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Nocturnal Activity of the Estuarine Dolphin *(Sotalia guianensis)* in the Region of Cananéia, São Paulo State, Brazil

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Abstract

The study of the nocturnal activity of the estuarine dolphin (*Sotalia guianensis*) was conducted in Cananéia on the southern coast of São Paulo state. The observations were made between March and October of 2003, which included 22 field outings resulting in a total of 66 h of field work. Two procedures were used: (1) visual observation of behaviours, using the focal-animal method; and (2) recording and acoustic monitoring of the animals. Observations were made during the nocturnal period from a medium-sized boat, illuminated by a crescent or full moon, which allowed easy observation of the behaviours. In view of the need to learn more about the biology and ecology of *S. guianensis*, the objectives of this study were to follow the behaviours of dolphins at night using only moonlight, describe the behavioural patterns displayed, and determine the activities of the dolphins using acoustic monitoring. Observation of dolphins with the help of moonlight was demonstrated to be an effective means of observing the animals, but at the same time, it did present some difficulties. Behaviours were described using a combination of empirical and functional methods, and then they were compared to those described by other investigators. All the behaviours observed for *S. guianensis* during the nocturnal period—diving, hunting, and leaping—were the same as those seen, named, and described by other authors for the diurnal period.

Key Words: estuarine dolphin, *Sotalia guianensis*, nocturnal activity, behaviour, Brazil

Introduction

Nocturnal Activity

Environmental conditions are subject to considerable fluctuations in the 24-h cycle. Apart from day-night variation, such changes include deviations in temperature and relative humidity as related to latitude and season among other factors. Depending on the period of activity, whether diurnal or nocturnal, animals live under very distinct conditions. Therefore, adaptation to one type of nocturnal or diurnal life characterizes complete families and orders of mammals that differ in morphological, physiological, and ecological characteristics (Kowalski, 1981).

Particularly for cetaceans, little is known with respect to their nocturnal activity. Studies that have been conducted on this subject are rare, but several that stand out include those of Leatherwood & Ljungblad (1979) on the swimming and diving behaviour of the pantropical spotted dolphin (*Stenella attenuata*) in the Pacific coast, and the study by Würsig & Würsig (1979), where important information was found on the diurnal and nocturnal activities of the dusky dolphin (*Lagenorhynchus obscurus*) along the shores of Argentina. More recently, Würsig et al. (1994) reported nighttime movements of tagged spinner dolphins (*S. longirostris*) in Hawaii, Day & Defran (1995) observed the nocturnal behaviour of the bottlenose dolphin (*Tursiops truncatus*) in California, and Baird et al. (2001) compared the diving behaviour of the pantropical spotted dolphin during day and night with the use of radiotags in Hawaii.

Other descriptions of nocturnal behaviour were based on opportunistic and isolated observations. Shane et al. (1986) suggested that direct observations are necessary to define the true level and type of nocturnal activity of cetaceans. Moreover, recent studies suggested that dolphins are active at night, as well as during the day. For example, Richard & Barbeau (1994) recorded spotted dolphins (*Stenella* sp.) hunting flying fish during the night in the Gulf of Mexico.

There have been many studies conducted on the estuarine dolphin, *Sotalia guianensis*, a small-sized delphinid that inhabits the estuarine regions and shallow coastal waters off the Atlantic coast of Central America and South America. Information

is still rare, however, such as references to nocturnal activity. Oliveira et al. (in press) recorded that the estuarine dolphin displays intense activity during the nocturnal period, although this study was limited to describing sound patterns used by this species without focusing on behaviour activities, which are difficult to observe at night.

In view of the lack of information on the type of activity displayed by *S. guianensis* during the nocturnal period, as is true for the majority of cetacean species, we conducted this study to determine the types of activity displayed and to compare these activities with those displayed during the day.

Materials and Methods

Study Area

The study was carried out in the estuarine-lagoon complex of Cananéia in the south of São Paulo State, situated in the southeast of Brazil (between 24° 59' and 25° 04' S and between 47° 54' and 47° 56' W; Figure 1). The estuarine-lagoon complex of Cananéia has a length of 110 km and is composed of a large channel called Mar Pequeno, protected by a barrier formed by two islands: Ilha Comprida to the east and Ilha do Cardoso to the south. The channel has a depth varying between 6.5 and 12.0 m. It is an area dominated by mangrove swamps, few beaches, and a predominantly muddy substrate (Schaeffer-Novelli et al., 1990).

