STUDY OF PHYSICO - CHEMICAL PARAMETERS AFFECTING THE DISTRIBUTION OF SPONGE

*Xestospongia exigua* (PHYLUM PORIFERA, CLASS DEMOSPONGIAE) IN A NORTHERN LAGOON OF MAURITIUS

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Received October 20, 2010            Accepted January 29, 2011

ABSTRACT

Sponges are very important in the marine ecosystems and also represent organisms known for producing a diversity of chemicals. The present study was performed from September 2009 to February 2010 and aimed at making a mapping of the sponge *Xestospongia exigua* in the lagoon of Trou aux Biches. This research is a first in the lagoons of Mauritius and it gives indication of sponge distribution and the physico-chemical parameters affecting their abundance. Such knowledge adds to the lack of information on the biology of these marine invertebrates in Mauritius. Visual censuses were made along the 2.5 Km lagoon during fifteen snorkeling sessions (15 days) covering a snorkeling distance of approximately 500 m per session. The distribution and mapping of sponge was done following surveys and recording of GPS positions of the sponge patches present. Abundance of sponge was assessed by random throws of 1.0 m$^2$ quadrats (n = 30). Moreover, physical and chemical parameters such as depth, pH and salinity were also recorded. The sponge size and the immediate habitats of sponges living in Trou aux Biches were assessed by random throw of 900 cm$^2$ quadrats. Observations showed that the sponge species *Xestospongia exigua* were distributed in six different patches of different sizes with a largest patch of 48922 m$^2$. From aerial maps, it was also observed that the distribution of sponges was not uniform (patches were of irregular forms) within the lagoon of Trou aux Biches. From statistical analysis (ANOVA), it has been observed that water depth, pH and salinity have an effect on the sponge abundance within the lagoon. The study shows that increasing depth is favorable to sponge abundance (8.0 specimen/m$^2$ at a depth of 3.0 m). Sponges were also observed to be abundant in water of higher pH (5.6 specimens/m$^2$ at pH 8.27). However, with increasing water salinity, a decrease in sponge abundance was observed. The study also showed that *Xestospongia exigua* sponges in Trou aux Biches were more abundant in habitats of dead corals.

Key Words: Sponge distribution, Physico-chemical parameters, Lagoon, Sponge, *Xestospongia exigua*

INTRODUCTION

Sponges are an important component in many benthic communities and can dominate the benthos in some regions. They are very important in the marine ecosystem acting as habitat for some species of molluscs, crabs, barnacles, fungi and crustaceans. Most importantly, marine sponges

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act as excavators and thus provide great help in nutrient cycles of the sea. It has been reported that there is a huge potential from sponges to produce a diversity of chemical products such as anticancer. Furthermore, bioactive marine alkaloids having anti malarial activity have been extracted from of Xestospongia exigua sponges from the Red Sea.

Sponge distribution and diversity have been previously studied by many marine scientists worldwide. Several complex factors such as physical/chemical features of the sea, biological features including ecology and evolution and water currents usually influence the specific distribution of sponges in an area. There is a significant relationship between the sponge biomass and water depth in the Persian Gulf. Other studies performed showed that the presence of corals and the aggressiveness of each sponge species can influence the abundance of sponges in a particular locality. Other organism which may either facilitate or be detrimental to sponge individuals is another biological factor which may affect the abundance and distribution of sponges. In the East African region, only few studies about sponge distribution have been carried out.

**AIMS AND OBJECTIVES**

To date, the only publication known on the sponges of Mauritius is the one entitled, Biological and chemical study of some soft corals and sponges of Mauritius waters. Nothing has been done hitherto regarding the qualitative and quantitative study of sponge distribution in Mauritius waters and the flourishing importance that marine organisms’ related medicinal research is gaining, this piece of research undertaken here have all its importance. The study consists of the taxonomic identification of the sponges which have been collected in situ. Moreover, a spatial map of the sponges present in the lagoon will be determined. Physical (depth), chemical (pH and salinity) parameters as well as habitats features will also be taken into consideration in this study. Finally, additional features such as sponge size, colour and sponge abundance are also taken into account during the course of this study.

**MATERIAL AND METHODS**

**Study site**

Trou aux Biches is found in the North West of Mauritius and is located at latitude 20°01’55.5”S and longitude 57°33’01.6”E. The beach of Trou aux Biches extends about 3 km starting from Pointe aux Piments and ending at Mon-Choisy. It must be noted that part of Trou aux Biches southern lagoon can be considered as a rocky shore. The remaining shoreline mainly consists of a sandy beach. The local reefs are located in the middle of two passes namely the Passe Corsaire (Northern Pass) and the Passe Marmite (Southern Pass) (National Coast Guard). The approximate distance between the beach and the lagoon varies from 350 m to 900 m (Google Earth, Version 5.1).

