

Title: Differences between Solitary and Group time budget in estuarine dolphin (*Sotalia guianensis*) at Northeastern – Brazil

Authors: Carolina Herédia Tosi, (Tosi, C.H.)
Renata Gonçalves Ferreira, (Ferreira, R.G)

Affiliation:

Carolina Herédia Tosi, MSc	Pós Graduação em Psicobiologia, Departamento de Fisiologia/Universidade Federal do Rio Grande do Norte – Natal/RN. Rua Belfort roxo 296/1301, Copacabana, CEP: 22020-010 – Rio de Janeiro/RJ E-mail: tosicarol@yahoo.com.br
Renata Gonçalves Ferreira, PhD	Associate Teacher Pós Graduação em Psicobiologia, Departamento de Fisiologia/Universidade Federal do Rio Grande do Norte – Natal/RN. Rua Salgado filho 3000, Centro de Biociências, CEP: 59072-970 – Natal/RN E-mail: rgf27br@yahoo.com.br

ABSTRACT

Advantages of social life relates to protection from predators and foraging efficiency. Disadvantages relate to the need to synchronise one owns activity with that of others. The analysis which activity is facilitated or detracted in social groups offers an indication of the benefits and costs of solitary or social life, and the pressures individuals suffer in each situation. In this paper we compare the activity budget adult estuarine dolphins (*Sotalia guianensis*) in two situations, solitary and in group. Analyses of 197 hours of behavioral sampling (Predominant Activity Sampling) at Pipa Bay located at south Rio Grande do Norte – Brazil, supports suggestions that protection from predators is facilitated in groups (animals Rest and Travel more in groups), but are obscure regarding advantages of groups for efficiency in foraging. The pressures for social life in estuarine dolphins are discussed in light of the small size of groups observed throughout its area of occurrence.

Keywords: *Sotalia guianensis*, time budget, social life

INTRODUCTION

Time or activity budget refers to the quantification of time employed by each individual in each activity needed to its survival or reproduction (DUNBAR, 1988). Four basic categories are defined: Forage, Travel, Rest and Socialize, although more detailed activity budget may be used depending on research aims and hypothesis. Each individual has a theoretical optimum activity budget that when accomplished yields the maximum survival and reproduction with minimum energetic expenditure (KREBS & DAVIES, 1996).

Diverse factors hinder individuals from reaching their optimum activity budget, from ecological variables to social influences. Life in groups presents costs and benefits for the group members. Benefits are normally associated to protection from predators (VAN SCHAICK, 1983) and communal defense of feeding sites (SEYFARTH, 1977), although other factors may also be important such as cooperative hunting, infant care and thermoregulation (LEE, 1994). Social life imposes costs either because similar organisms searching for similar resources are potential competitors or because each individual in a group has a different optimal foraging strategy. Life in groups, therefore, creates is a constant need to compromise between costs and benefits, and it has been suggested that capacity for behavioural manouvering in social life leads to increased cognition (BYRNE & WHITEN, 1988; WHITEN & BYRNE, 1997).

Odontocetes (Cetacea) are large brained aquatic mammals and their social life is related to protection from predators and, secondly, to foraging efficiency (CONNOR, 2007). Odontocetes exhibit diverse types of social organisation, from small groups, to matrilineal and fission-fusion societies (MANN *et al.*, 2000). However, to our knowledge, no correlation between encephalisation index and size of groups was performed to odontocetes as it has been from primates (DUNBAR, 1992).

The *estuarine* or *grey dolphin (boto cinza)*, *Sotalia guianensis* (VAN BÉNÉDÉN, 1864), is the commonest dolphin in Brazilian shallow waters. It is a small odontocete (mean size of 1.8 meters) that forms small groups from 3 to 40 animals throughout its distribution (GEISE *et al.*, 1999; LODI, 2003; DAURA-JORGE *et al.*, 2005; AZEVEDO *et al.*, 2005; QUEIROZ, 2006). Larger groups are found in more protected bay than in coastal areas, probably due to great availability of food in areas nearer river mouths than in open

coastal waters (QUEIROZ *et al.*, sub). However, large aggregations of animals (up 450 animals) were described (LODI & HETZEL, 1998).

