

# Cetacean diversity in a tropical lagoon (Mayotte, Comoros), in the Mozambique Channel (western tropical Indian Ocean)

Jeremy KISZKA<sup>1,4</sup>, Peter J. ERSTS<sup>2</sup> & Vincent RIDOUX<sup>3</sup>

<sup>1</sup> *Observatoire des Mammifères Marins. Office National de la Chasse et de la Faune Sauvage & Direction de l'Agriculture et de la Forêt. BP 103, F-97600, Mamoudzou, Mayotte, France.*

<sup>2</sup> *American Museum of Natural History. Center for Biodiversity and Conservation. Central Park West at 79<sup>th</sup> St. New York, New York, 10024. USA.*

<sup>3</sup> *University of La Rochelle. CRELA (Centre de Recherche sur les Ecosystèmes Littoraux Anthropisés). UMR 6217. CRNS-IFREMER-ULR. Avenue Michel Crépeau, 17042, La Rochelle, France.*

<sup>4</sup> *Contact: Jeremy KISZKA ([jeremy.kiszka@wanadoo.fr](mailto:jeremy.kiszka@wanadoo.fr))*

## ABSTRACT

The Indian Ocean has been designed as a whale sanctuary in 1979, at the initiative of the Seychelles government. However, very few studies have been conducted to assess the diversity, distribution and abundance of cetaceans in this area. In order to contribute to cetacean management and conservation in this area, a long-term research program is conducting around the island of Mayotte (Comoros, Mozambique Channel). From July 2004 to August 2005, preliminary small boat-based surveys have been undertaken to assess the diversity of cetaceans in the lagoon (1,200 km<sup>2</sup>) and in surrounding waters (external barrier reef slope, insular slope and deep oceanic waters). During the study period, a total of 221.4 hours were spent at sea and 17 cetacean species have been recorded around Mayotte (n=282 sightings). One mysticete (1 Balaenopterid) and sixteen odontocetes (1 Kogid, 1 Physeterid, 13 Delphinids and 2 Ziphiids) species were observed, i.e. humpback whale (*Megaptera novaeangliae*, n=37), sperm whale (*Physeter macrocephalus*, n=1), spinner dolphin (*Stenella longirostris longirostris*, n=118), pantropical spotted dolphin (*Stenella attenuata*, n=61), Indo-Pacific bottlenose dolphin (*Tursiops aduncus*, n=44), melon-headed whale (*Peponocephala electra*, n=5), Blainville's beaked whale (*Mesoplodon densirostris*, n=4), Indo-Pacific humpback dolphin (*Sousa chinensis*, n=4), common bottlenose dolphin (*Tursiops truncatus*, n=2), Risso's dolphin (*Grampus griseus*, n=2), false killer whale (*Pseudorca crassidens*, n=2), dwarf sperm whale (*Kogia sima*, n=2), pygmy killer whale (*Feresa attenuata*, n=1), short-finned pilot whale (*Globicephala macrorhynchus*, n=1), Fraser's dolphin (*Lagenodelphis hosei*, n=1), and Longman's beaked whale (*Mesoplodon pacificus*, n=1). To these 17 species recorded during dedicated surveys, another cetacean species has been observed opportunistically in February 2005 and identified as a Ginkgo-toothed beaked whale (*Mesoplodon ginkgodens*). Around Mayotte, the diversity of cetaceans appears high, especially for a such restricted area (area of 2,500-3,000 km<sup>2</sup> effectively covered). This can be interpreted by the presence of a wide diversity of habitat types, both represented close to each other.

