J. Mar. Biol. Ass. U.K. (2007), **87**, 101–104
Printed in the United Kingdom
doi: 10.1017/S0025315407055129

Atypical associations between dugongs (*Dugong dugon*) and dolphins in a tropical lagoon

Jeremy J. Kiszka

Office National de la Chasse et de la Faune Sauvage, Délégation Régionale Outre-Mer & Observatoire des Mammifères Marins (OMM), 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. Present address: Centre de Recherche sur les Ecosystèmes Littoraux Anthropisés (CRELA), UMR 6217, CNRS-Ifremer-Université de La Rochelle, Avenue Michel Crépeau, 17071, La Rochelle, France.
E-mail: jeremy.kiszka@wanadoo.fr

Several types of relationships link organisms to each other, including competition, predation and various types of associations. This paper presents the first case of association/interaction between dugongs, *Dugong dugon*, the only strictly marine herbivorous mammal, and three species of tropical dolphins in and around the lagoon of Mayotte (45°10'E 12°50'S), in the western tropical Indian ocean. Data were collected opportunistically from 1999 to 2005 in the surrounding waters of Mayotte from boat (N=2 observations) and ULM (ultra-light motorized vessel, N=2). The dolphin species involved in associations with dugongs were Indo-Pacific bottlenose dolphin, *Tursips aduncus*, Indo-Pacific humpback dolphin, *Sousa chinensis*, and spinner dolphin, *Stenella longirostris*. In one case, dugongs were associated with both bottlenose and humpback dolphins. Associations were observed in the protected waters of the lagoon and outside, along the external slope of the barrier reef. Group size, activity and group structure of each species were recorded. Behavioural observations suggest that dugongs and dolphins were engaged in similar activities, such as travelling, on several occasions and were clearly associated when group formation was tight. If dolphins and dugongs may not associate for feeding purposes, then these interactions may occur: (1) for predation avoidance toward sharks; or (2) without any ecological reasons due to dolphin and dugong habitat overlap around the island.

INTRODUCTION

Several types of relationships link organisms to each other, including competition, predation and various types of associations. In marine mammals, cooperation (including mutualism) is the most common type of association, especially for predation or predator avoidance. In cetaceans, this phenomenon seems most common in oceanic waters, where the risk of predation is higher and prey often aggregate in larger schools (Norris & Dohl, 1980; Wells et al., 1980). The most common type of interaction is aggression between sympatric species, often reported in small cetaceans (Herzing & Johnson, 1997; Baird, 1998; Wedekin et al., 2004). Some of them can have lethal consequences, such as aggressive interactions reported between Atlantic bottlenose dolphins (*Tursiops truncatus*) and harbour porpoises (*Phocoena phocoena*) in the Moray Firth, Scotland (Ross & Wilson, 1996). Associations or non-predatory interactions are essentially observed in species within the same order, having similar biological and ecological requirements. This can explain aggressive interactions, that can be related to competition for resource and habitat use. This paper presents the first documented case of association/interaction between dugongs (*Dugong dugon*), the only strictly marine herbivorous mammal, and three species of tropical dolphins in and around the lagoon of Mayotte, in the western tropical Indian Ocean (Comoros Archipelago, northern Mozambique Channel, Figure 1).

Mayotte (45°10'E 12°50'S) is almost entirely surrounded by a 197 km long barrier reef, with a second double-barrier in the south-west, and the immersed reef complex of Iris, in the north-west which has an area of 40 km² (Figure 1). There are a dozen deep passes through the reefs, some of them being the beds of old rivers (Quod et al., 2000). The inner lagoon is very large (1200 km²) and averages 20 m in depth, with deeper waters reaching 80 m. The main island is surrounded by a fringing reef (195 km), which is discontinuous where there are river mouths. The lagoon of Mayotte and adjacent insular slope waters are inhabited by a wide diversity of marine mammals, including the dugong and 20 cetacean species. The most common species are the spinner dolphin, *Stenella longirostris*, the pantropical spotted dolphin, *Stenella attenuata*, the melon-headed whale, *Peponocephala electra*, and the Blainville's beaked whale, *Mesoplodon densirostris*, occurring along the external slope of the barrier reef. The Indo-Pacific bottlenose dolphin, *Tursiops aduncus*, and the Indo-Pacific humpback dolphin, *Sousa chinensis*, are the most common coastal/lagoonal species (Kiszka et al., 2006). Dugongs are quite rare, but were apparently abundant before the 1980s according to local fishermen. Then, they declined significantly, probably because of unsustainable hunting pressure. A small marginal population survives in the lagoon and on seagrasses over the barrier reef (WWF Eastern African Marine Ecoregion, 2004).