Procedures

The study was initiated with a 3-wk period of pilot visual observations and acoustic recordings, as conducted by Oliveira et al. (in press). Most observations and sound recordings of the animals were made at Ponta da Trincheira (Figure 1, location c), which is a beach with deep mud where dolphins spend a large part of the day. Observations also were made at Baía de Trapandé

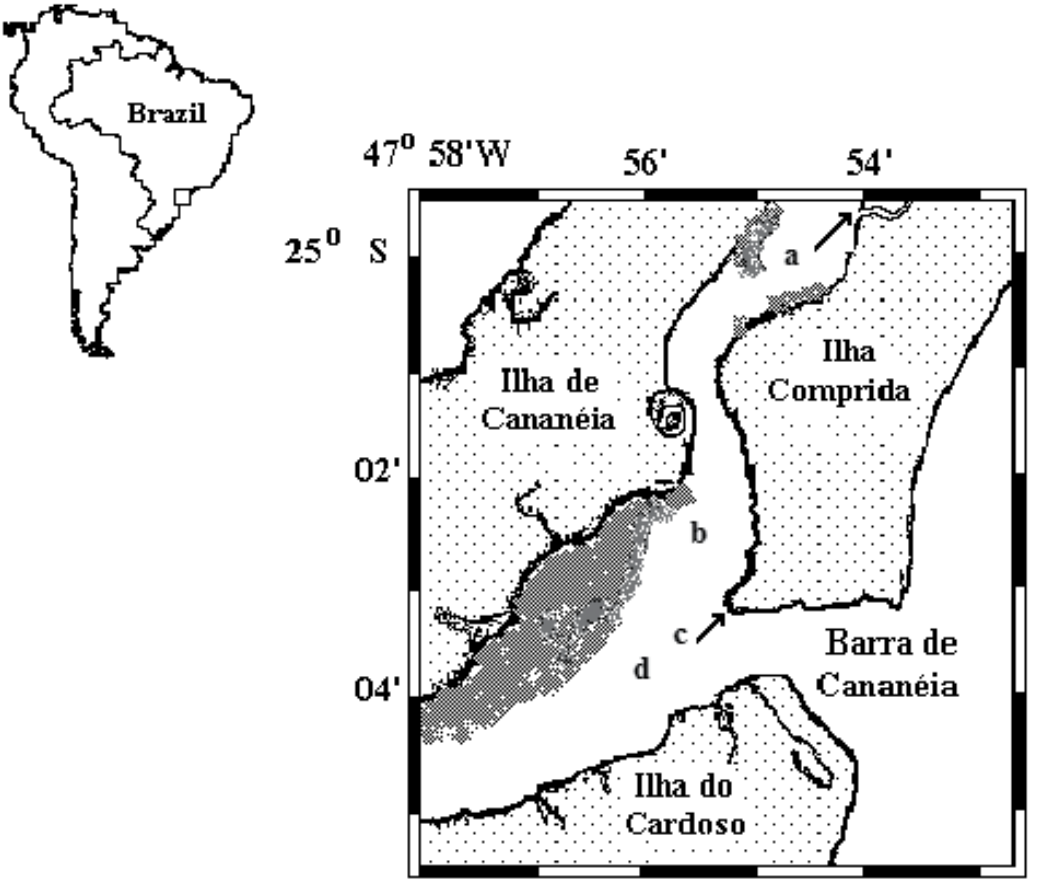

Figure 1. Map of the southern sector of the estuarine-lagoon complex of Cananéia, Brazil, where the nocturnal activity of *Sotalia guianensis* was investigated: a. Rio Boguaçu River, b. Mar Pequeno Channel, c. Ponta da Trincheira, and d. Baía de Trapandé Bay

Bay, Mar Pequeno, and at the mouth of the river Rio Boguaçu (see Figure 1, locations a, b, and d).

