Sea cucumbers and other echinoderms at Geyser Bank, Mayotte (Indian Ocean)

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Introduction

As part of a biodiversity study designed to monitor changes in fisheries resources,[4] we collected echinoderm samples, particularly Holothuridae, from Geyser Bank in Mayotte (Fig. 1). This sampling was the first inventory taken at this bank and little scientific information existed about sea cucumber biodiversity and exploitation in this region (e.g. for Mayotte: Pouget 2004, 2005; Conand et al. 2005; for the Comoros: Samyn et al. 2005). Data on sea cucumbers from Reunion Island (Conand and Mangion 2002) and crown-of-thorns starfish (Emeras et al. 2004) may also be useful. The biodiversity of other echinoderms from the islands in the Mozambique Canal zone is also poorly known and concerns the Glorioso Island reef flats (Vergonzanne 1977).

Geyser Bank is 300 km west of the northernmost tip of Madagascar and 110 km northeast of Mayotte. This bank, which has been fished since the 1990s because of its rich fisheries resources, is part of Mayotte's exclusive economic zone (73,600 km^2) and remains isolated from coastal human pressures.

Worldwide, sea cucumber fisheries are growing, thereby giving rise to overfishing in most tropical Indo-Pacific countries (Conand 1999 and 2004). A lack of data about sea cucumber populations at this bank was the reason behind this current study initiated by the Mayotte Government. The purpose of this work was to make an initial list of the sea cucumber species found and provide mean abundances in the prospected zones.

Materials and methods

Study site

Geyser Bank (surface area of 175 km^2) is in the western Indian Ocean, north of the Mozambique Canal, between Mayotte and the Glorioso Islands (Fig. 1). This coral structure is built on shoals in the open ocean and only certain parts of it can be

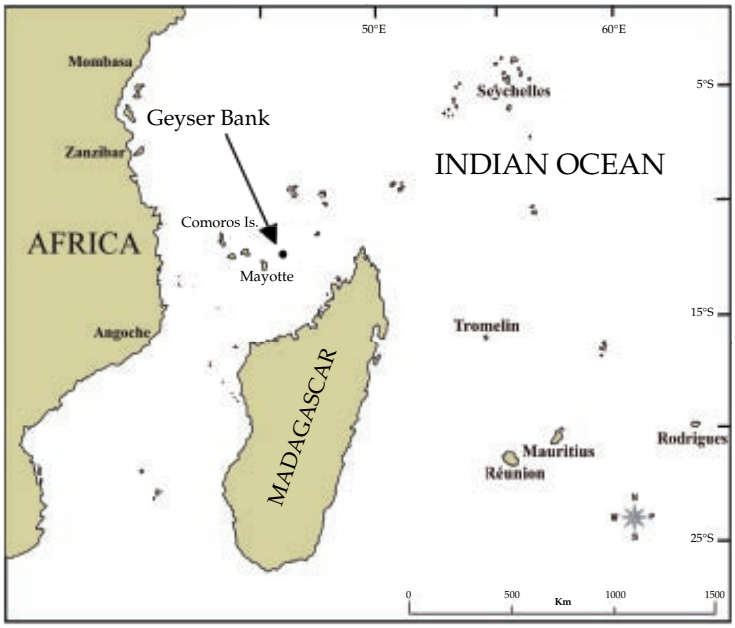

Figure 1. Geyser Bank, north of Mozambique Canal.

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4. This study was commissioned by the Mayotte Direction de l'Agriculture et de la Forêt (DAF) from 4–13 December 2006.

Table 1. Biotopes and biocenoses at the 11 stations sampled at Geyser Bank.