## INTRODUCTION

The Indian Ocean has been designed as a whale sanctuary in 1979, at the initiative of the Seychelles government. This comprises the waters of the Northern Hemisphere from the coast of Africa to 100°E, including the Red and Arabian Seas and the Gulf of Oman; and the waters of the Southern Hemisphere in the sector from 20°E to 130°E, with the southern boundary set at 55°S (Leatherwood & Donovan, 1991). However, few studies on cetacean populations have been made in the islands of the western part of the Indian Ocean Sanctuary (see for example Balance *et al.*, 2001 and Anderson, 2005 for the Maldives area; Keller *et al.*, 1982 for the Seychelles; Rosenbaum *et al.*, 1997 for Madagascar, Amir *et al.*, 2002 for Zanzibar or Corbett, 1994 for Mauritius), and none have been made in the Comoros archipelago and in the wider Mozambique Channel. The Comoros are

situated in the northern Mozambique Channel, in the western tropical Indian Ocean (Fig. 1). The archipelago is constituted by four main islands, and many surrounding small islets. Mayotte (40x20 km; 360 km<sup>2</sup>) is the oldest of the archipelago and the eastern most island. Placed under French administration, Mayotte has been identified as a significant biodiversity hotspot. This French overseas territories has been considered as a priority area (especially for its marine biodiversity) by the French government, in the context of the Biodiversity National Strategy. In addition, IUCN (The World Conservation Union) includes Mayotte, as part of the Comoros and Madagascar, as a worldwide biodiversity hotspot.

This island is actually supporting a large growing human population concentrated on the coastal band. As a result, both the marine and terrestrial biodiversity is threatened by land-use practices, coastal development, pollution, overfishing and the development of recreational activities in the lagoon and surrounding waters, including whale watching. No published studies are actually available (except for the dugong *Dugong dugon* that has been studied; Kiszka *et al.*, 2004). Dedicated small boat surveys were conducted from July 2004 to August 2005 in order to assess cetacean diversity in the lagoon of Mayotte and adjacent insular slope waters. These data provide a preliminary basis of cetacean knowledge in this poorly known area and a preliminary description of an atypical community of tropical cetaceans.

## MATERIALS AND METHODS

### Study area

Mayotte (45°10'E, 12°50'S) is situated in the northern Mozambique Channel (between Madagascar and the African mainland), as part of the Comoros archipelago (Fig. 1). The island is made up of two parts: the main island of Grande Terre (40x20km) where most of the population lives, and the smaller Petite Terre which is 13 km<sup>2</sup> and which is embedded in the barrier reef (Quod *et al.*, 2000; Fig. 1). The island is almost entirely surrounded by a 197 km long barrier reef, with a second double-barrier in the southwest and the immersed reef complex of Iris, in the northwest which has an area of 40 km<sup>2</sup>. There are a dozen of deep passes through the reefs, some of them being the beds of old rivers (Quod *et al.*, 2000).

The inner lagoon is one of the largest in the world (1,200 km<sup>2</sup>) and averages 20 meters in depth, with deeper waters reaching 80 meters in the west (most opened to oceanic waters). The main island is surrounded by a fringing reef (195 km), which is discontinuous where there are river mouths. Around 20 small islets are present in the lagoon (Fig. 1), from 242 to 1ha, and are surrounded by fringing reefs. A total of about 668 ha of mangrove forests occur around the main island, especially in protected bays (Gabri , 1998). For the early 2000's, a large Marine Protected Area project started, and primary aims tried to determine the diversity of species in the lagoon of Mayotte and surrounding waters. In early 2006, 210 hard corals, 800 molluscs, 670 fishes and two marine turtle species were recorded (*Direction de l'Agriculture et de la For t*, unpublished data).

### Data collection

From July 2004 to August 2005, small boat based surveys were undertaken by the *Observatoire des Mammif res Marins de Mayotte*, co-ordinated by the *Direction de l'Agriculture et de la For t* and the *Office National de la Chasse et de la Faune Sauvage*.

Several types of boats were used: 1- a 7 meters catamaran with two 60-hp outboard engines (four strokes); 2- a 7 meters *Yamaha* bark with two 40-hp outboard engines (two strokes); 3- a 6.40 meters cabin boat with a 150-hp outboard engine (four strokes). Surveys were conducted between 0700 h and 1800h, in sea conditions not exceeding Beaufort 3. Observation effort concentrated mostly in the lagoon, and over the insular slope, close to the barrier reef. Some offshore surveys were also undertaken in waters less than 2,000 meters.

