

Sea cucumber inventory in Mayotte, southwest Indian Ocean

C. Conand¹, V. Dinhut², J.-P. Quod² and R. Rolland³

Introduction

Recently, the number of echinoderm inventories in the southwest Indian Ocean has increased, and such inventories usually include a section on sea cucumbers. We should mention, for example, those carried out in Kenya and in Tanzania by Samyn (2003), Rodrigues by Rowe and Richmond (2004) and Reunion Island by Conand and Mangion (2002). A major inventory of sea cucumber species in Madagascar was published by Cherbonnier (1988), which included references to specimens in Mayotte, thus providing a rich working base. In addition, a new species was described in Madagascar (Massin et al. 1999).

Sea cucumber fisheries are growing worldwide, leading to overexploitation in most tropical Indo-Pacific countries (Conand 1999, 2004a). For that reason, FAO recently held a symposium on exploitation, management and aquaculture (Lovatelli et al. 2004) and CITES has also focused attention on conservation of these species at a number of its meetings (2003 Conference of the Parties in Chile, 2004; Meeting in Malaysia, 2004; Animals Committee Meeting in Bangkok [see www.cites.org and Conand 2004b]).

Mayotte is about 8 million years old and is the oldest of the four main island islands that make up the Comoros Archipelago (Grande Comore, Mohéli, Anjouan and Mayotte). With a surface area of 374 km² and a 185-km-long coastline, Mayotte has two main islands (Petite Terre and Grande Terre) and 30 smaller islands spread across a lagoon with an area of more than 1000 km². Mayotte's EEZ covers 73,600 km² and includes the Banc de la Zélée (Zelee Bank). Natural and human pressure on marine resources has been growing steadily in Mayotte, including coral bleaching, which destroyed 90% of the corals in 1998. Since then, efforts by the local government to sustainably manage reef resources have led to the creation of the Mayotte Lagoon Management Plan (PGLM) (CAREX et al. 2002), to a project to make six noteworthy marine areas into nature reserves, and to preliminary work on identifying "natural marine areas of interest for their ecology, fauna and floral" (ZNIEFF), in line

with the overall methodology used in France (Guillaume 2000). It was against this background that work to compile existing data was carried out in 2004. Designed as a pilot project, this study focused on several taxonomic groups, including echinoderms; the goal was to test operational protocols, with the real field inventory to be conducted later by specialists.

An initial article by Pouget (2004) directly addressed sea cucumbers of commercial interest in Mayotte (a topic that had never before been studied), and presented the characteristics of this fishery. Pouget (2005) then presented information on the distribution of the major species and displayed study sites on a map.

This paper discusses a new inventory conducted with a rapid method using different types of data.

Method

This approach combines those used:

- in French Overseas Departments with "ZNI-EFF-Mer" typologies (Guillaume 2000),
- to define noteworthy habitats and marine areas described in detail in Andrefouët's works (2002),
- as part of the Mayotte Lagoon Management Plan (CAREX et al. 2002), and
- in the *Atlas préliminaire des espaces naturels* (Exploratory Atlas of Natural Spaces) (Valentin and Vanssay 2004).

Echinoderms are one of the key groups used to characterize the habitats of Mayotte's marine flora and fauna.

The methodological approach consisted of compiling a list of existing works (scientific publications and reports) that mention sea cucumbers. In addition to the above-mentioned publications, there were a number of reports (ARVAM et al. 1997; ARVAM 1997; CAREX 2001; Thomassin 1997). During the period 1994 to 2005, 153 days of fieldwork were carried out by ARVAM (and its partners), during which a large number of underwater photos were taken; these were later linked to the "BDMay" information base in Excel format. Given

1. Laboratoire Ecomar, Université de La Réunion. Email: conand@univ-reunion.fr

2. Arvam. Email: arvam@arvam.com

3. Service environnement de la Direction de l'Agriculture et de la Forêt (DAF) de Mayotte. Email: robin.rolland@agriculture.gouv.fr

the methodology's obvious limits from the point of view of systematic identification of species, we created the following validation scale:

- 1: species mentioned in a publication by a well-known taxonomist,
- 2: species mentioned in report by a non-specialist author, and of a species that has been verified or identified (by photo) by a specialist,
- 3: species mentioned in a report, but deemed doubtful by a specialist; also includes those that must be later identified using an actual specimen,
- 4: species mentioned in a report but which probably does not exist in Mayotte, so not included here.

The BDMay database will include three major types of information for each sea cucumber observation (and for the other taxonomic groups as well):

- systematic data (family, genus, species, common name)
- spatial data (geomorphology of the seafloor, habitats, GPS point, depth)
- bibliographic references (reports, publications).

Results

The pilot sea cucumber database is shown in Table 1; the purpose of this work was not to con-

Table 1. BDMay sea cucumber database.

