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SHORT REPORT

Seasonal occurrences of *Manta birostris* (Chondrichthyes: Mobulidae) in southeastern Brazil

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Abstract An analysis of 79 underwater photographs of *Manta birostris* gathered over a period of nine years in a marine protected area in southeastern Brazil suggests a high predictability of manta ray occurrences in the region during the austral winter (June–September). The reasons for this are probably related to the seasonal oceanographic conditions, as characterized by the presence of a coastal front at the study site in winter and consequent plankton enrichment, which provides a feeding opportunity for manta rays. In addition, a melanistic individual in the Atlantic Ocean that is similar in color to the Pacific Ocean's "black manta" is reported for the first time.

Keywords *Manta birostris* · Seasonality · Coastal front · Melanism · Laje de Santos Marine State Park

Introduction

The manta ray, *Manta birostris*, is one of the largest fishes in the world, reaching a disc width of 6 m and weighing more than 1,300 kg (Bigelow and Schroeder 1953). The ecology and behavior of *M. birostris* are barely known, and are mostly based on occasional observations (Bigelow and Schroeder 1953; Homma et al. 1999; Yano et al. 1999). Notarbartolo-di-Sciara and Hillyer (1989) and Lobel (2003) reported patterns of seasonal occurrences at Venezuela (Southern Caribbean) and Johnston Atoll (Central Pacific). These authors infer that aggregations occur in temporally and spatially predictable foraging grounds where blooms of plankton arise. Seasonality in other large planktivorous elasmobranches such basking sharks, whale sharks and *Mobula* rays is often related to temporal variability in the abundance of their zooplankton prey (Notarbartolo-di-Sciara 1988; Taylor 1996; Sims et al. 1997; Wilson et al. 2001).

Manta rays are usually seen and photographed by recreational scuba divers in southeastern Brazil, especially in the Laje de Santos Marine State Park (Parque Estadual Marinho da Laje de Santos; Fig. 1), a popular dive site from where most of the reports from Brazil about these rays originate. These occurrences of *M. birostris* are thought to be seasonal, such that the local dive agencies which perform recreational diving operations usually advertise a "manta ray season" during the austral winter months, from June to August. In an attempt to detect temporal trends in the occurrences of *M. birostris* in the Laje de Santos Marine State Park, we analyzed a random, nine-year collection of manta ray photographs taken by scuba divers.

Materials and methods

The Laje de Santos Marine State Park (24°15′S; 46°10′W) is located 40 km from the city of Santos in southeastern Brazil (Fig. 1). The proximity (<145 km) of São Paulo, the largest city in the country, makes the Laje de Santos Marine State Park one of the most frequented dive sites in Brazil.

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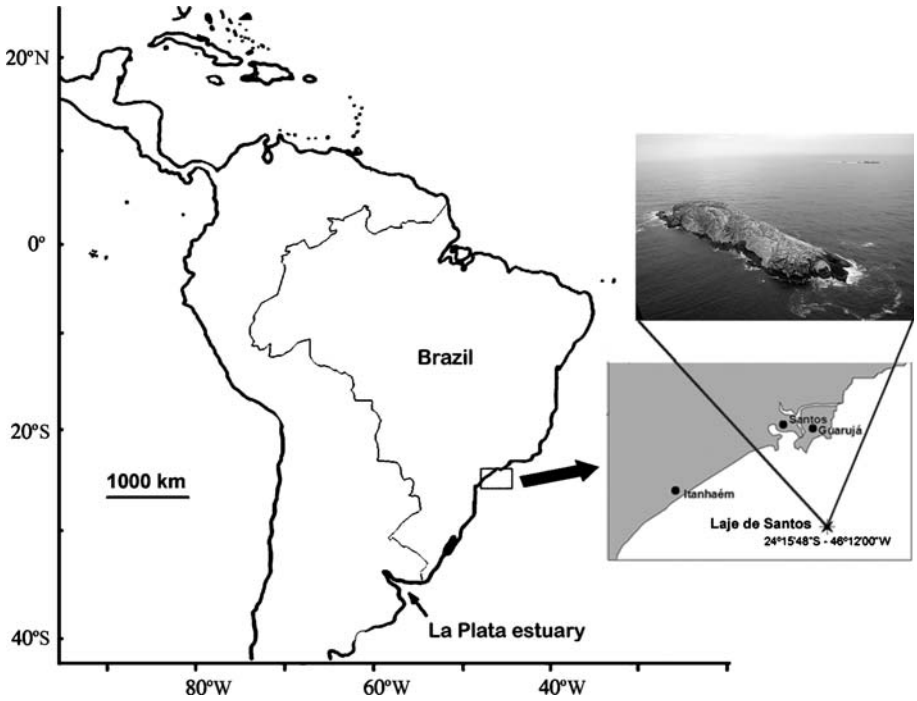

