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# A STUDY ON ASSEMBLAGE OF INVERTEBRATES INHABITING ROCKY SHORES WITHIN THE PORT- LIMIT OF PORT- LOUIS, MAURITIUS

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## ABSTRACT

*Rocky shores provide an important habitat for marine organisms. This study aimed at providing baseline data on assemblage of organisms on rocky shores within the port-limit of Port-Louis, Mauritius. Four rocky shores, with three at Pointe aux Sables (La Pointe1, La Pointe2, and Petit Verger) and one at Baie du Tombeau were studied from October 2007 to February 2008. On each site three stations, located at intervals of 2m, with an area of 40m$^2$ each were set up. Intertidal organisms were hand-collected within forty-eight, 1m$^2$ quadrat for invertebrates. Observations of 16,061 specimens led to identification of 30 faunal species belonging mostly to phyla Mollusca and Arthropoda. Mean total abundance of invertebrates per 1m$^2$ varied from 729.22±173.07 at la Pointe2 to 143.97±11.43 at Baie du Tombeau. The gastropod, Planaxis sulcatus was the most abundant species at La Pointe1 and Petit Verger with mean abundance of 196.86±179.71 and 168.10±113.44 per 1m$^2$ respectively. The bivalve, Modiolus auriculatus was the dominant species with mean abundance of 673.33±762.04 per 1m$^2$ at La Pointe2 and Nerita punctata was most abundant (39.41±57.35 per 1m$^2$) at Baie du Tombeau. Lowest Shannon diversity was observed La Pointe 2. The study is useful for future work on port area.*

**Keywords**: S*heltered rocky shore ; fauna ; molluscs ; port area*

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## INTRODUCTION

Intertidal rocky coastlines are heterogeneous habitat that support a wide variety of living forms (Araújo, *et al.*, 2005). They encompass a gradient of environmental conditions from fully marine below low tidal levels to fully terrestrial where splash and spray reach to the highest levels above high tide (Underwood, 2000).
In Mauritius very few studies exist on rocky shore organisms. According to literature one of the studies was conducted by Hodgkin and Michel (1960) where zonation of plants and animals on rocky shores were looked into around the island. The aim of the present study was to assess the invertebrate assemblage in the port area. Moreover, the port area is an area that is vulnerable to invasion by introduced species which are recognised as a serious threat to the natural ecology of biological systems worldwide (Mack, *et al.*, 2000). One of the first studies that need to be carried out is a port baseline survey and this study aims at contributing to biological aspect of the port area.

Invasive species are organisms that take hold of foreign habitats and become aggressive (Mooney and Hobbs, 2000). By extending its range into new regions invasive species have negative impacts on the native biota or local economies (Mooney, *et al.*, 2005). Invasive alien species are a major threat to biodiversity (Mack, *et al.*, 2000) especially in oceanic islands where high rates of endemism prevail as

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cited by Florens, *et al.*, (2010) and Baider and Florens (2011). Some of the introduced species are capable of causing serious harm to native biodiversity by preying on indigenous species or by aggressively competing for space (Thompson, *et al*., 2002). Mooney, *et al.*, (2005) report that invasive species may act as fish disrupters, impede navigation, be animal disease promoters, act as loggers to water works and act as modifiers of evolution.

The introduction of non-native species in coastal environment may occur either intentionally through deliberate importation of species for aquaculture or unintentionally through transport of fouling communities on sea chests and hulls' vessels, and that of planktonic larvae in ballast water (Carlton, 1987. Carlton and Geller, 1993. Grosholzl, 2002). The latter is thought to be the principal vector for the introduction of invasive species and is likely to remain with growing international trade.

The causes of invasion by introduced species is dependent on various ecological factors such as species diversity, richness and resource availability (Crawley, 1987). Before assessing the susceptibility of an environment to invasion one of the first studies that need to be carried out is a baseline survey of the actual assemblages of organisms.

## MATERIALS AND METHODS

### Characteristics of study site

Four rocky shores on the western coast were chosen within the port-limit of Port-Louis Mauritius to be representative of the Port area (**Fig. 1**). One shore was at Baie du Tombeau (20° 7' 10" S, 57° 29' 29" E) and three at Pointe aux Sables namely La Pointe1, La Pointe2 (20°10'25"S 57°26'16"E) and Petit Verger (20° 13' 2" S, 57° 30' 41" E). These shores were characterized by basalt boulder rocks of varying dimensions. The shore topography of Pointe aux Sables was predominantly big boulders rocks closely packed together whereas that of Baie du Tombeau drops from a steep cliff to rocky platforms with boulder rocks sparsely distributed along the shore.