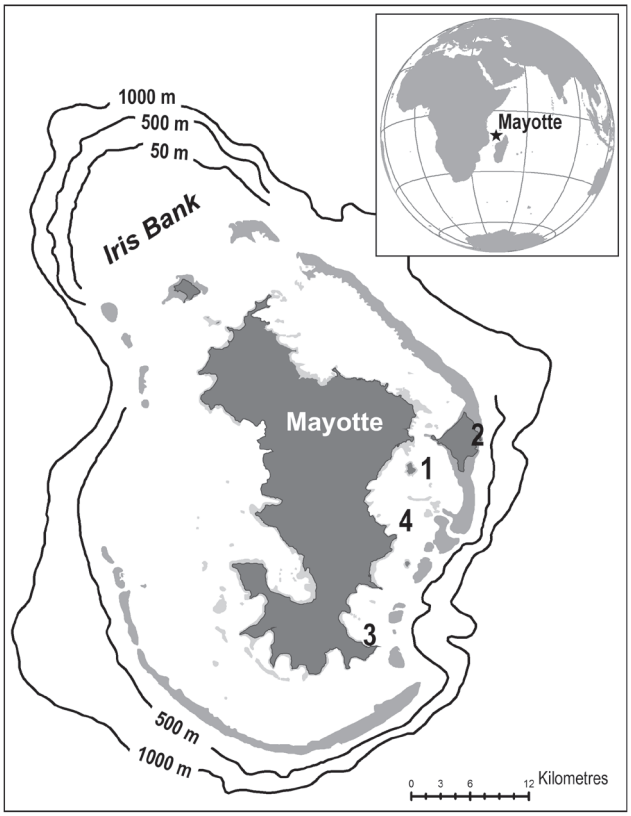

Figure 1. The study area and location of associations involving dugongs and dolphins.

Here we present four records of associations between dugongs and dolphins around Mayotte. Details of observations are described in this paper.

MATERIALS AND METHODS

The data were collected opportunistically by experienced observers, or inexperienced observers (for the Association 1). However, in this case, the interview was accompanied by pictures (Figure 2) supporting evidence of the association between dugongs and dolphins.

Observations of the other associations (Associations 2 & 3) were undertaken from a ULM (ultra-light motorized vessel) during recreational flights, and the last association was collected during a whale-watching trip. The summary of associations is presented in Table 1.

RESULTS

Association 1

In November 1999 (austral summer), two dugongs (an adult and a sub-adult), and a group of four Indo-Pacific bottlenose dolphins were opportunistically observed in the eastern part of the lagoon of Mayotte (Figure 1). Both animals were observed in around 18–20 m deep waters, swimming in the same direction, in tight formation, and breathing was quite synchronized (Figure 2). The general behaviour of both species was probably travelling. The observation was made by a yachtsman during approximately 20 min, confirming species identification by pictures (Figure 2). No direct contacts between these two species were observed. However, the observation of the animals was boat-based so potential underwater interactions were not observed. The contact with the animals was lost during a longer dive of both species.

Association 2

In April 2005, outside of the barrier reef (250 m from reef edge; Figure 1), off the east coast, a single dugong was seen in association with approximately 100 spinner dolphins, slowly travelling to the south parallel to the barrier reef. The observation was aerial-based. The depth where the group was observed was 70 m. The dugong was quite isolated from the dolphins. However, the animal was in the middle of the group and showed a similar travelling behaviour.

Association 3

In May 2005, during a recreational flight in a ULM, an association between one dugong and three Indo-Pacific humpback dolphins was observed in the south-east of the Bay of Bambo (Figure 1). The group formation was defined as tight. Both species were slowly milling in the middle of the bay (19 m deep). The dugong was constantly observed between the dolphins, and never at the periphery of the group. The observation was made during a respiratory phase (breathing every 10–20 s). The duration of the observation was very short (approximately 6 min).

Association 4

In September 2005, a mixed group of seven Indo-Pacific bottlenose dolphins, two humpback dolphins and three dugongs (a large adult and a mother–calf pair) was observed inside the lagoon (Figure 1). The observation was made by an experienced observer from a whale-watching vessel.

