

Commensalism Between Guiana Dolphins *Sotalia guianensis* and Sea Birds in the North Bay of Santa Catarina, Southern Brazil

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Abstract: Commensal associations between Guiana dolphins *Sotalia guianensis* and sea birds, *Larus dominicanus*, *Sula leucogaster*, *Sterna* sp. and *Fregata magnificens* have been frequently observed during the feeding behavior of the dolphins in the North Bay of Santa Catarina, (26°00'–28°25'S, 48°30'–48°49'W), Southern Brazil. Boat and land surveys were performed, using focal group sampling method, in blocks of five minutes. In 81 surveys, between 1993 to 1997, associations with birds were observed in 67% of the days (n= 54 days). The most representative years were 1993 (63.16%) and 1994 (73.68%), with a total frequency of 62.72%. In 1995, less associations were registered, only 8.5% of the total. In the following years associations were registered more frequently (16.13% in 1996 and 12.64% in 1997), but with lower intensity and numbers than the early years. The frequency of occurrence of the bird species also varied each year. *Sterna* sp. showed the highest time of occurrence in observed association (1587 minutes, 33.32% of the total time observed) and the highest frequency days in associations (n = 46, 85.18% of the total (= 54)). The second most representative bird species was *F. magnificens* with 1218 minutes of associations, almost 26% of the total, and observed in 40 days (74.07% of the total). *S. leucogaster* appeared with 951 minutes in association (19.97%) and it was observed in 29 (53.70%) of the 54 total days of associations registered. *L. dominicanus* showed the smaller time of occurrence, 925 minutes (19.42%) and it was registered in 29 days (53.7%) of associations, mainly in the austral winter. These associations occurs principally when the dolphins are executing coordinated feeding strategies, railing the fishes in big groups, making easy the obtainment of food to the birds, that is characterize this relation like commensalism.

Keywords: Commensalism, Feeding, Guiana dolphin, *Sotalia guianensis*, Sea birds, Southern Brazil.

1. INTRODUCTION

Theoretically, the populations of two or more species can interact themselves following basic ways that correspond a combinations of neutral, positive and negative factors, that can be represented, in the whole ecosystem in two general types: The negative and positive interactions [1].

Commensalism is described in the literature like being a simple kind of positive interaction between two or more species in which only one part of the relationship is benefited, but, in the other hand, the other part is not affected prejudicially [1].

The Guiana dolphin, *Sotalia guianensis* (for adopted name see [2]) inhabit coastal habitats, mainly estuaries and bays, along the Atlantic coast of Central and South America [3] from Nicaragua [4] to Santa Catarina state, Southern Brazil [5].

In the southern limit of its distribution, the North Bay waters, there is a resident population [5, 6], staying more than 70% of its life time in the region, within the limits of the Environmental Protection Area (EPA) of Anhatomirim, mainly in a beach called Enseada or Praia dos Currais, where they feed, mate, nurse calves and rest [6, 7].

In this area, [6] registered, initially, the feeding interactions or associations between *S. guianensis* and sea birds *Larus dominicanus*, *Sula leucogaster*, *Sterna* sp., *Fregata magnificens* and *Phalacrocorax olivaceus* in 88% of 43 observation days among 1991 and 1992.

The aim of this work is to describe the existence of commensalism between *S. guianensis* and sea birds in the North bay of Santa Catarina.

2. MATERIALS AND METHODS

The North Bay of Santa Catarina (Fig. 1) is located between Santa Catarina Island and the continental shore. The mean depth is less than 12 m, with a sandy substrate and some flagstones. It presents eight islands and shores with sandy beaches, rocky coasts, mangroves, Atlantic forest and urban areas such as fishermen communities, summer points and industrial zones.

The EPA of Anhatomirim, was created by the Federal decree n° 528/ 1992/May/ 20, with the main aim to protect

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the resident dolphin population, the remaining Atlantic forest and the freshwater courses in the area.