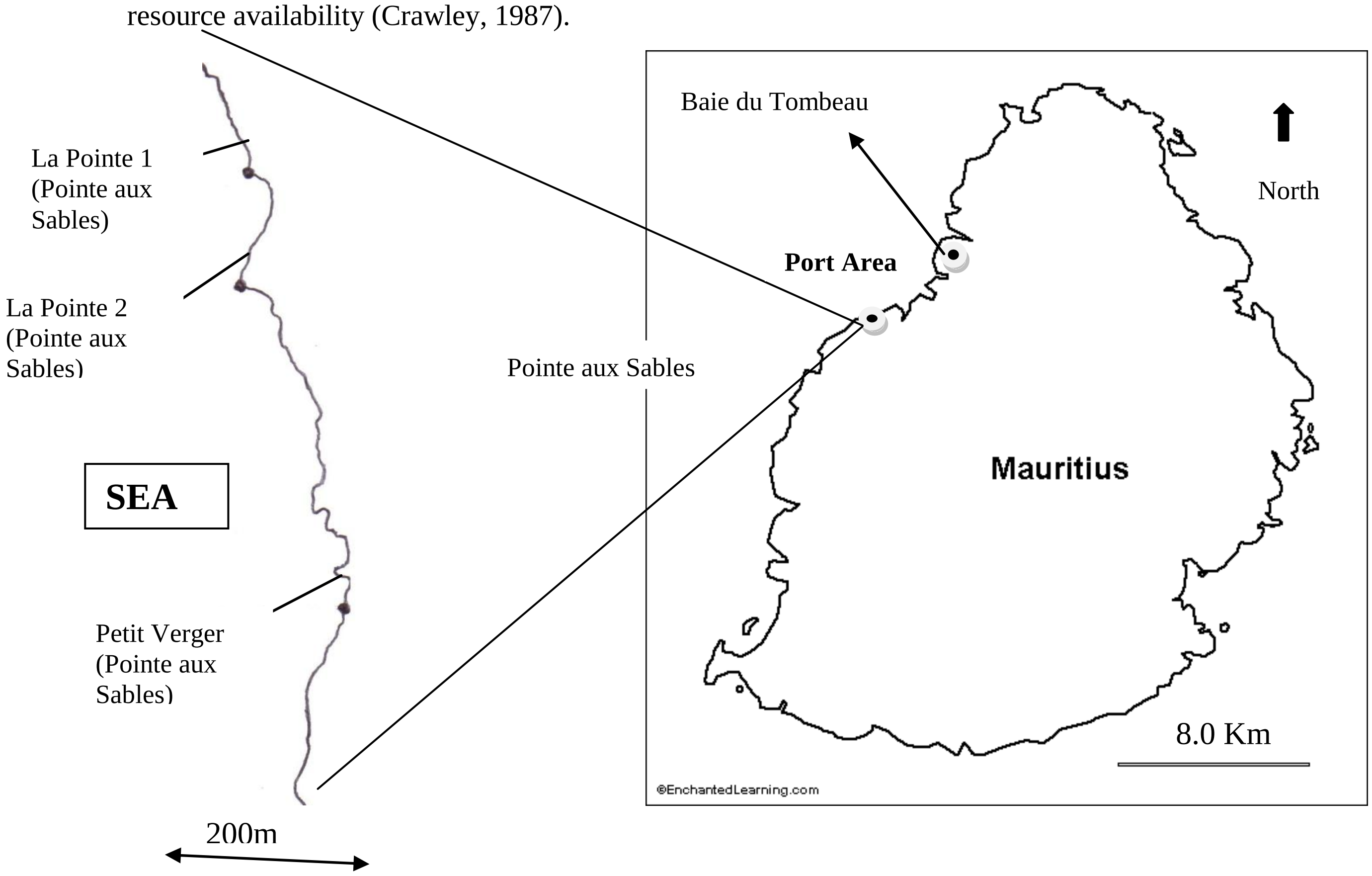


**Fig.1.** Map of Mauritius showing locations of four sampling sites (three at Pointe aux Sables (La Pointe 1, La Pointe2 and Petit Verger) and one at Baie du Tombeau. Sites are located within the Port limit of Port-Louis.