For each sighting, species encountered were identified, group size was estimated (maximum, minimum, best estimate), geographic position and main activity were determined. Photo-identification was performed on every species encountered, and biopsy sampling was undertaken on humpback whales and the commonest dolphin species. Objectives of the surveys varied according to seasons, with surveys performed from July to October 2004 mostly dedicated to humpback whales (*Megaptera novaeangliae*) assessment of distribution, occurrence, demographic characteristics and habitat preferences. From November 2004 to August 2005, surveys concentrated on the assessment of dolphin distribution, abundance, habitat use, preferences and social structure.

## RESULTS AND DISCUSSION

### Effort

From July 2004 to August 2005, a total amount of 221.4 hours were spent at sea to look at cetacean diversity around Mayotte. Effort varied according to months, with a more constant effort applied in austral summer (Fig.

2). The spatial distribution of effort around the island is heterogeneous. More effort has been applied in the northern part of the island, including the Iris bank, the southern portion of the lagoon, the coastal waters of the north-east, south-east of the main island as well as the waters out of the barrier reef in the north, east and south. Less effort has been undertaken in the west.

### Cetacean diversity

From July 2004 to August 2005, a total of 17 cetacean species have been recorded around Mayotte (n=282 sightings, Table 1). One mysticete (Balaenopterid) and sixteen odontocetes (1 Kogid, 1 Physeterid, 13 Delphinids and 2 Ziphiids) species were observed, i.e. humpback whale (*Megaptera novaeangliae*, n=37), sperm whale (*Physeter macrocephalus*, n=1), spinner dolphin (*Stenella longirostris*, n=118), pantropical spotted dolphin (*Stenella attenuata*, n=61), Indo-Pacific bottlenose dolphin (*Tursiops aduncus*, n=44), Melon-headed whale (*Peponocephala electra*, n=5), Blainville's beaked whale (*Mesoplodon densirostris*, n=4), Indo-Pacific humpback dolphin (*Sousa chinensis*, n=4), common bottlenose dolphin (*Tursiops truncatus*, n=2), Risso's dolphin (*Grampus griseus*, n=2), false killer whale (*Pseudorca crassidens*, n=2), dwarf sperm whale (*Kogia sima*, n=2), pygmy killer whale (*Feresa attenuata*, n=1), short-finned pilot whale (*Globicephala macrorhynchus*, n=1), Fraser's dolphin (*Lagenodelphis hosei*, n=1), and Longman's beaked whale (*Mesoplodon pacificus*, n=1). To these 17 species recorded during dedicated surveys, another cetacean species has been identified opportunistically by the first author in February 2005. A small and dark beaked whale has been identified as a Ginkgo-toothed beaked whale (*Mesoplodon ginkgodens*) off the east coast, around the 1,200-m isobath. In the eastern African region, there are at least 25 cetacean species recorded, including six baleen whales, 10 toothed whales and nine delphinids (de Lestang, 1993; La Hausse de la Louviere, 1991; reviewed by de Boer *et al.*, 2002). The commonest dolphin species observed are the humpback dolphin, the bottlenose dolphin, the spinner dolphin, the pantropical spotted dolphin and the striped dolphin (*Stenella coeruleoalba*). Around Mayotte, the diversity of cetaceans appears high, especially for a such restricted area (area of 2,500-3,000 km<sup>2</sup> effectively covered). In similar insular tropical islands, few studies have been dedicated to describe cetacean diversity (especially of toothed cetaceans). Cetacean diversity in other tropical archipelagos/islands is generally lower. Recently, dedicated surveys have been undertaken around the main Hawaiian waters to investigate the population structure of odontocete populations, both in coastal and deep oceanic waters (Baird *et al.*, 2003). In 521 hours of effort, only 14 odontocete species were recorded. In addition, the amount of effort was significantly higher in Hawaii, covered a larger area as well as deep oceanic waters, where many potential species can be recorded (which is not the case for the surveys around Mayotte). In Great Abaco (Bahamas), a same amount of effort than in Mayotte (but concentrated in summer) in slope waters associated to Little Bahama Bank (no lagoon/coastal waters) allowed to observe only nine odontocete species (Macleod *et al.*, 2004). Most of them were ziphiids, which can be due to a substantial effort undertaken in deep slope waters, a habitat preferentially used by this cetacean family (Macleod *et al.*, 2004). In French Polynesia, where considerable survey effort has been undertaken around the Marquesas and the Society Islands (with 4,174 and 14,297 km of survey effort, respectively), 11 delphinid species were recorded. Again, the bulk of the diversity was constituted by oceanic species (Gannier, 2000; Gannier, 2002).

