Abundance and distribution of holothurians on the fringing reef flats of Grande Terre, Mayotte, Indian Ocean

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Introduction

Lying at the northern end of the Mozambique Channel, between the East African coast and Madagascar, Mayotte is part of the Comoros island group. Mayotte lies inside an enclosed lagoon comprising exceptionally diverse biotopes.

No detailed research has yet been carried out on holothurians, or "papacajo" in the Mahorian language, in Mayotte. Contrary to Madagascar, the gathering and exploitation of this resource for the Asian market have only developed recently, and on a limited scale (Pouget 2004). No special action has been taken towards sustainable management of the fishery. The potential development of this activity therefore justifies research into the fishery and the state of the resource. This article presents an assessment of the specific richness, abundance and distribution of holothurians on the fringing reef flats of Grande Terre.

Materials and methods

Mayotte, which is 376 km² in area, comprises two main islands: Grande Terre and Petite Terre. Eight million years old (Marty 1993), these volcanic islands are surrounded by a reef and lagoon complex spread out over some 1500 km², making it the biggest in this part of the Indian Ocean. Fringing reefs, 50–800 m wide, abut the islands and islets. The holothurians of Grande Terre's fringing reef were studied between 28 May and 21 July 2003. Twenty sampling stations were selected (Fig. 1).

At each station, sampling was carried out at two locations on the reef flat: the outer reef flat and the inner reef flat. Within each of these biotopes, the tide and current, biological, bathymetric and sedimentological conditions are relatively uniform and are therefore determining factors in species distribution (Conand 1990).

At each station, two transects (inner and outer reef flat) 50 m in length and 5 m in width were made at random, parallel to the shore, resulting in a sampled area of 250 m² for each biotope. The choice of this surface area was due to the assumed widespread distribution of this megafauna.

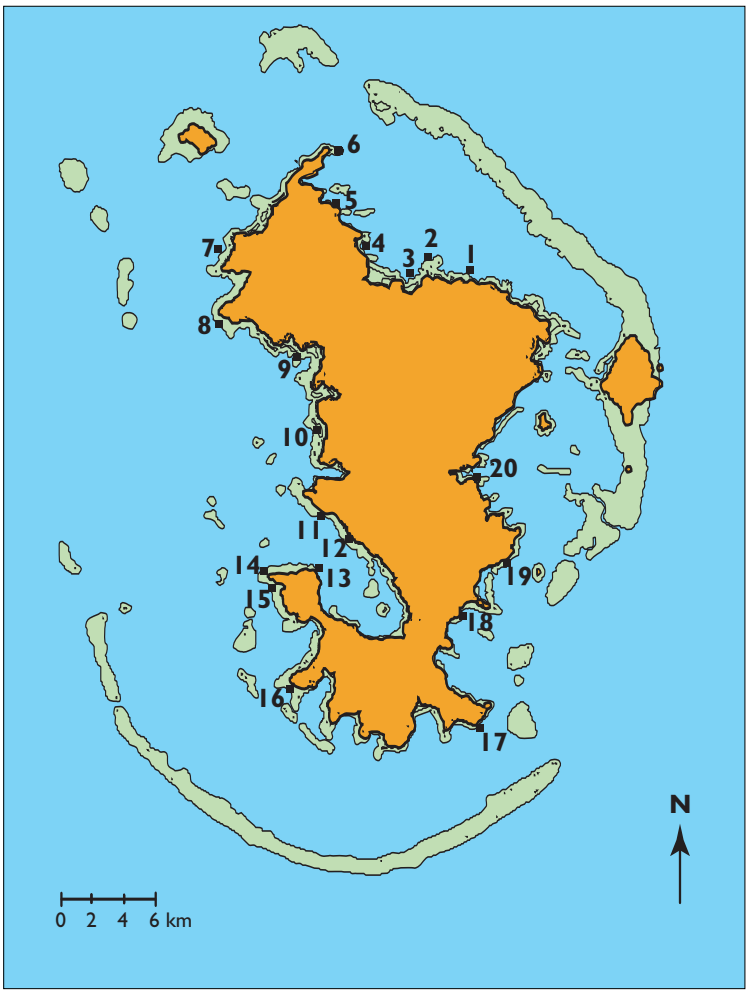

Figure 1.

