

## The surface behavior of the estuarine dolphin in Baía dos Golfinhos, RN, Brazil: a field and comparative study

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**Abstract.** The estuarine dolphin or tucuxi (*Sotalia fluviatilis* (Gervais & Deville, 1853)) is becoming the target of many behavioral and ecological studies. Nevertheless, an ethogram, a basic tool for more reliable research replication, is still missing. The present study aimed at contributing to a standardized partial ethogram for the behaviors of the estuarine dolphin. Behavioral patterns were recorded and compared to the available data in literature for *S. fluviatilis* and other species of dolphins. A total of eleven clear distinguishable patterns of behavior were carefully named and described. The ethogram obtained through this field and comparative study is an attempt to clarify the terminologies for *S. fluviatilis*' activity, which is important for future behavioral studies.

**Key words:** *Sotalia fluviatilis*, estuarine dolphin, tucuxi, behavior, ethogram.

**Resumo: Comportamento de superfície de golfinhos estuarinos da Baía dos Golfinhos, RN, Brasil: um estudo de campo e comparativo.** O golfinho estuarino ou tucuxi (*Sotalia fluviatilis* (Gervais & Deville, 1853)) tem se tornado alvo de muitos estudos ecológicos e comportamentais. Entretanto, um etograma, ferramenta básica para a repetição de pesquisas mais confiáveis, ainda está ausente. o presente estudo teve como objetivo contribuir com a elaboração de um etograma padronizado parcial para os comportamentos do golfinho estuarino. um total de onze padrões comportamentais claramente distinguíveis foi cuidadosamente nomeado e descrito. o etograma obtido através deste estudo de campo e comparativo é uma tentativa de clarear as terminologias para a atividade de *S. fluviatilis*, que será importante para estudos comportamentais futuros.

Palavras-chave: *Sotalia fluviatilis*, golfinho estuarino, tucuxi, comportamento, etograma.

### INTRODUCTION

Although inhabiting the tropical and subtropical Atlantic coasts of South and Central America, the estuarine dolphin or tucuxi, *Sotalia fluviatilis* (Gervais & Deville, 1853) is classified as "Data Deficient" (IUCN, 2006). Our observations refer in particular to the "marine ecotype" (*sensu* FLORES, 2002) or the subspecies *S. f. guianensis* (P. J. van Bénédén, 1864) (see RICE, 1998).

As regards particularly the behavior of *S. fluviatilis*, we lack even standardized terminology for an ethogram, considered to be the most basic tool

for any ethological research (LEHNER, 1996). In fact, a precise list and description of the behavioral repertoire of any species is the necessary start point to facilitate comparable results (see, for instance, ROOD, 1972; STEVESON & POOLE, 1976; SCHLEIDT *et al.*, 1984; McDONNELL & POULIN, 2002).

In the new but rapidly growing literature on *S. fluviatilis*, behavioral terms are still often undefined, analogous terms are used for different types of behavior, and different names are given for similar behavioral descriptions (compare, in this sense, GEISE, 1991; MONTEIRO-FILHO, 1995; OLIVEIRA *et al.*, 1995; DA SILVA & BEST, 1996).

The main objective of this paper is to overcome these confusions, establishing the first unified ethogram for *S. fluviatilis*' behavior. In doing so it was also our aim to provide more information on the general behavior of the estuarine dolphin. To accomplish this task we observed the activity of free-living estuarine dolphins and compared our results with previously published material to decide on the most appropriate terms and definitions.

### MATERIAL AND METHODS

We carried out a field survey at Baía dos Golfinhos ("Dolphin Bay"), Tibau do Sul (6°10 S, 35°05 W), Rio Grande do Norte State, Brazil. The water temperature here ranges from 19°C to 28°C, whilst salinity values are between 36 and 37‰; the water is relatively turbid, probably because of the moderate waves and the soil's small particle composition, its modest depth and the erosion caused by the water when it reaches the cliff's walls at high tides. Estuarine dolphin behavior was monitored from a viewpoint on the side of a cliff, at a height of about 20m above the beach and 30m from the water's edge at high tide. This site, sheltered by trees, was a privileged location for naked-eye observation, enabling accurate recording of the animals' activities. During the study we used an SLR (Single Lens Reflex) camera with a 400mm lens to photograph the different forms of behavior (Plates I and II are based on actual pictures of dolphins at Dolphin Bay, except for the reproductive behavior, which was carefully drawn based on the observer description and illustrations from other species of dolphins).

