



Estuarine dolphins (*Sotalia guianensis*, Cetacea, Delphinidae) play at Porto de Ilhéus harbor, Bahia, Brazil

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Abstract. The play consists, apparently, of actions performed for no other purpose than amusement of the animal. This study aimed to describe the play performed by estuarine dolphins (*Sotalia guianensis*) at Porto de Ilhéus. A total of 548.3 hours of direct observation were carried out from September 2007 through August 2008, by means of incident sampling method. A total of 2794 play events were recorded, expressed by individuals belonging to 719 groups. We identified 16 behavioral patterns related to play that were divided into six categories: play with object, play with prey, aerial play, surfing play, social play and impulsion play. New play behaviors – fish throwing, inverted jump and contact play – were observed. Social and aerial play were the most often observed plays. More than two thirds of the groups (69%) in which play was observed were composed mostly by immature animals. The study of play behavior contributed to the understanding of the population's social structure, besides of confirming that Porto de Ilhéus is a favorable area for the estuarine dolphin's socialization.

Key Words: dolphin, recreational, socialization

Resumo. Comportamento de brincadeira em boto-cinza (*Sotalia guianensis*, Cetacea, Delphinidae) no Porto de Ilhéus, Bahia, Brasil. A brincadeira consiste em ações realizadas, aparentemente, para nenhum outro propósito que não seja o próprio divertimento do animal. Este estudo teve como objetivo descrever as brincadeiras dos botos-cinza (*Sotalia guianensis*) no Porto de Ilhéus. Realizou-se 548,3 horas de observação direta de setembro de 2007 à agosto de 2008, utilizando o método de amostragem "todas as ocorrências". Um total de 2794 brincadeiras foi registrado por indivíduos pertencentes a 719 grupos. Foram identificados 16 padrões comportamentais de brincadeira distribuídos em seis categorias: brincadeira com objeto, com presa, aérea, surfe, social e de impulsão. Comportamentos de brincadeira inéditos de arremesso de peixe, salto invertido e contato foram observados. As categorias de brincadeira observadas com maior frequência foram as brincadeiras sociais e as aéreas. Mais de dois terços dos grupos (69%) nos quais se registrou brincadeiras eram compostos em sua maioria por animais imaturos. O estudo dos comportamentos de brincadeira contribuiu na compreensão da estrutura social da população, além de confirmar que o Porto de Ilhéus corresponde a uma área favorável para a socialização dos botos-cinza.

Palavras chave: golfinho, lúdico, socialização

Introduction

The play consists of actions apparently performed for no other purpose than the animal's

amusement (Würsig 2009). However, it is well recognized that the play performed by younger animals is a means for learning social and motor

skills essential for survival (Würsig 2009). According to Sharpe (2005), play gives young animals the opportunity to practice and refine motor skills that they will need in adulthood.

Play has often been ignored in biology because it is difficult to define, and its importance seems far from obvious (Graham & Burghardt 2010). Play seems purposeless because the observer simply may not understand the purpose, because eventual benefits are not immediate or identified, or because the benefits are multiple (Heinrich & Smolker 1998, Pellegrini & Smith 1998). An animal only plays when it is healthy, free of stress, not hungry, not busy with other activity and no other need directs its behavior (Eibl-Eibesfeldt 1974, Burghardt 1999). Play may be a motivated and self-rewarding (autotelic) activity so as to maintain the physiological, behavioral and perceptual condition in animals where parental care eliminates the need for time consuming survival behaviors in the young (Graham & Burghardt 2010).

When individuals play they typically use action patterns that are also used in other contexts, such as predatory behavior, antipredatory behavior, and mating (Bekoff 2001). According to Bekoff, these actions may not vary much across different contexts, or they may be hard to discriminate even for the participants. According to Fagen (1981), studies about play suggest at least three possible functions: development of the behavioral flexibility calibrated by the environment; development of cognitive and motor skills; promotion of the recognition of relatives and social learning. Spinka *et al.* (2001) present another functional hypothesis: the play would allow the development of flexible movements and emotional responses to unexpected events in which there is a sudden loss of control over locomotion, position or sensory/spatial input.