Location of the 20 sampling stations

Numbers correspond to the following stations: Trevani (1), Pointe de Longoni (2), Longoni (3), Dzoumogné (4), M'tsangaboua (5), Pointe d'Handrema (6), M'tsangadoua (7), Tanaraki (8), Hambato (9), Sohoa (10), Tahiti plage (11), Poroani (12), Hagnoundrou (13), Le Soleil Couchant (14), Le Poulpe (15), N'Gouja (16), Saziley (17), Musical plage (18), Sakouli (19), Iloni (20).

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Results

Specific richness, abundance and general species distribution

Nine species of holothurians were found during the sampling carried out on the fringing reef flats of Grande Terre (Table 1).

With relative proportions of 42% and 22%, respectively, *Holothuria atra* and *Bohadschia atra*, a recently described species (Massin et al. 1999), were the two most abundant species found. These two species were also those with the highest observation frequencies: *H. atra* and *B. atra* were observed at 30% and 35% of sampling stations, respectively. At these stations, *H. atra* was the characteristic species of the inner reef flat, where it occurred in a mean density of 88 specimens 10^{-4} m^{-2} (Fig. 2). Conversely, *B. atra* was characteristic of the outer reef flat, occurring in a density of 44 10^{-4} m^{-2}.

Bohadschia subrubra and *B. vitiensis* were also two relatively abundant species on Grande Terre's fringing reef, representing 13% and 10% of all holothurians found. However, specimens of these species were only observed at 5% of the sampling stations and only on the inner reef flats. On the scale of the island, therefore, the mean density on the inner reef flats corresponded to 30 specimens 10^{-4} m^{-2} for *Bohadschia subrubra* and 22 10^{-4} m^{-2} for *B. vitiensis*.

In terms of abundance, *Stichopus chloronotus* and *Holothuria nobilis* represented 6% and 4%, respectively of all holothurians observed. Their frequency of observation (number of stations where the species has been observed/total number of stations), however, was 15% and 20%. *S. chloronotus* was present on both the inner reef flat (mean density of 8 specimens 10^{-4} m^{-2}) and on the outer reef flat (mean density of 6 specimens 10^{-4} m^{-2}, as opposed to 2 specimens 10^{-4} m^{-2} on the inner reef flat).

Table 1. Relative abundance of each species (number of ind. from one species/total number of holothurian specimens) on the fringing reef of Grande Terre (on the inner and outer reefs, or a total area of 2 x 20 x 250 m² = 10,000 m²) and observation frequency of each species (number of stations where the species has been observed/total number of stations)

Species	Relative abundance	Observation frequency
Actinopyga mauritiana	1%	5%
Bohadschia atra	22%	35%
Bohadschia subrubra	13%	5%
Bohadschia vitiensis	10%	5%
Holothuria atra	42%	30%
Holothuria nobilis	4%	20%
Holothuria scabra versicolor	1%	5%
Stichopus chloronotus	6%	15%
Thelenota ananas	2%	5%