The presence of animals in the area was registered through direct observations with the help of moonlight or a flashlight, by hearing breathing sounds (blows) and jumps produced on the surface, or even by using a hydrophone to hear the sub-aquatic sounds emitted by the dolphins, which were the only delphinid species in the area. On clearer nights with a crescent or full moon, natural observations were made between 1800 h and 0600 h, with the majority being before 0300 h, during night outings averaging 3 to 4 h. On darker nights, a flashlight covered with red cellophane was utilized, making it possible to observe the animals without frightening them with a strong light.

The weather conditions were considered perfect when the sea was calm; the wind was not blowing much with speeds of < 6 kts, Beaufort Scale < 2, and the sky was not overcast. In perfect weather, the observations were effective out to approximately 100 m. Outside these conditions, the minimal nocturnal visibility was limited, and the observation sessions were interrupted.

Two procedures were used for the identification of nocturnal activity. The first corresponded to the observation of behaviours, using the method "focal-animal," in which one individual was the focus of the observations during a period of time, but not necessarily for the entire sampling period, mixed with "sequential sampling," when the focus corresponded to a sequence of behaviours displayed by one or more rather than one individual (cf. Lehner, 1996). The second method employed was the recording and acoustic monitoring of the animals. All the observations were made from a medium-sized boat, which remained with the motor off and anchored most of the time. The motor was turned off as soon as the dolphins were detected. The dolphins generally approached the boat, and an observation session lasted in average 10 to 20 min, and for longer periods if the dolphins stayed close to the boat. With this procedure, we avoided pursuits, which could have altered the activities or caused the animals to stay away from the area.

Another method used to find dolphins was to allow the boat to drift with the motor turned off. Normally, the dolphins were sighted at a distance of approximately 100 m. If the dolphins were not spotted, a hydrophone was lowered into the water until we could hear the sounds of dolphins. If there were no sounds, we moved to a different area. If there were sounds, we stayed until the dolphins were sighted. For acoustic monitoring and recordings, we used an analogue recorder (COBY CX-R55, with linear frequency response until 8 kHz) or a digital recorder (Sony DAT Dt-8, with linear frequency response until 20 kHz) connected to a hydrophone (Sea Systems, with frequency response of 1Hz to 150 kHz) at depths of 1.0 to 2.5 m.

Based on the observations, behaviours were described using a mixture of the empirical method, which consisted of descriptions of behaviour in terms of body parts, movements, and postures; and the functional method, which is an incorporation of reference to the behaviour's function (cf. Lehner, 1996) and later were compared to those described by Monteiro-Filho (1992, 1995, in press) in the same area.

Results

The study of the nocturnal activity of *Sotalia guianensis* in the estuarine-lagoon complex of Cananéia was conducted over 8 mo, from March to October of 2003, which included 66 h of work during 22 d in the field. Animals were effectively observed for approximately 25 h in 15 field trips, and sounds were monitored in 20 field trips.

The dolphins were located within the Baía de Trapandé Bay and near the beach at Ponta da Trincheira, in the channel of Mar Pequeno, and in the mouth of the Rio Boguaçu River (Figure 1, locations a and d). During the study, we sighted single individuals and groups that varied from three to a little more than 10 individuals, with an average group size of three to four individuals.

Method

The best nights for following the behaviour of the dolphins were the last two nights of a crescent moon and the first three nights of a full moon. On the other nights, it was necessary to use a flashlight to make observations possible. Even on nights well-illuminated by the moon, however, observation of behaviour was difficult when strong winds caused the formation of waves that made it impossible to sight the animals when they surfaced to breath. This also occurred when clouds blocked the moon, darkening the night, which was the factor that made observations most difficult.

Regardless of whether or not artificial illumination was used, only the dolphins that swam a few meters from the boat (about 50 to 100 m) could be easily observed, while the presence of more distant dolphins could only be detected using the hydrophone.

The use of a flashlight was demonstrated to be efficient for illuminating an area of about 100 m on dark nights; however, when lit, it caused an immediate flight reaction in the animals, and they did not return until some time after the flashlight was turned off.

Behaviours Observed

In total, it was possible to register three different behavioural categories associated with hunting and displacement activities: (1) diving, (2) hunting, and (3) leaping.

At all the locations, the animals initiated hunting activities while moving around. Such activities were seen in both deep and shallow areas. The presence of calves moving away together with the adults also was observed during the nocturnal period.