Validity*	Family	Genus	Species	Author, year	Pictures	Market value**
1	Cucumariidae	<i>Havelockia</i>	<i>turrispinea</i>	Cherbonnier, 1988	-	-
1	Cucumariidae	<i>Thyone</i>	<i>comata</i>	Cherbonnier, 1988	-	-
1	Holothuriidae	<i>Actinopyga</i>	<i>echinites</i>	(Jaeger, 1833)	x	2
1	Holothuriidae	<i>Actinopyga</i>	<i>mauritiana</i>	(Quoy & Gaimard, 1833)	x	2
1	Holothuriidae	<i>Actinopyga</i>	<i>miliaris</i>	(Quoy & Gaimard, 1833)	-	2
1	Holothuriidae	<i>Actinopyga</i>	<i>obesa</i>	(Selenka, 1867)	-	3
2	Holothuriidae	<i>Bohadschia</i>	<i>atra</i>	Massin et al., 1999	x	3
2	Holothuriidae	<i>Bohadschia</i>	<i>marmorata</i>	(Jaeger, 1833)	-	3
1	Holothuriidae	<i>Bohadschia</i>	<i>similis</i>	(Jaeger, 1833)	-	3
1	Holothuriidae	<i>Bohadschia</i>	<i>subrubra</i>	(Quoy & Gaymard, 1833)	x	3
1	Holothuriidae	<i>Bohadschia</i>	<i>vitiensis</i>	(Jaeger, 1833)	x	3
1	Holothuriidae	<i>Holothuria</i>	<i>atra</i>	(Jaeger, 1833)	x	3
2	Holothuriidae	<i>Holothuria</i>	<i>fuscogilva</i>	(Cherbonnier, 1980)	x	1
1	Holothuriidae	<i>Holothuria</i>	<i>fuscopunctata</i>	(Jaeger, 1833)	x	3
2	Holothuriidae	<i>Holothuria</i>	<i>nobilis</i>	(Selenka, 1867)	x	1
1	Holothuriidae	<i>Holothuria</i>	<i>pardalis</i>	(Selenka, 1867)	-	-
1	Holothuriidae	<i>Holothuria</i>	<i>pervicax</i>	(Selenka, 1867)	-	-
1	Holothuriidae	<i>Holothuria</i>	<i>impatiens</i>	(Forsk., 1775)	-	-
1	Holothuriidae	<i>Holothuria</i>	<i>scabra</i>	(Jaeger, 1833)	-	1
1	Holothuriidae	<i>Holothuria</i>	<i>scabra versicolor</i>	(Conand, 1986)	x	1
1	Holothuriidae	<i>Pearsonothuria</i>	<i>graeffeii</i>	(Semper, 1868)	x	3
1	Stichopodidae	<i>Stichopus</i>	<i>chloronotus</i>	(Brandt, 1835)	x	2
1	Stichopodidae	<i>Stichopus</i>	<i>hermani</i>	(Semper, 1868)	x	2
1	Stichopodidae	<i>Thelenota</i>	<i>ananas</i>	(Jaeger, 1833)	x	1
2	Stichopodidae	<i>Thelenota</i>	<i>anax</i>	(Clark, 1921)	x	2
1	Synaptidae	<i>Euapta</i>	<i>godeffroyi</i>	(Semper, 1868)	-	-
1	Synaptidae	<i>Synapta</i>	<i>maculata</i>	(Chamisso & Eysenhardt, 1821)	-	-

* Validity: 1 to 3 (see text)

** Market value: 1: high value, 2: medium and 3: low, according to Conand (1999)

duct true taxonomic assessments. Of the 27 species listed, 22 had Level 1 validity, 2 species still need to be confirmed, and 3 species were added to the database through the use of photos.

The photos of a few common large-sized species are shown in Figure 1 (A to F).

Discussion and conclusions

Before the ZNIEFF inventories for Mayotte were carried out, methodological work was undertaken so as to optimise these efforts. This work was based on a review of existing information (species and sites). During this work, we realised that several prerequisites had not yet been fulfilled, such as creating a single recognised list of flora and fauna and creating a list of Mayotte's marine habitats to supplement the one that exists for the French Overseas Departments. Based on the work done on echinoderms, it was shown that consolidating available data would make it possible to begin the actual inventory under the best possible conditions. Such data provide the bases of an information system on the species' spatial distribution, which may make it possible to determine more precisely those species that should be considered decisive in terms of the ZNIEFF, ap-

proach, and determine those that need specific management/conservation measures (protected habitats, regulations, etc.). The list of sea cucumber species given here is still provisional. Small-size or cryptic species are not listed and require additional collection work. Using photos to identify species made it possible to illustrate 25 species with almost absolute certainty. This work allowed us to add three species that had not been reported previously. Other photo collections exist and should be analysed.

