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Human-induced injuries to marine tucuxis (*Sotalia guianensis*) (Cetacea: Delphinidae) in Brazil

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Guanabara Bay constitutes the most degraded habitat along the marine tucuxi dolphin (*Sotalia guianensis*) distribution. Considering that these mammals are found year-round in this area, where the dolphin population is estimated to be approximately 70 individuals, interactions between cetaceans and human activities are of concern. From 1995 to 2005, photo-identification techniques have been employed to study marine tucuxis in Guanabara Bay and data on the individual injuries has been collected. Seven out of 78 photo-identified and catalogued individuals presented noticeable injuries on their bodies, including cut-like wound, skin ulceration and mutilation. Part of fishing gear attached to the body of some dolphins was also observed. The concern elicited by the injuries reported here is amplified if we consider that this cetacean population is highly exposed to contaminants of known immunosuppressive action, such as organochlorine, organotin and perfluoroalkyl compounds.

INTRODUCTION

Cetaceans are usually exposed to a considerable number of human-induced threats. Proximity to urban areas increases vulnerability, since individuals are more likely to interact with fisheries, boat traffic, pollution and others (Reeves et al., 2003). Direct and indirect effects of anthropogenic action may cause death or become obstacles to the health of individuals and populations.

The marine tucuxi dolphin (*Sotalia guianensis*) occurs exclusively in coastal waters of western Atlantic along South and Central America, from southern Brazil (27°35'S 48°34'W) to Nicaragua (14°35'N 83°14'W), with possible records from Honduras (15°58'N 79°54'W) (Flores, 2002; Cunha et al., 2005). This small delphinid inhabits shallow waters and is often found year-round in bays and estuaries (da Silva & Best, 1996). The species is listed as 'Data Deficient' by the World Conservation Union (IUCN) due to lack of information on the ecology, biology and abundance of this species in several sites (Reeves et al., 2003).

The development of Brazilian coastal zones has been followed by chaotic occupation without previous planning or sustainable management. The south-eastern Brazilian region, historically, had turned into an important industrial centre of Brazil. Hence, many coastal ecosystems, including estuaries and bays, have been receiving discharges of chemical contaminants from domestic, industrial and agricultural wastewaters (Dorneles et al., 2007). Among these areas, Guanabara Bay is the most dramatic example of man-made degradation. A massive metropolitan complex surrounds Guanabara Bay and the area is degraded by overfishing, harbour activities and inputs of chemical pollutants, such as heavy metals and organohalogen compounds. Guanabara Bay is bordered by 6000 industries, with more than 6000 additional industries in its drainage basin (Kjerve et al., 1997). In addition, sewage discharges from industrial and domestic activities as well as solid trash constitute an important source of pollution in that area (Perin et al., 1997).

Guanabara Bay is the most degraded area along *S. guianensis* distribution (Lailson-Brito, 2007). Despite this, the bay supplies food and breeding grounds for marine tucuxi dolphins which are found year-round in this site (Azevedo et al., 2004; Azevedo et al., 2007). Some individuals have been seen for ten years and calves have remained in the area beyond sexual maturity (Azevedo et al., 2004). They have been seen in aggregations up to 50 dolphins, but groups that vary from two to ten members are more frequently observed (Azevedo et al., 2005).

Since 1995 a systematic population study of *S. guianensis* has been carried out in Guanabara Bay using photo-identification techniques. Here we present several human-induced injuries to marine tucuxi dolphins recorded while carrying out the population investigation mentioned.

MATERIALS AND METHODS

Study site

Guanabara Bay (22°50'S 43°10'W) is located in Rio de Janeiro State, south-eastern Brazil (Figure 1). The bay has a total area of 384 km^2, with an entrance 1.8 km wide. Although the mean depth of the bay as a whole is 5.7 m, along the main channel, which follows the central south–north axis of the bay, the average depth is 20 m (Kjerfve et al., 1997). The bay possesses some features of an estuarine system. The freshwater contribution is derived from 35 rivers that flow into the bay and also from the waste input (Kjerfve et al., 1997).

Pollution in Guanabara Bay may be summarized by the statement that 10.9 kg of heavy metals and 343 kg of oils are released daily into the bay. Concerning the oxygen biochemical demand (OBD) and the oxygen chemical demand (OCD), the features are 4763 kg/day and 12,752 kg/day, respectively (Kjerfve et al., 1997; Perin et al., 1997). With reference to the organic burden and the domestic wastewater received by Guanabara Bay, there are also remarkable features since the numbers are 465 t/day and 17 m^3 s^{-1}, respectively. In addition, a daily production of 13,000 tons of solid waste is reported; however, it is assumed that 4000 tons/day are not collected and also that 1000 tons/day are disposed on a sanitary embankment that can spill to Guanabara Bay (Kjerfve et al., 1997).