Diving—Based on the behaviours displayed when surfacing to breath, two forms of diving were registered when the animals were displacing or while hunting. In the first, the animal exposed only the dorsal portion of the body on the surface, showing a small curvature of the body in an apparently shallow dive. In the second, the curvature of the body was accentuated, allowing the exposure of the head, flanks, and even the tail, in an apparently deep dive.

Hunting—These behaviours were always initiated by pursuits that occurred when an individual moved behind a shoal. On these occasions, sudden changes in direction occurred, causing great movements of water on the surface. At this time, the dolphins produced a noise in the water surface similar to a burst that often helped us locate the animals since we could hear it at distances up to 100 m.

During hunting activities, after pursuits, several animals surfaced at the same place, but with crisscrossing trajectories, affecting a crossed dive on the shoal.

Another hunting activity observed only in the Baía de Trapandé Bay occurred when the dolphins swam in large groups in a circular arrangement surrounding the shoal; this formation was observed four times. During this activity, some animals dove intensely into the centre of the shoal, which remained concentrated because of the circular arrangement assumed by the majority of the dolphins.

On only one occasion was a dolphin seen close to a "cerco-fixo" (a local traditional fish trap). On this occasion, the fish that found themselves in the "cerco-fixo" appeared agitated, which suggested that the dolphin was engaged in hunting.

Leaping—Leaps often were observed when the dolphins performed one of the hunting activities described above. These leaps occurred with the body passing close to the surface or even on occasion with the body completely projected out of the water, returning after forming a parabola in the air. Dolphins occasionally leaped with their belly turned upward and then dived perpendicularly into the water.

The three categories of behaviours—diving, hunting, and leaping—were observed in all the observation sites, but they were more common in the Ponta da Trincheira because it was the site where the majority of the dolphins occurred. The main goal of the present study was to detect and describe the behavioural strategies employed by the estuarine dolphin during the night; therefore, no quantitative data are shown.

Acoustic Activity

It was possible to monitor and record the acoustic activity of the dolphins during 20 field outings. It was not possible to effectively observe and record at the same time, however. Underwater acoustic monitoring revealed intense sound emission, including many whistles, screams, and clicks. Acoustic monitoring was used in this study only to help detect animal presence in the area.

Discussion

Nocturnal observations of any animal can present difficulties, mainly due to the lack of light. Despite this major limitation, studies of the nocturnal activity of cetaceans can be conducted using night vision binoculars, artificial light (lanterns), or radio-telemetry (Leatherwood & Ljungblad, 1979; Richard & Barbeau, 1994; Würsig et al., 1994; Day & Defran, 1995; Baird et al., 2001). Nocturnal observation of cetaceans with the help of moonlight had not been tested previously, but it was demonstrated here to be effective for observing these animals.

The last two nights of the crescent moon and the first three nights of the full moon offered the best observation conditions. These are the phases in which the moon is well-illuminated and provides better reflection of light in the area and for longer periods, from 1800 h until approximately 0600 h. The method of visually observing the dolphins by moonlight and with the boat anchored or drifting was efficient because most of the time the animals came very close to the boat and could be seen as close as about 100 m away.

During the present study, a flashlight covered with red cellophane was also used to help conduct observations on very dark nights. Despite making observations possible, the light from the flashlight frightened the animals away—even with the cellophane cover. Perhaps the best procedure would be to begin observations on dark nights with the flashlight already lit.

Acoustic monitoring of the animals, in a manner similar to that already performed by Oliveira et al. (in press), was efficient to detect the presence of dolphins in the area. Sounds were emitted that have been related to social activities (calls and whistles; cf. Monteiro-Filho & Monteiro, 2001) and to the localisation of targets and obstacles

(echolocation clicks). These sounds could not be used to describe the behaviour that the animals were displaying, however.

All the behaviours verified for the estuarine dolphin during the nocturnal period have already been described for the diurnal period by Monteiro-Filho (1992, 1995, in press) and Monteiro-Filho et al. (in press). The dives observed were described and designated by Monteiro-Filho (in press) as shallow or deep dives. According to the author, they were part of all the behavioural sequences, and at least one dive was performed in each type of behaviour employed, and it could be distinguished during both hunting strategies and relocation periods. Both dives observed during the night were seen for all the behavioural sequences verified in this study, especially during hunting activities.