According to Burghardt (2005), there are evidences that play has evolved independently in many vertebrates, as well as in all families of placental mammals. However, not all species play, and it is suggested that this behavior is associated to a complex social life and high degree of encephalic development (Furlow 2001, Spinelli *et al.* 2002). The cetaceans have all characteristics for playing: they are highly encephalized; they have complex social lives; and they need to learn an elaborate behavioral repertoire, including interactions with highly unpredictable preys (Connor *et al.* 1998). Play in Brazilian populations of estuarine dolphins (*Sotalia guianensis*, Van Bénédén 1864) were reported by Geise (1991), Geise *et al.* (1999), Reis (2002), Spinelli *et al.* (2002), Spínola (2006),

Souto *et al.* (2006), Nascimento *et al.* (2008), among others. In this study, we aimed to identify the behaviors that compose the repertoire of play in the estuarine dolphin in Ilhéus, Bahia, by analyzing the expression of each behavior as regards the age of the individuals involved and some of the environmental variables.

Materials and Methods

Study area

The Porto de Ilhéus harbor (14°47'S, 39°02'W) is located at the cove Enseada das Trincheiras, in Malhado district of Ilhéus city, south coast of Bahia (Fig. 1). The harbor area was chosen for this study due to previous reports of the almost daily presence of estuarine dolphins in the area for long periods of time (Reis 2002, Assis 2008). The animals remain close to the edge of a 2262 m breakwater. The closeness of animals to the breakwater facilitates their observation, fact that determined the choice of the observation's fixed point. An intense flow of cargo, ships, tourism, fishing boats and divers which practice recreational fishing characterize the monitored area (Andrade 2003, personal observations).

Data collection

From June to July 2007, 50 hours of observation "*ad libitum*" (Altmann 1974) were carried out to identify and establish the ethogram of the behavior patterns of play. The ethogram was based on the existing behavioral literature about the estuarine dolphin and other delphinidae. Play behaviors absent from the bibliography consulted were defined.

The quantitative data collection was conducted from September 2007 through August 2008. We carried out 48 hours per month of sampling, in four hours sessions alternating mornings and afternoons. The monitored area included 321.7 m² with a radius of 320 m, the maximum distance that allowed, for most of the time, age determination of the individual dolphins using binoculars. This distance was measured using a digital LEICA T110 theodolite with an angular precision of 10 seconds. All observations were made at approximately six meters above sea level (Santos 2010). Scan samplings (Altmann 1974) were carried out every 15 minutes, with the help of binoculars, to verify the entrance or exit of groups from the monitoring area.

Date, beginning and finishing times of each session, arrival and departure of animals from the monitored area, sea state, sea swell and water visibility were recorded on a standardized data sheet. Incident samplings (Mann 1999, 2000) were

conducted to register all play events, number of animals involved and the age class of the animals in the play (definition further ahead). The information collected were transferred to Excel spreadsheets

with Visual Basic programs developed for this study, which allowed speeding up of the transcription and avoid typing errors.

