

Short Note

Home Alone: Solitary Rough-Toothed Dolphin (*Steno bredanensis*) in Residence Area of Guiana Dolphins (*Sotalia guianensis*)

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The rough-toothed dolphin (*Steno bredanensis*) is a social species that typically lives in small groups (Ritter, 2002; Kuczaj & Yeater, 2007), which swim in synchrony and tactile contact (Ritter, 2002). The organization of rough-toothed dolphin groups indicates the existence of strong social bonds (Ritter, 2002; Kuczaj & Yeater, 2007).

While most dolphins (family Delphinidae) are known to live in groups, solitary individuals have been reported in some species, in particular bottlenose dolphins (*Tursiops* spp.; e.g., Dudzinski et al., 1995; Santos, 1997; Müller & Bossley, 2002). Solitary behavior may be the result of a number of different factors, such as predator pressure (Connor et al., 2000; Müller & Bossley, 2002), food availability (Müller & Bossley, 2002; Frohoff & Peterson, 2003), reproductive strategies (Müller & Bossley, 2002), human interference (Santos, 2000), disease (Baker et al., 2000), and individual traits (Connor et al., 2000; Müller & Bossley, 2002).

The absence of conspecific interactions may lead solitary dolphins to focus their social behavior on other cetacean species or even on humans (Dudzinski et al., 1995; Müller & Bossley, 2002; Wilke et al., 2005). Solitary dolphins frequently seek out interactions with humans, and this behavior may provide important physical contact, substituting that usually provided by conspecifics (Wilke et al., 2005). When exposed to uncontrolled human contact, however, these interactions may have negative consequences for the dolphin, leading to injuries, lacerations, or death (Lockyer, 1978; Frohoff, 2000).

When isolated, solitary dolphins display frequent patterns of behavior over time, beginning

with a process of habituation to its new home range. This area is generally associated with human activities and prey availability, and the interactions with humans seem to be increasing (see Wilke et al., 2005). However, humans typically do not feed solitary dolphins. The present study describes the occurrence and behavior of a solitary rough-toothed dolphin in a coastal bay in southeastern Brazil inhabited by a resident population of Guiana dolphins (*Sotalia guianensis*; van Bénédén, 1864). Also, we attempted to classify the solitary dolphin stage following Wilke et al.'s (2005) categorization.

Sepetiba Bay is located approximately 60 km southwest of downtown Rio de Janeiro between latitudes 22° 54' S and 23° 04' S and longitudes 43° 34' W and 44° 10' W (Figure 1). This bay is an enclosed area with an opening to the sea; a mean depth of 6 m; and a variety of bottom substrates, including mud, sand, and gravel (Borges, 1990; Araújo et al., 2002). The waters of the bay are influenced by the input from rivers and mangroves, which increases turbidity and supports a diverse fish fauna that uses the bay as a nursery area and feeding grounds (Araújo et al., 1998, 2002). Given its ecological importance, Sepetiba Bay is considered to be a priority area for biodiversity conservation and was designated a Marine Protected Area (MPA) for the conservation of Guiana dolphins (Figure 1). Despite a recent decline in numbers, the local *S. guianensis* population is estimated to include more than a thousand individuals (Flach et al., 2008; Nery & Simão, 2012) of which more than 60% are



Figure 1. Occurrence of the rough-toothed dolphin (*Steno bredanensis*) in Sepetiba Bay, Rio de Janeiro state, Brazil. The upper figure shows the study area, the Guiana Dolphin MPA, and the industrial complex (the white square delimits the area where *S. bredanensis* was monitored). The lower figure shows the focal area of the present study, and the locations of the opportunistic records and surveys of the solitary rough-toothed dolphin in the inner area of Sepetiba Bay.

resident. These dolphins use the bay primarily to feed and reproduce (Nery et al., 2008; Oliveira et al., 2013), mostly within the area of the MPA (Flach et al., 2008).

Despite the importance of Sepetiba Bay to the ecology of many aquatic species, there is no conservation plan in this area. Its drainage basin is occupied by an extensive network of industrial installations, including major steel mills, mining operations, and some of the largest shipping terminals in Brazil, as well as a military shipyard (Dourado et al., 2012). This industrial complex is located mainly along the innermost margin of the bay and has multiple impacts on the local environment.