Observations were made entirely by one of us (J. Araújo) using the *ad libitum* and the scan methods, described by ALTMANN (1974). A trial run of 33 hours (between September and November 1994) was used as reconnaissance observations (LEHNER, 1996). To judge if we have reached a reasonably complete surface repertoire of the *Sotalia fluviatilis* we plot a cumulative number of observed behaviors by the time (LEHNER, 1996). The asymptote was reached after 22 hours of observations, beyond which only the behavior "mating" was added. In a second phase, when data were collected for analysis, observations of the dolphin's activities were carried out from January 1995 to November 1996 and from January 2000 to August of the same year. Observations were

carried out during daylight (between 6:00h and 17:00h). The scan method was solely used to obtain the dolphins' frequency distribution (at every 15 minutes the number of individuals at the bay was recorded). The total duration of observations for this second phase was 360 hours.

Once our data had been collected we compared them with those published by other researchers. By doing so we could decide on which term and description would fit them best. As far as possible we avoided creating new terms and descriptions for the behavioral patterns. Thus, preference was given to terms already used for *S. fluviatilis*. However, if there were older publications with names and descriptions adopted for other species of dolphins that fitted into our observations they were employed.

The criterion for separation of the animals into adults and calves was the coloration as described by CARVALHO (1963) and GEISE *et al.* (1999, who also added the aspect of size): calves are 1/4 of the adult size and present a reddish-colored belly. Additionally, GEISE *et al.* (1999) stated that calves possess a brighter gray than adults.

Statistical analysis was made with the program Statistica 5.1<sup>a</sup> (StatSoft, Inc.) using the Mann-Whitney *U* test. Significance was set at  $p = 0.05$  (two-tailed).

### RESULTS

**Sightings and group size:** Animals were sighted at the Bay in 89.9% of the cases (322 hours of effective observation). The number of estuarine dolphins there, at any one time, varied between one and eight animals. The most frequently observed number of animals was four (Fig. 1).

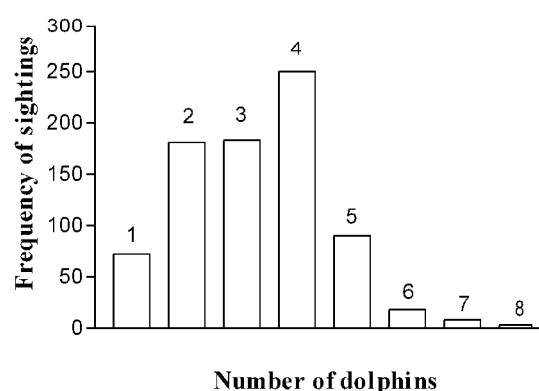


Figure 1. Profile of frequency distribution of *S. fluviatilis* at Baía dos Golfinhos (Dolphin Bay).

**Recorded behavioral patterns (the ethogram):**

The observations made at the Bay resulted in eleven behavioral patterns (swimming, chase, object controlling, total leaping, partial leaping, somersaults, tailslap, spy-hopping, surfing, play and mating) (see Plates I and II for illustrations of the most common ones). **References indicate other sources that provide comparable descriptions.**

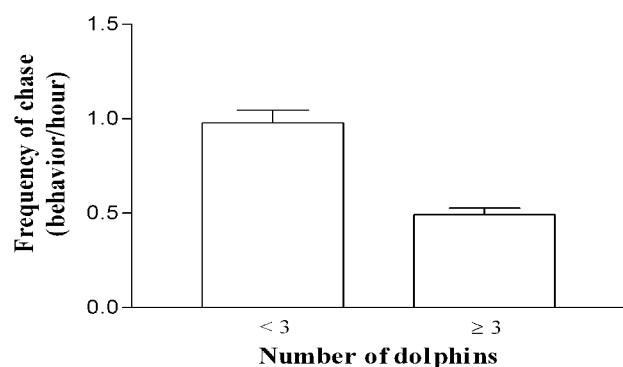
**a) Swimming**

This represents the simple behavior of moving through the water for at least a few minutes. In this action the dolphin dives frequently. When it dives, the upper part of the head is the first to come to the surface, followed by part of the back and the dorsal fin. The tail rarely emerges from the water. Each dive is long and parallel to the surface. Swimming speed is constant and the movement has a defined direction. The estuarine dolphin stays on the surface for short periods of time (GEISE, 1991). The time in which dolphins stays under the water is also short, between 11 and 90 seconds, with an average of 40 s (EDWARDS & SCHNELL, 2001).