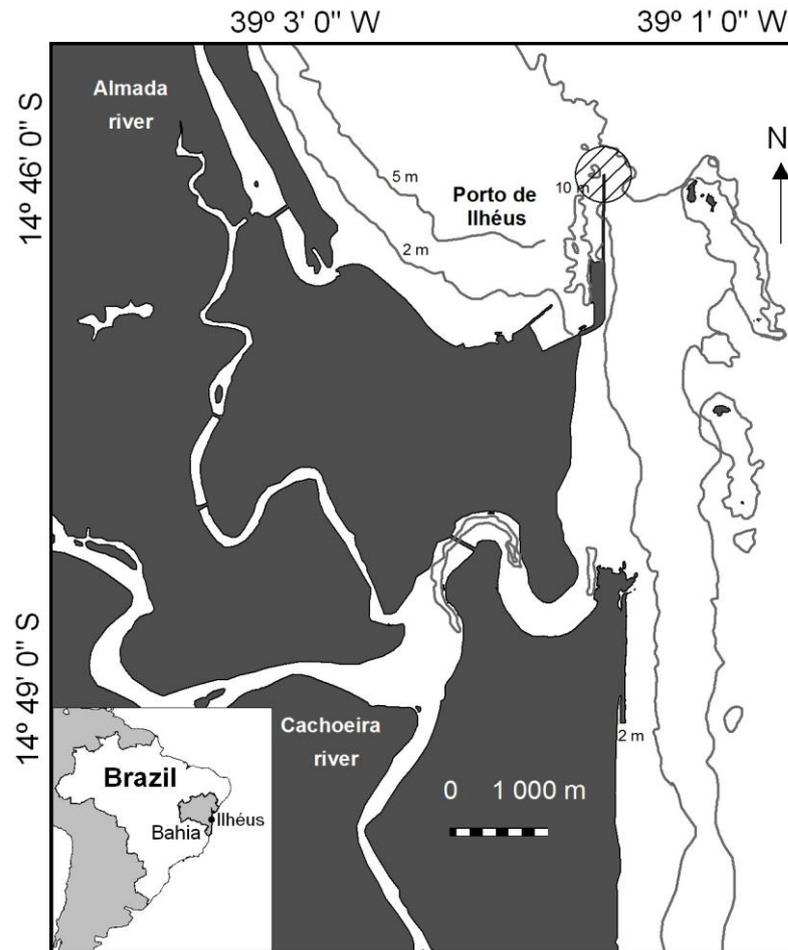


Figure 1. Location of the Porto de Ilhéus harbor. The hatched circumference (radius = 320 m) indicates the location of the monitored area.

Definition of environmental variables

We visually estimated sea state, sea swell and water visibility at the start of each session and when a change in one of these features was detected during the session. Sea state and sea swell were classified using international codes and definitions: the state of the sea describes the state of the water surface and was classified as calm, smooth, slight and moderate (World Meteorological Organization 2011). The sea swell was classified according to the height of the swell waves as low (0-2m), moderate (2-4 m) and heavy (exceeding 4 m).

The water visibility was also visually estimated because the use of a Secchi disk from the breakwater was not safe enough and using a boat to

make the measurement would have scared away the dolphins. Water visibility was defined as high (clear, transparent water with blue tones and white foam), medium (water with brown or grey tones, brownish foam), and low (muddy and murky water, generally with sediments on the surface).

Definition of groups

The animals were identified as infants, juveniles and adults, according to coloring pattern and body size, which were visually estimated. Those individuals with a grey-pinkish color (Randi *et al.* 2008) and up to 2/3 of the size of an adult were classified as infants. According to Randi *et al.* (2008), the juvenile individuals display a grey back, including part of the pectoral and tail

fins, with a pinkish stain at the center of the dorsal fin. The size of the juveniles was visually estimated to be larger than 2/3 of an adult's size. The term "immature" refers to both infant and juvenile age classes. Adult animals are characterized by a predominantly grey, with a lighter grey on the belly from the neck up to the genital region (Randi *et al.* 2008). According to Monteiro-Filho & Monteiro (2008), the body length of adult varies from 170 to 220 cm.

Group: set of animals observed in apparent association, moving in the same direction and often, but not always, engaged in the same activity (Shane 1990). The groups were recorded once as soon as they arrived at the study area. We considered that the animals had left the observation area when they were not visualized for two successive scans (at an interval of 15 minutes).

Play association: group of individuals distant from each other by up to two bodies, performing any one of the different types of play considered in this study (adapted from Spinelli *et al.* 2002).

Play performed by an isolated individual: one animal, distant from another animal for more than two bodies, performs any one of the different

types of play considered in this study, obviously not addressed to a conspecific (adapted from Mendoza-Granados & Sommer 1995).

Playful behavior: all behaviors characterized by qualitative features such as the lack of apparent function and excessive repetition, intensity or frequency (adapted from Spinelli *et al.* 2002) besides fragmented sequences of behavior (Mendoza-Granados & Sommer 1995).