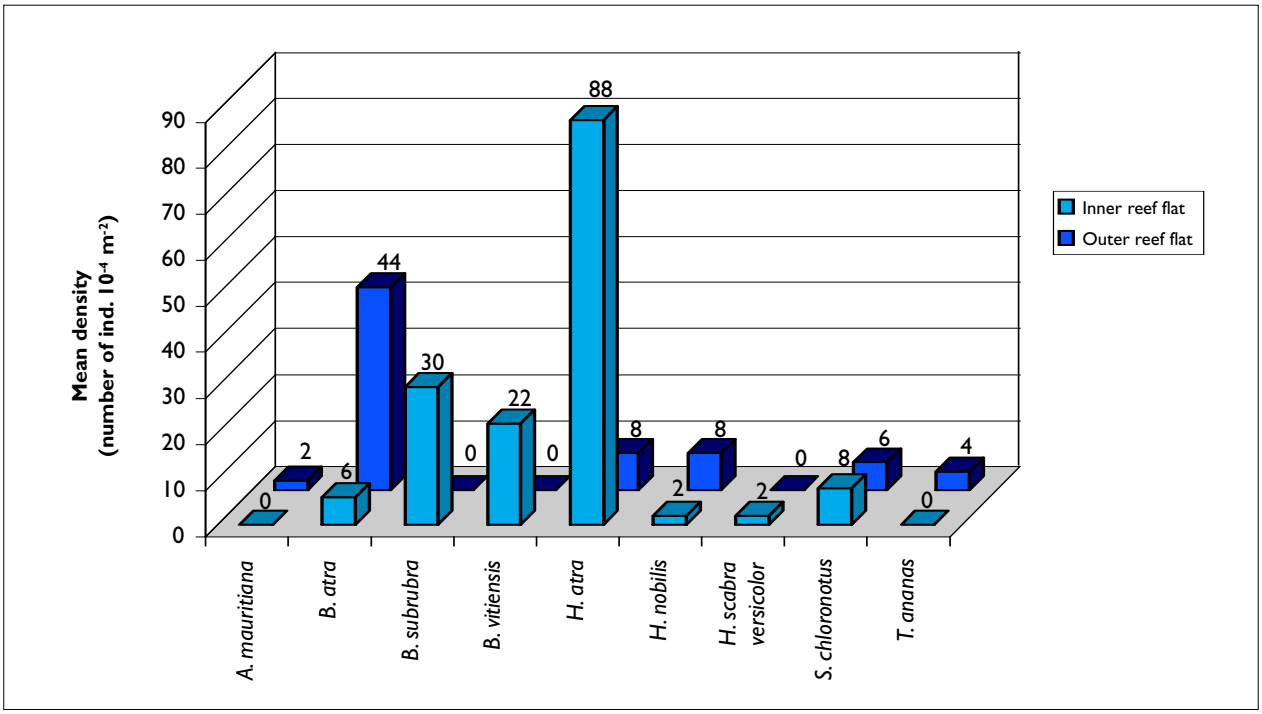

Figure 2. Mean density of each species present at the 20 sampling stations on Grande Terre's fringing reef (inner and outer reef flat).

Actinopyga mauritiana, *H. scabra* var. *versicolor* and *Thelenota ananas* can be considered as scarce species on the fringing reef flats. Only 4% of the specimens sampled from all transects belonged to one of these three species. Each of these species also showed low observation frequencies (5%). Over the reef flats as a whole, their distribution was limited to a single biotope: *A. mauritiana* and *T. ananas* were only observed on the outer reef flat, whereas *H. scabra* var. *versicolor* was only present on the inner reef flat.

Distribution of the most common species

Figure 3 shows the heterogeneous distribution of the four most frequent species (*H. atra*, *B. atra*, *S. chloronotus* and *H. nobilis*) at the various stations. Only 9 of the 20 sampling stations were concerned by the presence of the species.

Holothurian densities were particularly high at the following stations: "Le soleil couchant", Sakouli, and especially N'Gouja, where the density of the main species on the inner reef flat reached 880