Stations	Depth	Biotope	Biocenose
Station 1 on 05.12.2006 AM	12–18 m	External slope – bottom of slope Hard substrate: 46% Rubble: 34% Sand: 20%	50% coral cover 39% seaweed cover (including 76% calcareous algae) 11% other organisms
Station 2 on 06.12.2006 AM	12–18 m	Outer slope– Area along the edge of the reef Hard substrate: 84% Rubble: 34% Sand: 12%	67% coral cover 30% seaweed cover (including 67% standing seaweed) 3% other organisms
Station 3 on 06.12.2006 PM	12–18 m	Outer slope – bottom of slope Hard substrates: 64% Rubble : 21% Sand : 15%	40% coral cover 51% seaweed cover (including 82% calcareous algae) 9% other organisms
Station 4 on 07.12.2006 AM	12–18 m	Outer slope – bottom of slope Hard substrate: 63% Rubble: 26% Sand: 11%	68% coral cover 32% seaweed cover (including 39% calcareous algae and 39% standing seaweed)
Station 5 on 07.12.2006 PM	12–18 m	Outer slope – bottom of slope Hard substrate: 70% Rubble: 20% Sand: 10%	69% coral cover 28% seaweed cover (including 62% calcareous algae)
Station 6 on 08.12.06 AM	12–18 m	Coral heads on sandy bottoms Hard substrate: 82% Rubble : 14% Sand : 4%	21% coral cover 79% seaweed cover (including 98% seaweed bed)
Station 7 on 08.12.06 PM	15 m	Thallassodendron sea grass bed and coral heads of sandy-rubble bottoms Sand : 50%	50% seagrass cover
Station 8 on 09.12.06 AM	12 – 18 m	Outer slope – bottom of slope Hard substrate: 66% Rubble: 22% Sand: 12%	39% coral cover 61% seaweed cover (including 60% calcareous algae)
Station 9 on 09.12.06 PM	12–18 m	Inner slope – Foot of slope Hard substrate: 84% Rubble: 13% Sand: 3%	68% coral cover 31% seaweed cover (including 88% calcareous algae)
Station 10 on 10.12.06 AM	12–18 m	Outer slope – Along the edges of the reef Hard substrate: 76% Rubble: 20% Sand: 4%	47% coral cover 53% seaweed cover (including 72% calcareous algae)
Station 11 on 10.12.06 PM	9 m	Lagoon Hard substrate: 88% Rubble: 12%	46% coral cover 54% seaweed cover (including 75% standing seaweed)

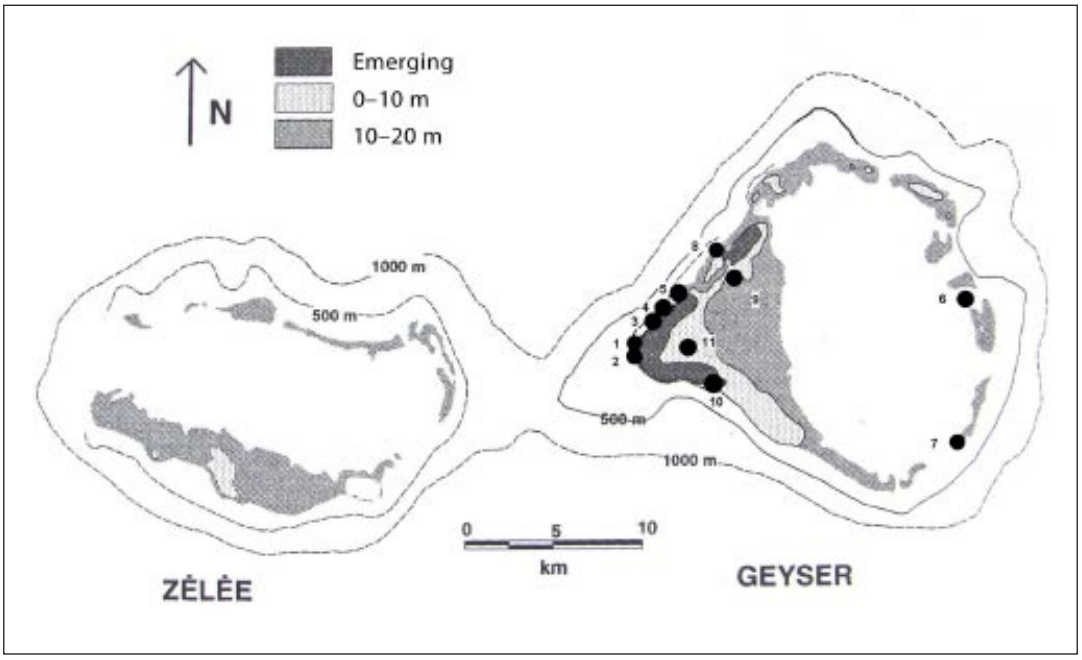

Figure 2. Location of the 11 study stations at Geyser Bank.

seen at the surface during low tide. Several habitats with differing geomorphologic criteria were sampled from 11 stations (Fig. 2 and Table 1): the external and internal slopes of the outlying subsurface reefs, the external slope of the outlying underwater reef, the coral heads, and the sedimentary terrace bottoms.