In Mayotte, the bulk of the diversity is mostly constituted by delphinid species. Four species sub-groups can be defined on the basis of their general spatial distribution:

- migrating species, occurring both inside the lagoon and along the external slope of the barrier reef, e.g. the humpback whale;
- coastal dolphins, occurring essentially inside the lagoon and close to the coast, i.e. the Indo-Pacific bottlenose dolphin and the Indo-Pacific humpback dolphin;
- barrier reef-associated dolphins, occurring along the external slope of the barrier and rarely inside the lagoon, i.e. the spinner dolphin and the pantropical spotted dolphin;
- oceanic species, occurring over the insular slope (more than 200m deep), such as "blackfishes", beaked whales and sperm whales.

The diversity of cetaceans may be well interpreted by the presence of various marine habitats in the lagoon and adjacent insular slope/deep oceanic waters, in close proximity to each other. In the lagoon, productive waters associated to mangrove systems as well as fringing reef complexes provide potential habitats for Indo-Pacific bottlenose and humpback dolphins (Ross *et al.*, 1994; Wells & Scott, 1994; Karczmarski *et al.*, 2000; Amir *et al.*, 2005). For our study, the distinction between Indo-Pacific and common bottlenose dolphins was based on visual criteria available in the literature (Ross, 1977; Ross & Cockcroft, 1990; Shikakihara *et al.*, 2003). A molecular identification is actually undertaken. The coastal species (*T. aduncus*), is observed in the lagoon and adjacent waters associated with reef complexes, and the oceanic one (*T. truncatus*), is significantly longer, heavier and darker than the coastal species. The offshore bottlenose dolphin is rarely seen. Conversely, coastal

Indo-Pacific bottlenose dolphins are commonly observed, and recent photo-identification surveys indicated high levels of site fidelity (Kiszka, unpublished data).

For the other species encountered, the presence of reef complexes and shallow waters provide ideal habitat characteristics for resting spinner dolphins as well as for pantropical spotted dolphins during their diurnal movements (Norris *et al.*, 1985; Norris, 1991, Psarakos *et al.*, 2003). The proximity of steep insular slope and deep oceanic waters close to the barrier reef allows the presence of a wide diversity of pelagic species, such as the largest delphinids, beaked whales and sperm whales. Other odontocete species (especially oceanic species) in the western Indian Ocean region have been not recorded around Mayotte, such as the striped dolphin, the rough-toothed dolphin (*Steno bredanensis*) or the Cuvier's beaked whale (*Ziphius cavirostris*). In the present study, the occurrence of oceanic species was quite low. This may be attributable to the low searching effort undertaken in these pelagic waters, especially in deeper waters than 500 meters. Conversely, effort has been significantly higher in coastal waters in the lagoon and along the external slope of the barrier reef. This may, at least partially, well explain the high encounter rate of spinner dolphins, pantropical spotted dolphins (along the barrier reef) and Indo-Pacific bottlenose dolphins (in coastal waters).