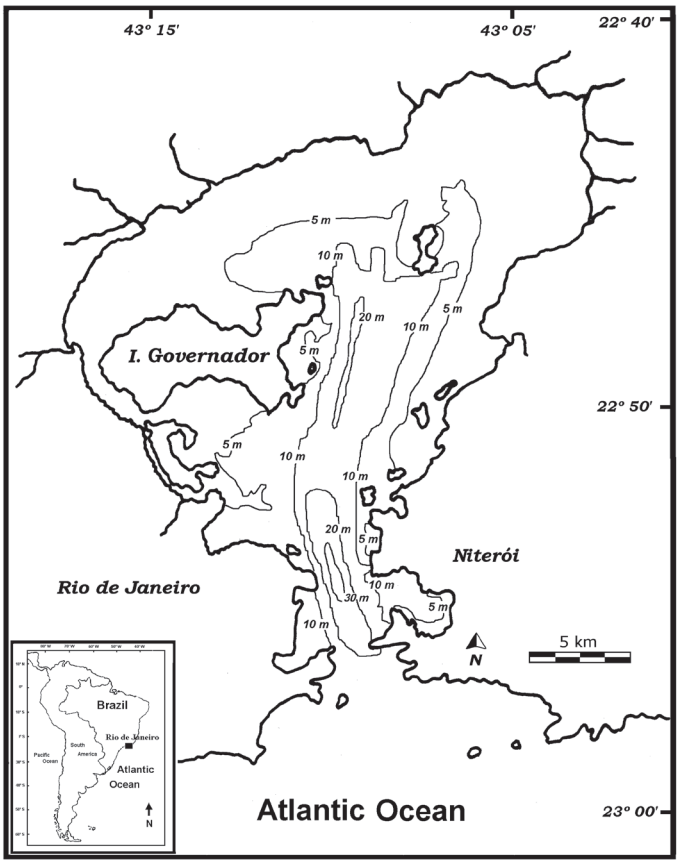

Figure 1. Map of the Guanabara Bay (22°50'S 43°10'W), south-eastern Brazilian coast, where marine tucuxi photo-id surveys were conducted between 1995 and 2005.

Sampling

Data on injuries of marine tucuxi dolphins were obtained while carrying out photo-identification and behavioural activity surveys. From May 1995 to May 2005, 74 photo-identification surveys were conducted in Guanabara Bay. The effort was not equally distributed and the intervals between consecutive surveys ranged from 1 to 360 days. All surveys were carried out in Beaufort sea states <3, using small (4.5–6.6 m) outboard powered boats. Photographs were taken at close range (usually <10 m). An auto-focus camera with a variable length (70–300 mm) lens was used. Most photographs were taken using ASA 400 colour and black-and-white film. Dorsal fins pictures were examined by negative projection. Nicks and notches along dorsal fins were the main features to distinguish individual dolphins, but scars and injuries along dolphin bodies were used as auxiliary marks.

RESULTS

Seventy-eight dolphins were photo-identified between 1995 and 2005, of which seven (9.0%) and one calf not catalogued had noticeable injuries on their bodies (Table 1, Figure 2). Individuals catalogued as BG#44, BG#60, BG#78 and one calf (not catalogued) had their injuries caused by entanglement in fishing gears. The calf had part of a net with nylon and styrofoam fragments attached from the middle of its body to the flukes. BG#44 had a cut-like wound on its dorsal fin. In this case, pictures revealed that a nylon thread still attached to its dorsal fin was the reason for the injury. The most impressive dolphin entanglement case, however; involved BG#60. The specimen had been

Table 1. *Individual injuries observed in* Sotalia guianensis*, in Guanabara Bay, from 1995 to 2005.*

Individual	Injury Details	First sight	Last sight
BG#13	Cut-like wound on its right tail fluke.	1995	2005
BG#14	Cut-like wound on its back.	1995	2005
BG#23	Cut-like wound on its back.	1995	2005
BG#44	Cut-like wound in its dorsal fin, with a nylon thread still attached to its fin.	1998	2003
BG#60	Part of a net strangling its body.	2001	2004
BG#69	Cut-like wound on the back and the dorsal fin.	2003	2005
BG#78	Part of fishing net attached to its body.	2003	2005
Not catalogued	Part of fishing net attached to its body.	2003	2003