Sampling technique

Sampling was done using underwater dives at depths of between 10 and 20 meters. Nine divers carried out 40 hours of diving in order to count and photograph the different species. The total surface area inventoried was 28,600 m^2 (i.e. about 0.015% of the bank's overall surface area). The estimated surface area for each station sampled covered about 2600 m^2: 750 m^2 for the "fish" transect (500 m^2 for the transect and 250 m^2 outside) and 1850 m^2 for the fixed "fish" points. Sampling at the 11 stations consisted of systematically inventorying the reef's surface area, cavities, boulders of dead coral that could be turned over, and the sediment.

Results

Total sea cucumber density over the surveyed area was 18 specimens for 28,600 m^2 (about 5 specimens ha^{-1}). Seven species of sea cucumbers were represented by 18 specimens. Table 2 shows the relative abundance and frequency of the various species.

The two most abundant species were *Thelenota ananas* (Fig. 3C), with a relative abundance of 39%, and *Bohadschia subrubra* (Fig. 3B), at 28%. These were also the two species with the highest frequency of observation at 54.5% and 36%, respectively. *Thelenota ananas* had a mean density of 2 specimens ha^{-1}.

Table 2. Relative abundance* of each sea cucumber species at 11 stations surveyed at Geyser Bank and the frequency of observation** for each species.

Species	Relative abundance	Frequency of observation
Thelenota ananas	39.0%	54.5%
Bohadschia subrubra	28.0%	36.0%
Actinopyga obesa	11.0%	18.0%
Actinopyga mauritiana	5.5%	1.0%
Bohadschia sp.	5.5%	1.0%
Holothuria nobilis	5.5%	1.0%
Holothuria sp.	5.5%	1.0%

* Expressed as the number of specimens per species/total number of sea cucumbers.
** Expressed as the number of stations where the species was found /total number of stations.

Actinopyga obesa (Fig. 3D) was relatively rare with a relative abundance of 11% and a frequency of observation of 18%.

All other species — *Actinopyga mauritiana* (Fig. 3A), *Bohadschia* sp. (Fig. 3E), *Holothuria nobilis* (Fig. 3F), and *Holothuria* sp. — were only seen once at a single station and can therefore be considered as rare at Geyser Bank.

Stations 1 and 8, outer slope stations with an average level of coral cover (Table 1), are the stations where species richness and abundance were the highest with three species each and seven specimens (Table 3). Stations 2, 3, 5, 6, 9 and 10 had lower species richness with one or two species. No sea cucumbers were recorded at Stations 4, 7 and 11. Station 4, which had the same biotope and biocenosis as Station 9), was an inner slope station with a high level of coral cover. Station 7, a seagrass bed station on a sedimentary bottom and Station 11 was a shallow coral head station with average coral cover (Tables 1 and 3).

Other echinoderms found included 13 Echinidae species, 4 Ophiuridae species, 3 Asteridae species and 3 Crinoidae species (Table 3)

Table 3. Abundance of the various echinoderm species sampled by station at Geyser Bank (total surface area prospected: 28,600 m^2) during 40 hours of diving (4.5 h $diver^{-1}$)

Stations (St)	St 1	St 2	St 3	St 4	St 5	St 6	St 7	St 8	St 9	St 10	St 11
Holothuridae (7 species)											
Thelenota ananas	1	1			2	1		1	1		
Bohadschia subrubra	1		1			1		2			
Actinopyga mauritiana			1								
Actinopyga obesa	1							1			
Holothuria nobilis									1		
Bohadschia sp.		1									
Holothuroidea sp.										1	
Echinidae (13 species)											
Echinothrix calamaris	1				2			1			
Echinothrix diadema		1			1						
Diadema savignyi					2						
Diadema setosum					2						
Eucidaris metularia			1								
Prionocidaris verticillata									1		
Echinostrephus aciculatus	2	1	1		10	1		50	1	1	
Chondrocidoris gigantea											1
Metalia sp.											1
Clypeaster sp.									1		
Cassiduloida or *Spatangoida* sp. 1						50					
Cassiduloida or *Spatangoida* sp. 2							50				
Heterocentrus mammillatus			1		5						
Asteridae (3 species)											
Fromia milleporella	1						1	1			
Leiaster coriaceus								1			
Acanthaster planci										40	
Ophiuridae (4 species)											
Ophiarachnella gorgonia						1					
Ophiocoma erinaceus										1	
Ophiotrix sp. aff *vigelandi*										1	
Ophiotrix sp.					1						
Crinoidae (3 species)											
Tropiometra carinata			1								
Dorometra mauritiana					2						
Dorometra sp.										1	