Located in the EPA's heart, the Enseada do Currais (Fig. 1) has 1 Km², maximum depth of 5.7 m, sandy-silted bottom, two sandy beaches, three rock coasts and a small island at the north point of the bay.

Data were collected in systematic boat surveys (15 or 25 Hp engines) to study general behavior and ecology of *S. guianensis* in the North Bay. Focal group sampling method was used, when the focus is the activity realized by the entire observed group like just one [8]. The behavior was registered in blocks of five minutes, in which occurrence and numbers of each seabird species were registered during associations with the dolphins.

Data sheets of Sotalia Dolphin Project from 1993 to 1997 were analyzed in addition to the feeding behavior study conducted by Rossi-Santos MR [9] to draw a general profile of five years of observations.

The data were organized in a table with the years of observations, the seabird species involved and its time of permanence in interaction/ association (minutes). The seasons

considered were: Autumn- March, April, May; Winter- June, July, August; Spring- September, October, November and Summer- December, January and February.

To verify if there is statistical difference between the means of time of permanence in (duration of the) association of the seabirds and the dolphins we used Scheffé test.

3. RESULTS

The interactions between *S. guianensis* and sea birds *Larus dominicanus*, *Sula leucogaster*, *Fregata magnificens* and *Sterna* sp., often occurred in the study area, during the dolphin feeding activity in 1993 to 1997. The associations happened in 67% (n= 54) of the total number of days (n= 81) (see Table 1).

The Table 2 shows, the permanence time in interactions of the different seabird species between themselves, it is possible to note that *Sterna* sp. (SS) showed a higher significant difference, in relation to the other two species (*Sula leucogaster*, SL and, *Larus dominicanus*, LD) and the biggest time of occurrence observed in interactions, although not be statistically separated of *Fregata magnificens*, FM.