Table 1. *Summarized records of dugong–dolphin association in the lagoon of Mayotte.*

	No. of dugongs involved	Dolphin species involved	No. of dolphins involved	Activity	Group formation
Association 1	2 (adults)	Indo-Pacific bottlenose dolphin	4	Travelling	Tight
Association 2	1 (adult)	Spinner dolphin	100	Travelling	Loose
Association 3	1 (adult)	Indo-Pacific humpback dolphin	3	Milling	Tight
Association 4	3 (including mother–calf pair)	Indo-Pacific bottlenose–humpback dolphin	7–3	Resting	Variable

Figure 2. Two dugongs associated with a group of Indo-Pacific bottlenose dolphins (Association 1).

Firstly, the bottlenose dolphins were detected and seen resting. Then, an adult dugong was seen in the group, quite ahead of the dolphins, followed by a mother–calf pair in the core of the group of dolphins. The two humpback dolphins were seen further in the front of the aggregation. The encounter lasted 25 min (1150 to 1215 h), and the bottlenose dolphins were clearly associated with the dugongs (close proximity of the animals to each other). The main activity of the aggregation was resting. The dives of dugongs were long (7 to 8 min), whereas the dolphins were observed essentially close to the surface. The two dugongs surfacing first were very synchronized, and the largest animal (in the front) appeared to wait for the mother–calf pair to surface. The last surfacing dugong was synchronized with the bottlenose dolphins, and both species fluke-dived at the same time. The humpback dolphins never showed any sign of interaction with the dugongs or even with the bottlenose dolphins. The depth of the position where the association had been observed was 20 m.

DISCUSSION

Dugongs and dolphins occur at a different level of abundance around the island of Mayotte. Dugongs are not abundant but are regularly observed. The population inhabiting the waters of the lagoon is quite marginal (no available abundance estimates). Their potential habitats (seagrass meadows; Heinsohn & Birch, 1972) are abundant in the shallow waters of the lagoon, especially on the fringing and barrier reefs (Direction de l'Agriculture et de la Forêt de Mayotte, unpublished data). 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 & Scott, 1994). The presence of reef complexes and shallow waters provide ideal habitat characteristics for resting spinner dolphins during their diurnal movements (Norris, 1991; Norris et al., 1994). The associations between dolphins and dugongs are probably not related to feeding purposes: dugongs primarily feed on seagrasses (Preen, 1992) while the dolphin species involved in these associations with dugongs feed exclusively on fish, cephalopod and crustacea (Norris et al., 1994; Amir et al., 2005). If non-predatory and non-dietary interactions occurred between dugongs and dolphins, then we can suspect that these associations can be anti-predatory, especially toward sharks inhabiting both internal waters of the lagoon and along the slope of the barrier reef. Sharks, especially tiger sharks (*Galeocerdo cuvier*), are known to feed on dolphins and dugongs in tropical waters, such as in Shark Bay, western Australia (Heithaus & Dill 2002; Wirsing, 2005). Tiger sharks are known to occur in the lagoon of Mayotte, but their occurrence is not proven. They may be attracted (especially the largest individuals feeding on large organisms such as dugongs) to the waters around Mayotte that are areas of high productivity in an oceanic environment. Dugongs may use the presence of dolphins to avoid sharks, as it is hypothesized that dolphins may be more able to detect and avoid them. This phenomenon may occur because of the relatively deep waters, even in the lagoon, and the subsequent higher risk of shark predation. Indeed, in Australia, extensive aerial surveys have been performed, such as in Moreton Bay where both dugongs and dolphins are abundant (H. Marsh, personal communication). Nevertheless, such dolphin and dugong associations/interactions have never been reported. This may be explained by the fact that dugong and dolphin sightings were done in shallow waters, over seagrass beds (2–4 m, T. Preen, personal communication).

In conclusion, it is quite difficult to speculate on the reasons explaining interactions/associations between dugongs and dolphins. All potential habitats for both dolphins (especially coastal species) and dugongs tend to be distributed close to each other in the lagoon of Mayotte, which induce potential

interactions between each species habitat and the species themselves. Then, it is possible that these interactions take place without any ecological reasons.

The author would like to thank Pascal Hervé (Mayotte ULM), Robin Rolland (Direction de l'Agriculture et de la Forêt) for providing records of dolphin–dugong associations and Peter Ersts (American Museum of Natural History, Center for Biodiversity and Conservation) for providing the map of the study area. Special thanks are addressed to Helene Marsh (James Cook University) for having supported the writing of this paper and for her valuable comments on the manuscript, and to Tony Preen for reviewing the early version of the manuscript. The study of marine mammals in Mayotte is supported by the Collectivité Départementale de Mayotte and the Ministère de l'Ecologie et du Développement Durable.