In this paper we present an analysis comparing the activity budget exhibited by adult *estuarine dolphins* (*Sotalia guianensis*) when solitary and when in adult groups during their daylight activity period. We assume that an analysis of which activity is facilitated or detracted in social groups offers an indication of the advantages and costs of solitary or social life, and the pressures individuals suffer in each situation.

MATERIALS AND METHODS

Study Areas

The study was conducted on two contiguous areas (Madeiro beach and Curral beach) that together compose the Pipa bay area (6°13'21.16"S 35°04'15.91"W), located at south Rio Grande do Norte coast (figure 1). Pipa Bay presents a gradually shelving sea-bed, alternately rocky and sandy, with an average depth of 6m. The bay is encircled by cliffs approximately 30m in height, having sandy beaches which are heavily strewn in places with beachrocks, forming bays which are sheltered from the prevailing trade wind and ocean currents. Curral area has the remnants of an antique artisanal fishery area, and Madeiro area is frequented by tourists and surfing practitioners.

Figure 1 about here

Data Collection

Direct observations were conducted from a land base located at Madeiro and Curral areas, with the help of binoculars (Bushnell 10x50), a digital clock, and specific register protocol. Daily observations lasted for 6 hours, during the period of February to December 2006. Accompaniment of dolphins occurred only during dry periods, with no data collections conducted on June, July and August, period of heavy rains. According to previous studies (TOSI & FERREIRA, 2008; GUILHERME-SILVEIRA & SILVA, 2007) dolphins forage less and locomote more after and before the rains.

Methodology of data registering was Predominant Activity Sampling (MANN & SMUTS, 1999; TOSI & FERREIRA, 2008) at two minutes intervals of each animal observed on the bay, regardless of the distance between them. At each registers it was noted: i) the behavioral state of each dolphin; ii) the number of dolphins within the bay.

Behavioral categories used in this work were adapted from many authors, and classified as: 1-Travel: swimming characterized by a uniform directional movement resulting on the change of animals' position from one area to another. It can occurs in different speeds; 2-Social Behavior: high level activity of the dolphins, where they remain longer on the surface and indulged in intense physical contact (cf. BALANCE, 1992; MANN & SMUTS, 1999; LUSSEAU, 2003); 3-Rest: characterized by a pronounced diminution in one level of activity and very slow rate of swimming, without defined direction (cf. WÜRSIG & WÜRSIG 1980; GNONE *et al.*, 2001; CONSTANTINE *et al.*, 2004; LUSSEAU, 2003); 4-Forage: Involved variable directional movement, periodically interrupted by events of persecution and lunges towards a prey. This may or may not result in a successful catch of prey (cf. NORRIS & DOHL, 1980).

Data Analyses

The activity budget was calculated for the registers when only one adult within the bay (Solitary Activity Budget) and when more than one adult but no immature was

present within the bay (Group Activity Budget). A group was defined as all individuals presented within the bay, regardless on the distance between them. We conducted pairwise analyses comparing solitary and social situation regardless of group size.

Data were analyzed using SPSS 13.0. When data were normally distributed T paired test was used, otherwise, Wilcoxon test for related samples was used. Significance value was set to 5% ($p \leq 0.05$) (Z_{AR}, 1996). Data were divided in two periods: before (February to May) and after the rains (September to December).

RESULTS

A total of 76 days of field effort and 70 days of effective data collection were accomplished, resulting in a total of 414.9 h of field effort and 197.12 h (47.5 % success) of data collection. From these, 222.2 h of field effort or 88,66 h of effective data collection (39.9% success) occurred during the period 1 (before the rains), and 192.7 h of field effort and 110. 46 h of effective data collection (57.3% success) on period 2 (after the rains).

Time budget

Period 1 – Travel occurs more often by groups of adults than by solitary dolphins (solitary: 38%; group: 48%), Rest is also more frequently exhibited by groups than by individuals alone (solitary: 2%; group: 5%). Conversely, Forage is more frequently exhibited when animals are alone within the bay than when in groups (solitary: 60%; groups: 41%). All differences were statistically significant: Travel ($t = -2.542$; $n = 31$ e $p = 0.016$), Rest ($z = -2.580$; $n = 31$ e $p = 0.010$), Forage ($t = 3.940$; $n = 31$ e $p = 0.000$). Social behavior represents 5% of group activity budget (figure 2a).