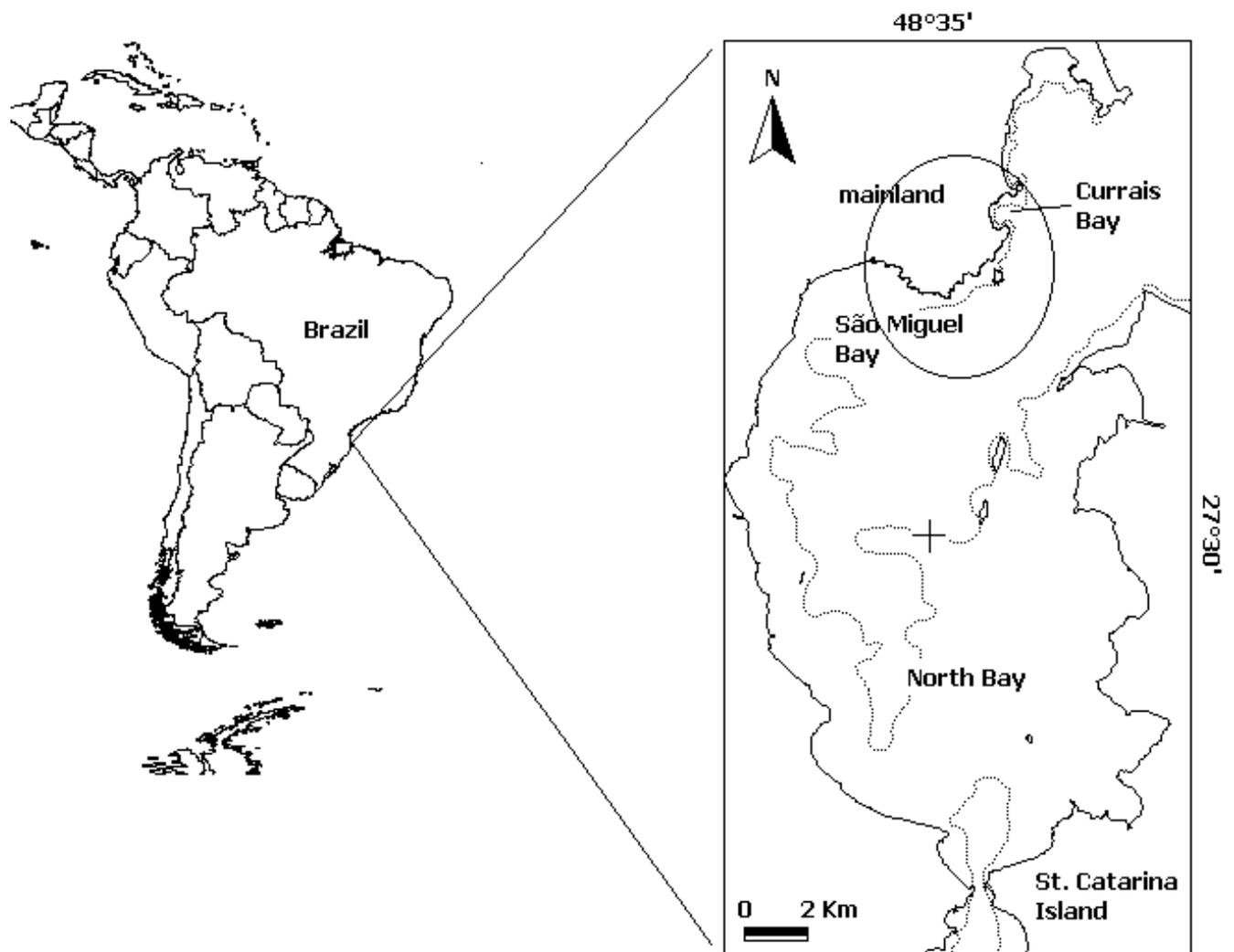


Fig. (1). Study area in the North Bay, Santa Catarina, Southern Brazil.

Table 1. Total Number of Days of Observations, Number of Day in which were Registered Feeding Interactions between Seabirds and Dolphins, and Relative Frequency of these Days with Interactions (from the Total Number of Observed Days in Each Year)

| Years of Study | Total N° of Observation's Days. | n° of Days with Observed Interactions | % of Total N° of Days by Year |
|----------------|---------------------------------|---------------------------------------|-------------------------------|
| 1993 | 19 | 12 | 63.16 |
| 1994 | 19 | 14 | 73.68 |
| 1995 | 17 | 08 | 47.05 |
| 1996 | 19 | 10 | 52.63 |
| 1997 | 17 | 10 | 58.82 |
| 1993-97 | 81 | 54 | 66.6 |

Table 2. Variance Analysis Results of the Means of Time (Minutes) of Occurrence for the Interactions between Seabirds and *Sotalia guianensis*, during the Feeding Activity of the Dolphins, in the North Bay of Santa Catarina, Among the Years 1993 to 1997

| Seabird Species | N° of Observed Years | Mean* of the Year of Study | Standard Deviation | Minimum | Maximum |
|-----------------|----------------------|----------------------------|--------------------|---------|---------|
| LD | 5 | 183.6 a | 123.5 | 75 | 298 |
| SL | 5 | 190.2 a | 137.3 | 20 | 416 |
| FM | 5 | 243.6 ab | 90.7 | 90 | 423 |
| SS | 5 | 317.4 b | 189.5 | 210 | 510 |