Statistical analysis

The chi-square adherence test was used for two purposes: it was first used to check the homogeneity of the play's expression according to age class of the performing individual. Second, the test was used to check the influence of the state of the sea, swell waves and water visibility on the frequency of the play.

Results

Plays were observed on 101 (73.7%) out of the 137 sampled days. A total of 2794 plays were recorded for 719 groups of estuarine dolphins. Fifteen types of play were observed and classified into six categories (Table I) and are illustrated on Figure 2.

Table I. Descriptions of the types of plays observed at Porto de Ilhéus harbor, classified by category. The types of play being described for the first time for this species are marked with asterisks.

Plays with object	
Play with object	The animal uses any object found on the water surface (seaweeds, pieces of kindling, plastic bags, etc.), throwing it up with the mouth or tail fin, carrying it on its back, or swimming and carrying it with the mouth (Spinelli <i>et al.</i> 2002).
Play with prey	
Play with prey*	Juveniles or adult animals capture dead or alive fish(es) and throw it with the mouth to other individual(s) of the group.
Aerial plays	
Head slap	The dolphin emerges only the head, without exposing the pectoral fins, in an angle of 30-45°. When it falls back into the water, it arches its body and slap the head, usually with the jaw (Norris & Dohl 1980, Silva-Jr 1996).
Dorsal backslap	The animal raises the body from the water down to the pectoral fins, showing part of the belly. Then it falls back into the water (complemented from Nascimento <i>et al.</i> 2008).

Table I (Cont.)

Tailslap	The dolphin places itself horizontally on the surface of the water, arches the tail base and bangs the tail vigorously producing sound. This pattern may be performed in two positions: normal and inverted (Norris & Dohl 1980, Silva-Jr 1996). These tailslap events were never observed during forage activity or in an agonistic context, but frequently during a sequence of play events.
Backslap	The animal partially leaves the water exposing the body from the pectoral fins to the base of the tail, then it arches the body and falls on its belly, side or back (Norris & Dohl 1980, Silva-Jr 1996).
Somersault	This is an acrobatic leap in which the animal somersaults – especially the immature – totally leaving the water and spinning the body at 360°; and then falling on its back, side or belly (Geise 1991, Souto <i>et al.</i> 2006).
Spy-hopping	The dolphin emerges vertically exposing the head down to the eyes, or down to the pectoral fins; it remains on this position for a few seconds and submerges on the same position without arching the body. There are cases when the animal stands still, with the head vertical or parallel to the surface of the water, then it spins the head as if seeking for something, shaking from one side to the other, or back-and-forth. The animal may also stand vertically still, with two-thirds of the body out of the water, remaining on this position for a few seconds, vibrating the body and returning to the water also in a vertical position (Geise 1991). We only considered spy-hopping events performed in a play context (e.g. during a sequence of play events).
Inverted leap*	The animal leap totally exposing the body with the dorsal region facing the water. This is the first body region of the dolphin to touch the surface of the water at the end of the leap.
Partial leap	The animal emerges diagonally in relation to the surface of the water, remaining with the body exposed down to the pectoral fins or dorsal fins; then it falls back on its belly or sideways (Geise 1991, Souto <i>et al.</i> 2006).
Total leap	The dolphin totally emerges from the water, above the surface, vertically and with the body straight. When it reaches the maximum height it arches the body and dives head first. When it does not arch the body, it falls on its belly or back, causing lots of noise and splashing water (Geise 1991, Souto <i>et al.</i> 2002).
Surfing play	
Surfing	Characterized as the riding of waves, alone or in groups; in this case the animals may also perform synchronized leaps (Spinelli <i>et al.</i> 2002)
Social plays	
Contact play*	An animal uses the rostrum to touch any part of another individual's body. The animal that was touched allows the physical contact and remains floating or moves offering another part of the body to be touched.
Social locomotor play	The animals stand very close to the surface of the water and present intense locomotor agitation, stirring turbulences and causing physical contact. Frequently immature animals are seen going over other animals (adults or immature), sometimes hitting the other animal's body, or falling on another animal after a leap. The animals may be seen in mutual pursuit, swimming in sync and lightly biting each other (Spinelli <i>et al.</i> 2002).
Impulsion play	
Impulsion play	An animal throws an immature animal up, which stays with its whole body out of the water (Spinelli <i>et al.</i> 2002).