The humpback whale is the only baleen whale species that was recorded in Mayotte. Other species can be potentially encountered, such as the blue whale (*Balaenoptera musculus*), the Bryde's whale (*Balaenoptera edeni*), the sei whale (*Balaenoptera borealis*), the fin whale (*Balaenoptera physalus*) and the Minke whale (*Balaenoptera acutorostrata*) (Kasuya & Wada, 1991; Robineau, 1991; Anderson, 2005). However, they seem to occur in deeper waters further offshore. The low amount of effort in the oceanic waters of Mayotte and in the wider Mozambique Channel could explain the absence of these large baleen whales in our records. Conversely, the protected waters of the lagoon of Mayotte and associated reef complexes provide ideal conditions for wintering humpback whales. Indeed, during the winter months, when mating and calving take place, humpback whales migrate to low-latitude waters where they congregate with relatively high densities in disjunct, localized regions over shoals, banks, offshore reef systems, and in near-shore waters (Dawbin, 1966; Balcomb & Nichols, 1982; Whitehead & Moore, 1982). In the Southern Hemisphere, the International Whaling Commission currently recognizes seven major humpback whale wintering regions [A-G] (IWC, 2000; IWC, 2004). The Mozambique Channel and greater south-western Indian Ocean has been designated Wintering Region C. Best *et al.* (1998) postulate that there exist three primary migratory streams in the south-western Indian Ocean; one of which terminates among the northern Mozambique Channel Islands.

## CONCLUSION

Mayotte waters appear as an exceptional area for cetaceans, especially for a large and diversified dolphin community. More accurate studies on the distribution, encounter rate, absolute abundance and habitat preference are actually undertaken to clarify the status of populations. The proximity of many habitat types to each other and subsequent accessibility of a wide range of species underline the interest of these waters as a pilot field site for tropical cetacean studies.

## ACKNOWLEDGEMENTS

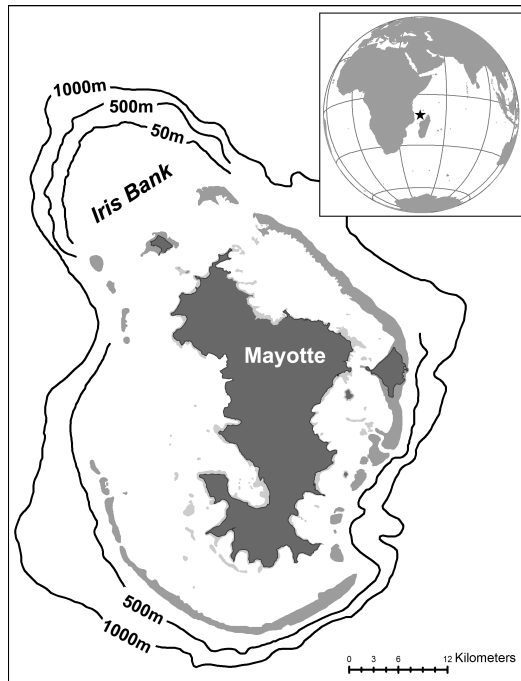
We thanks the Collectivité Départementale de Mayotte and the Ministère de l'Écologie et du Développement Durable for funding this research. Many thanks to the Direction de l'Agriculture et de la Forêt and the Office National de la Chasse et de la Faune Sauvage for their involvement.