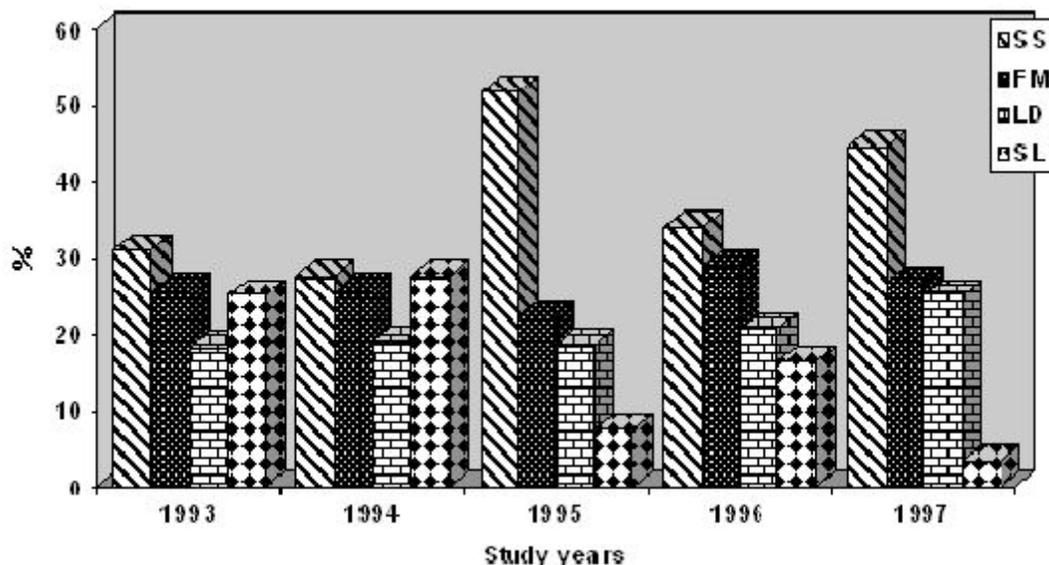
* Means followed by different letters are significantly different (Scheffé 5%).

FM species showed the second time of occurrence observed in interactions, not presenting, however, relevant difference between the other three species (Fig. 2).

Estimated error value (p value) stayed in 0.0039%, that means that the probability of these samples had collected randomly is very small, affirming that can be differences between some of the times of occurrence in observed interaction for each seabird species.

3.1. Sea Birds Feeding Strategies

Terns (*Sterna* sp.): are generally founded in big groups. Two species occurs in the region: *Sterna eurygnatha* and *S. hirundinacea*. Feed on small fish that they capture in rapid dives that break your flight. Fly quickly, diving to search fishes from high altitudes and most perpendicularly to the water surface, when they not pass one meter deep.

**Fig. (2).** Relative frequencies of sea birds occurrence time in feeding associations with Guiana dolphins *Sotalia guianensis*, in the North Bay of Santa Catarina, between 1993 to 1997. LD = *Larus dominicanus*; SL = *Sula leucogaster*; SS = *Sterna* sp.; FM = *Fregata magnificens*.

Brown Boobies (*S. leucogaster*): Feed falling of medium altitude submerging completely, reaching 4m deep.

Frigates (*F. magnificens*): Is common to observe them in association with the dolphins flying over the group to catch the surrounded fish on the water surface without be wet, executing a head movement. They have the habit of robbing from the boobies and other seabirds the swallowed prey chasing them, by directing the movements during flight, forcing to regurgitate the captured fish.

KelpGulls (*Larus dominicanus*): This is another larid bird that occurs in the region. Like the terns they also feed on small fish in the seawater surface. Sometimes they are sighted flowing in the water near of the dolphin's feeding behavior. Were took some photos exemplifying these interactions (Fig. 3).

The Table 3 shows that SS was the species with more observed interaction with the dolphins *S. guianensis*, with time varying from 510 minutes, in 1993, to 257 minutes, in



Fig. (3). Examples of the foraging interactions between Guiana dolphins *Sotalia guianensis* and seabirds in the North Bay, Santa Catarina State, Southern Brazil. Top and bottom: interactions between *S. guianensis* dolphins and kelp gulls *Larus dominicanus*; Middle: interaction among one *S. guianensis* dolphin and one frigatebird *Fregata magnificens*.