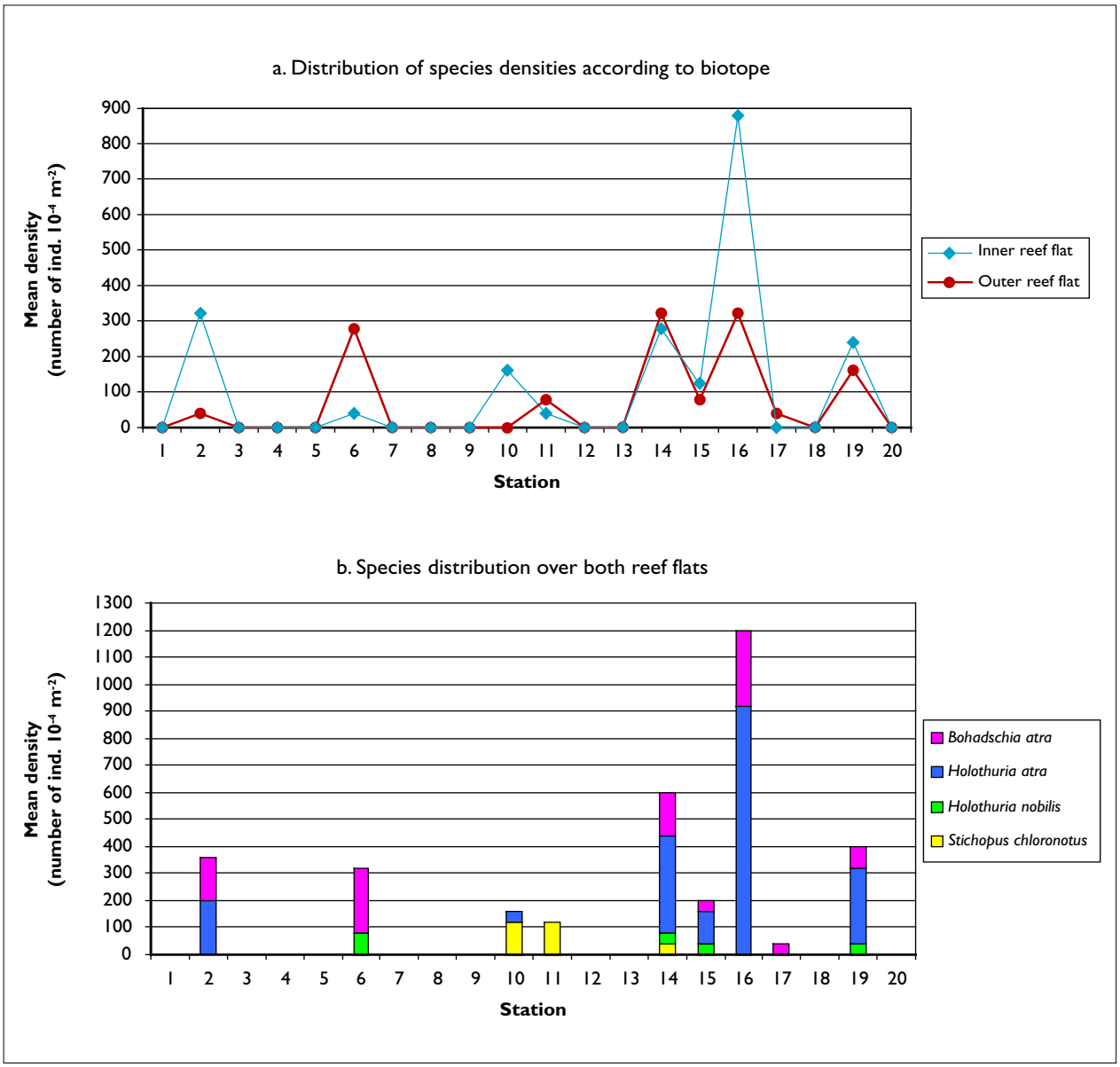

Figure 3.

Density distribution of the four main species (*Bohadschia atra, Holothuria atra, Holothuria nobilis* and *Stichopus chloronotus*) by station and biotope.

Numbers correspond to the following stations: Trevani (1), Pointe de Longoni (2), Longoni (3), Dzoumogné (4), M'tsangaboua (5), Pointe d'Handrema (6), M'tsangadoua (7), Tanaraki (8), Hambato (9), Sohoa (10), Tahiti plage (11), Poroani (12), Hagnoundrou (13), Le Soleil Couchant (14), Le Poulpe (15), N'Gouja (16), Saziley (17), Musical plage (18), Sakouli (19), Iloni (20).

specimens 10^{-4} m^{-2}. At these three stations, only *H. atra* was present on the inner reef flat. The maximum density for *B. atra*, the dominant species on the outer reef flat, was also observed at N'Gouja: 280 specimens 10^{-4} m^{-2}.

Within the two biotopes, the dominance of these two species could be seen at the majority of stations. However, certain sampling areas did not show this distribution pattern:

- On the inner and outer reef flats of Tahiti plage, only *S. chloronotus* was observed; its overall density was 120 specimens 10^{-4} m^{-2}.
- The Sohoa Station is also dominated by *S. chloronotus*. Present only on the inner reef flat, its density was 120 specimens 10^{-4} m^{-2}.
- At Handrema Point, *H. nobilis* was the only species present on the inner reef flat, where its density was 80 specimens 10^{-4} m^{-2}.
- On the outer reef flat of the "Le Poulpe" station, *H. nobilis* was found in a density of 40 specimens 10^{-4} m^{-2}, in other words a density equal to that of *B. atra*.

Discussion

This survey of nine species was the first of its kind on Mayotte. Because the survey only covered the fringing reef flat of Grande Terre, the list is not comprehensive for Mayotte overall. A parallel study of the fishery (Pouget 2004) revealed the presence of two other species: *A. echinites* and *H. fuscopunctata*. These two joint studies make it possible to conclude that a total of 11 species of holothurians are present in Mayotte.