**b) Feeding (GEISE *et al.*, 1999)**

This involves all acts that are employed to assure the maintenance of the individual through the acquisition of food, in this case through the capture of prey items.

**b.1) Chase (MONTEIRO-FILHO, 1995):** A high-speed pursuit. It can end up in a "partial leaping" pattern to catch the prey (GEISE, 1991; MONTEIRO-FILHO, 1995; GEISE *et al.*, 1999). The chase rate was dependent upon the number of individuals in the Bay. When three or more estuarine dolphins were present the chase rate decreased significantly (Fig.2).



**Figure 2.** Differences in chase rates between less than three (< 3) and equal to or greater than three dolphins (> 3) in Baía dos Golfinhos. Statistics:  $n_1 = 152$ ;  $n_2 = 124$ ;  $U = 4378$ ;  $z = -7.649$ ;  $p < 0.001$  (two-tailed); error bars = SEM.

**b.2) Object controlling:** The estuarine dolphin uses its mouth to catch an object and hit it against the water. Sometimes the object is thrown into the air or to another estuarine dolphin (ARAÚJO, 2001; ARAÚJO *et al.*, 2001).

**c) Leaps (NORRIS & DOHL, 1980)**

This is the generic name for the acts through which the dolphin's body rises above the water surface in a vigorous movement.

**c.1) Total leaping:** The estuarine dolphin rises completely out of the water, moving up to 1.5 to 2.0 meters above the surface in a vertical position. When the maximum height is reached, it curves its body, falling back into the water. When the dolphin does not bend its body, it can fall back in three main positions: laterally, on its belly or on its back (GEISE, 1991).

**c.2) Partial leaping (GEISE *et al.*, 1999):** The estuarine dolphin rises in a fast movement, diagonally, above the surface of the water, keeping the body partially exposed (the only part that is never exposed is the tail fin). After a very short appearance, it drops back on its belly or sideways (GEISE, 1991).

**c.3) Somersaults (GEISE, 1991):** The estuarine dolphin rises completely out of the water, and the body rotates in a full circle (360°), with the tail coming up over the head. This behavior is observed most commonly in calves.

**d) Tailslap (NORRIS & DOHL, 1980)**

The estuarine dolphin raises its tail vertically out of the water, and then slides smoothly back to its prior position (although the flapping of the tail hitting the water surface is sometimes observed) (GEISE, 1991).

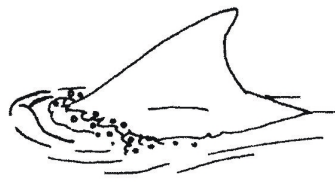
**e) Spy-hopping (DA SILVA & BEST, 1996)**

The estuarine dolphin slowly breaks through the water surface vertically, up to the level of its eyes, or up to the pectoral fins, actively maintaining this position for some seconds. Its head can stay vertical at the surface, looking to see what is going on around (GEISE, 1991). From an observer's point of view, "spy-hopping" resembles an emerging or emerged periscope.

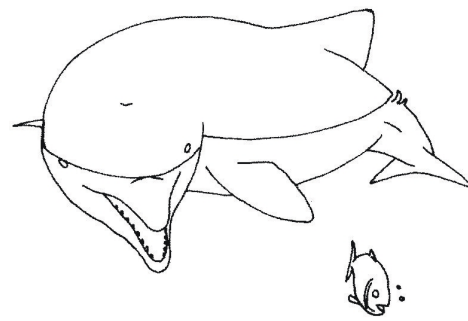
**f) Surfing (DA SILVA & BEST, 1996)**

The estuarine dolphin moves forward at high speed riding a wave, swimming short distances quickly and, apparently, without much effort.