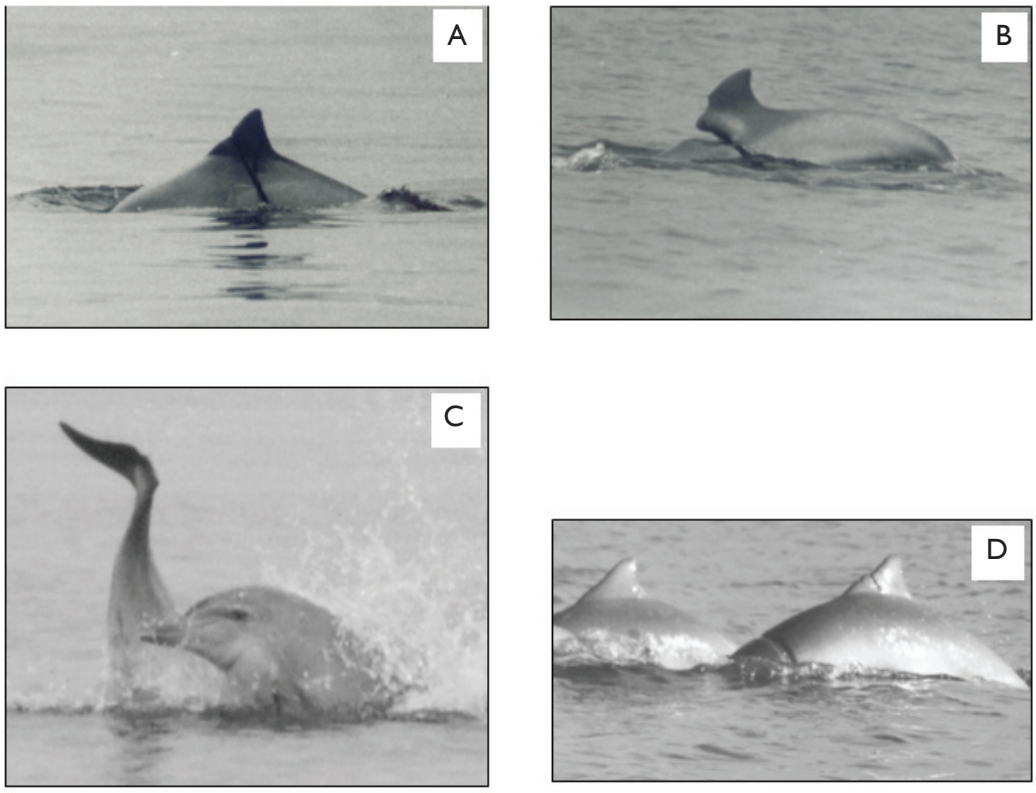

Figure 2. Individual injuries observed in *Sotalia guianensis*, in Guanabara Bay, from 1995 to 2005. (A) BG#60: part of a fishing net attached to its body in 2001; (B) BG#60: part of a net attached to its body in 2004; (C) BG#13: cut-like wound on its right tail fluke, picture taken in 2004; (D) BG#69: cut-like wound on the back and the dorsal fin, picture taken in 2004.

seen in early 2001 when a rope was entangled on its body. At that time, apparently, BG#60 had only part of its dorsal fin injured (Figure 2A). The individual was constantly seen until 2004 and the mentioned rope was still present (Figure 2B). BG#78 was identified in 2003 and had a net fragment around its body and dorsal fin, which seemed to be turning the wound more deep in this latter anatomical region. In 2007 July, BG#78 was found dead with recent fishing net marks, however, the mentioned net fragment was not attached its body. Carcass examination revealed that BG#78 was a juvenile male that presented additional scared injuries. Other scars were observed in its mouth and a large part of its dorsal and right pectoral fin had been cut off. In 1995, a calf was seen with its tail fluke cut off (Figure 2C). This dolphin was catalogued as BG#13 and was seen in Guanabara Bay until 2005. BG#13 was a female that had her first calf in 2001 and a second one in 2004. We hypothesized that the dolphin concerned had entangled in fishing net and a fishermen ended up cutting off its tail fluke while trying to release the animal, in order to avoid a greater damage to his fishing gear.