Fig. 1 The location of the Laje de Santos Marine State Park in the southwestern Atlantic. The photograph shows the island where most of the dives have occurred. (Photo by C.L.B. Francini)

The image bank analyzed included a series of manta ray photographs taken by the authors inside park boundaries. We also requested images taken by local divers (i.e., dive instructors, staff guides and frequent users). For a photograph to be accepted for use in this study, the date that it was taken had to be known. The identification of *Manta birostris* in the photographs followed the diagnostic characters used by Duffy and Abbot (2003).

Results and discussion

A total of 79 photographic records of *Manta birostris* were obtained, covering a nine-year period (1999–2007) at the Laje de Santos Marine State Park (Fig. 2, Table 1). The authors and other collaborators usually visit the marine park all year round. All pictures of *M. birostris*, however, were taken only from March to September, with a peak in July (Fig. 2, Table 1). Dive trips to the study area can be canceled due to rough weather. Data obtained from dive operators' logbooks show that about 10% of the trips are canceled during the austral summer (December–March), while in winter (June–September) this number rises up to 40%. Because the sampling effort was not constant and was higher in the summer, there is a bias towards underestimating the winter sightings of *M. birostris*. This, in fact, strengthens our observations. Data thus provide strong evidence of a temporal trend in *M. birostris* occurrences, suggesting a much higher probability of manta ray encounters at the Laje de Santos Marine State Park during the austral winter.

The reasons for these seasonal occurrences of manta rays in southeastern Brazil are not known, but inferences can be made after reviewing the oceanographic patterns that affect the study site. Zooplanktivorous vertebrates usually follow their prey, which are transported by oceanic currents, and they congregate in areas where seasonal upwellings and fronts enhance plankton productivity (Sims and Quayle 1998; Wilson 2004; Etnoyer et al. 2006). Water masses along coastal southeastern South America are derived from different sources, and the influences of these different sources vary over the course of the year. The warm Brazil Current runs southward, carrying tropical oligotrophic waters from the equator, and in the summer it is intensified by the trade winds (Campos et al. 1995). In the winter, however, the Brazil Current loses strength and the coastal waters change direction to move northward (Pereira 1989), allowing waters from the southern Falklands Current to reach areas of the study site (Campos et al. 1996; Pimenta et al. 2005). A characteristic seasonal pattern is the displacement of a low salinity front, derived from the discharge of the La Plata River, which is carried by the Falklands Current toward lower latitudes (to 23°S) during the winter (Campos et al. 1996; Pimenta et al. 2005), and the permanency of this front at the vicinity of the mouth of the La Plata River in summer.

The co-occurrence of *M. birostris* and the coastal front in the winter at the study site could be a coincidence, but the potential of this relationship cannot be dismissed. The coastal front is part of the subtropical shelf front (Piola et al. 2000) that has important ecological implications for

