

# Cetacean diversity around the Mozambique Channel island of Mayotte (Comoros archipelago)

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## ABSTRACT

The Indian Ocean was designated as a whale sanctuary in 1979. While cetacean research has been conducted throughout the sanctuary, few studies have been conducted to assess the diversity, distribution and abundance of cetaceans inhabiting the waters surrounding the islands in the northern Mozambique Channel. In order to contribute to management and conservation efforts in this area, a series of small boat-based surveys were undertaken around the island of Mayotte from July 2004 to August 2005 to assess the diversity of cetaceans in the lagoon and surrounding waters, i.e. external barrier reef slope, insular slope (200–1,000m) and oceanic (>1,000m) waters. During this period, more than 284 hours were spent at sea on-effort and 17 cetacean species were recorded around Mayotte ( $n=286$  sightings). One mysticete (1 Balaenopterid) and sixteen odontocetes (1 Kogid, 1 Physeterid, 13 Delphinids and 2 Ziphiids) were observed: spinner dolphin,  $n=118$ ; pantropical spotted dolphin,  $n=61$ ; Indo-Pacific bottlenose dolphin,  $n=44$ ; humpback whale,  $n=37$ ; melon-headed whale,  $n=5$ ; Blainville's beaked whale,  $n=4$ ; Indo-Pacific humpback dolphin,  $n=4$ ; common bottlenose dolphin,  $n=2$ ; Risso's dolphin,  $n=2$ ; false killer whale,  $n=2$ ; dwarf sperm whale,  $n=2$ ; sperm whale,  $n=1$ ; pygmy killer whale,  $n=1$ ; short-finned pilot whale,  $n=1$ ; Fraser's dolphin,  $n=1$ ; and Longman's beaked whale,  $n=1$ . In addition to these 17 species recorded during dedicated surveys, two other cetacean species were observed opportunistically and subsequently identified as the Ginkgo-toothed beaked whale and the blue whale. The relatively large diversity of cetaceans around Mayotte is attributed to the wide range of marine habitats, such as coastal, reef-associated and oceanic, within close proximity to one another.

KEYWORDS: INDIAN OCEAN; MOZAMBIQUE CHANNEL; ODONTOCETES; DIVERSITY; SURVEY-VESSEL; SPINNER DOLPHIN; PANTROPICAL SPOTTED DOLPHIN; INDO-PACIFIC BOTTLENOSE DOLPHIN; HUMPBACK WHALE; MELON-HEADED WHALE; BLAINVILLE'S BEAKED WHALE; INDO-PACIFIC HUMPBACK DOLPHIN; COMMON BOTTLENOSE DOLPHIN; RISSO'S DOLPHIN; FALSE KILLER WHALE; DWARF SPERM WHALE; SPERM WHALE; PYGMY KILLER WHALE; SHORT-FINNED PILOT WHALE; FRASER'S DOLPHIN; LONGMAN'S BEAKED WHALE; HABITAT; DISTRIBUTION; SOUTHERN HEMISPHERE

## INTRODUCTION

In 1979, the International Whaling Commission (IWC) accepted a proposal to create a large sanctuary in the Indian Ocean that comprised 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 (de Boer *et al.*, 2002; Leatherwood and Donovan, 1991). Cetacean research has been conducted throughout the Indian Ocean Sanctuary although most studies to date have focused on continental coastal waters (Cockcroft *et al.*, 1990;1991; Cockcroft *et al.*, 1992; Findlay and Best, 1996; Findlay *et al.*, 1994; Karczmarski, 1996; Karczmarski and Cockcroft, 1999). Some studies have been undertaken around the islands of the western reaches of the Indian Ocean Sanctuary: Seychelles (Keller *et al.*, 1982); Madagascar (Rosenbaum *et al.*, 1997); Zanzibar (Amir *et al.*, 2002; Amir *et al.*, 2005a; Amir *et al.*, 2005b; Stensland *et al.*, 2006); and Mauritius (Corbett, 1994). Currently, no published data exist for the Comoros archipelago and the wider Mozambique Channel.

