

sea cucumber and the animal can be hauled to the surface. In clear water this method has been successfully used in depths up to 30–35 meters. This collection method has not been used in Jaluit. A ban on the use of bombs will prevent deeper water sea cucumber stocks from being harvested.

- The suggested marine reserve areas have been designed to prevent harvesting of organisms within the area, therefore preventing the harvesting of sea cucumbers. These reserve areas will allow reproductive stocks of the commercial species to survive and reproduce in shallow water.

Sea cucumbers are only harvested on Jaluit Atoll for commercial activities; they are not used for subsistence.

Monitoring programme

A monitoring and licensing system should be developed with the community council to collect reliable data on all commercial sea cucumber activities.

Information should be collected on species, location, number, water depth, date and whether processed or not. In addition, each company (local and off island) and diver should be registered with the island council and made to provide the above information. The council may wish to place a small license fee on these commercial activities. This industry is suitable for Jaluit Atoll and should be developed along with a management plan. The Conservation Area Supporting Officer should also discuss the general biology and reasons behind the sea cucumber management plan, and assist collectors in producing a top quality product that increases profits.

In addition, biannual marine assessment surveys should be undertaken to provide baseline population numbers of sea cucumbers in the reserves and on the harvested sections of the Jaluit reef.

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Sea cucumber fisheries in the Mayotte reef system, Indian Ocean

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Introduction

On Mayotte, a small French island in the Comoros Islands, sea cucumbers (*papacajo* in Mahorais) have not yet been studied. The development of this fishery and the steep rise in the number of tickets issued for illegal underwater harvesting of sea cucumbers, justified setting up a study to examine the fishery and the status of the resource. This article provides an overview of the fishery gained through information from fishers and animal health services.

Beginning of fishery operations

In contrast to the Malagasy islands, sea cucumber fishing in Mayotte has only recently begun in a very limited way. It may be linked to a transfer of activity due to stock depletion in Madagascar.

It is difficult to state exactly when sea cucumber fishing began. In fact, no fisheries information exists for Mayotte. This is due, in part, to the fact that

those people involved perform a wide range of other work activities, and there is a high percentage of fishers who are fishing illegally.

As with most sea cucumber producing countries, production is not meant for local consumption but rather for export to Asian countries (Conand 1990). The first seafood product health and quality export certificate was issued by the Mayotte Animal Health Office (DSV) on 11 April 2002. Therefore, it is estimated that sea cucumber fishing for export first began in early 2002.

Management measures and fishing techniques

At present, sea cucumber fishing is not subject to any specific measures designed to ensure sustainable resource management. However, this activity is subject to Prefectural Order no. 3/95/CAB/AM, which provides regulations for underwater fishing in the French coastal and territorial waters adjacent to the Department of Mayotte. Articles 1 and 2 of this order respectively stipulate that:

- Underwater fishing refers to actively capturing animals while swimming or diving, and collecting marine plants by any method whatsoever (by hand, harpoon, net or using special underwater fishing gear).
- Fishing in coastal waters (lagoon) or inside the base lines set out by the Decree of 12 September 1977 is prohibited."

Sea cucumbers must therefore be collected along the fringing or barrier reef at low tide.

Exploitation zones

Due to constraints linked to regulations, it is difficult to determine where the exact fishing zones are located. In fact, a difference must be made between the legally exploitable zone and the zone that is actually exploited. Fishers go to sea every day, weather permitting, for about nine hours (personal interviews with fishers), beyond low tide periods. From information from tickets issued by the DAF/SPEM, exploited zones appear to comprise very circumscribed sectors of the lagoon, (Fig. 1):

- the inner reef off the bay of Kani Keli;
- the reef flat on the outer barrier reef opposite Kani Keli;
- the white sand islet;
- the reef flat on the outer barrier reef north of Petite Terre;
- the area around Sada islet;
- M'tsahara and N'Gouja fringing reefs (personal interviews with fishers);
- areas outside the barrier reef (from north of Petite Terre all the way to the pass opposite Koungou).

Estimated catches

Because little information on sea cucumber exports exist in Mayotte, most of our data come from seafood product health and quality export certificates issued by the Mayotte Office of Animal Health (DSV).