During low tide, the depth of the lagoon varies from 1.50 m to 3.00 m and during high tide, the depth may vary from 2.00 m to 4.00 m (National Coast Guard). The lagoon of Trou aux Biches also experiences a water current motion towards the Southern direction. It must also be noted that there is an underground freshwater seepage entering in the middle part of the lagoon which sometimes alter the density and salinity of the surrounding seawater.

**Assessment of sponge distribution**

Due to the lack of data concerning the distribution and location of sponges within the Trou aux Biches, a first preliminary survey was performed with the help of a glass bottom boat with the aim to identify sponge locations within the lagoon. After the preliminary survey, further surveys of sponge distribution were conducted via visual censuses. Fifteen snorkeling sessions (15 days) covering a snorkeling distance of approximately 500 m per session were carried out. A GPS (Garmin, GPS 72) was used to mark GPS positions on the borders of each patch of sponge identified. A minimum of ten and a maximum of twenty GPS points were recorded, depending on the patch size. To investigate sponge abundance, a 1.0 x 1.0 m (1.0 m²) quadrat was thrown randomly 30 times (n =30) in each sponge patch. The number of sponge individuals per 30 m² was used to estimate sponge abundance within each patch. Similarly, a quadrat of 30 x 30 cm (900 cm²) was placed randomly around 10 sponges (n = 10) per patch.
and the approximate percentage of algae, rocks, sand and other specimens found within the quadrat was carefully noted. Only the immediate habitats of the sponges were studied. The colour of the sponge species was also noted. Sponge size was carefully measured by first placing the 900 cm² quadrat randomly around 20 sponges (n =20) and then measuring the size of the sponge individual with a plastic measuring tape. This process was repeated for all patches.

Water depth was measured by making use of a plastic measuring tape (n = 5). A sample of water in each sponge patch was also collected. The salinity and pH of the water samples were recorded in the University Laboratory (n = 3). A Captive Purity Refractometer (Model: CP2111) was used to measure the salinity while a pH-meter (Oakton, Eutech Instruments) was used to assess the acidity or alkalinity of the water samples.

A voucher specimen of the sponge was taken for identification and classification purposes. Identification and classification processes were performed via spicule analysis under an inverted microscope (Model: Leica DMIL) at the Mauritius Oceanography Institute (MOI). The acid digestion protocol was used for this study.

**Data analysis**

The GPS positions of the border of each patch were exactly marked (pinned) on a Trou aux Biches map on the Google Earth Software. The pinned points could then be joined together by another option known as the add path option which acts as a drawing pen. From the GPS points recorded a map with the approximate form and size of the sponge patches could be determined by the use of the computer program Google Earth (Version 5.1). However, due to their irregular forms, the exact size of the patches could not be measured with precision and hence only estimates of their sizes were calculated. Interpretation of the mean sponge sizes within all patches was performed by using the program Microsoft Excel 2003. Pie charts were designed so as to interpret the different percentage habitats surrounding sponges present in the Trou aux Biches lagoon. ANOVA tests were performed to assess the effect of salinity and depth on sponge abundance. In addition, any effect of acidity/alkalinity (pH) of the seawater on sponge abundance was also analysed. Data analyses were performed by making use of the programs Microsoft Excel 2003 and SPSS (Version 17).

**RESULTS AND DISCUSSION**

A single dark brown branched sponge species of irregular shape was observed within the lagoon of Trou aux Biches. Spicules analysis revealed oaxes spicules which are pointed at both ends and having a relatively uniform length. Spicules from this category are mainly present from the Class Demospongiæ. Further comparison with a previously taxonomically identified sample revealed that the sponge in Trou aux Biches was from the species *Xestospongia exigua*.

**Distribution**

Preliminary observations showed that sponges in the lagoon were distributed in several separated patches. Sponges were abundant in some specific areas and in some other regions no single sponge specimen could be observed. Further investigations revealed a total of six sponge patches of irregular forms and sizes. The sponge patches were named Patch 1, Patch 2, Patch 3, Patch 4, Patch 5 and Patch 6 (from bottom to top of Fig. 1).