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### Sampling method

Sampling was conducted during daytime at low tide from October 2007 to February 2008. At each study site at Pointe aux Sables and Baie du Tombeau, three stations of $40m^2$ (10 m parallel x 4 m perpendicular to shore) were defined. The stations were at intervals of 2m from each other alongside the coastline. Using stratified random sampling, the station was then subdivided symmetrically into two equal areas (first 2 m perpendicular to shore line demarking the upper area of the station and the next 2 m demarking the lower area of the station). Within each area two $1m^2$ quadrat, subdivided into 16 sub-quadrats of $625cm^2$, were placed haphazardly and all organisms occurring in each $1m^2$ quadrat (except for those trapped in sediments), were hand collected by scraping the rock surface with a hand shovel. A total of 48 quadrats of $1m^2$ were sampled within the 12 stations visited over the period of the study. Counting and identification of organisms (except sessile organisms) were done in the laboratory. All organisms were identified at least to the family level and in where possible to species level, using field guides such as Driva and Maurice (2001), Richmond (1997) and Michel (1985).

### Data analysis

Total abundance of organisms was computed as number per $1m^2$ quadrats. Species diversity and evenness was calculated using the Shannon-Weiner diversity index and the Evenness index (Magurran, 1988). Similarity was calculated using the Jaccard Similarity index (Henderson, 2003) and proportional abundance of the most abundant species was calculated using the Berger-Parker index (Magurran, 1988).

## RESULTS AND DISCUSSION

### Results

### Fauna and algae of rocky shores

A total of 16,061 specimens were collected from the 48 quadrats sampled at the four sites. Highest number of organisms was collected on sites at La Pointe2, 8751 (729.22±173.07 per $1m^2$) organisms and the lowest number at Baie du Tombeau, 1728 organisms (143.97±11.43 per $1m^2$) collected from the 12 quadrats set up at each site (**Fig. 2.**).

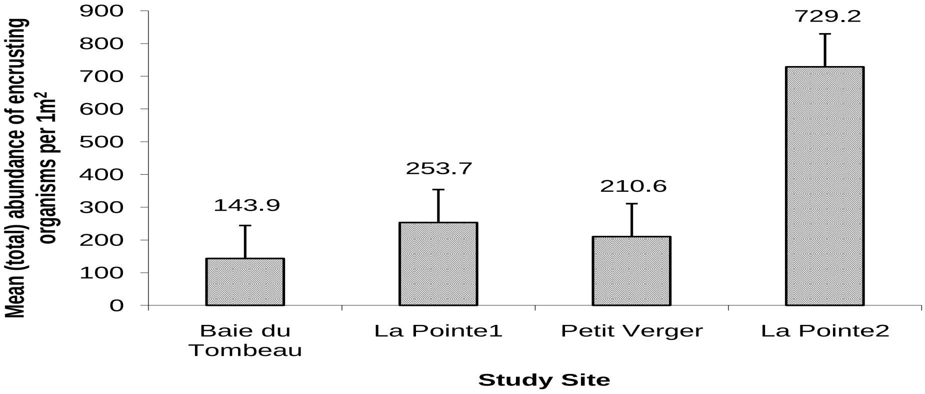


**Fig. 2.** Mean (total) abundance of encrusting organisms per $1m^2$ at each study site. Columns and bars denote average and standard deviation of data collected at the four rocky shores

*Planaxis sulcatus* was the most abundant species per $1m^2$ on sites at La Pointe1 and Petit Verger with mean abundance of 196.86±179.71 (Percentage abundance 77% per $1m^2$) and 168.10±113.44 (Percentage abundance 79% per $1m^2$) respectively (**Fig. 3**) but it was less abundant on sites at Baie du Tombeau with mean abundance of 23.66±41.99 per $1m^2$ (Percentage abundance 16 % per $1m^2$) (**Fig. 3**). The bivalve *Modiolus auriculatus* was the most abundant species on sites at La Pointe2 with mean abundance of 673.33±762.04 per $1m^2$ (percentage abundance 92% per $1m^2$)(**Fig. 3**) and the second most abundant species on sites at Baie du Tombeau (**Fig. 3**) with mean abundance of 38.08±49.83 per $1m^2$ (Percentage

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abundance 26% per 1m$^2$). However, it was not recorded from sites at Petit Verger (**Table 1**).