## REFERENCES CITED

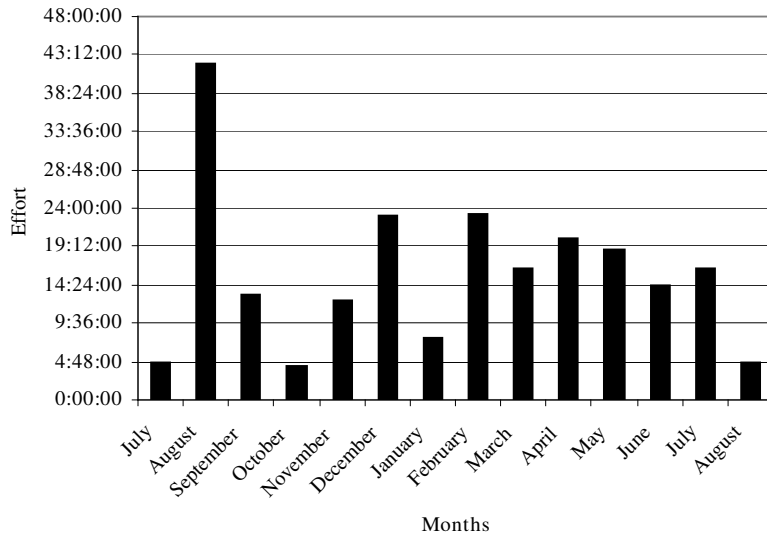
- Amir, O.A., Berggren, P. & Jiddawi, N.S. 2002. The incidental catch of dolphins in gillnets fisheries in Zanzibar, Tanzania. *Western Indian Ocean Journal of Marine Science*, 1: 155-162.
- Amir, O.A., Berggren, P., Ndaró, S.G.M. & Jiddawi, N.S. 2005. Feeding ecology of the Indo-Pacific bottlenose dolphin (*Tursiops aduncus*) incidentally caught in the gillnet fisheries off Zanzibar, Tanzania. *Estuarine, Coastal and Shelf Science*, 63: 429-437.
- Anderson, R.C. 2005. Observations of cetaceans in the Maldives, 1990-2002. *Journal of Cetacean Research and Management*, 7: 119-135.
- Avolio, M., Ersts, P.J., Pomilla, C., Vély, M., Bastid, J.-J., Wendling, B., Seitre, R., Seitre, J., Dammangeat, P., Collin-Mones, V., Razafindrakoto, Y., Findlay, K. & Rosenbaum, H.C. 2002. Humpback whale