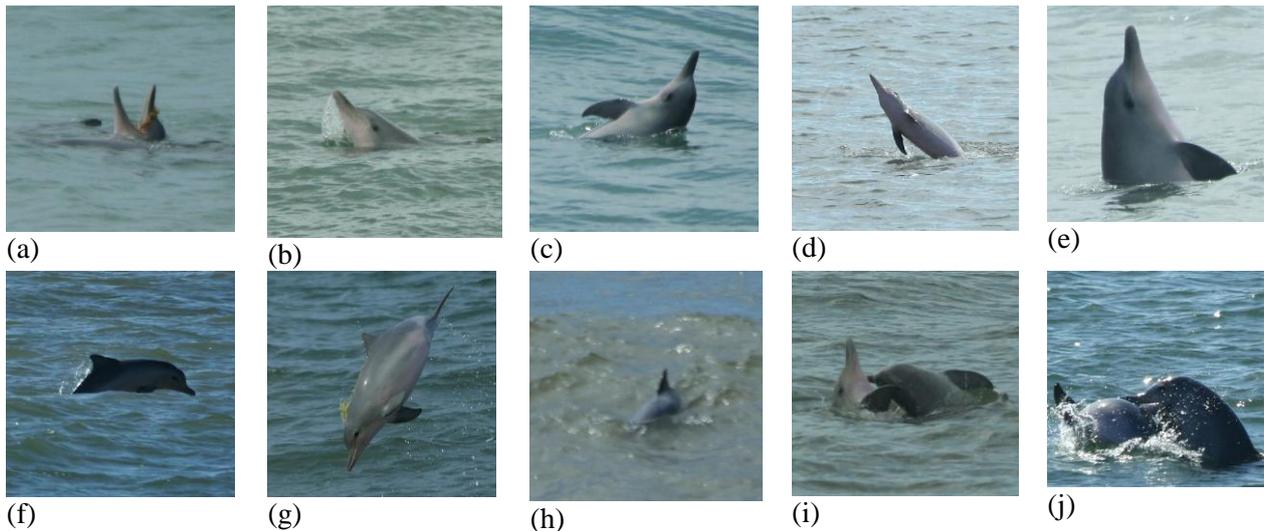


Figure 2. Pictures of some plays observed at Porto de Ilhéus harbor. (a) play with object, (b) head slap, (c) dorsal backslap, (d) backslap, (e) spy-hopping, (f) partial leap, (g) total leap, (h) surfing, (i) contact play, (j) social locomotor play.

Individuals of all age classes were observed during the study period, being 117 infants (13%), 335 juveniles (37%) and 443 adults (49%). A total of 243 play events were performed by infants (12%) 1056 by juveniles (53%) and 697 by adults (35%). Although more adults than juveniles were seen, most

of the plays were performed by juveniles ($X^2=214.64$; $p<0.0001$). Almost all play associations ($n=86$, 66%) included immature individuals; 69% of the play associations ($n=62$) were composed by a majority of immature individuals (Fig. 3).