Information validation is an important issue for future studies. While using photographic data can provide a rapid assessment method (as long as a referencing procedure is adopted that integrates baseline information on substrata and locations), it cannot replace actual taxonomic work, for which precise specimens must be collected, set, identified, and archived.

The use of *in situ* photos distributed to a large range of agencies and governments may make it possible to better define the habitats of the various species. Field prospecting should also be carried out, focusing on those reef flats that are relatively easy to access but which have not yet been studied in detail.

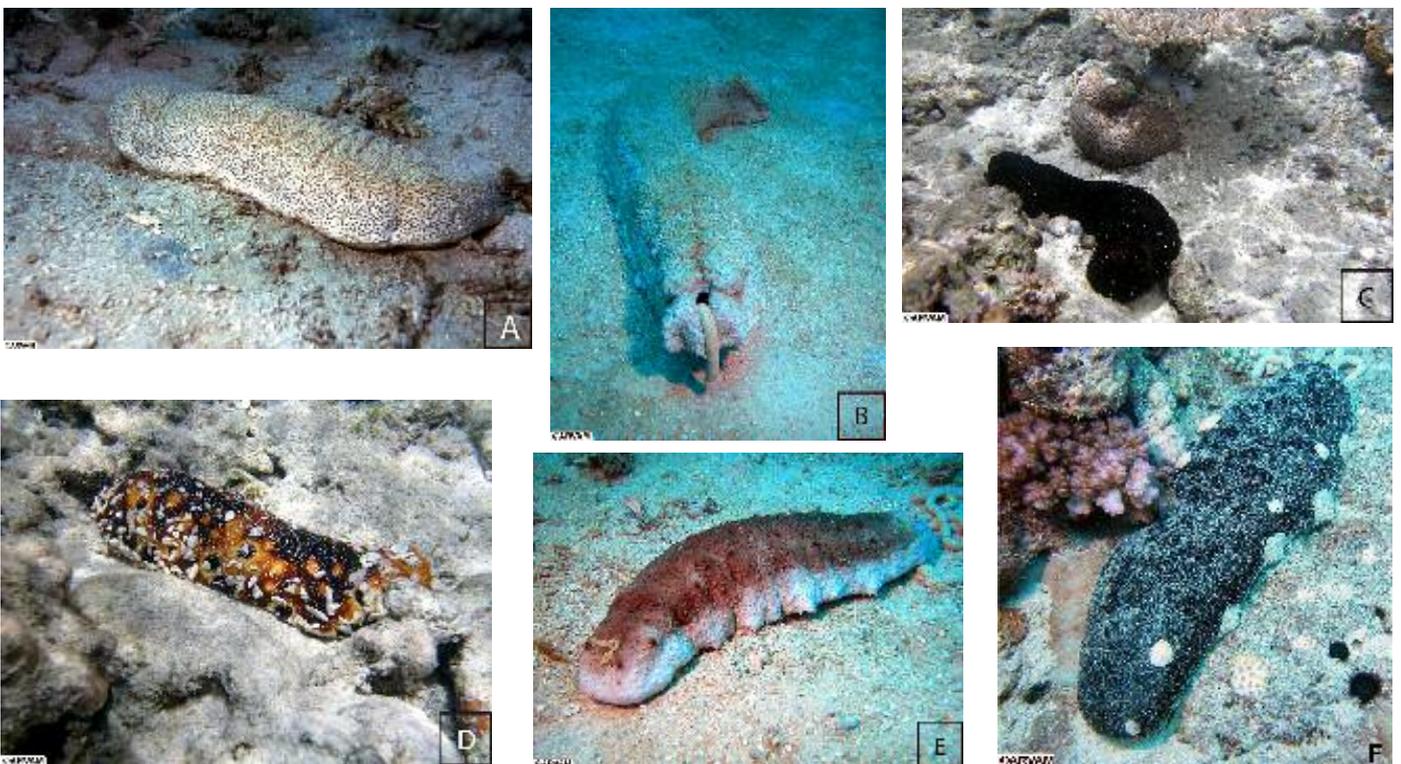


Figure 1. Some large holothurians species common in Mayotte: A) *Holothuria fuscopunctata*; B) *Thelenota anax*; C) *Bohadschia atra*; D) *Bohadschia subrubra*; E) *Holothuria nobilis*. All images: © ARVAM

Gaps do exist in this work: we should point out that there are other publications and reports on Mayotte (mentioned by Thomassin 2004) that were not available for this phase of the study. The various activities planned during implementation and scientific control of ZNIEFF-Mer in Mayotte will be continued; this is an original and timely approach, and should be effective, as is sought by the local government. It should make it possible to supplement and correct the inventory in an iterative and constructive manner, and allow comparison, in a relevant way, of Mayotte's marine biodiversity with that of the other Comoros islands, the Mozambique Canal and the Indian Ocean. This is a vital step towards gaining a better understanding of the issues involved in marine and coastal resource conservation and the operational measures that need to be taken.