- distribution and marine mammal diversity in the waters of Mayotte (Comoros archipelago), in the Mozambique Channel. Paper SC/54/H18 presented to the IWC Scientific Committee.
- Baird, R.W., McSweeney, D.J., Webster, D.L., Gorgone, A.M., Ligon, A.D. 2003. Studies of odontocete population structure in Hawaiian waters: results of a survey through the main Hawaiian islands in May and June 2003. Report prepared under contract N°AB133F-02-CN-0106 from the National Oceanic and Atmospheric Administration, Western Administrative Support Center, Seattle, USA. 25 p.
- Balcomb, K.C. & G. Nichols. 1982. Humpback whale censuses in the West Indies. *Report of the International Whaling Commission* 32:401-406.
- Ballance, L.T., Anderson, R.C., Pitman, R.L., Stafford, K., Shaan, A., Waheed, Z. & Brownell Jr. R.L. 2001. Cetacean sightings around the Republic of the Maldives, April 1998. *Journal of Cetacean Research and Management*, 3: 213-218.
- Best, P. B., Findlay, K.P., Sekiguchi, K., Peddemors, V.M., Rakotonirian, B., Rossouw, A. & Grove, D. 1998. Winter distribution and possible migration routes of humpback whales (*Megaptera novaeangliae*) in the southwest Indian Ocean. *Marine Ecology Progress Series*, 162:287-299.
- Corbett, H.D. 1994. The occurrence of cetaceans of Mauritius and adjacent waters. *Report of the International Whaling Commission*, 44: 393-397.
- Dawbin, W. H. 1966. The seasonal migratory cycle of humpback whales. Pp. 145-170. In K.S. Norris (Ed). *Whales, Dolphins, and Porpoises*. Berkeley: University of California Press.
- De Boer, M.N., Baldwin, R., Burton, C.L.K., Eyre, E.L., Jenner, K.C.S., Jenner, M.N.M., Keith, S.G., McCabe, K.A., Parsons, E.C.M., Peddemors, V.M., Rosenbaum, H.C., Rudolph, P. and Simmonds, M. 2002. Cetaceans in the Indian Ocean Sanctuary: A review. Paper SC/54/O5 presented to the IWC Scientific Committee, April 2002 [unpublished].
- De Lestang, J.N. 1993. Status of marine mammals in the eastern African region. Report to UNEP. Regional Seas Reports and Studies Series.
- Gabrié, C. 1998. State of the coral reefs in French overseas departments and territories. Ministry of spatial planning and environment report. 36 p.
- Gannier, A. 2000. Distribution of cetaceans off the Society Islands (French Polynesia) as obtained from dedicated survey. *Aquatic Mammals*, 26: 111-126.
- Gannier, A. 2002. Distribution of cetaceans in the Marquesas Islands (French Polynesia) as obtained from a small boat dedicated survey. *Aquatic Mammals*, 28: 198-210.
- IWC. 2000. Report of the Sub-Committee on In-Depth Assessments. Report of the International Whaling Commission #52.
- IWC. 2004. Report of the Sub-Committee on Southern Hemisphere humpback whales. Report of the International Whaling Commission #56.
- Kasuya, T. & Wada, S. 1991. Distribution of large cetaceans in the Indian Ocean: data from Japanese sighting records, November-March. In: S. Leatherwood & G.P. Donovan, eds. *Cetaceans and cetacean research in the Indian Ocean Sanctuary*. Marine Mammal Technical Report N°3. UNEP, Nairobi, Kenya: 139-170.
- Keller, R.W., Leatherwood, S. & Holt, S.J. 1982. Indian Ocean cetacean survey, Seychelles islands, April through June 1980. *Report of the International Whaling Commission*, 32: 503-513.
- Kiszka, J., 2004. *Les mammifères marins dans les eaux de Mayotte (Océan Indien): statut écologique et de conservation dans le cadre de l'inventaire du patrimoine naturel selon la méthodologie nationale ZNIEFF*. Rapport de l'Observatoire des Mammifères Marins de Mayotte (Office National de la Chasse et de la Faune Sauvage & Direction de l'Agriculture et de la Forêt). 24 p.
- Kiszka, J., Vely, M., Bertrand, N., Breyse, O., Wickel, J. & Maleck-Bertrand, N. 2004. Mayotte and Reunion. In: C. Muir, A. Ngusaru & L. Mwananema (eds.). *The Status of Dugongs in the Western Indian Ocean & Priority Conservation Actions*. The Eastern African Marine Ecoregion: 50-55.
- La Hausse De La Louviere, P. 1991. Whales and dolphins of Mauritius. An identification guide. Mauritius Marine Conservation Society, Phoenix, Mauritius. 32 p.
- Leatherwood, S. & Donovan, G.P. 1991. Cetaceans and cetacean research in the Indian Ocean Sanctuary. In: S. Leatherwood & G.P. Donovan (eds). *Cetaceans and cetacean research in the Indian Ocean Sanctuary*. Marine Mammal Technical Report N°3, UNEP, Nairobi, Kenya.
- Louette, M., Meirte, D. & Jocqué, R. (eds.) 2004. *La faune terrestre de l'archipel des Comores*. Studies in Afrotropical Zoology, 293. Tervuren : MRAC.
- Macleod, C.D., Hauser, N. & Peckham, H. 2004. Diversity, relative density and structure of the cetacean community in summer months east of Great Abaco, Bahamas. *Journal of the Marine Biological Association, UK*, 84: 469-474.
- Norris, K.S. 1991. "Dolphin Day. The Life and Times of the Spinner Dolphin". Norton, New York. 335 p.
- Norris, K.S., Würsig, B., Wells, R.S., Würsig, M., Brownlee, S.M., Johnson, C. & Solow, J. 1985. The behavior of the Hawaiian spinner dolphin, *Stenella longirostris*. *Southwestern Fisheries Center Administration Report*. LJ-85-06C. 213 p.