1997. SS's minimum time was 210 minutes, in 1995, but this value was not so small comparing to the total observed time in interactions with the dolphins.

Table 3. Observed Time of Occurrence (Minutes) and Relative Frequency (by Year) of Interactions between Seabirds and *Sotalia guianensis* during the Feeding Activity of the Dolphins at North Bay of Santa Catarina, SC, Among the years 1993 to 1997. SS= *Sterna* sp.; FM= *Fregata magnificens*; LD= *Larus dominicanus* e SL= *Sula leucogaster*

| Seabird Species/Year | SS | FM | LD | SL | Total |
|----------------------|----------------|----------------|----------------|-----------------|----------------|
| 1993 | 510 (31%) | 423 (25.7%) | 298 (18.1%) | 416 (25.2%) | 1647 (100%) |
| 1994 | 370 (27.6%) | 345 (25.7%) | 255 (19%) | 370 (27.6%) | 1340 (100%) |
| 1995 | 210 (51.8%) | 90 (22.2%) | 75 (18.5%) | 30 (7.4%) | 405 (100%) |
| 1996 | 240 (34%) | 205 (29%) | 145 (20.6%) | 115 (16.31%) | 705 (100%) |
| 1997 | 257 (44.5%) | 155 (26.8%) | 145 (25.1%) | 20 (3.5%) | 577 (100%) |

The second bird more present in feeding association was FM, with time values varying from 423 minutes, in 1993, to 90 minutes, in 1995.

S. leucogaster (SL) showed some variations in time of occurrence in the analyzed years. In 1993 it was the third more observed species in interactions with the dolphins (298 minutes). In the following year, it was the most present, together with SS, both with 370 minutes of observed associations. After this in the next years, FM was the smaller in time of observed interactions, 30 minutes in 1995, 115 minutes in 1996 and 20 minutes in 1997.

Considering that the total time of observations is different between the analyzed years, the data also were analyzed as regards correspondent relative frequency to the total by year, like it shows the Fig. (2) below.

Seeing this graphic of the seabirds in feeding interactions with *S. guianensis*, was possible to note that the most frequent bird, all long the analyzed years, was *Sterna* sp. (SS), with the minimum frequency of 27.6% in 1994 to the maximum frequency of 51.8% in 1995.

The second most frequent bird was *F. magnificens* (FM), which appeared well distributed all long the years, with frequencies varying from 25.7% (1993 and 1994) to 29% (1996).

L. dominicanus (LD) appeared fine distributed all long the years, but with smaller frequencies (18.1% in 1993 to 25.1% in 1997).

S. leucogaster (SL) was the less frequent seabird species in observed interactions, generally in the analyzed years despite it was the most frequent in 1994 (27.6%), together with *Sterna* sp.. In the previous year, 1993, SL was the third more frequent, with 25.2% of the year's total. In 1995 your frequency down to 7.4%, staying small in 1996 (16.3%) and 1997 (3.4%) being the less frequent in these three last analyzed years (Fig. 2).

4. DISCUSSION

The associations between populations of different species that are traduced by positive effects are so important in the determination of the nature of the community like the negative interactions like competition, parasitism and others. Commensalism is a simple kind of positive interaction and presents the first step in the development of the benefic relations [1].

This same author says too that the ocean is, in special, a good place to observe the commensalism because almost all marine worms, mussels and sponges have organisms that need of some protection but not produce, in the other hand, any benefit o malefic. These beings, like fish and crabs, among other, live catching the rejected or exceeding food of the hosts.

Is pertinent to comment about the example cited by Heat-whole (1965) *apud* [10] in which commensalism is seen in the association between the white heron and the bovine herd. These herons follow the bovine herd that are moving under the sun to capture the preys, mainly insects, that raising up with the bullock's pace.