Two types of records were considered in the present study: (1) opportunistic observations conducted by citizen scientists (i.e., volunteers who collect data as part of this research; see Silvertown, 2009, for more details), who obtained photographs or video footage of adequate quality for the identification of the species, with an approximate location confirmed by an experienced researcher ($N = 5$); and (2) the results of formal surveys with data collected through photo-identification (photo-ID) and behavioral observations ($N = 2$). Data provided by citizen scientists were considered only to record occurrences and not for other analyses.

The occurrence of a solitary rough-toothed dolphin in Sepetiba Bay was documented through surveys conducted along haphazard routes in a 6-m motorboat. Whenever the dolphin was sighted, it was approached slowly, with the boat moving in the same direction as the animal. When the boat was within approximately 50 m of the dolphin, its geographic location was recorded using a handheld GPS (Garmin E-Trex Vista CX GPS). The behavior of the dolphin was then observed using focal-animal sampling (Altmann, 1974), with its position being recorded every time it moved 500 m from its previous position (estimated by GPS tracking). Nicks, scars, and natural marks on both sides of the dorsal fin were photographed using a Canon EOS 70D camera (75- to 300-mm zoom lens) to

support the identification of the individual dolphin observed during the study by the photo-ID technique (Hammond et al., 1990).

The boat's engine was switched off to eliminate background noise and reduce potential impact on the dolphin's behavior. After the boat's engine was switched off, a 10-min habituation period was established before the recordings. Acoustic data were collected using an M-Audio MicroTrack 24/96 (24-bit .wav files; 96 kHz) digital recorder fitted with a C54 hydrophone (Cetacean Research Technology, Inc., Seattle, WA, USA; 0.008 to 100 kHz; -165 dB re 1 V/mPa) deployed at a depth of approximately 2 m. Whenever the dolphin moved more than 100 m from the boat, the acoustic recording was interrupted, and a new approach was initiated. The behavior (states and events) of the animal was recorded simultaneously by focal-animal sampling with continuous recording (Altmann, 1974), with data recorded on a standardized worksheet. To identify the stages in the Development of Friendly Solitary Dolphins, we followed Wilke et al.'s (2005) categorization (Table 1).

To identify occurrence areas of the rough-toothed dolphin, geographic positions were plotted in ArcGIS®, Version 10.6. The dorsal fin photographs were compared with those available in the photo-ID catalog of two different databases using *finFindR*, Version 0.1.6. Since there is no catalog of rough-toothed dolphins in Sepetiba Bay, the photographs of this dolphin were compared with the catalogs available for the city of Rio de Janeiro (approximately 65 km to the east) and the region of Cabo Frio (approximately 180 km to the east).

To characterize the acoustic behavior of the study subject, all the sounds recorded were visualized in *Raven Pro*, Version 1.5 (Cornell Laboratory of Ornithology, Ithaca, NY, USA) and in spectrograms (Hann window, 3 dB bandwidth of 67.4 Hz, overlap coefficient of 70%, DFT size 2,048 samples).

The behavioral state of the subject was assigned to one of five categories: (1) foraging, (2) traveling,

Table 1. Stages in the Development of Friendly Solitary Dolphins (adapted from Wilke et al., 2005)

Stages	Description
1	A solitary dolphin using a small home range, usually providing abundant and accessible prey. The dolphin may follow boats or inspect fishing gear but does not approach humans.
2	Some humans who become aware of the presence of the dolphin attempt to approach the animal, but the dolphin is not yet human-focussed and keeps distant.
3	The solitary dolphin becomes habituated with the presence of people. Aerial behavior, including spy hops, are common at this stage.
4	The presence of the solitary dolphin becomes widely known. Inappropriate human behavior may provoke unwanted and even dangerous behavior in the dolphin, including dominant, aggressive, and sexual behaviors directed at humans.

Table 2. Behavioral states identified in the solitary rough-toothed dolphin (*Steno bredanensis*) monitored in Sepetiba Bay, Rio de Janeiro state, Brazil

Behavioral state	Description
Foraging	Repeated long or short dives within a limited area, with frequent, sudden changes of direction
Traveling	Movement in a single direction with short dive intervals and frequent surfacing
Resting	Animal motionless at the surface with dorsal fin exposed
Playing	Repetitive movements directed at interacting with objects
Human–dolphin interaction	Animal seeking physical contact with humans, remaining at the surface most of the time; behaviors include display rolling, jumps, tail slaps, belly up, and others, in close proximity to human beings.

(3) resting, (4) playing, and (5) human–dolphin interaction (Table 2). The proportion of the time allocated to each category by the subject was quantified based on the records collected during the focal-animal sampling.