The Comoros archipelago is a cluster of four islands situated in the northern Mozambique Channel, between Madagascar and Mozambique (Fig. 1). The main island of Mayotte and its surrounding islets, currently under French administration, are located on the eastern edge of the

Comoros archipelago and Mayotte is, geologically, the oldest island (Quod *et al.*, 2000). This overseas territory is considered by the French government to be a priority area in the context of the National Biodiversity Strategy, especially regarding marine biodiversity. The World Conservation Union (IUCN) lists Mayotte, as well as the neighbouring islands of the Union of the Comoros and Madagascar, as a global biodiversity hotspot.

Mayotte supports a growing human population concentrated along the coast. As a result, both its terrestrial and marine biodiversities are threatened by land-use practices, coastal development, pollution, overfishing and the development of recreational activities in the lagoon and surrounding waters, including whalewatching. In response to these growing concerns, a large Marine Protected Area (MPA) network project has recently started with the primary objective of determining the diversity of species found in the lagoon of Mayotte and its surrounding waters. No published data are available on the status of marine mammals in the waters surrounding Mayotte and the Comoros archipelago. In order to contribute to the baseline knowledge on cetacean populations within the waters of Mayotte and the Indian Ocean Sanctuary, dedicated small boat surveys were conducted from July 2004 to August 2005 in order to assess cetacean diversity in the lagoon and adjacent slope waters. These data provide a preliminary description of cetacean diversity in this poorly studied area.

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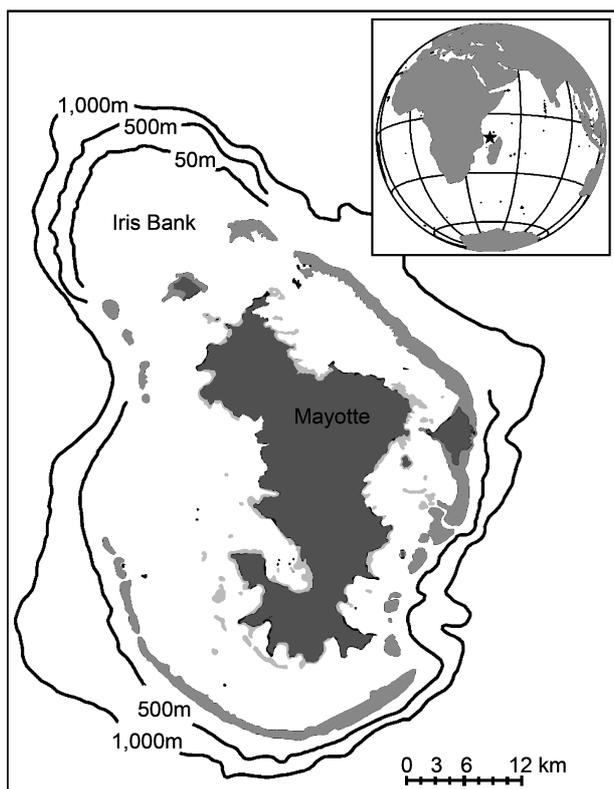


Fig. 1. Location of the island of Mayotte and its lagoon complex. The dark grey area is the barrier reef. The light grey areas represent the fringing reef and the double barrier reef, in the south-west.

## MATERIALS AND METHODS

### Study area

Mayotte (12°50'S, 45°10'E) is situated in the northern Mozambique Channel between Madagascar and the African mainland (Fig. 1). The island is made up of two major parts: the main island of Grande Terre where most of the population lives (approximately 360km<sup>2</sup>); and the smaller Petite Terre (approximately 13km<sup>2</sup>), which is embedded in the barrier reef (Quod *et al.*, 2000). Mayotte is almost entirely surrounded by a 197km long barrier reef, with a second double-barrier in the southwest. Adjacent to the northern extent of the lagoon is the immersed reef complex of Iris Bank (approximately 215km<sup>2</sup>).

The inner lagoon ranks among the largest lagoons in the world (1,500km<sup>2</sup>) (Quod *et al.*, 2000), averaging 20m in depth, with deeper waters reaching 80m in the west. Numerous deep passes are present in the barrier reef, many of which are the beds of old rivers. The main island is surrounded by a fringing reef (195km), which is discontinuous where there are river mouths. Some 20 small islets are present in the lagoon ranging from 1 to 242ha in size and are surrounded by fringing reefs. Approximately 670ha of mangrove forests occur around the main island, especially in protected bays (Quod *et al.*, 2000).