**Table 1.** List of families of invertebrates identified on the four rocky shores with their respective mean and standard deviation per 1m$^2$. -- denote absence of this family on site and the number of * indicates the number of species recorded in each of these families

| **Mollusca Class Gastropoda Family** | **Number of species per Family** | **Baie du Tombeau** | **La Pointe1** | **Petit verger** | **La Pointe2** |
|---|---|---|---|---|---|
| Buccinidae | 1 | 1.08±1.50 | 2.08±6.30 | 0.08±0.28 | 7.91±16.61 |
| Cerithiidae | 1 | -- | 033±1.15 | 0.16±0.57 | -- |
| Conidae | 1 | -- | 0.08±0.28 | -- | -- |
| Coralliophilidae | 1 | 0.08±0.28 | -- | -- | -- |
| Cypraeidae | 1 | 0.08±0.28 | -- | -- | -- |
| Littorinidae | 3 | -- | -- | 3.66±97.2*** | -- |
| Mitridae | 1 | 0.75±2.0 | -- | -- | 0.08±0.28 |
| Municidae | 1 | 0.58±11.44 | 1.75±3.19 | 0.66±1.23 | 1.91±3.20 |
| Nassariidae | 1 | 0.33±1.15 | 0.25±0.86 | -- | 1.75±4.11 |
| Neritidae | 3 | 53.0±53.99*** (Including *Nerita punctata* (Quoy and Gaimard, 1834)) | 13.0±17.19** (Including *Nerita punctata*) | 27.25±34.76 (*Nerita punctata*) | -- |
| Patellidae | 2 | 4.25±4.36** | 0.83±5.73 | 1.08±2.93 | 3.41±6.92 |
| Planaxidae | 1 | 23.66±41.99 *(Planaxis sulcatus* (Born, 1791)) | 196.86±179.7 *(Planaxis sulcatus)* | 168.0±113.44 *(Planaxis sulcatus)* | -- |
| **Mollusca Class Bivalvia Family** | | | | | |
| Isognomotidae | 1 | 1.41±2.60 | 8.53±27.5 | 8.91±29.32 | 0.25±0.62 |
| Mytilidae | 2 | 55.58±50.16** (including *Modiolus auriculatus* **(Krauss, 1848)**) | 28.33±107.9** (including *Modiolus auriculatus*) | 0.08±0.28 (excluding *Modiolus auriculatus*) | 709.66±796.5** (*including Modiolus auriculatus)* |
| Neridae | 2 | 13.25±27.34 | 0.08±0.28 | -- | -- |
| **Total** | **22** | | | | |
| **Arthropoda Class Malacostraca Family** | | | | | |
| Diogenidae | 4 | 0.66±1.34**** | 0.50±1.73 | 0.16±0.57 | 1.58±0.98*** |
| Grapsidae | 2 | 0.33±1.15 | -- | 0.41±1.15** | 0.08±0.28 |
| Portunidae | 1 | 0.08±0.28 | -- | -- | -- |
| **Total** | ***7*** | | | | |
| **Echinodermata Class Echinoidea Family** | | | | | |
| Parasaleniidae | 1 | 0.08±0.28 | -- | -- | -- |
| **Total** | ***1*** | | | | |
| **Total No of Species identified in all** | 30 | | | | |

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Except for La Pointe2, the gastropod *Nerita punctata* was present on all sites with a mean abundance of 39.41±57.35 at Baie du Tombeau (percentage abundance of 27% per $1m^2$) (**Fig. 3**) to 7.91±16.49 at La Pointe1, (Percentage abundance 3% per $1m^2$) (**Fig. 3**). Calculated mean abundance for the other families of molluscs (**Table 1**) on the four study sites varied from 13.25±27.34 to 0.08±0.28 per $1m^2$. The family Diogenidae was the most abundant arthropods on all sites. Their mean abundance varied from 0.66±1.55 to 0.08±0.28. The most abundant species are illustrated in **Fig. 4.**