- Paris, B., 1999. *Espèces de faune et de flore connues en RFI des Comores. Projet de conservation de la biodiversité et développement durable*. (PNUD/FEM) Moroni, Comores.
- Pitman, R.L., Palacios, D.M., Brennan, P.L.R., Brennan, B.J., Balcomb, K.C.III, & Miyashita, T. 1999. Sightings and possible identity of a bottlenose whale in the tropical Indo-Pacific: *Indopacetus pacificus*? *Marine Mammal Science*, 15: 531-549.
- Psarakos, S., Herzing, D.L. & Marten, K. 2003. Mixed-species associations between pantropical spotted dolphins (*Stenella attenuata*) and spinner dolphins (*Stenella longirostris*) off Oahu, Hawai'i. *Aquatic Mammals*, 29: 390-395.
- Quod, J.P., Naim, O. & Abdourazi, F., 2000. The Comoros archipelago. Pp. 243-252. In: C. Sheppard (Ed.). *Seas at the Millennium: an environmental evaluation*. Pergamon Press, Oxford.
- Robineau, D. 1975. Echouage d'un *Ziphius cavirostris*, Cuvier 1823, dans l'archipel des Comores (Océan Indien). *Mammalia*, 39: 513-515.
- Robineau, D. 1991. Balaenopterid sightings in the western tropical Indian Ocean (Seychelles area), 1982-1986. In: S. Leatherwood & G.P. Donovan, eds. *Cetaceans and cetacean research in the Indian Ocean Sanctuary*. Marine Mammal Technical Report N°3. UNEP, Nairobi, Kenya: 171-179.
- Rosenbaum, H.C., Walsh, P.D., Razafindrakoto, Y., Vely, M. & DeSalle, R. 1997. First description of a humpback whale breeding ground in Baie d'Antongil, Madagascar. *Conservation Biology*, 11: 312-314.
- Ross, G.J.B. 1984. The smaller cetaceans of the southeast coast of southern Africa. *Annals of Cape Province Museum (Nat. Hist.)*, 15 (2): 173-410.
- Ross, G.J.B. & Cockcroft, V.G. 1990. Comments on Australian bottlenose dolphins and taxonomic stock of *Tursiops aduncus* (Ehrenburg, 1832). Pp: 329-336. In: S. Leatherwood & R. Reeves (Eds.). *The Bottlenose Dolphin*. Academic Press, San Diego. 653 p.
- Ross, G.J.B., Heinsohn, G.E. & Cockcroft, V.G.C. 1994. Humpback dolphins *Sousa chinensis* (Osbeck, 1765), *Sousa plumbea* (Cuvier, 1829) and *Sousa teuszii* (Kukenthal, 1892). In S.H. Ridway & Sir R. Harrison. *Handbook of Marine Mammals*. Volume 5: The first book of dolphins: 23-42.
- Shirakihara, M., Yoshida, H. & Shirakihara, K. 2003. Indo-Pacific bottlenose dolphins *Tursiops aduncus* in Amakusa, western Kyushu, Japan. *Fisheries Science*, 69: 654-656.
- Tillot, V. 1994. *Etude de l'environnement marin et côtiers et des aspects socio-économiques de la pêche autour de l'île de Mohéli*. Rapport de projet PNUD/UNESCO/UICN – COI/91/006 « Appui à la programmation nationale en matière d'environnement ». 80 p.
- Tilot, V. 1997. Caractéristiques écologiques et recommandations pour la conservation de la biodiversité des ressources naturelles des milieux marins, côtiers et terrestres de la Grande Comore (République Fédérale Islamique des Comores, SW Océan Indien). *Mésogée*, 55: 65-106.
- Wells, R.S. & Scott, M.D. 1994. Bottlenose dolphin. In: S.H. Ridgway & F.R.S. Harrison, eds. *Handbook of marine mammals*. The second book of dolphins. Academic Press, London. Pp. 1-55.
- Whitehead, H. & Moore, M. J. 1982. Distribution and movements of West Indian humpback whales in winter. *Canadian Journal of Zoology*, 60: 2203-2211.



**Fig. 1:** Location of the island of Mayotte and its lagoon complex. The dark grey area is the barrier reef. The light grey areas represent the fringing reef and the double barrier reef, in the south-west.



**Fig. 2:** Effort undertaken around Mayotte from July 2004 to August 2005 (in hours and minutes).