Exports are not made directly to Asia but rather pass by "middleman countries" such as Mauritius, Madagascar or Tanzania. Since April 1992, 1582 kg of processed sea cucumbers have been exported. This quantity seems to be decreasing because in November 2002, exports totalled 1410 kg but in July 1993 they were only 122 kg (Table 1).

This decrease may be due to the following factors:

- dissuasive surveillance by the Lagoon Brigade (DAF/SPEM);
- the vagrancies of fishing (e.g. buyers, weather);
- trepang exports conducted in a clandestine manner (i.e. without going through DSV checks, on vessels that transport the sea cucumbers, processed or unprocessed, directly to middleman countries).

During this same time period, the number of tickets issued by the Lagoon Brigade (DAF/SPEM) increased. No steps were taken in 2002, whereas since January 2003, 425 kg of sea cucumbers have been seized.



Figure 1. Mayotte and the areas where sea cucumbers are collected

Species captured and product processing

A meeting with fishers to photo-identify using identification records and personal examination of the products after processing, made it possible to determine that about seven species are harvested in Mayotte.

Most of these species, however, are harvested on an experimental basis. In fact, this fishery, which is new to Mayotte, requires fishers to acquire very precise techniques for processing the products (process de-

scribed by Conand 1990, 1999) in order to meet certain criteria imposed by the Asian market.

Two processing techniques are used (personal interviews with fishers) as shown in Table 2. These techniques differ somewhat from those used in Madagascar but fishers are currently in a testing phase that is designed to observe how various species respond to processing (in particular, their size after cooking and drying).

The species harvested are shown in Table 3. The species caught most often is *Holothuria nobilis*.

Table 1: Trepang exports from Mayotte (information taken from seafood product health and quality export certificates issued by the Mayotte DSV)

Certificate's date of issue	Destination	Species	Weight (kg)
11/04/02	Tanzania	<i>Holothuria</i> sp.	1000
21/10/02	Hong Kong via Mauritius	<i>Holothuria nobilis</i>	275
19/11/02	Hong Kong via Mauritius	<i>Holothuria nobilis</i>	1410
29/11/02	Hong Kong via Mauritius	<i>Holothuria nobilis</i>	480
13/12/02	Hong Kong via Mauritius	<i>Holothuria nobilis</i>	900
23/12/02	Hong Kong via Mauritius	<i>Holothuria</i> sp.	1295
21/02/03	Madagascar	<i>Holothuria</i> sp.	300
11/07/03	Tanzania	<i>Holothuria</i> sp.	122

Conclusions and prospects

Sea cucumber fishing in Mayotte is just beginning. Based on the Madagascar model, some fishers began this activity in early 2002. But two major problems limit sustainable exploitation of these species: 1) no resource management regulations exist, and 2) information on these creatures and the techniques

for processing them is still very limited. Additional studies, particularly on exploitable sea cucumber stocks, are needed in order to enact appropriate legislation for managing them. An awareness and information campaign for fishers could also avoid poor exploitation of available stocks.

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Table 2 Processing techniques

Processing phases	Length of time
Technique #1	
Gutting on boat	
Covered with salt water in shop	24 hours
Cooked in boiling water	35–40 min
Dried at constant temperature	A few days
Technique #2	
Gutting on boat	
Cooked in boiling water	12 min
Covered with salt water in shop	24 hours
Dried at constant temperature	A few days

Table 3: Sea cucumber species harvested in Mayotte, according to a market classification (Conand 1999)

	Species	English name
FIRST CATEGORY: Species of high market value	<i>Holothuria nobilis</i>	black teatfish
	<i>Holothuria scabra</i>	sandfish
SECOND CATEGORY: Species of average market value	<i>Actinopyga echinites</i>	deepwater redfish
	<i>Thelenota ananas</i>	prickly redfish
THIRD CATEGORY: Species of low market value	<i>Holothuria fuscopunctata</i>	elephant trunkfish
	<i>Bohadschia vitiensis</i>	brown sandfish
	<i>Stichopus chloronotus</i>	greenfish

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Black teatfish (*Holothuria nobilis*) dipped in seawater



The room used for the drying process



Different species at different stages of processing (L to R: *H. nobilis*, *B. vitiensis* and *A. echinites*)



"Trepang", the processed product