Between November 2018 and April 2019, five reports were received from citizen scientists of the occurrence of a rough-toothed dolphin in Sepetiba Bay. The formal surveys resulted in a total of 2 h and 48 min of direct observation in 2 d. The animal appeared healthy, with no evidence of muscle wasting and no visible injuries. All the occurrences of rough-toothed dolphin ($N = 7$) were recorded in the innermost area of Sepetiba Bay (Figure 1). This area is heavily impacted by shipping and industrial activities both day and night, which have resulted in a prohibition on fisheries. Even so, schools of both mullet (*Mugilidae*) and Atlantic bumper (*Chloroscombrus chrysurus*) were observed within the study area.

The photo-ID analysis confirmed that the records of the rough-toothed dolphin did in fact correspond to a single juvenile individual. The Sepetiba Bay dolphin was not present in either the Rio de Janeiro (115 individuals catalogued) or the Cabo Frio region (38 individuals) *S. bredanensis* databases.

The acoustic recordings covered a total time of 1 h and 41 min. The dolphin emitted whistles ($N = 3$), pulsed calls ($N = 9$), and echolocation click trains ($N = 12$) (Figure 2). All the pulsed calls were emitted during human–dolphin interactions, whereas whistles and echolocation clicks were emitted during play and foraging.

The solitary dolphin spent most of its time engaging in human–dolphin interactions (42%), followed by foraging (32%) (Figure 3). In most reports from citizen scientists, the dolphin was described following boats and performing aerial activities. Following Wilke et al.'s (2005) categorization, the solitary rough-toothed dolphin was categorized at Stage Three in the Development of Friendly Solitary Dolphins.

During the first formal survey, the dolphin was observed resting and then playing with a water hyacinth (*Eichhornia* sp.). This play behavior involved nudging the plant with its head, diving under the water while carrying the hyacinth on its head, and launching it out of the water with its mouth (see Supplemental Figures; the Supplemental Figures for this short note are

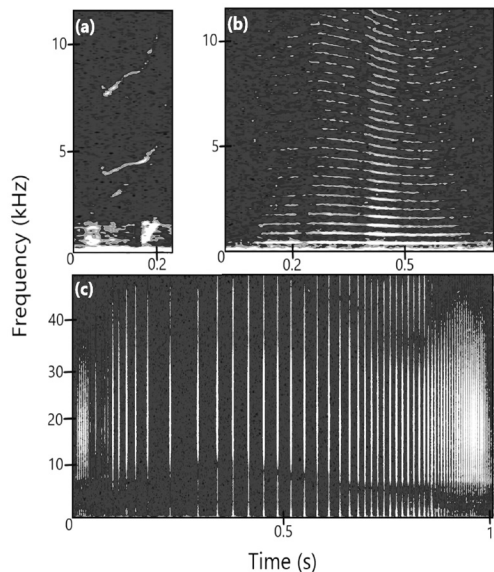


Figure 2. Spectrogram of a typical (a) whistle, (b) pulsed call, and (c) echolocation click train emitted by the solitary rough-toothed dolphin monitored in Sepetiba Bay, Rio de Janeiro state, Brazil. Sounds (a) and (b) were digitized at 11.5 kHz, and the spectrograms were generated using a fast Fourier transformation of 2,048 samples and 70% overlap between frames. Sound (c) was digitized at 48 kHz, and the spectrograms were generated using a fast Fourier transformation of 512 samples and 70% overlap between frames. A Hann window was used for normalization.

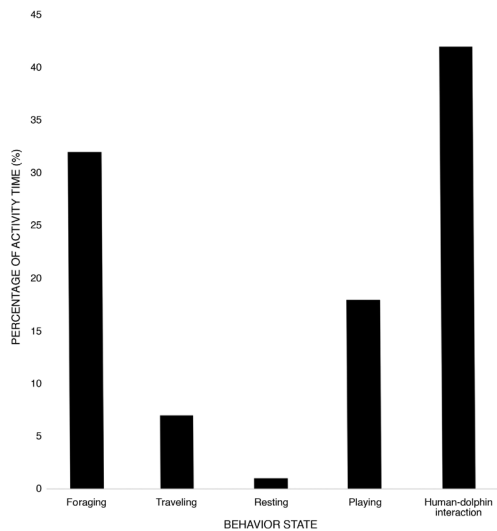


Figure 3. Percentage of activity time spent in each behavior state by the solitary rough-toothed dolphin monitored in Sepetiba Bay, Rio de Janeiro state, Brazil

available on the “Supplemental Material” page of the *Aquatic Mammals* website: https://www.aquaticmammalsjournal.org/index.php?option=com_content&view=article&id=10&Itemid=147). After a few minutes of observation, the dolphin approached the research boat, bringing the hyacinth with it. When close to the boat, the dolphin repeated its interaction with the hyacinth before turning its attention to the boat and interacting with the people on the boat. This behavior included swimming around the boat, spy hops, pulsed calls directed at the research boat, and an attempt to take an underwater camera from the hand of one of the researchers.