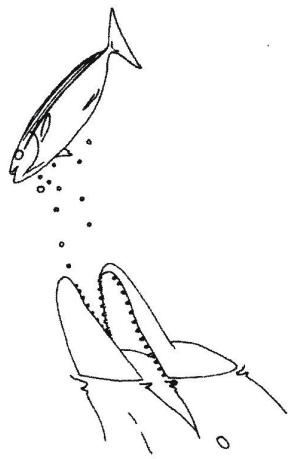
Plate I



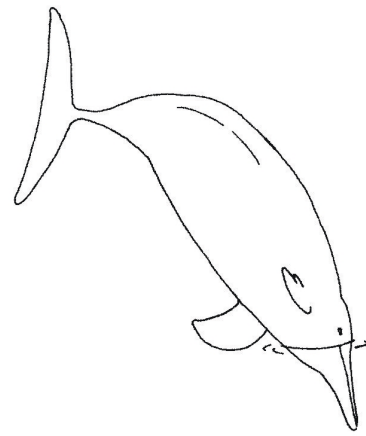
Swimming



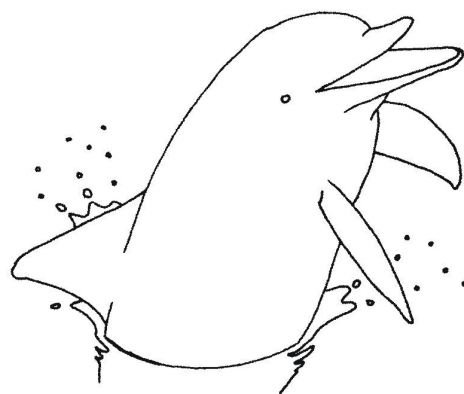
Chase



Object Controlling

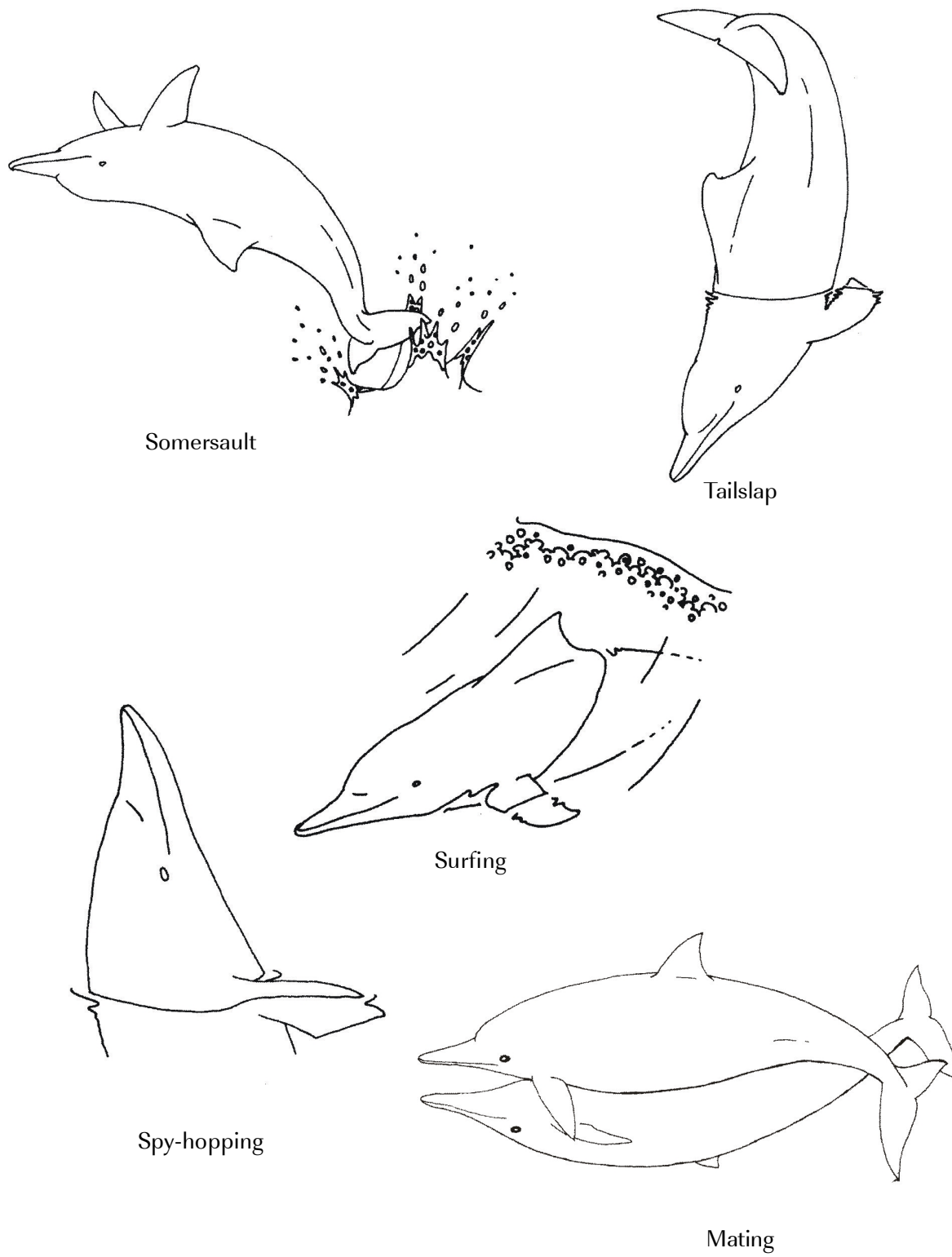


Total Leaping



Partial Leaping

Plate II



**g) Play** (GEISE *et al.*, 1999)

This consists of a number of types of behavior (somersaults, tailslap, surfing, leaps, fast swimming and object controlling) displayed without a clear function. It is usually the calves that perform this activity. They jump over the adults, and often drop back sideways, and over the backs of the adults (GEISE, 1991).

**h) Mating**

Two adults got close together, belly to belly (with their belly area in contact).

On one occasion, when a third adult tried to join the couple, it was repelled by one of the individuals (displaying a tailslap behavior).

**DISCUSSION**

The constant presence of dolphins in the Bay indicates that the area is highly important for the animals. This preference seems to be associated with the physiographic conditions of the Bay. Its topography and structure ensures good conditions for the small estuarine dolphin, animals that typically live near the coast, by providing calmer waters. Indeed, it seems to be beyond a mere coincidence that other studies were carried out at sheltered bays along the Brazilian coast (BITTENCOURT, 1984 at Paranaguá Bay; SIMÕES-LOPES, 1988 at North Bay; BOROBIA *et al.*, 1991 at Guanabara Bay; GEISE, 1991 at Cananéia Estuary Region; OLIVEIRA *et al.*, 1995, at Mucuripe Bay; LODI, 2003 at Paraty Bay).

In the same way our results do not diverge markedly from some of the studies that deal with the amount of individuals observed at a certain time (one to eight, with a mode of four). Thus, this is in accordance with the findings of OLIVEIRA *et al.* (1995) at Mucuripe Bay, who have encountered from 1 to 10 animals in their observations. However, it seems that these data do not represent the most common group size for *S. fluviatilis*, as some other researchers obtained quite different numbers. Thus, SIMÕES-LOPES (1988) reports 30 individuals at North Bay. Such a discrepancy may be related to some factors (as the amount of available food, for instance), which are still open to investigation. Another important factor

