Aquatic Mammals 2008, *34*(3), 269-276, DOI 10.1578/AM.34.3.2008.269

Behaviour Patterns in Captive Manatees (*Trichechus manatus manatus*) at Itamaracá Island, Brazil

Fabíola F. A. Gomes,[1] Jociery E. Vergara-Parente,[2] and Stephen F. Ferrari[1]

[1]*Department of Biology, Universidade Federal de Sergipe, 49.100-000 São Cristóvão – SE, Brazil*
E-mail: biola_gomes@hotmail.com
[2]*Centro Mamíferos Aquáticos, 53.900-000 Ilha de Itamaracá – PE, Brazil*

Abstract

The Antillean manatee (*Trichechus manatus manatus*) is distributed along much of the northern and eastern coasts of Brazil, although relatively little is known of the ecology or behaviour of the members of this population. In the present study, the behaviour of seven juvenile manatees earmarked for reintroduction to the wild was monitored using focal animal sampling over a 20-d period at the Aquatic Mammal Centre (CMA/ICMBIO) on Itamaracá Island, Pernambuco. The primary aim of this study was to characterise behaviour patterns, especially individual differences, as a baseline for monitoring during reintroduction. In particular, it was hoped that specific patterns could be identified as a diagnostic reference for the evaluation of an individual's potential for successful reintroduction. Overall, while resting was the predominant activity of all but one subject, considerable individual variation was recorded in all behavioural categories. In addition, significant differences were recorded between morning and afternoon sessions, with some individuals presenting a given category during only one part of the day. Some of the behaviour patterns, such as circular movement, appeared to be related to anxiety or stress and might be useful for the behavioural diagnosis of individuals earmarked for reintroduction, although it will only be possible to interpret the exact implications following the reintroduction process.

Key Words: Antillean manatee, *Trichechus manatus manatus*, behaviour, captivity, individual variation, reintroduction, Brazil

Introduction

Manatees (order Sirenia) are the only exclusively herbivorous extant marine mammals (Ronald et al., 1978). They play an important ecological role in many coastal ecosystems, where they may contribute significantly to the control of aquatic macrophytes, the ecology of seagrass beds, and the production of algae and plankton (Domning & Magor, 1978). They are also vulnerable to a variety of anthropogenic pressures, including direct impacts such as hunting and watercraft collisions and indirect threats such as habitat loss and pollution. The Antillean manatee (*Trichechus manatus manatus*) is listed as "endangered" by the International Union for Conservation of Nature (IUCN) (2007), and the Brazilian population is listed as critically endangered by the Environment Ministry (MMA, 2007).

In Brazil, the major threats to *T. m. manatus* include the recent explosive growth in tourism along the northern and eastern coasts, and the installation of aquaculture systems in many estuaries. An increase in the number of stranded neonates rescued over the past 20 years has been attributed to the loss of habitat necessary for successful parturition and neonatal care (Parente et al., 2004). Lima et al. (2001) point specifically to the siltation of rivers, which may often force mothers into more open waters, where they are more likely to lose contact with their calves.

The rescue and rehabilitation of stranded neonates is a core conservation strategy of the Aquatic Mammal Centre on Itamaracá Island in Pernambuco State, which is a subunit of ICMBIO, part of the Federal Environment Institute (Lima, 1997). Captive-raised manatees appear to be able to adapt well to life in the wild—two animals have survived more than 13 years and one female has given birth—but their naiveté towards humans can be a major problem. Many individuals will actively seek human company by approaching boats, for example, which not only brings them into potential danger but also interrupts the adaptation process. The survival of manatees in the wild and the optimal exploitation of resources may depend on complex behaviour patterns (Gannon et al., 2007).

Since 1994, a total of 15 animals have been reintroduced (CMA/ICMBIO, unpub. data), and six are still being monitored, including the one that

has given birth, attesting to the effectiveness of the reintroduction process. Although radio contact has been lost with four other animals, since their carcasses have not been found, it seems likely that at least some of them may have joined natural populations. Of the remaining five animals, two died and three were recaptured and returned to the Rehabilitation Centre. One of these animals—Assu—has been reintroduced unsuccessfully on two separate occasions.

One fatality was the result of the animal approaching humans—it was injured by a home-made bomb used by fishermen. The second death appears to have been caused by the ingestion of plastic. The three recaptured animals had strayed far from their release zones (one was almost 100 km from the coast); they were thin and dehydrated.