Period 2 – After the rains the pattern of more solitary Forage (solitary: 79%; group: 67%) and more group Travel (solitary: 17%; group: 22%) and Rest (solitary: 3%; group: 5%) was maintained. However, only Forage presented a statistically significant difference: Forage: $t = -3.594$; $n = 37$ e $p = 0.001$; Travel: $t = -1.397$; $n = 37$ e $p = 0.171$; Rest: $z = 1.402$; $n = 37$ e $p = 0.161$). Social behavior represents 6% of group activity budget (figure 2b).

Comparison between periods:

On the period after the heavy rains individuals forage more, both alone ($t = 3.261$; $n = 31$ e $p = 0.003$) and in groups ($t = -5.512$; $n = 33$ e $p = 0.001$). After the rains individuals also Travel less, both alone ($t = 3.105$; $n = 31$ e $p = 0,004$) or in groups ($t = 5.789$; $n = 33$ e $p = 0.001$). Rest alone and in groups, and Social behavior is less frequent in period after the rains, but these are not statistically significant differences ($z = -0.357$; $n = 31$ e $p = 0.721$; $z = -0.093$; $n = 33$ e $p = 0.926$; $z = -0.545$; $n = 33$ e $p = 0.586$, respectively).

However, when Forage behavior is decomposed in two components: search and persecution, it is possible to verify that the increase in forage behavior in period after the rains relates to an increase in search behavior but not an increase in actual persecution of preys (Persecution period 1: 11%; Persecution period 2: 13%; $t = -1.669$; $n = 33$ e $p = 0.099$; Search period 1: 30%; Search period 2: 54%; $t = -5.501$; $n = 33$ e $p = 0.001$).

Figure 2a and 2b about here

CONCLUSION

For social species, studies of periods of solitary activity (eg. during migration, during temporary detachment from groups) offer opportunities to observe individuals activity budget without the constraint of group live, and offer glimpses on costs and benefits for group living. In this work we compared days of solitary activity and of group activity by adult *estuarine dolphins*. Although these animals tended to form smalls groups on the study area (less than five individuals- TOSI & FERREIRA, 2008), the increase in Rest and Travel indicate that group life offer benefits in terms of protection from predators, similar to the main beneficial factor described on the specialized literature (GNONE *et al.*, 2001).

Time employed in Forage decreases when individuals are in group relative to when individual area alone within the bay. There are two possible explanations for this result. Firstly, it is possible to argue for an increased foraging efficiency, probably related to a collective (cooperative?) hunting, as suggested by HOELZEL, 1991; NEUMANN & ORAMS, 2005 for other odontocetes. In fact, it is common to observe dyads and even groups of animals shoalowing fish schools towards shallow waters, and there are descriptions of *Sotalia* encircling fish schools (SILVA & BEST, 1996; LODI & HETZEL, 1998; GEISE *et al.*, 1999). Conversely, it is possible to argue that there is an increase feeding competition in groups, with individuals having fewer opportunities for successful feeding when in groups, therefore, the decreased time in foraging observed.

The lack of differences between Rest and Travel solitary and group activities during the period after the rains may be related to an overall increase in Forage activity observed in this period. A change in behavior patterns during periods of less food abundance was also described in other areas occupied by *estuarine dolphins* (DAURA-JORGE *et al.*, 2004).

Despite this advantage of life in groups, *estuarine dolphin* tend to form small groups, with a modal size of less than 6 individuals in diverse populations (GEISE *et al.* 1999; LODI, 2003; DAURA-JORGE *et al.*, 2005; AZEVEDO *et al.*, 2005; QUEIROZ, 2006). *Estuarine dolphins* present site fidelity, and the factors that hinder these animals from forming larger groups may be related to ecological constraints such as the availability of prey in each area (as suggested by QUEIROZ *et al.*, sub.).