REFERENCES

Amir, O.A., Berggren, P., Ndaro, 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.

Baird, R.W., 1998. An interaction between Pacific white-sided dolphins and a neonatal harbor porpoise. *Mammalia*, **62**, 129–134.

Heinsohn, G.E. & Birch W.R., 1972. Foods and feeding habits of the dugong, *Dugong dugon* (Erxleben), in northern Queensland. *Mammalia*, **36**, 414–422.

Heithaus, M.R. & Dill, L.M., 2002. Food availability and tiger shark predation risk influence bottlenose dolphin habitat use. *Ecology*, **83**, 480–491.

Herzing, D.L. & Johnson, C.M., 1997. Interspecific interactions between Atlantic spotted dolphins (*Stenella frontalis*) and bottlenose dolphins (*Tursiops truncatus*) in the Bahamas, 1985–1995. *Aquatic Mammals*, **23**, 85–99.

Kiszka, J., Ersts, P.J. & Ridoux, V., 2006. Cetacean diversity in the lagoon and surrounding waters of Mayotte, Comoros Archipelago. *Report SC/58/013 submitted to the Scientific Committee of the International Whaling Commission*, 8 pp.

Marsh, H., Penrose, H., Eros, C. & Hughes, J., 2001. Dugong: status report and action plans for countries and territories. *Early Warning and Assessment Report Series*, UNEP, 162 pp.

Norris, K.S., 1991. *Dolphin days: the life and times of the spinner dolphin*. New York. W.W. Norton.

Norris, K.S. & Dohl, T.P., 1980. Behavior of the Hawaiian spinner dolphin, *Stenella longirostris*. *Fishery Bulletin*, **77**, 821–849.

Norris, K.S., Würsig, B., Wells, R.S. & Würsig, M., 1994. *The Hawaiian spinner dolphin*. Berkeley: University of California Press.

Preen, A., 1992. *Interactions between dugongs and seagrasses in a subtropical environment*. PhD thesis, James Cook University of North Queensland, Townsville, Australia.

Quod, J.P., Naim, O. & Abdourazi, F., 2000. The Comoros Archipelago. In *Seas at the millennium: an environmental evaluation* (ed. C. Sheppard), pp. 243–252. Oxford: Pergamon Press.

Ross, G.J.B., Heinsohn, G.E. & Cockroft, V.G.C., 1994. Humpback dolphins *Sousa chinensis* (Osbeck, 1765), *Sousa plumbea* (Cuvier, 1829) and *Sousa teuszii* (Kukenthal, 1892). In *Handbook of marine mammals. Volume 5: the first book of dolphins* (ed. S.H. Ridway & Sir R. Harrison), pp. 23–42. London: Academic Press.

Ross, H.M. & Wilson, B., 1996. Violent interactions between bottlenose dolphins and harbour porpoises. *Proceedings of the Royal Society of London B*, **263**, 283–286.

Wedekin, L.L., Daura-Jorge, F.G. & Simões-Lopes, P.C., 2004. An aggressive interaction between bottlenose dolphins (*Tursiops truncatus*) and estuarine dolphins (*Sotalia guianensis*) in southern Brazil. *Aquatic Mammals*, **30**, 391–397.

Wells, R.S., Irvine, A.B. & Scott, M.D., 1980. The social ecology of inshore odontocetes. In *Cetacean behaviour: mechanism and functions* (ed. L.M. Herman), pp. 263–317. New York: John Wiley & Sons.

Wells, R.S. & Scott, M.D., 1994. Bottlenose dolphin. In *Handbook of marine mammals. The second book of dolphins* (ed. S.H. Ridgway & F.R.S. Harrison), pp. 1–55. London: Academic Press.

Wirsing, A.J., 2005. *Predation-sensitive foraging behaviour of dugongs (*Dugong dugon*)*. PhD thesis, Simon Fraser University, Canada.

WWF Eastern African Marine Ecoregion, 2004. *Towards a Western Indian Ocean Dugong Conservation Strategy: the Status of Dugongs in the Western Indian Ocean Region and Priority Conservation Actions*. Dar Es Salam, Tanzania: World Wide Fund for Nature.

Submitted 4 July 2006. Accepted 21 November 2006.