The first Patch which is situated on the south west of the map has GPS position of 20° 2’10.68”S, 57°32’34.87”E and is about 240 m long and about 70 m wide having a trapezium like form. Patch 2 located besides the first patch is about 110 m length and 110 m wide having an irregular form (GPS position 20° 2’0.46”S, 57°32’35.88”E). The two middle patches that is Patch 3 (GPS position 20° 1’55.35”S, 57°32’34.50”E) and Patch 4 (GPS position 20° 1’42.81”S, 57°32’40.28”E) are found in front of the Trou aux Biches hotel (now known as Trou aux Biches Resort and Spa) and are more or less of the same size. The remaining two patches situated in the northern part of the map are Patch 5 (GPS position 20° 1’36.34”S, 57°32’41.84”E) and Patch 6 (GPS position 20° 1’29.46”S, 57°32’47.06”E) respectively. They are the biggest two sponge patches and are separated 40 m from each other.

**Sponge abundance**

Having different sizes and forms, the sponge patches indicated that their abundance in sponge
were not uniform. From field observations, it has been observed that the poorest patch in terms of sponge individuals was Patch 1 (1.20 ± 0.42 individuals/m²) and the most abundant patch being Patch 6 (8.03 ± 0.98 individuals/m²). However, it was observed that despite being relatively small; Patch 2 accommodated a relatively high number of sponges (5.60 ± 1.10 individuals/m²).

Factors affecting abundance

Water depth (n = 5; F-value = 8.485; p-value = 0.000), pH (n = 5; F-value = 8.328; p-value = 0.000) and salinity (n = 5; F-value = 8.328; p-value = 0.000) was observed to affect the sponge distribution within the lagoon of Trou aux Biches. It was also observed that the abundance of sponges within the lagoon of Trou aux Biches seemed to alter with depth. With increasing depth, the number of sponge specimen had an increasing tendency. However, there is an exception concerning Patch 2 where despite of having a relatively low depth (1.40 m), the abundance of sponge within this patch was high. Water pH within the lagoon of Trou aux Biches is not uniform due to underground water seepage. Seawater from the lagoon were mostly alkaline (pH is above 7.00). Emphasis was laid on Patch 2 where the fresh water seepage effect was mostly experienced. The pH within the different patches with the exception of Patch 2 varied between 8.01 and 8.15. However, it was noted that Patch 2 has a higher water pH of 8.27. The salinity of each patch was also noted for similar reason. When considering Patch 1 (33 ppt), Patch 2 (35 ppt) and Patch 3 (36 ppt), it has been observed that the salinity in these regions was approximately the same. However, it has been noted that the salinity of Patch 4 (24 ppt), Patch 5 (23 ppt) and Patch 6 (34 ppt) were much lower compared to the previous three patches but with approximately the same value.

Sponge habitats

The most common sponge habitats in all sponge patches were dead corals followed by Sand and the Padina sp algae. However, the absence of the coral Acropora formosa and the algae Turbinaria ornata in the southern region of the lagoon were noted. Moreover, a relatively low percentage of the coral Acropora mirophthalma and the algae Dictyota sp were also observed in
some of the patches such as Patch 2, Patch 5 and Patch 6.

**Sponge size**

Ground truth observations, showed that the sponges’ sizes were not the same within the patches. Patch 1 (14.70 ± 1.38 cm) and Patch 6 (14.72 ± 1.46 cm) are nearly the same in terms of sponge size having a mean sponge size of approximately 15 cm. Similarly, the mean sponge size of Patch 3 (17.79 ± 1.72 cm), Patch 4 (17.95 ± 1.12 cm) and Patch 5 (16.40 ± 2.35 cm) does
not show great difference in size. However, the mean sponge size in Patch 2 (26.87 ± 1.35 cm) was observed to be larger than the mean sponge size of the remaining patches.

Distribution of the *Xestospongia* species has already been reported in Western Indian Ocean namely in Kenya and Mozambique at water depth varying from 0 m to 15 m\(^1\). The presence of sponges in the Trou aux Biches lagoon is mainly due to the fact that there is a constant flow of water within the lagoon especially during high tides and low tides actions which favor the growth of many filter feeding organisms.

Moving from south to north within the lagoon, the water depth increases from 1.50 m to 3.00 m at low tide. As observed in many previous studies, increasing water depth usually promote the distribution of sponges\(^7,12\). Similarly, in Trou aux Biches, the sponge abundance increases with increasing water depth. Due to their fragility, high wave action can often cause major damage to branched sponges. Therefore, slightly deeper waters having a relatively low wave action tend to be more appropriate for their survival. As it can be observed from the map, no sponge specimen was identified near the coral reefs and along the shoreline where the wave actions and human presence are usually high.