Another kind of conspicuous lesion observed was a large healed cut-like wound on the back. Three photo-identified individuals (BG# 14, BG# 23 and BG# 69) had this kind of injury (Figure 2D).

DISCUSSION

In Guanabara Bay, at least eight *Sotalia guianensis* individuals had serious injuries caused by human activities. We believe that most of interactions occurred inside the bay, because dolphins spent a lot of time in the study area (Azevedo et al., 2004) and human activities are intense within the bay, including fisheries and disposal of marine debris. Entanglements in fishing gear have been reported worldwide for several marine taxa, including turtles, seabirds, cetaceans and seals (Chan et al. 1988; Norman 2000; López et al. 2003; Baker & Wise 2005). It represents a serious threat to dolphins (Reeves et al., 2003) and marine tucuxis have been incidentally captured in nets set for fishes all over their distribution (Flores, 2002). Dolphin entanglement in fishing gear do not always result in death, since sometimes the animal can free itself or can be released from the entanglement by the fishermen (Perrin et al., 1994). However, the incident can cause injury and deep wounds that take a long time to heal. This kind of injury may become life threatening, since animals may suffer impaired ability to catch food or avoid predators, acquire infections, or exhibit altered behaviour patterns that place them at a survival disadvantage (Laist, 1987). In Guanabara Bay, fishing activity is intense year-round and about 1400 fishing boats operate in that area (Jablonski et al., 2006). Among these boats, approximately 860 vessels use gillnets and, a smaller number of boats use purse seines, trawl

and handline apparatus (Jablonski et al., 2006). These fisheries overlap a large part of the dolphin home range in Guanabara Bay (Azevedo et al., 2004) and approximately one individual per year has been found dead due to incidental catch in gillnets.

As mentioned above, it is well-known that cetaceans may entangle in fishing gear such as trap lines and nets; however, it is not possible to determine whether such animals entangled in debris or active gear. Floating net fragments and derelict fishing gears in general have been reported to entangle and kill marine animals (Laist, 1987). Besides the fishing gears discharged directly at sea, Guanabara Bay waters receive great solid waste discharge (Kjerfve et al., 1997). Hence, the possibility of entangling in a floating trash cannot be discarded. The amount of floating solid trash is so substantial in Guanabara Bay that marine tucuxis were regularly seen playing with it, most of the time with plastic bags.

The concern raised by the injuries reported herewith is amplified if it is considered that this cetacean population is highly exposed to organochlorine, organotin and perfluoroalkyl compounds. High concentrations of these pollutants have been recently reported for marine tucuxis from Guanabara Bay and the levels are comparable to those observed in highly industrialized regions of the Northern Hemisphere (Torres et al., 2006; Dorneles et al., 2008; Dorneles et al., in press). Exposure to the contaminants mentioned may increase the possibility of infection through skin wounds, since the three pollutant classes constitute endocrine-disrupting chemicals with a number of different pathological effects attributed to them (WHO, 2002), including immunosuppressive action (Whalen et al., 2002; Beineke et al., 2005; Peden-Adams et al., 2007), which constitutes an obvious obstacle to the healing process. Therefore, the synergistic effect of injuries and contaminant exposure should not be ruled out when the conservation of such a small dolphin population is considered.

From a purely academic point of view, further research on abundance, biological parameters, habitat use and environmental disturbance is not only recommended but also required to assess and monitor the status of these resident dolphins. Potential threats that require monitoring and possible mitigation include those related to chemical pollution, intense vessel traffic (disturbance and strikes), and fishing activities (bycatches and overfishing). Such threats may have long-term effects and may operate cumulatively and synergistically (Azevedo et al., 2004).

The interactions with human activities faced by *S. guianensis* in Guanabara Bay are of even greater concern when the problems observed in the entire distribution of the species are taken into account. The species occurs in coastal waters, occupying bays and estuaries, where the greatest demographic concentration on the Atlantic coast of countries from South and Central America can be found. On the Brazilian coast, for example, the unplanned growing of the cities as well as the uncontrolled fishery threatens the conservation of a number of coastal species, including marine and terrestrial ones. Artisanal fishing activities are widely carried out along Brazilian coast and have killed several cetacean species (Perrin et al., 1994). Bearing in mind the seriousness of the situation faced by the small dolphin population present in Guanabara Bay, even though all cetaceans are protected in Brazilian waters under Federal Law, the perspectives in a near future can be better only with the implementation of law enforcement, educational programmes and the development of research efforts conducted by multidisciplinary specialists, working together with federal and state governments.

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