During the second survey, the rough-toothed dolphin spent most of its time foraging in a school of mullet. As the subject was located within the Brazilian Navy shipyard, a restricted military area, the research boat maintained a distance of approximately 500 m from the dolphin during this monitoring session. The dolphin subsequently left the restricted area, turning its attention to the research boat and interacting with humans. After several minutes engaging in surface behavior (i.e., displaying belly and tail, spy hops, and tail slaps), the dolphin began to carry a tree leaf on its pectoral fin (see Supplemental Figures). After about 10 min, it moved back to the restricted area of the naval shipyard.

This short note reports on the occurrence of a solitary rough-toothed dolphin in a coastal lagoon inhabited by a population of Guiana dolphins. The individual monitored in the present study had not been catalogued previously, possibly because it was a juvenile. Given this, while the individual

may have come from the Rio de Janeiro or Cabo Frio populations but was too young to have been catalogued, it may in fact have come from another, unidentified stock.

Under normal conditions, rough-toothed dolphins, like most other Delphinidae, have strong social bonds (Ritter, 2002; Kuczaj & Yeater, 2007), but when solitary, they seem to actively seek out social contact with humans (Wilke et al., 2005; Nunny & Simmonds, 2018). In the absence of conspecifics, the human–dolphin interaction may play an important social role for the isolated individual (Wilke et al., 2005). However, negative consequences of uncontrolled exposure to humans was already reported in Brazil. Santos (1997) describes human aggressions to a solitary bottlenose dolphin called “Tião.” In this case, it was reported that some bathers jumped on the dolphin and even attempted to put an ice-cream stick into its blowhole.

In all the records presented herein, the solitary rough-toothed dolphin was observed within a small home range adjacent to the Sepetiba Bay industrial complex. A restricted home range appears to be typical of solitary dolphins (Müller et al., 1998). This reduction of home range used by the solitary dolphin may be related to a possible difficulty of a social dolphin in exploring large areas in the absence of conspecifics, which would increase the chances of being predated. The specific area used by the rough-toothed dolphin monitored in the present study is characterized by intense human activity, an abundance of fish, and the absence of the Guiana dolphin. Other areas of Sepetiba Bay, closer to its connection with the ocean, are known to have a greater abundance of prey (Araújo et al., 2016) and a similar potential for interaction with humans, while also being less impacted, with less water and acoustic pollution. As agonistic interactions have been observed between Guiana dolphins (Nery & Simão, 2009) and bottlenose dolphins (Flores, 2003; Wedekin et al., 2004), the solitary rough-toothed dolphin may be avoiding the areas occupied by Guiana dolphins to evade contact with these dolphins.

While it is unclear whether the local Guiana dolphins have interacted agonistically with the solitary rough-toothed dolphin, the small number of vocalizations recorded during the study may reflect a behavioral strategy adopted by this dolphin to avoid being detected by *S. guianensis*. Similar acoustic strategies related to the avoidance or predation of other species have been recorded in some marine mammals (Deecke et al., 2002, 2005), and this conclusion is reinforced by the fact that the solitary dolphin vocalized mainly when interacting with humans or feeding. However, more conclusive behavioral and

acoustical data will be necessary to confirm that this behavior represents a strategy adopted by the rough-toothed dolphin to avoid being detected by the local Guiana dolphins.

During formal monitoring, the solitary rough-toothed dolphin spent most of its time actively seeking human interaction through social displays at the surface in the vicinity of boats, which is consistent with the third stage in the Development of Friendly Solitary Dolphins (see Wilke et al., 2005). According to Wilke et al. (2005), at Stage Three, it is essential to implement a management plan to discourage negative human–dolphin interactions, although, given the social requirements of solitary dolphins, total isolation from human contact may not always be the most humane option and may not even be viable in many cases.

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Editor's Note

There are two notes in this issue about the same rough-toothed dolphin. They present different but complementary information: Maciel et al. (2020) and Flach & Dias (2020).

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