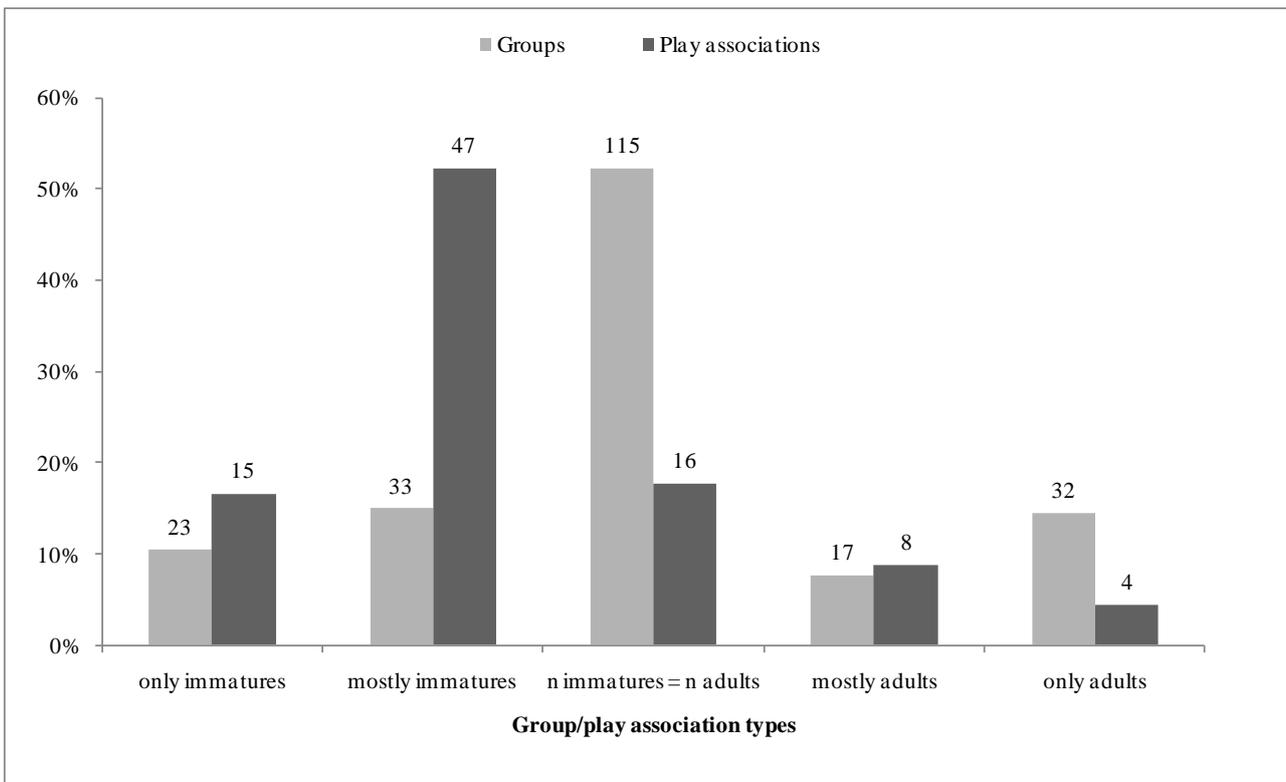


Figure 3. Relative frequency of the occurrence of groups ($n=220$) and play associations ($n=90$) of estuarine dolphins according to their age composition (immature and adults) at Porto de Ilhéus harbor.

The social plays category was the most frequent (47%) followed by aerial plays (33%) (Table II). The number of plays observed varied significantly according to the sea's conditions (Table III). The

record of plays was more frequent than expected when the sea was calm ($X^2=463.29$; $p<0.0001$), the swell moderate ($X^2=54.10$; $p<0.0001$) and the water visibility medium or low ($X^2=1197.63$; $p<0.0001$).

Table II. Frequencies of play behavior performed by estuarine dolphins at Porto de Ilhéus harbor from September 2007 through August 2008.

Categories	Type	<i>n</i> plays	%
Social plays	Social locomotor play	1257	45
	Contact play	68	2
Aerial plays	Total leap	373	13
	Partial leap	175	6
	Spy-hopping	135	5
	Tailslap	79	3
	Inverted leap	55	2
	Headslap	50	2
	Backslap	29	1
	Dorsal backslap	18	1
	Somersault	9	0
Surfing play		421	15
Play with prey		102	4
Play with object		20	1
Impulsion plays		3	0
Total		2794	100

Table III. Observed and expected frequencies of plays performed by estuarine dolphins in different environmental conditions at Porto de Ilhéus harbor from September 2007 through August 2008 ($n=2794$ play events). The conditions in which observed frequency of play was significantly higher than expected are highlighted.