### Data collection and analysis

From July 2004 to August 2005, small boat based surveys were undertaken by the Observatoire des Mammifères Marins de Mayotte, coordinated by the Direction de l'Agriculture et de la Forêt and the Office National de la Chasse et de la Faune Sauvage.

Several types of boats were used: a 7m catamaran equipped with two, four-stroke, 60hp outboard engines; a 7m boat equipped with two, two-stroke, 40hp outboard

engines; a 6.40m cabin boat equipped with one, four-stroke, 150hp outboard engine. Surveys were conducted throughout the study period during daylight hours, i.e. between 07:00h and 18:00h, in seastate conditions not exceeding Beaufort 3. Survey vessels did not follow pre-defined transects but every attempt was made to sample each habitat type within the surrounding waters of Mayotte. Observation effort concentrated mostly in the lagoon and over the insular slope. Limited survey effort was also applied in waters more than 1,000m deep. From July 2004 to August 2005, a total of 284 hours were spent actively searching for marine mammals around Mayotte. Effort varied according to month, with more effort occurring during the austral summer.

For each sighting, the species, group size (maximum, minimum, best estimate), geographic position and primary behavioural activity were recorded. Cetaceans were identified to their species level using morphological characters and compared to a published identification guide (Jefferson *et al.*, 1993). The objectives of the surveys varied according to season and species. Surveys conducted during July to October 2004 were mostly dedicated to the assessment of humpback whale (*Megaptera novaeangliae*) distribution, occurrence, group composition and habitat use. From November 2004 to August 2005, surveys concentrated on the assessment of dolphin distribution, abundance, habitat use and social organisation.

## RESULTS

From July 2004 to August 2005, a total of 17 cetacean species were encountered around Mayotte ( $n=286$  sightings, Table 1): humpback whale ( $n=37$ ), sperm whale (*Physeter macrocephalus*,  $n=1$ ), spinner dolphin (*Stenella longirostris*,  $n=118$ ), pantropical spotted dolphin (*S. 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 (*T. 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 (*M. pacificus*,  $n=1$ ).

In addition to these 17 species recorded during dedicated surveys, two other cetacean species were identified opportunistically by the first author. A beaked whale was encountered from a small boat in February 2005 and identified *in situ* as a ginkgo-toothed beaked whale (*M. ginkgodens*) off the east coast, around the 1,200m isobath. However, no photographs were available to confirm the specific identification of this animal. A group of three blue whales (*Balaenoptera musculus*) was encountered from an aircraft in August 2006 off the east coast, around the 300m isobath.

## DISCUSSION

In the western Indian Ocean, 25 cetacean species have been recorded, including six baleen whales, ten toothed whales and nine delphinids (De Lestang, 1993). Of the nine delphinids, the Indo-Pacific humpback dolphin, bottlenose dolphin, spinner dolphin, pantropical spotted dolphin and striped dolphin were the most frequently encountered (de Boer *et al.*, 2002; De Lestang, 1993). With the exception of

Table 1

Number of cetacean sightings (mono-specific groups), cumulated numbers of individuals and group size characteristics (July 2004–August 2005).

Species	No. sightings	% sightings	Mean group size	Group size range
<b>Odontocetes</b>				
Spinner dolphin	118	41.259	70.5	3–400
Pan-tropical spotted dolphin	61	21.329	78.5	3–300
Indo-Pacific bottlenose dolphin	44	15.385	6.3	1–12
Melon-headed whale	5	1.748	310	200–450
Blainville's beaked whale	4	1.4	2.5	1–5
Indo-Pacific humpbacked dolphin	4	1.4	2.2	1–3
False killer whale	2	0.7	125	100–150
Dwarf sperm whale	2	0.7	1.5	1–2
Risso's dolphin	2	0.7	11	2–20
Bottlenose dolphin	2	0.7	80	40–120
Longman's beaked whale	1	0.4	1	-
Pygmy killer whale	1	0.4	4	-
Short-finned pilot whale	1	0.4	60	-
Fraser's dolphin	1	0.4	120	-
Sperm whale	1	0.4	11	-
<b>Mysticetes</b>				
Humpback whale	37	12.937	2.1	1–4
<b>Total</b>	<b>286</b>	<b>100%</b>	-	-

striped dolphins (*S. coeruleoalba*), the assemblage of dolphin species frequently encountered in Mayotte is similar to the rest of western Indian Ocean.