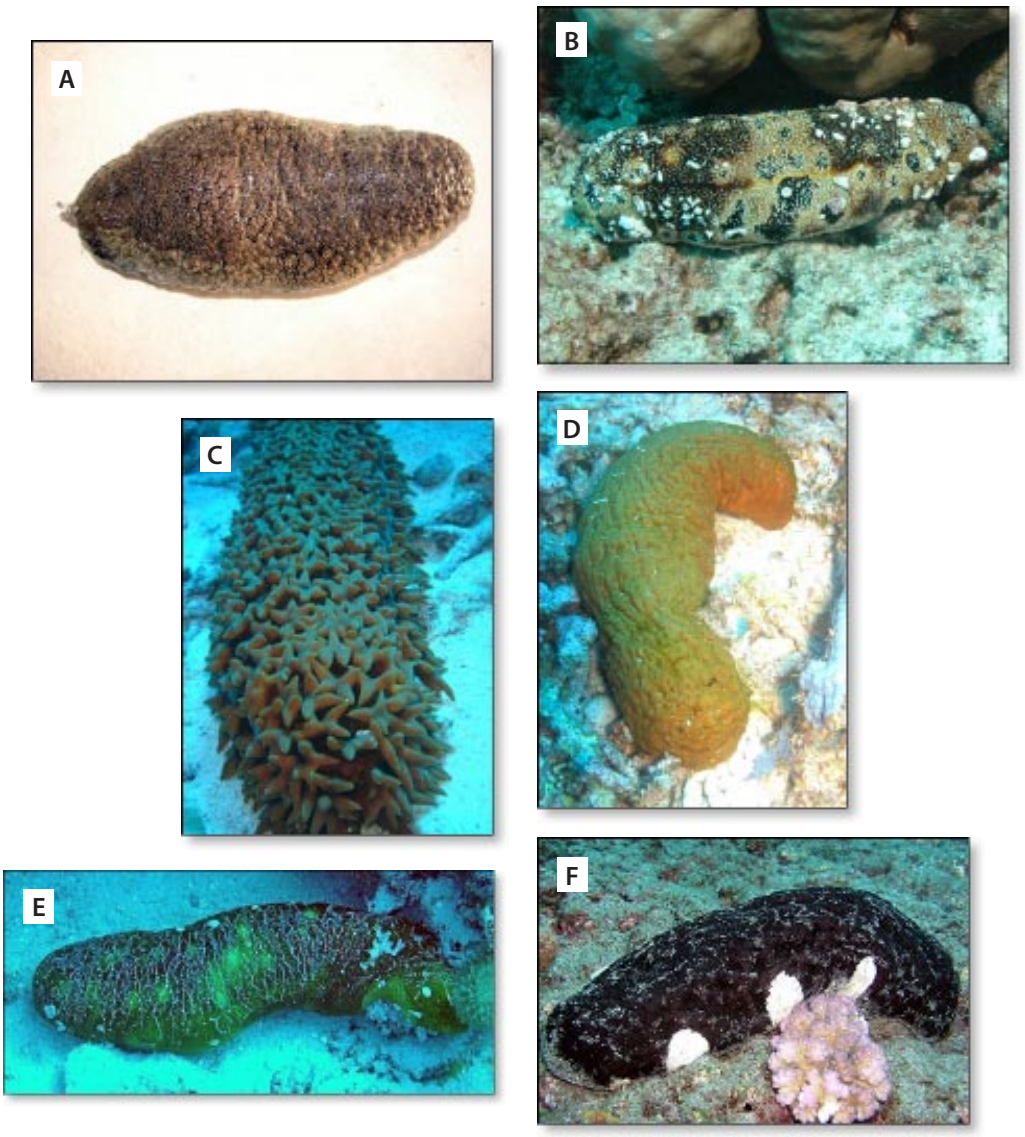

Figure 3. A few large sea cucumber species sampled at Geyser Bank (Mayotte).
A: *Actinopyga mauritiana*; B: *Bohadschia subrubra*; C: *Thelenota ananas*;
D: *Actinopyga obesa*; E: *Bohadschia* sp.; *Holothuria nobilis*