Based on Social Intelligence hypothesis, CONNOR (2007) has recently argued that large brains in odontocetes, or more specifically in *bottlenose dolphins* (*Tursiops aduncus*) derives from the need to keep stable alliances in a fission-fusion societies, due to a risk environment. The type of social organisation of *estuarine dolphin* is still unknown. MONTEIRO-FILHO (2000) suggested that this species forms monogamic pairs due to the high incidence of dyads and calves in a population inhabiting a protected bay (Cananéia). However, other studies reveals that group of up to 40 individuals may split in dyads within foraging areas (LODI, 2003; DAURA-JORGE *et al.*, 2005), although no study has directly related large group sizes to efficiency in foraging. In addition TOSI & FERREIRA (sub.) discuss that *estuarine dolphin* do not present social displays (synchrony and petting) typical of the *bottlenose* population described by CONNOR (2007).

Protection from predators and foraging efficiency are two main ecological pressures suggested for group living, although species differ in which is strongest, and on the degree of dependency on group living. Although our analyses did not differentiate among various group sizes (which is an indicative of social complexity), according to the data presented in this work it is possible to say that the advantages for group relates to protection from predators (increases in Rest and Travel). However, data

are more obscure regarding the advantages for collective hunt, an ecological pressure commonly suggested for group living in odontocetes considering their large size and their mobile prey (MANN *et al.*, 2000). Considering that the study area is a bay with direct contact with the ocean, and about 7,5 km apart from the nearest river mouth, where large fish schools are occasionally but not often observed, it is possible to infer that living in a group for these dolphins are more related to protection from predators than to foraging efficiency. More detailed studies are needed to properly confirm this suggestion, but if this is the case, the sociality of these dolphins may not be as complex as that of *Tursiops*, and it is in accordance to the absence of elaborated social displays presented by the dolphins in this area.

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Figure 1

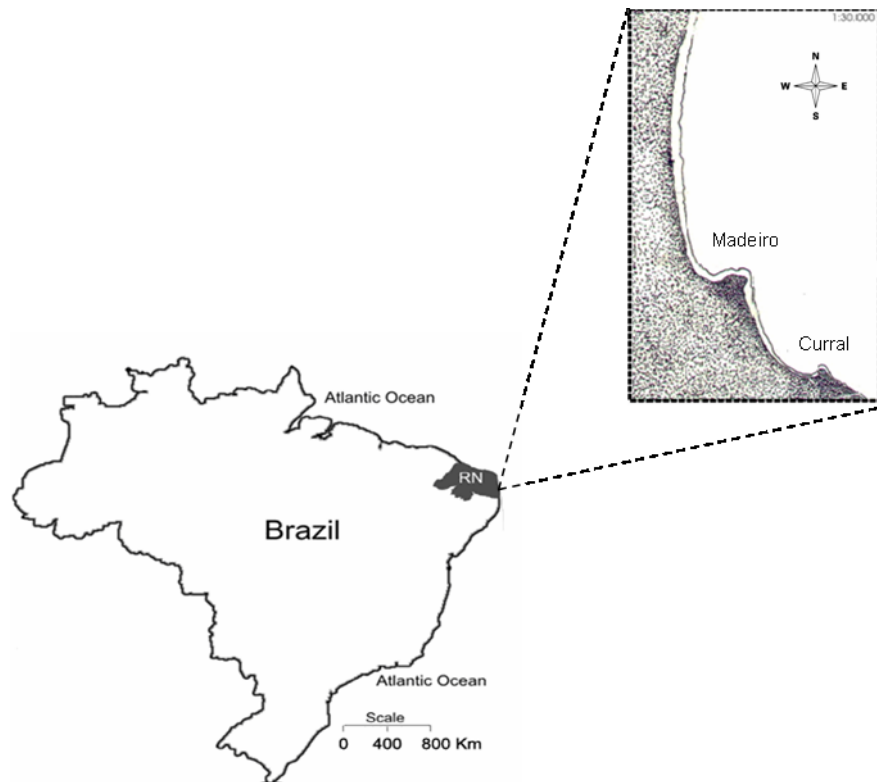
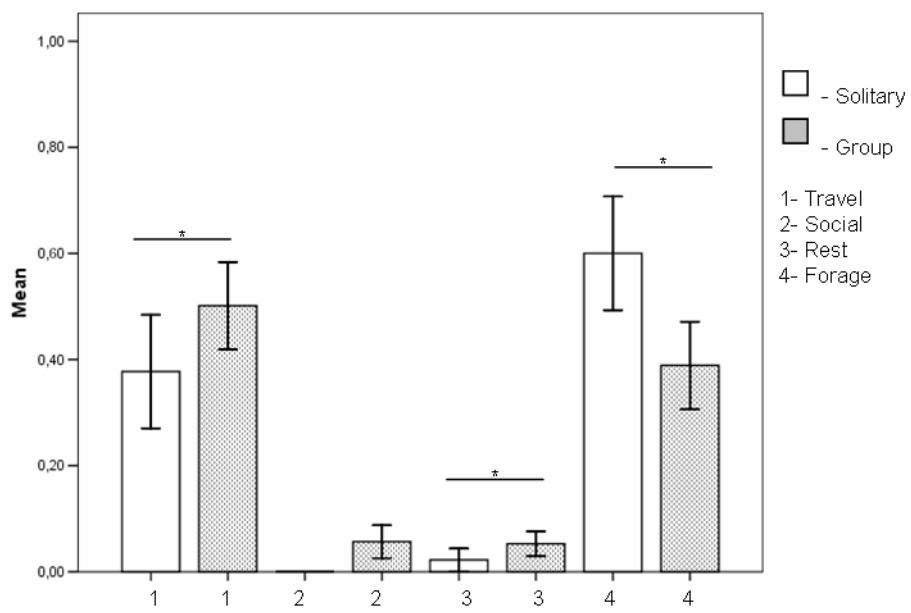