Also, the specimen densities observed during this survey appear to be lower than those recorded in other islands of the Indian Ocean. *H. atra* was in fact the most abundant and common species over the main island as a whole. However, the maximum density observed on the inner reef flat at N'Gouja station was only 920 specimens 10^{-4} m^{-2}. At Reunion Island, however, where *H. atra* is also the dominant species (Conand and Mangion 2002), maximum density in this biotope was 0.25 specimens 10^{-4} m^{-2}. It should also be noted that the species with high commercial value (Conand 1999), such as *H. nobilis* and *H. scabra versicolor*, only represented 4% and 1% of the species found on Grande Terre. *H. nobilis*, however, was the most frequently gathered species on Mayotte (Pouget 2004). The majority of the exploitable stock on Mayotte would not therefore appear to be located on the fringing reef of Grande Terre.

The distribution of these species around the perimeter of Grande Terre in Mayotte would appear to be very uneven. Over half of the stations sampled had no holothurians whatsoever. There are two possible reasons for these absences: 1) the stations selected for this survey have a very wide range of reef structures and physical and chemical characteristics (particularly related to the proximity of a river, a mangrove area or an urban area). These environmental parameters could influence the development and therefore the distribution of these echinoderms around the island perimeter; or 2) within the biotope itself, the holothurians show aggregating behaviour, probably linked to feeding (Hammond 1983; Uthicke and Karez 1999). In each part of the reef flat, only a single transect was performed at random. Despite the large surface area concerned (one transect of 250 m^2 per biotope in our survey), it is possible that this sampling technique was not the optimum one for this type of animal. The use of a larger number of transects or quadrats along radials perpendicular to the shore might make it possible to gain a better picture of the abundance of these animals on the reef flat.

Conclusions and prospects

This survey, carried out on the fringing reef of the main island of Mayotte, revealed the presence of nine species of holothurians, of which two were broadly dominant: *Holothuria atra* and *Bohadschia atra*. The distribution of these species around the main island emerged as very heterogeneous. The continuation of this study on all the islands and islets of the main island of Mayotte would complete this survey as regards the fringing reef. In addition, a similar review of the double inner barrier reef and the barrier reef proper would make it possible to complete a more accurate review of the areas harvested. Research on the population structures (weighing and measuring animals) and regular monitoring would make it possible to introduce sustainable management measures for this resource.

Acknowledgements

I wish to think Olivier Abellard, Director of the Fisheries and Marine Environment Department of Mayotte for having enabled me to carry out this survey, Julien Wickel, my supervisor and Chantal Conand. My thanks are also due to the Fisheries and Marine Environment Department team and especially Didier Fray for his logistical assistance and thorough knowledge of the island.

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Information on juvenile holothurians: A contribution by Dr D.B. James

As communicated by Glenn Shiell[1]

Following a request for anecdotal information on the habitat preferences of juvenile holothurians (see Beche-de-Mer Information Bulletin #19), issue #20 included a short article entitled, "Field observations of juvenile sea cucumbers". The aim of the article was to consolidate observations of juveniles in their natural environment and identify differences in habitat preferences between adult and juvenile holothurians. By consolidating this information, the article ultimately aimed to identify juvenile ecology research directions and to clarify some of the details of the little-known but important juvenile life phase. At the time of writing the article, I had received 26 responses covering 18 different species.

However, since that time, I have received further information from Dr D.B. James of India. Given the range of species covered in his list of observations (many of which were not included in the previous article), and the extensive time frame over which these observations were made, it seemed appropriate to include the observations in this issue as a follow up to that published in the previous issue.

In his list, Dr James includes 21 holothurian species (see Table 1). Of these, 17 were observed concurrently in the same habitat as adults, and 4 in the absence of adults. These observations again reflect the patterns identified in the article published in issue #20. In examples provided by Dr James, there appears, in most cases, to be a close association between the habitat preferences of adult and juvenile holothurians of the same species. However, Dr James also provides evidence to suggest that juveniles of selected species may occupy different habitats to that of the adult form. This trend, which is now reported in a number of species (*Holothuria fuscogilva*; *H. whitmaei* [previously *H. nobilis*]; *Cucumaria frondosa* and *Stichopus hermanni* — see issue #20 for corresponding references), requires further and more detailed research.

At this point, I would like to take the opportunity to thank those who contributed observations of juvenile sea cucumbers. This information may help to provide a starting point for future research into this interesting, but poorly understood aspect of holothurian biology. I will continue to compile this information and welcome further correspondence regarding this subject.

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