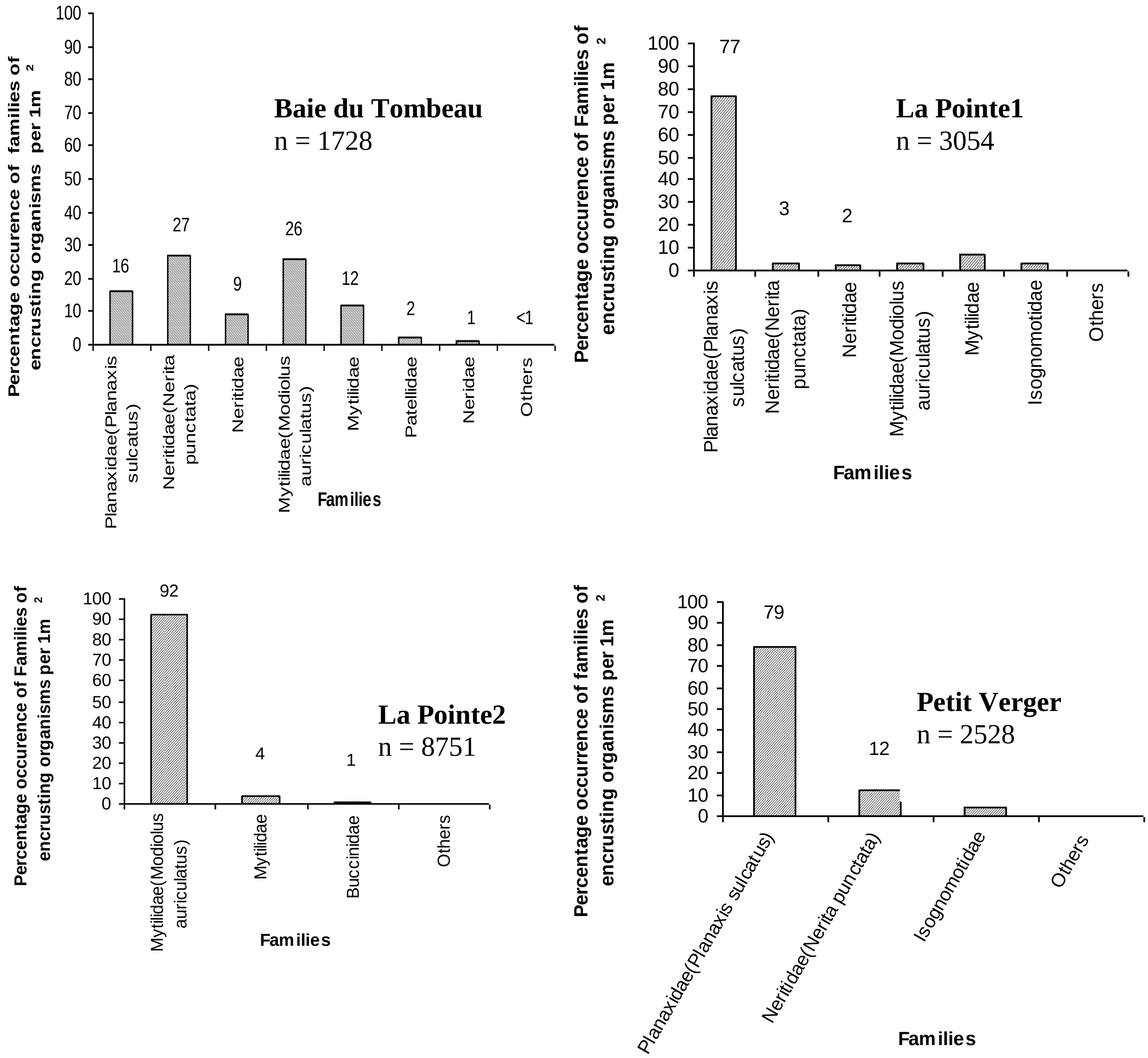


**Fig. 3.** Percentage occurrence of families of encrusting organisms per $1m^2$ for the four study sites. n is the number

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*Planaxis sulcatus*


*Modiolus*



*Nerita punctata*

**Fig. 4.** Most abundant species collected on sites. *Planaxis sulcatus* at La Pointe1 and Petit Verger, *Nerita punctata* at Baie du Tombeau and *Modiolus auriculatus* at La Pointe2 . Scale is in cm.

**Species diversity and similarity**

Highest species diversity and evenness (Shannon-Wiener diversity index 1.88, Shannon Evennness index, 0.23) (**Table 2**) was calculated for sites at Baie du Tombeau. Berger-parker dominance index calculated as a measure of diversity indicates a low diversity on shores at La Pointe2.

Variation in similarities among shores range from lowest number of shared species (Jaccard Similarity index, 0.27) between sites at La Pointe2 and Petit Verger to highest number of shared species (Jaccard Similarity index, 0.47) (**Table 3**) between sites at La Pointe1 and Petit Verger. Calculation of mean similarity was also conducted for the three stations belonging to the four study sites so as to identify the similarity level among the three stations within each site i.e. assessing the probability of sampling the same species in the three stations. The results revealed that La Pointe2 has the highest similarity between its three stations (Mean Jaccard Similarity index, 0.49) and Baie du Tombeau the least (Mean Jaccard Similarity, 0.23).