could be related to predation pressure, but we did not observe any sharks, believed to be the main predators of dolphins (DA SILVA & BEST, 1996; WELLS & SCOTT, 1999).

As far as the behavioral patterns are concerned, our results point to 11 clearly differentiated forms of action for *S. fluviatilis*: "object controlling", "spy-hopping", "tailslap", "chase", "swimming", "surf", "total leaping", "partial leaping", "somersault", "mating".

The pattern "object controlling" is a relatively common activity in other cetaceans, albeit subject to some variation. WELLS & SCOTT (1999), for example, noted that the bottlenose dolphin (*Tursiops truncatus*) performs an activity called "fishwhacking", which is the behavior of throwing upwards a fish by using the fin (included by the authors in the "food and feeding" category). The supposed reason for doing so is to hurl the fish "onto the shore and then partially beaching to capture them" (WELLS & SCOTT, 1999; based on HOESE, 1971). Although somehow similar to our observations, the description of WELLS & SCOTT (1999) bears three differences: (i) the prey that is hit is always a fish; (ii) the dolphins use their flukes to strike the fish; (iii) the prey is thrown onto shore. On the other hand, LODI & HETZEL (1999), studying the rough-toothed dolphin (*Steno bredanensis*), described a display that is more similar to the one found in *S. fluviatilis*. The authors refer to the so called "holding of a fish", described as: the dolphin "holding a fish out of the water in its mouth, shaking its head several times until the fish ceased movement, and then, quickly diving holding its prey in its mouth" (LODI & HETZEL, 1999). Although "holding a fish" is more similar to "object controlling" than "fishwhacking" it still exhibits some differences that justify a particular term for *S. fluviatilis*. In "holding a fish", as the denomination makes clear, a dolphin solely catches a fish. The cetacean does not throw the animal in the air, nor to another dolphin, but dives with it in its mouth after shaking and killing the fish (LODI & HETZEL, 1999). The *S. fluviatilis* individuals in Dolphin Bay control fishes, cephalopods and crustaceans, throwing them upwards frequently and conspicuously. Therefore, both terms ("fishwhacking" and "holding a fish") are