Compared to similar oceanic islands, the diversity of cetaceans observed around Mayotte appears to be high, with the majority being delphinid species. However, few studies have been dedicated to describing cetacean diversity in similar insular tropical islands/archipelagos. Recently, surveys were undertaken around the main Hawaiian islands to investigate the structure of odontocete populations, both in coastal and oceanic waters (Baird *et al.*, 2003). During 521 hours of effort, 14 odontocete species were recorded (Baird *et al.*, 2003). In Great Abaco (northern Bahamas), in slope waters associated with Little Bahama Bank, only nine odontocete species were recorded (MacLeod *et al.*, 2004). Most of the odontocetes reported by MacLeod *et al.* (2004) belonged to the ziphiid family, which may be due to a substantial effort undertaken in deep slope waters; a habitat preferentially used by this cetacean family (e.g. for Blainville's beaked whale; MacLeod and Zuur (2005)). In French Polynesia, where considerable survey effort has been undertaken around the Marquesas and the Society Islands, 11 delphinid species were recorded. Most of the diversity was constituted by oceanic species (Gannier, 2000;2002).

The diversity of cetaceans occurring around Mayotte could be attributed to the presence of a wide range of marine habitats within close proximity to one another. The presence of reef complexes and shallow waters provide a habitat characteristic of that used by resting spinner dolphins as well as pantropical spotted dolphins during their diurnal movements (Norris, 1991; Norris *et al.*, 1985; Psarakos *et al.*, 2003). In the lagoon, productive waters associated with mangrove systems, as well as fringing reef complexes, provide potential habitats for Indo-Pacific bottlenose and humpback dolphins (Ross *et al.*, 1994; Wells and Scott, 1999).

For the *Tursiops* data reported here, the distinction between Indo-Pacific and common bottlenose dolphins was based on visual criteria available in the literature (Ross and Cockcroft, 1990; Shirakihara *et al.*, 2003) and molecular identification is currently in progress. At present, the IWC recognises only these two species of *Tursiops* (International

Whaling Commission, 2000). The Indo-Pacific bottlenose dolphin is smaller than the common bottlenose dolphin and the former develops ventral spotting at about the time of sexual maturity (Ross and Cockcroft, 1990). Around Mayotte, both species occur. *T. aduncus* has been observed in the lagoon and adjacent waters associated with reef complexes. It is commonly observed and photo-ID indicates high levels of site-fidelity (unpublished data). *T. truncatus* is significantly longer, heavier and darker than this coastal species and although rarely seen, has been observed in deeper waters outside the lagoon.

The proximity of the steep insular slope and deep oceanic waters close to the barrier reef allow for possible encounters with pelagic species, such as the largest delphinids, beaked whales and sperm whales. Other odontocete species (especially oceanic species) that have been documented in the western Indian Ocean region such as the striped dolphin, the rough-toothed dolphin (*Steno bredanensis*) and Cuvier's beaked whale (*Ziphius cavirostris*) (de Boer *et al.*, 2002; Peddemors, 1999; Robineau, 1975), have not yet been observed around Mayotte during systematic surveys. In general, the occurrence of oceanic species was quite low. This is attributable to the low search effort undertaken in waters deeper than 500m. Effort was significantly higher in the coastal waters of the lagoon and along the external slope of the barrier reef. This may 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 and the blue whale are the only baleen whale species that have been recorded around Mayotte. Other species that have been documented in the Indian Ocean include: Bryde's whales (*B. edeni*); sei whales (*B. borealis*); fin whales (*B. physalus*); and minke whales (*B. acutorostrata*) (Anderson, 2005; Kasuya and Wada, 1991; Robineau, 1991). However, these baleen whales 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 other baleen whales, while the protected waters of the lagoon of Mayotte and associated reef complexes provide characteristic conditions for wintering humpback whales

(Balcomb and Nichols, 1982; Dawbin, 1966; Whitehead and Moore, 1982). The observation of the three blue whales close to the barrier reef seems to be exceptional, as this species is generally oceanic (Kasuya and Wada, 1991).

The waters surrounding Mayotte appear to be an exceptional area for cetacean abundance, especially for a large and diversified dolphin community. More accurate studies on distribution, encounter rate, absolute abundance and habitat preference are currently being undertaken to clarify the status of these populations. The close proximity of diverse 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.

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