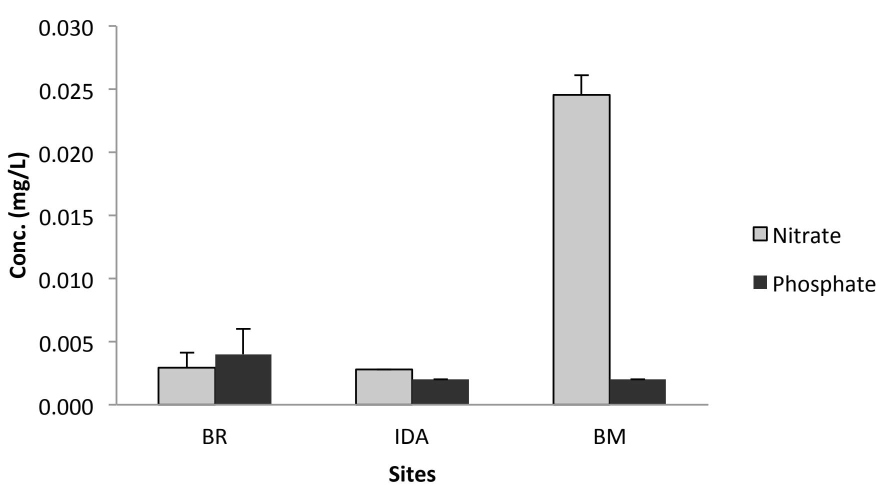

Figure 5. Nitrate and Phosphate concentrations (mg/L) at the three sites namely: Black River (BR); Ile D'Ambre (IDA); and Belle Mare (BM). Data represent Mean ± SD (n=3).

The global phenomenon "El Nino" which caused massive coral bleaching in December 2015 and January 2016 could also be one reason for the low population of giant clams recorded during the survey. Neo *et al.* (2013) demonstrated that fertilisation success of *T. squamosa* larva was significantly higher at a warmer temperature (29.5 °C), however this resulted in total mortality within 24 hours. It is possible that the results from the present study indicate that some giant clams did not recover from the recent bleaching events and died as a result (Junchompoo *et al.,* 2013; Soo & Todd, 2014), or that the populations suffered from the loss of substrate for attachment due to coral bleaching and mortality. Mattan-Moorgawa *et al.* (2012) reported that tabular corals, such as *Acropora cytherea* and *Acropora hyacynthus*, were the most vulnerable scleractinian coral species to bleaching. These coral species are common substrates for giant clams, especially *T. squamosa.*

Another major finding in this study is the strong correlation of the two giant clam species (*T. maxima* and *T. squamosa*) with MC and NMC. Apte *et al.* (2010a) explained that the difference in size/age and anchorage plays an important role in the survival probability among individuals. The literature suggests that there is very low survival rate in young age classes, which increases as the animal grows, and then decreases again in old age (LaBarbera, 1975; Gomez & Mingoa-Licuanan, 1998). Moreover Calumpong *et al.* (1992) described *T. squamosa* as having a weak byssus, which explains its preference for living corals or coral rubble, and its vulnerability to environmental and anthropogenic impacts. This may explain the low recorded density of this species in this study as compared to *T. maxima*, which is partly embedded or firmly attached to coral heads. Similar observations were made in this study where is *T. squamosa* was easily collected from its substrate as compared to *T. maxima.*

The choice of substrate for attachment by giant clams occurs during their early laval stage. Giant clam pediveligers are believed to possess a mechanism within the foot which functions as a sensory organ testing the surrounding substrate and orienting the clam (Jameson, 1976) towards finding the most suitable substrate for attachment. Some giant clam larvae tend to settle on substrates which offer shelter in the form of grooves and crevices, such as corals (Soo & Todd, 2014). High substrate rugosity such as on coral rubble and rough cement tiles were also found to favour larval settlement (Neo *et al.,* 2009). In their study on larval settlement, Calumpong *et al.* (2003) showed that a significantly higher settlement was observed on rough and smooth Mactan stones. In this study, the substrate choices of *T. squamosa* and *T. maxima* were rough, dead rubble or plate corals, and relatively smooth massive corals such as *Porites* spp., respectively. Recently, Dumas *et al.* (2014) demonstrated that *T. maxima* larvae are also attracted to chemicals released into the water by juvenile conspecifics which could explain the affinity of *T. maxima* with massive corals and *T. squamosa* to plate corals or rubble.

No significant difference was noted between nitrate and phosphate concentrations at the sites except for BM where the nitrate concentration was relatively high. Sadally *et al.* (2014; 2015) reported that nutrient concentrations exhibited a clear pattern of seasonal and spatial variation in the waters of Mauritius Island, and in this study spatial variation was noted at BM. Moreover, the study also showed a higher concentration of nitrate as compared to phosphate for two sites which is consistent with Jacquet *et al.* (2006), indicating that such a phenomenon is normal for reef waters. Though the nutrient levels did not seem to affect substrate choice for giant clams in this study, further in-depth investigations are warranted in this direction.

Conclusion

This study demonstrated that the percentage occurrence of encrusting giant clams (*T. maxima*) and non-encrusting giant clams (*T. squamosa*) is dependent on the occurrence of massive or non-massive corals on the reef. The low number of giant clams encountered within the 500m² area could suggest either a reduction in the reproductive output of the species, or a negative impact from several environmental and anthropogenicfactors. Further investigations on the impacts of exploitation and environmental changes over time are warranted to identify other possible reasons of such a decline in these threatened tridacnid populations, and their choice of substrate.

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