It was observed that the number of associated herons depends of the bovine herd's activity. He observed less herons than the hoped when the bovine herd was resting and, although, the double than the hoped when the herd was moving actively under the sun. One time that the birds do not obtained their preys (like ectoparasites) directly from the body's animal, these mammals probably are not beneficiated directly of their relation with the herons. In addition, the author demonstrates that the feeding rate of the herons was greater than when these birds were associated with the bullocks.

Associations between dolphins and sea birds can be interpreted in some cases like mutualism and others like commensalism. In the first case, the seabirds benefit themselves of a school of fish founded initially by dolphins while another dolphins take benefits by the intense activity of the birds, during feeding time for too found the school [11]. In commensalism only the birds take benefits, using of the school founded by the dolphins [12].

The variations on relative frequencies and time of occurrence of the feeding association can be related with some factors like: the biological cycle of the birds in the region, food availability in the study area and the feeding strategies used by the dolphins and by each bird species.

Lodi LF [13] found some interactions between *S. guianensis* and sea birds in 41% of the foraging events observed, during 28 encounters, including five species: Brown boobies, *Sula leucogaster*, frigates, *Fregata magnificens*, yellow-billed terns, *Sterna eurignatha*, real terns, *S. maxima*, and cormorants, *Phalacrocorax brasilianus*.

The same author shows that the most common association with a single bird species occurred with *S. leucogaster* (34%). Dolphins, frigates and boobies composed the most frequent multispecific foraging association registered in 39% (total= 28 occasions). Mixed associations, involving *S. guianensis*, *S. leucogaster* and *F. magnificens* were also reported to Cananéia region, Southeastern Brazil by Monterio-Filho ELA [14].

Associations between dolphins and cormorants, as those observed in two occasions by Flores (1992), were not regis-

tered in the years of study, suggesting that this is a uncommon interaction. The same was reported by Lodi LF [13] for the Paraty Bay, Rio de Janeiro State and by Monteiro-Filho ELA [14] with just few observations of this seabird, when compared with the other bird frequencies of encounters. By the other hand, Cremer *et al.* [15] found cormorants (*P. brasiliensis*) as the most frequent bird species in associations with *S. guianensis* in Babitonga Bay, north of Santa Catarina State.

Frigates were the most observed seabird species interacting with *S. guianensis* dolphins in the Cayos Mistiko Reserve, Nicaragua [16] and in the Morrosquillo Gulf, Colombia [17]. Also concerning *F. magnificens*, Lodi LF [18] describes for the Paraty Bay, a kind of relationship nominated “kleptoparasitism”, observed in three events, characterized by a probable molestation to *S. guianensis*, through repeated and fast attacks, forcing the dolphins to leave their prey for the insistent birds.

The coast of Santa Catarina State presents many islands that are important mating and nesting sites of these seabirds. These reproduction sites allow the birds to stay in a limited area, searching for food in the vicinities to save time and energy, required to feed the offspring waiting inside the nests.

The terns (*Sterna* sp) are, probably, the most abundant seabirds in the tropical zone of the Earth [19]. In addition, the fact of the existence of two species of this genus in the study area can justify your larger frequency of occurrence, when compared to any other bird species.

Possibly the prey size consumed by the birds is smaller than that captured by the dolphins. This can represent the fact that the birds prey on the surrounded fish, but not captured by the dolphins, in other words, the exceeding food.

These associations occurs principally when the dolphins are executing coordinated feeding strategies, railing the fish in big groups, making easy the obtainment of food to the seabirds. When the dolphins are feeding in a large number of individuals, it is possible to locate all the activity at distance, by the approximation of many birds, either isolated species or mixed groups, that capture the fish surrounded by dolphins, coming from high flights decreasing altitude until they keep flying very close to the sea surface and the dolphins.

In this way, it is suggested that this is a kind of commensal interaction, being the seabirds the great benefited by the feeding activity of the dolphins, like commented early by Rossi-Santos MR [9]. Martin AR [12] and Monteiro Filho ELA [14] keep this same theory.

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