Environmental variables	Categories	Observed frequency of play	Expected frequency of play
State of the sea ($X^2=463,29$; $p<0,0001$)	Calm	<u>1561 (56%)</u>	<u>1082.2 (39%)</u>
	Smooth	673 (24%)	1177.3 (42%)
	Slight	554 (20%)	494.9 (18%)
	Moderate	6 (0%)	39.5 (1%)
Sea swell ($X^2=54,10$; $p<0,0001$)	Low	1886 (68%)	1934.9 (69%)
	Moderate	<u>847 (30%)</u>	<u>131.5 (26%)</u>
	Heavy	61 (2%)	127.5 (5%)
Water visibility ($X^2=1197,63$; $p<0,0001$)	High	367 (13%)	949.5 (34%)
	Medium	1475 (53%)	1460.5 (52%)
	Low	<u>952 (34%)</u>	<u>384 (14%)</u>

Discussion

Although adults were the most frequently observed age class, their participation in the plays

was low, as reported by Spinelli *et al.* (2002). Adult animals play less with elements of the physical environment than younger animals because adults

are already more familiarized with these elements. The environment is more predictable for adults and there is less need to be trained for the unexpected (Spinka *et al.* 2001).

The majority of the plays were performed by juvenile individuals, when animals are more prone to face unpredictable situations (Spinka *et al.* 2001). However, according to the “surplus resource model” (Burghardt 1999), the protection of youngsters against the threat of predators would be guaranteed by parental care which support younger individuals by providing them food. This would allow the young ones to play more frequently, besides an aerobic metabolism allowing them to vigorously prolong this activity.

In accordance with our study, Spinelli *et al.* (2002) observed higher frequencies of social (42%) and aerial plays, called locomotor plays by the authors (35%), at Praia de Pipa beach. The motor plays present benefits on the short term, resulting in an increase of versatility for the performance of movements used for recovering from gravitational, kinematic or postural shocks, such as: losing ground underfoot, falling over, being knocked over, being pinned down or vigorously shaken (Spinka *et al.* 2001). Benefits for the long term are associated to social plays, that would allow the individual to deal with psychological shocks (Spinka *et al.* 2001, Spinelli *et al.* 2002) such as facing a scaring or dangerous stimulus, suddenly meeting a stranger, or a sudden reverse of dominance (Spinka *et al.* 2001). According to Spinka *et al.* (2001), researchers agree that play is very important in social, cognitive, and/or physical development, and may also be important for training youngsters for unexpected circumstances.

Spinelli *et al.* (2006) recorded prey-transfer behavior in *S. guianensis* where an adult animal, caught a fish, swam towards a calf and transferred it to the calf's mouth. Our records of play with prey events were different since the fish was thrown with the mouth to another individual and was seen in groups composed of juveniles only or adults and juveniles. Santos *et al.* (2007) observed *Tursiops truncatus* manipulating prey before ingestion in an apparent playful behavior. Since the play with prey events of *S. guianensis* were not followed by ingestion and were observed in a playful context, we considered them as play events.

A larger number of sightings of estuarine dolphins occurred with calm sea, medium or low water visibility and low swell. This species presents shy, fearful and evasive behavior (Lodi 2003, Monteiro-Filho *et al.* 2008) and under these environmental conditions the animals probably feel

less vulnerable against the action of possible predators or threats, being able to play. According to Spinka *et al.* (2001), the play occurs only under relatively safe environmental conditions, and may be interrupted when predators or other dangers are detected. Strong or prolonged negative emotions such as fear, pain, suffering, anger, hunger, frustration or indisposition may suppress the play. We propose another hypothesis: with calm sea state and turbid water the efficiency for the capturing of preys is higher, and the animals would catch this opportunity to feed and would, consequently, play less. The ability of the observer to detect play events may have been reduced in moderate state and heavy swell but probably not in slight state, since observed frequency of play events was higher than expected. The study of play behavior of the estuarine dolphin contributed for the understanding of the social structure of the population. It also confirmed that Porto de Ilhéus is an area where the species frequently socializes. These results reinforce the value of the species for the population's environmental awareness, and point to a possible development of the cetacean's observation tourism in Ilhéus. Such activity, when conducted in a controlled and responsible way, would enrich the tourism options of the city and would help the municipality's economy.

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