inadequate, being semantically restricted to fishes and inaccurate as to *S. fluviatilis*' precise behavior. We have elsewhere used the term "prey manipulation" (ARAÚJO, 2001; ARAÚJO *et al.*, 2001) when this behavioral pattern was recorded for the first time. The term "prey manipulation" can be restrictive. On the other hand, "object controlling" is a more adequate name because it is flexible enough to involve both living prey and inanimate things.

Apart from the cited activity, "object controlling", the other ten behavioral patterns are well established for *S. fluviatilis*, as our observations confirmed. Nevertheless, a lack of uniformity concerning terms and descriptions hampers their precise use. In this sense, the three most problematic ones were "spy-hopping", "tailslap" and "chase".

The pattern "spy-hopping" is a very clear behavior, which will rarely present problems of identification. The denomination "spy-hopping" is well established for other cetaceans. The definition of this pattern for *S. fluviatilis* followed GEISE (1991), since DA SILVA & BEST (1996) did not provide any description of it. On the other hand, OLIVEIRA *et al.* (1995) wrote about such behavior in a similar way to GEISE (1991) but did not mention a term for the described activity. Since the study of OLIVEIRA *et al.* was published later we decided to use the one from GEISE.

Concerning the behavioral pattern "tailslap" in dolphins, NORRIS & DOHL (1980) were the first to use it to describe (in *Stenella longirostris*) the act of hitting the water surface with the tail fin. GEISE (1991) adopted the name "tailslap" in her study on *Sotalia fluviatilis*, relating such display to a feeding activity as well as to a reaction of fear (it would serve as a sign of alert). On the other hand, DA SILVA & BEST (1996) and WELLS & SCOTT (1999) mentioned the same behavior under the title "tail-lob". The name "tail-lob" was firstly used to identify a pattern displayed by whales. Their huge size would produce a movement with the rear end of their body adequately represented by the term "tail-lob" (or "lobtailing"). It seems to be more appropriate to avoid such a name when the subjects are marine dolphins, and especially *S. fluviatilis*, which is the smallest of them. In fact, such a recommendation was made in NORRIS & DOHL's study: "A whaler's term 'lobtailing', describes

the same behavior, but seems less descriptive than 'tailslap', a term now widely used by porpoise trainers" (NORRIS & DOHL, 1980). We believe that researchers, when studying dolphins' behavior in nature as well as in captivity should use the term "tailslap", as is common nowadays.

The behavior designated as "chase" was one of the most characteristic activities of *S. guianensis* at Dolphin Bay. The estuarine dolphin quickly pursues a single fish or a fish school (GEISE, 1991; MONTEIRO-FILHO, 1995; GEISE *et al.*, 1999), which is high enough to clearly disturb the water surface, forming a trail of white foam. Frequently the upper part of the cetacean is seen. Although GEISE (1991) and GEISE *et al.* (1999) have entered the above description, they did not use the term "chase". In the former work the name "lateral attack" was adopted and, in the second, no name was given but just the characterization. We think the term "lateral attack" is extremely limited, confining the pattern to a certain movement or body position that does not correspond accurately to the behavior observed. We have chosen the word "chase" based on the study from MONTEIRO-FILHO (1995), who, nevertheless, gave a description that restricts the act to a specific area and situation. In any case, we used some of his information, enriching the account for this behavioral pattern. Besides, we chose to cut out part of his term ("chase in a small declivity area", maintaining just "chase") because it is restrictive.