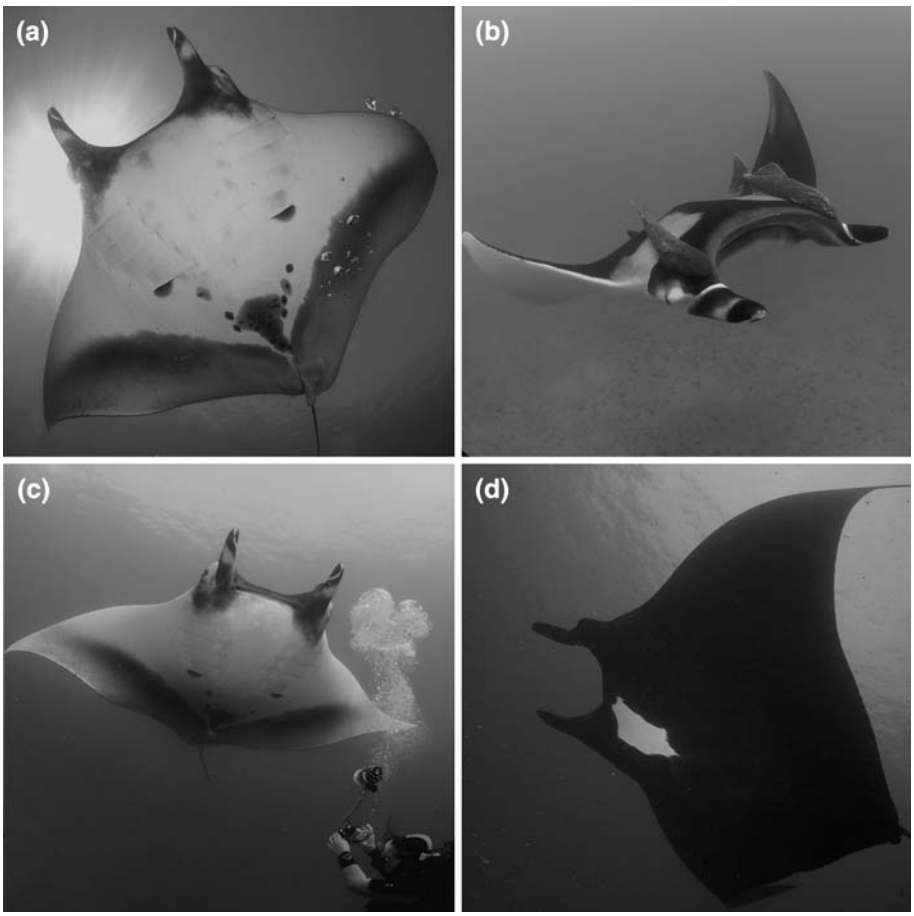

Fig. 2 Selected examples of the manta ray photographs analyzed: **a** taken 3 July 2004, **b** taken 4 September 2004, **c** taken August 2001, **d** taken July 2002 (Photos by M. Andrade)

Table 1 Monthly occurrences of *Manta birostris* in the nine-year period from 1999 to 2007 in the Laje de Santos Marine State Park

	Months with *M. birostris* occurrences							Total
	Mar	Apr	May	Jun	Jul	Aug	Sep	
1999				1	2			3
2000			1					1
2001				1	12	4		17
2002				2	4	3		9
2003						1		1
2004					5	1	5	11
2005					1			1
2006		1		4	3			8
2007	1		1	3	23			28
Total	1	1	2	11	50	9	5	79

Records were based on photographs taken by the authors and collaborators

marine organisms (Acha et al. 2004; Molina-Schiller et al. 2005). Marine fronts are well known for their bioaccumulative properties, concentrating plankton and generating patches of high productivity (Le Fèvre 1986; Franks 1992), with which filter-feeding predators are associated.

Milessi and Oddone (2003) recorded a manta ray at the mouth of the La Plata River in the austral summer, and the fishery records of Itajaí Harbor, in the state of Santa Catarina (27°S, Brazil), report landings of *M. birostris* only for the months of March and April (Mazzoleni and Schwingel 1999; R. Mazzoleni, personal communication). Although there a only a few of them, these records would fit into the spatial and temporal pattern that would be expected based on a hypothesis that correlates manta ray occurrences with the front generated by the La Plata River discharge. Further studies using satellite telemetry (Eckert and Stewart 2001; Clark 2005) should improve our understanding of manta ray migration patterns in southeastern South America.

In a photograph taken in July 2002, an oddly colored individual of *M. birostris* was documented (Fig. 2d). The specimen was entirely black with the exception of a small white blotch at the thorax. Such a color pattern is typical of that displayed by the "black manta" form that has previously only been recorded in the Pacific Ocean (Barton 1948; Homma et al. 1999). This therefore represents the first record of a "black manta" in the Atlantic Ocean.

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