Acknowledgements

This prospecting work was part of the assignment the Direction de l'Agriculture et de la Forêt (DAF) of Mayotte gave to the Mascarin National Botanical Conservatory (CBNM)–ARVAM group for implementation of the scientific management of the ZNIEFF in Mayotte. We would particularly like to thank V. Boulet, Director of the CBNM.

References

- Andrefouët S., 2002. Cartographie et inventaire du système récifal barrière de Mayotte par imagerie ikonos, SPOT – HRV et Landsat 7 ETM+. DAF/SPEM, 8p.
- ARVAM. 1997. Impact environnemental de la pose d'un câble sous-marin d'énergie entre petite et Grande Terre (Mayotte). Étude de l'état initial du milieu marin. Rapport EDM, 27 p.
- ARVAM, IARE, SPEM. 1995. La réserve passe en S (île de Mayotte). Expertise biologique et cartographie des peuplements benthiques. Rapport 30 p. + annexes.
- CAREX Environnement. 2001. Extension du port de Longoni, réalisation du remblai pour le deuxième quai. Rapport Direction de l'équipement Mayotte. 109 p. + annexes.
- CAREX, WWF & ARVAM, 2002. Plan de Gestion du Lagon de Mayotte. Rapport réalisé pour le compte de la DAF Mayotte, 128 p.
- Cherbonnier G. 1988. Échinodermes: Holothurides. Faune de Madagascar. ORSTOM 70 292 p.
- Conand C. 1999. Manuel de qualité des holothuries commerciales du Sud-Ouest de l'Océan Indien. Commission Océan Indien: 39 p.
- Conand C. 2004a. Present status of world sea cucumber resources and utilisation: an international overview. p. 13–23. In: Lovatelli A., Conand C., Purcell S., Uthicke S., Hamel J.-F. and Mercier A. (eds). Advances in sea cucumber aquaculture and management. FAO Fisheries Technical Paper No. 463, 425 p.
- Conand C. 2004b. Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES): conservation and trade in sea cucumbers. SPC Beche-de-mer Information Bulletin 20:3–5.
- Conand and Mangion. 2002. Holothurians from La Réunion fringing reefs: diversity, distribution, abundance and population structure. SPC Beche-de-mer Information Bulletin 17:27–33.
- Guillaume M. 2000. L'inventaire des ZNIEFF-Mer dans les DOM: bilan méthodologique et mise en place. Patrimoines naturels 42. 227 p.
- Lovatelli A., Conand C., Purcell S., Uthicke S., Hamel J.-F. AND Mercier A. (eds). 2004. Advances in sea cucumber aquaculture and management. FAO Fisheries Technical Paper No. 463. 425 p.
- Massin C, Rasolofonirina R., Conand C. and Samyn Y. 1999. A new species of *Bohadschia* (Echinodermata, Holothuroidea) from the Western Indian Ocean with a redescription of *Bohadschia subrubra*. Bulletin de l'Institut Royal des Sciences de Belgique 69: 151–160.
- Pouget, A. 2004. Sea cucumber fisheries in the Mayotte reef system, Indian Ocean. SPC Beche-de-mer Information Bulletin 19:35–38.
- Pouget A. 2005. Abundance and distribution of holothurians on the fringing reef flats of Grande Terre, Mayotte, Indian Ocean. SPC Beche-de-mer Information Bulletin 21:22–26.
- Rowe F. and Richmond M. 2004 A preliminary account of the shallow-water Echinoderms of Rodrigues, Mauritius, western Indian Ocean. Journal of Natural History, 38:3273–3314.
- Samyn Y. 2003. Shallow-water Holothuroidea (Echinodermata) from Kenya and Pemba Island (Tanzania). Studies in Afrotropical Zoology 292:1–158.
- Thomassin B.A. 1997. Le complexe recifo-lagonaire de Daoudzi-Pamanzi (Mayotte, lagon Est). Projet de doublement de la canalisation d'eau sous-marine entre "Grande Terre" et "Petite Terre"; étude du site et des impacts possibles. Rapport DAF, COM, GIS "LAGMAY". 55 p.
- Thomassin B.A. 2004. Travaux sur les milieux marins et littoraux, Mayotte & bancs coralliens. Rapport GIS "LAG-MAY". 91 p.
- Valentin A. et Vanssay A. 2004. Atlas préliminaire des espaces naturels et patrimoniaux de Mayotte. Document de travail. Rapport DAF. 104 p.