At the beginning of activities related to hunting, it was common to see pursuit behaviours close to the surface, which were finalized by the dolphin changing direction on the shoal. This behaviour also had been described for the hunting activities of adults (Monteiro-Filho, in press) and calves (Camila Domit, pers. comm.) during the day. Based on the noise produced at the end of the pursuit, it was termed a "surface burst." The "surface burst" sound often is made by the estuarine dolphin during the day when it is hunting close to the "cerco-fixo" and close to the shore (Monteiro-Filho, in press), and it often also was observed during the nocturnal period in the present study. This behaviour does not appear to be unique to the estuarine dolphin. It was described by Bel'kovich et al. (1991) for bottlenose dolphin hunting alone, where the dolphin leads the shoal towards the shore and then moves on the shoal for the capture.

Other hunting behaviours, already described for the estuarine dolphin in its diurnal activities (Monteiro-Filho 1992, 1995), also were observed during nocturnal activities. One of these was termed "cross fishing" and corresponds to two dolphins crossing trajectories into the same shoal. Another behaviour observed both diurnally and nocturnally was that of the trajectories of several dolphins producing the formation of one large group, with approximately 15 to 20 individuals, that encircles the shoal (Monteiro-Filho 1991, 1992, in press). Hunting in large groups was observed during the nocturnal period; these big group formations were observed in a few occasions when the night was very clear. At deeper locations, as in the case of Baía de Trapandé Bay, it is probable that gatherings of several small groups have more success in hunting activities because more dolphins cooperate to herd a shoal and, consequently, to capture the fish. A similar formation was reported by Bel'kovich et al. (1991) for *T. truncatus* in which the dolphins encircled the shoal forming a carousel and dove into it vertically or from various directions to capture the fish.

The "cerco-fixo," a form of trapping in traditional fishing that is employed by fishermen from the region of Cananéia, can be used by dolphins as a form of blockade for the capture of fish. The dolphins corral the fish against the "cerco-fixo" that serves as a bulkhead and allows them to capture the fish (Monteiro-Filho, 1995). Despite the fact that estuarine dolphins spend a great deal of time hunting close to "cercos-fixos" during the day, there was only one occasion of this type of hunting noted in the present study. The behaviour of herding a shoal against a bulkhead ("cerco-fixo," fishing nets) has been reported during diurnal hunting activities for *T. truncatus* (Bel'kovich et al., 1991; Simões-Lopes et al., 1998), whereas this is the first report of this behaviour as a nocturnal activity.

Shane et al. (1986) suggested that the leaps are associated with feeding in cetaceans. The majority of the leaps occur during the search for food and immediately afterwards, during resting periods, and when the dolphins are reunited (Bel'kovich et al., 1991). Accordingly, Bel'kovich et al. and Monteiro-Filho (in press) reported various types of leaps in adult specimens of the dolphins *T. truncatus* and *S. guianensis*, respectively, all related to hunting.

Whitehead (1985) found that breaching by humpback whales (*Megaptera novaeangliae*) is associated mainly with social interactions. Similarly, Monteiro-Filho et al. (in press) showed that breaching with a bent posture and also the perpendicular leap of estuarine dolphin calves were possibly linked to play behaviour.

In the study of nocturnal activity of the estuarine dolphin, four types of leaps were noted and were involved in some hunting strategy. The finding that leaps were numerous during the nocturnal period also suggests that they function in communication. Since visual contact is limited during the night, the dolphins could use a form of communication other than sound emission. According to Payne (in Whitehead, 1985), the leaps can have a communication function when the noise from the waves or the wind interferes with vocal communication.

It is probable that the dolphins have moments of rest or low activity at night, just as they do during the day. This behaviour was not detected in the study conducted here since it is the most difficult behaviour to observe.

Even with all the difficulties, the method adopted to study the nocturnal activity of the estuarine dolphin was demonstrated to be efficient for understanding new aspects of its biology and

ecology, confirming the knowledge of high nocturnal activity already described through sound recordings (Oliveira et al., in press) and principally showing that the hunting activities used during the night are the same as those described for the diurnal period.

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