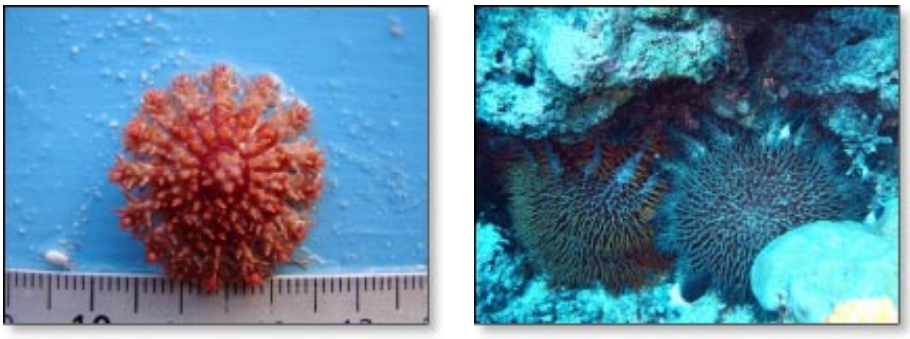

Figure 4. *Acanthaster planci* at Station 10 at Geyser Bank

Some 13 Echinidae species were sampled for this category from a total of 188 specimens. Their relative abundance and frequency are given in Table 4.

Three Asteridae species represented by 3 *Fromia milleporella* were found at Stations 1, 7 and 8; 1 *Leiaster coriaceus* at Station 8; and a cluster of about 20 specimens per 100 m^2 of *Acanthaster planci* over an estimated surface area of 200 m^2 at Station 10 on the outlying underwater reef flat. The mean size of the *Acanthaster planci* was 40 cm. We also found an *Acanthaster* juvenile at the same site (Fig. 4).

Finally, four Ophiuridae species and three Crinoidae species were also observed.

Discussion

Sea cucumber diversity observed in this survey (7 species) was very low compared with other sites studied in the Comoros (Samyn et al. 2005), Mayotte (27 species Conand et al. 2005), and at Reunion Island (Conand and Mangion 2002). In particular, no species were found on the reef flats during a supplementary sampling carried out over a surface area of about 5000 m^2, which suggests either a lack of a favourable biotopes or, more likely, harvesting by fishers since Geyser Bank may be fished on a sporadic basis. In fact, a boat with five divers was observed in 2004.

Sea cucumber density at the surveyed surface area also seems to be very low in comparison with certain areas at other Indian Ocean islands. These data are mainly linked to reef flats such as the fringing reef flats in Reunion Island where figures often reach several specimens per m^2 (Conand and Mangion, 2002) and on Mayotte, where densities are lower. This scarcity may be explained by a lack of favourable biotopes due to the concentration of organic matter, a prerequisite for sea cucumber feeding, is low at Geyser Bank because it is isolated from supplemental coastal organic matter.

Thelenota ananas, a species of commercial interest, considered to be a rare on the outer flat of the fringing reef in Mayotte with 4 specimens ha^{-1} (Pouget 2005), only had densities here of some 2 specimens ha^{-1}.

Table 4. Relative abundance of each Echinidae species (number of specimens for one species/total number of urchins) at 11 stations at Geyser Bank (total surface area surveyed: 28,600 m^2) and frequency of observation for each species (number of stations where the species was observed/total number of stations).

Species	Relative abundance	Frequency of observation
Echinothrix calamaris	1.5%	27%
Echinothrix diadema	1.0%	18%
Diadema savignyi	1.0%	1%
Diadema setosum	1.0%	1%
Eucidaris metularia	0.5%	1%
Prionocidaris verticillata	0.5%	1%
Echinostrophus aciculatus	36.0%	73%
Chondrocidoris gigantea	0.5%	1%
Metalia sp.	0.5%	1%
Clypeaster sp.	0.5%	1%
Cassiduloida or *Spatangoida* sp 1	27.0%	1%
Cassiduloida or *Spatangoida* sp 2	27.0%	1%
Heterocentrus mammillatus	3.0%	18%

Sampling methods could be improved to make it possible to record smaller species but large-sized species could not be overlooked. Night dives would also have allowed sampling of other species.

Other echinoderm populations observed during this study also seemed to have low levels of diversity and were generally not very abundant. The lack of any *Acanthaster* at most stations was interesting, however a large group (Conand 2001) was observed along with one juvenile at Station 10. At Reunion Island, the largest clusters did not exceed three to four species on average, per 30-minute dive (Emeras et al. 2004). It is important to verify at a later time what has happened with the *Acanthaster* population at Station 10 and its effects on the coral.

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