**Table 2.** Relationship between species diversity, evenness and dominance for the four study sites.

| Sites | No of organisms | No of Families | Shannon Diversity index | Shannon Evenness index | Berger Parker index |
|---|---|---|---|---|---|
| **Baie du Tombeau** | 1728 | 16 | 1.88 | 0.23 | 0.27 |
| **La Pointe1** | 3054 | 12 | 1.01 | 0.12 | 0.77 |
| **Petit Verger** | 2528 | 11 | 0.78 | 0.10 | 0.79 |
| **La Pointe2** | 8751 | 9 | 0.37 | 0.04 | 0.92 |

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**Table 3.** List of shared families between the different shores with their respective Jaccard similarity index.

| | La Pointe1 v/s La Pointe 2 | La Pointe1 v/s Petit Verger | La Pointe2 v/s Petit Verger | La Pointe1 v/s Baie du Tombeau | Baie du Tombeau v/s Petit Verger | Baie du Tombeau v/s La Pointe2 |
|---|---|---|---|---|---|---|
| **Proportional Number of Families common to both sites over total Number of Families in both sites** | *7/14* | *9/12* | *7/11* | *10/16* | *9/16* | *9/16* |
| **Jaccard similarity** | **0.32** | **0.47** | **0.27** | **0.42** | **0.28** | **0.41** |

# DISCUSSION

## Rocky shore fauna

The invertebrate faunal assemblage was dominated by gastropods (Phylum Mollusca). Similar observations have been made by Hodgkin and Michel (1960) in their study of 'Zonation of plants and animals on rocky shores of Mauritius'. Moreover the genera *Planaxis* and *Nerita* species are characteristics of sheltered rocky shores as is the case of the fours shores under the present study.

The presence of high numbers of the bivalve *Modiolus auriculatus* is also noted in the present study. Seed and Suchanek (1992) stated that *Modiolus auriculatus* are dominant space occupiers on rocky shores resistant to high temperature which span the entire vertical area from low zone to high zone; likewise this was reflected on shores at La Pointe2 with a high dominance of *Modiolus auriculatus*. *Planaxis* tend to be among the most abundant gastropod on shores at Baie du Tombeau, La Pointe1 and Petit Verger. This observation is in line with observations made by Hodgkin and Michel (1960) who characterised *Planaxis* as the commonest mollusc's grazers on sheltered shores. Baissac, *et al.*, (1962), who studied rocky shores of Mauritius, pointed out that rocky shore at Pointe aux Sables is characterised mostly by families of Littorinidae, Planaxidae, Mytilidae, Cerithiidae and Grapsidae. Similarly these organisms were observed on shores at Pointe aux Sables.

### Faunal Diversity

The greatest species diversity and evenness was obtained for shores at Baie du Tombeau, consequently the lowest dominance index was obtained for this study site. Laboratory experiments conducted by Kassen (2002), demonstrated a positive correlation between habitat heterogeneity and species diversity.

Likewise the high diversity at Baie du Tombeau can be attributed to the fact that Baie du Tombeau has a higher habitat complexity as compared to the other shores. The large number of crevices (compared to shores at Pointe aux Sables), observed during sampling on sites at Baie du Tombeau harboured a greater variety of organisms.

## Similarity between shores

Based on Jaccard similarity index the highest similarity was found between sites at La Pointe1 and Petit Verger. Possibly there is no monopolisation of abiotic resources by a dominant species as is the case of the dominant space occupiers *Modiolus auriculatus* at La Pointe2. One of the factors affecting susceptibility of a community to invasion by opportunistic organisms is diversity of organisms on the shore. Works by Elton (1958) and Lavorel, *et al.*, (1999) showed that resistance to invasion may be enhanced in species rich communities or in communities with diverse functional groups. According to these more diverse, complex and constant habitats are less susceptible to invasion as compared to less diverse habitats; this is because diversity reduces the survival and percent cover of invaders and may decrease their settlement and recruitment indirectly mostly because in such communities the amount of space available is a limiting factor (Stachowicz, *et al.,* 2002). In the present study Baie du Tombeau bears the highest diversity of

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organisms compared to the other rocky shores and may be considered to be less susceptible to invasion compared to the other rocky shores.

# CONCLUSION

The study provides information on the sheltered rocky shore fauna in the port area (namely Pointe aux Sables on the south and Baie to du Tombeau on the north), together with knowledge on species composition and abundance. It will be useful for further studies on port area especially with regards to risk to invasion by other species.

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