As pointed out previously, "chase" is a quite typical behavior in *S. fluviatilis*, but it is the act of rising out of the water that mostly catches people's attention. There are two main terms in the literature dealing with such display: "full jumps" (DA SILVA & BEST, 1996) and "partial leaping" (GEISE *et al.*, 1999). We are adopting the word "leaping" (NORRIS & DOHL, 1980; SILVA JÚNIOR, 1996; GEISE *et al.*, 1999; LODI & HETZEL, 1999; WELLS & SCOTT, 1999; FLORES, 2002) because its use is more commonly employed in this context than "jumping" (DA SILVA & BEST, 1996; HAYES, 1998; PATTERSON *et al.*, 1998). Moreover, jumping is often considered in terms of "muscular effort of the legs and feet" (THE AMERICAN HERITAGE DICTIONARY, 1994), while the verb "to leap" is not so obviously related with a particular body part to generate the action. As

is understandable our definition includes a main pattern, "leaps", and its variations: "partial leaping", "total leaping" and "somersaults". The term "leaps" was used by NORRIS & DOHL (1980) when studying *Stenella longirostris*. Their definition of it was precise enough and should be used. Nevertheless, NORRIS & DOHL (1980) did not break it into smaller elements, restricting their registering to the pattern "leap". On the other hand, GEISE (1991) has divided it into three variants (but without a main pattern), all of which we have also observed. With regards to "somersaults", it is important to note that during twisting the body is in a vertical position (tail above head). This is different to the behavior "spinning", observed among the *S. longirostris*, in which the body is horizontally positioned (SILVA JÚNIOR, 1996).

The behavior "swimming" simply represents the act of moving through water. GEISE (1991) named such display as "traveling", which is a misleading term. The word "traveling" should only be used when one or more individuals are observed going from one place to another, cruising long distances. By just using the basic term "swimming", we would avoid this confusion.

An interesting behavioral pattern observed was the act of engaging in the movement of a formed wave, following its main direction. Such a display received the appropriate name "surfing", as used by DA SILVA & BEST (1996). However, DA SILVA & BEST (1996) conceived a description for "surfing" that was too restrictive ("surfing in waves made by a passing boat"). We avoided using the above characterization because its limitation to a "passing boat" could set it apart from its more natural occurrence.

As regards reproductive displays, we observed a clear situation in which two individuals engaged in such an activity. This kind of observation is rather rare (in comparison with the other ones, above mentioned) and we have found only one short report in DA SILVA & BEST (1996), who wrote, "copulation is belly to belly and is often preceded by tactile contact and masturbation" (DA SILVA & BEST, 1996). Our own observation supports the attempt to copulate (the belly to belly position) but failed to register a preceding tactile contact or masturbatory display. Further studies should concentrate their efforts on registering the courtship behavior of *S. fluvialilis*.

As regards play behavior there is still much to be done to understand and clearly differentiate it from other displays. A peculiar behavior of an adult throwing a calve upwards was observed on three occasions. These observations could be an act of playing but could also be a form of punishment for the calf or even an attempt of infanticide, as observed in bottlenose dolphins (PATTERSON *et al.*, 1998).

GEISE (1991) considers play as a difficult conduct to describe, being a mixture of several forms of behavior carried out in a peculiar way. We also assume that many of the patterns mentioned in this study could be presented in a frolic context. Partial and total leaping, for example, as well as the spy-hopping, can be related to both feeding and playing. On the other hand, somersaults seem to be almost always related to playing. It is in fact a pattern mostly displayed by infants. Together with reproduction, play behavior is a major topic for specific investigation in *S. fluvialilis*. Nevertheless, we believe that a satisfactory clear-cut between playing and other forms of behavior will demand an observational study directed solely toward this task. SPINELLI *et al.* (2002), for instance, analyzed "object controlling" as an act of playing (although they did not name the behavioral pattern, their description seems consistent with what we observed and call as "object controlling").

Finally, we have not made any direct observation of cooperative behavior in *S. fluvialilis* as described by MONTEIRO-FILHO (1995) in Cananéia or by WELLS & SCOTT (1999, using the very appropriate term "cooperative herding" for bottlenose dolphins). The relatively turbid waters at Baía dos Golfinhos did not allow a clear view of coordinated movements among individuals there. However, chase was statistically more frequent when less than three individuals were in the Bay. This possibly occurred because the presence of a few individuals did not allow them to completely surround a shoal. That is why the animals would have to use this pattern more frequently to obtain a sufficient amount of food. On the other hand, a greater number of estuarine dolphins could direct the shoal to a certain spot and encircle it, which would make capture easier. By doing so, they would not need to display the energetic chase behavior so often to catch the prey.



The authors hope that the information offered here has helped to clarify the terminologies for *S. fluviatilis*' activity, which is important for future behavioral and ecological studies.

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