Despite being relatively small in size having a low water depth (1.40 m), the sponge abundance in Patch 2 was observed to be very high (5.6 individuals/ m\(^2\)). It can also be observed that in the region of Patch 2 and Patch 3 the concentration of dead corals are much higher. In situ observations showed that the sponges in the lagoon of Trou aux Biches grew mostly on dead corals which provide them with suitable habitats. A research in 2003 also showed that sponges have a general tendency to grow on dead corals from the *Acropora* Species\(^13\).

The size of sponge in Trou aux Biches does not differ much among five sponge patches having their mean size ranging from 14.72 cm -17.95 cm (Patch 1, Patch 3, Patch 4, Patch 5, Patch 6). However, there is an exception concerning Patch 2 which accommodates the largest sponge specimens (26.87 cm). This is mainly because the presence of freshwater has result in the death of numerous corals in this part of the lagoon, hence providing further habitats and space for sponges.

The sponge abundance in the lagoon was noted to be affected by both water salinity and water pH. It was observed that the sponge abundance tends to increase with increasing pH. Experimental studies performed in laboratory showed that a combination of low pH and low salinity in the surrounding water of a sponge individual caused a disturbance in the normal functioning of sponges\(^14\). However, with an increase in water pH (e" 7.0) and water salinity (e" 30 ppt) no disturbances were recorded. Therefore, the trend of increasing sponge abundance with increasing water pH in Trou aux Biches is normal amongst sponges. This can be confirmed when considering Patch 2 which have relatively high sponge abundance (5.6 individuals/ m\(^2\)) while having a high water pH (8.27).

However, when considering the effect of salinity upon sponge abundance, it has been observed that the sponge abundance tends to decrease with increasing salinity. To date, few published studies have been conducted to observe the effect of water salinity on the *Xestospongia* species. It has been reported that low salinity facilitates the accumulation of Cadmium in *Microciona* and thus may disruptive for sponges\(^14\). Since the salinity observations obtained in Trou aux Biches do not coincide with the other experiment carried out, there may a possibility that highly saline water is not favorable amongst sponges of this species.

The ability of the *Xestospongia exigua* sponges to grow mostly on and in the regions of dead corals is mainly due to the fact that the dead corals provide the sponges with a much more stable substrate which can prevent them from being uprooted easily. Few specimens were observed in the sandy areas. As a substrate, sand is more fragile than dead corals. The sponges recorded also cohabited mostly with the algae *Padina* sp and in the deeper waters sponges were very comfortable with the algae *Dictyota* sp. The algae *Dictyota* sp. is known for releasing antifouling substances to repulse other predatory marine organisms from its surroundings\(^15\). There may be a symbiotic relationship existing between the *Dictyota* sp. and the *Xestospongia exigua* where
the sponge takes advantage of the algae’s antifouling repulsive substances for protection purposes. From the results obtained and from *in situ* observations it has been observed that very few sponges live among living corals. The distribution of the *Xestospongia exigua* in Trou aux Biches tends to be invasive in some regions. This is mainly because the competition for space between the corals and sponges which results in the non-relationship between the living corals and the sponges. This phenomenon has previously been reported by other researchers\(^ {16,17}\).  

### CONCLUSION

Few surveys have been carried out in the lagoons of Mauritius. Therefore, this study contributed to an initial sponge mapping around the island of Mauritius. Our waters are very rich in benthic organisms. Thus the protection and sustainable management of our coastal areas should be given more attention both by the government as well as the Mauritian people. Mauritius has an Exclusive Economic Zone of about 1.9 million Km\(^2\), but few studies have been conducted in our waters. Therefore, further studies in our internal waters should be performed so as to enhance the knowledge and explore the richness of our own water territory.

### RECOMMENDATIONS

This study has been performed from September 2009 and February 2010. It should be noted that there may be seasonal changes which may influence the proliferation and propagation of marine algae. It is recommended to consider water current as physical parameter in future works on sponge distribution. A further study can be performed to analyse any effect and/or any symbiotic relationship which may exist between the *Dictyota* sp. algae and the *Padina* sp. algae on the sponge *Xestospongia exigua*. Studies on sponge distribution with respect to physical parameters can also be undertaken in other lagoons around Mauritius and thus make a comparison between the different sites.

### ACKNOWLEDGEMENT

The author are thankful to the Laboratory team from the University of Mauritius. They also like to thank the MOI and Mr Girish Beedassee who provided his help for spicule analysis. A special thank goes to Mr Krishan Beesoon for his invaluable support for this study.

### REFERENCES