Figure 2

(a)



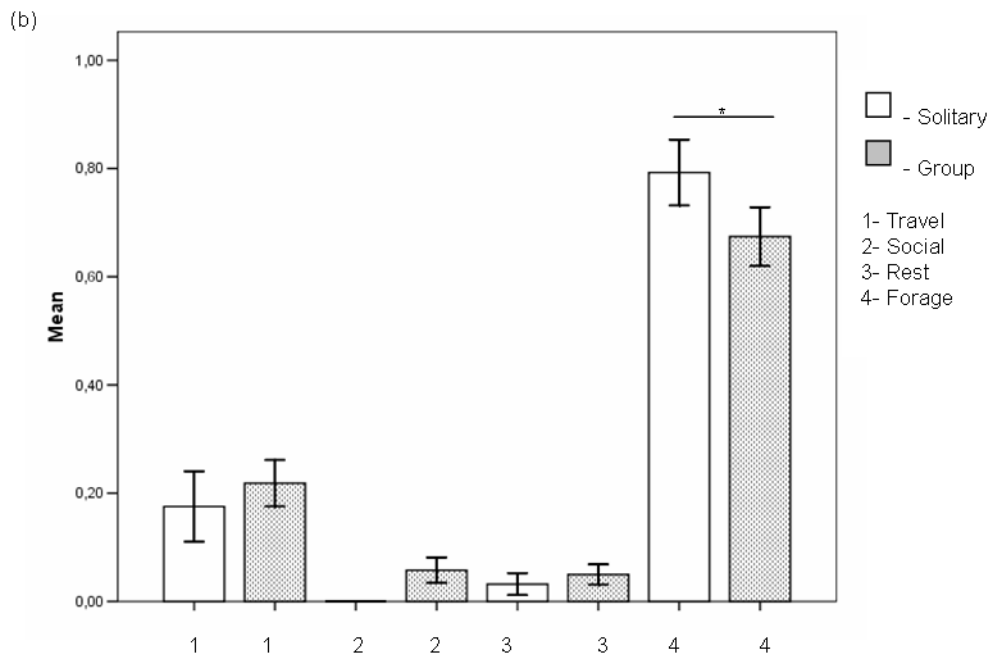


Figure legends

Figure 1- Localization of study area: Pipa bay (Curral and Madeiro beach)

Figure 2. Time budget of adult *estuarine dolphins*, solitary and group situations. (a) period 1 - before the rains and (b) period 2 – after the rains (b). * = significative differences at $p= 0.05$.