Overall, then, at least one third of reintroductions have been unsuccessful. In addition to the potential risks to the animals, such setbacks result in the loss of invaluable time and resources. The reintroduction process involves tracking and behavioural monitoring (Florin Filho, 2004), but it does not provide sufficient detail for the systematic evaluation of individual differences that may affect the probability of a successful reintroduction. This study reports on the preliminary monitoring of the behaviour of seven Itamaracá manatees earmarked for reintroduction in an effort to identify individual and temporal differences in activity patterns, which may translate into significantly different potentialities for reintroduction.

Materials and Methods

The study took place at the Brazilian National Centre for Research, Conservation and Management of Aquatic Mammals (Centro Nacional de Pesquisa, Conservação e Manejo de Mamíferos Aquáticos) on Itamaracá Island in Pernambuco State (7° 48' 33" S, 34° 50' 16" W). The Aquatic Mammal Centre (CMA/ICMBIO) has a capacity for 26 Antillean manatees, and its primary objective is to rehabilitate wild-born individuals for reintroduction into their natural environment.

During the months of November and December 2005, seven subadult (*cf.* Marmontel, 1993) manatees (Table 1) earmarked for reintroduction in early 2008 were housed in a double enclosure of 5.3 m by 4.0 m connected by a sliding door, which is closed only for maintenance. One pool was 3.2-m deep and uncovered, while the other was 1.5-m deep and covered by a roof. All of the subjects were wild-born and had been rescued at approximately 10 d of age. All were raised under the same standardised conditions at the CMA, and had been housed together in the same enclosure for approximately 1 y prior to this study, so there was minimal variation in environmental variables likely to influence behavioural differences.

In October 2005, a preliminary list of behavioural categories was elaborated based on the studies of Hartman (1979), Rosas (1994), and Linhares et al. (2001). These were evaluated and adapted, as necessary, during preliminary observations of the subjects, resulting in a final list of 23 categories (Appendix 1), which was used during monitoring. The sampling method and schedule were also defined during this preliminary period.

Observations were conducted from a position which provided a full view of the entire enclosure, but precluded any interaction between the subjects and the observer. Quantitative behavioural data were collected in 2-h-long focal animal samples with continuous recording (Martin & Bateson, 1993). During each sample, the initial behavioural state of the subject was noted, and the time (to the nearest second) of each subsequent change in behaviour was recorded, together with the identification of the new category. This provided a record of the sequence of activities and the duration of each bout.

Samples were taken at 1000 to 1200 h and 1400 to 1600 h to avoid periods of contact with humans (provisioning, pool maintenance). Data were collected daily over a 23-d period, except on Mondays, when weekly pool draining altered observation conditions significantly. Subjects were sampled on a predetermined, rotating random schedule in which the initial sequence was selected randomly and rotated in subsequent sessions by moving the first subject to the end of the sequence. This resulted in six focal animal samples per individual, divided equally between morning and afternoon sessions, for a total of 12 h of monitoring per individual.

Individual activity budgets were compiled by summing the total time a subject was recorded in each behavioural category and dividing this sum by total observation time. General budgets were assembled in the same way, by summing individual values. Budgets were also calculated separately for morning and afternoon samples in order to assess the possible influence of the time of day on behaviour patterns.

Frequency rates (bouts/h) were calculated by dividing the total number of bouts by the number of hours of observation. Mean bout duration was calculated by dividing the total duration of a given category by the number of bouts recorded.

Results

General Patterns

Overall, only 19 of the 23 established behavioural categories (Appendix 1) were observed during the study period. The categories *mount*, *expose penis*, *copulate*, and *autogroom* were not observed. The relative lack of sociosexual behaviour was expected from the immaturity of the subjects (Table 1), although it is not clear why autogrooming was not observed. Six categories accounted for 96.43% of the general activity budget (Figure 1), although there were considerable individual differences in the proportions of different categories (Table 2). One category, *circular movement*, was restricted to three individuals—Arani, Tinga, and Zelinha. Despite this variation, no animal dedicated less than 92.00% of its time to the six main activities, and for two individuals—Atol and Zelinha—the total was more than 99.00%.

With the possible exception of Aira, subjects presented considerable deviations from the average values for most categories (Table 2). Aira did not exhibit one of the six major categories—*circular movement*. Of the remaining subjects, two—Atol and Potiguar—were relatively inactive and spent a comparatively large proportion of their time at rest, as well as engaging in a relatively reduced

Table 1. Study subjects monitored at the CMA/ICMBIO, Itamaracá Island, Brazil.

Subject	CMA register	Sex	Age (months) at time of study
Aira	01S0112/124	Female	36
Arani	01S0111/119	Male	38
Artur	01S0111/131	Male	34
Atol	01S0111/117	Male	44
Potiguar	01S0111/122	Male	38
Tinga	01S0111/118	Male	43
Zelinha	01S0112/133	Female	33

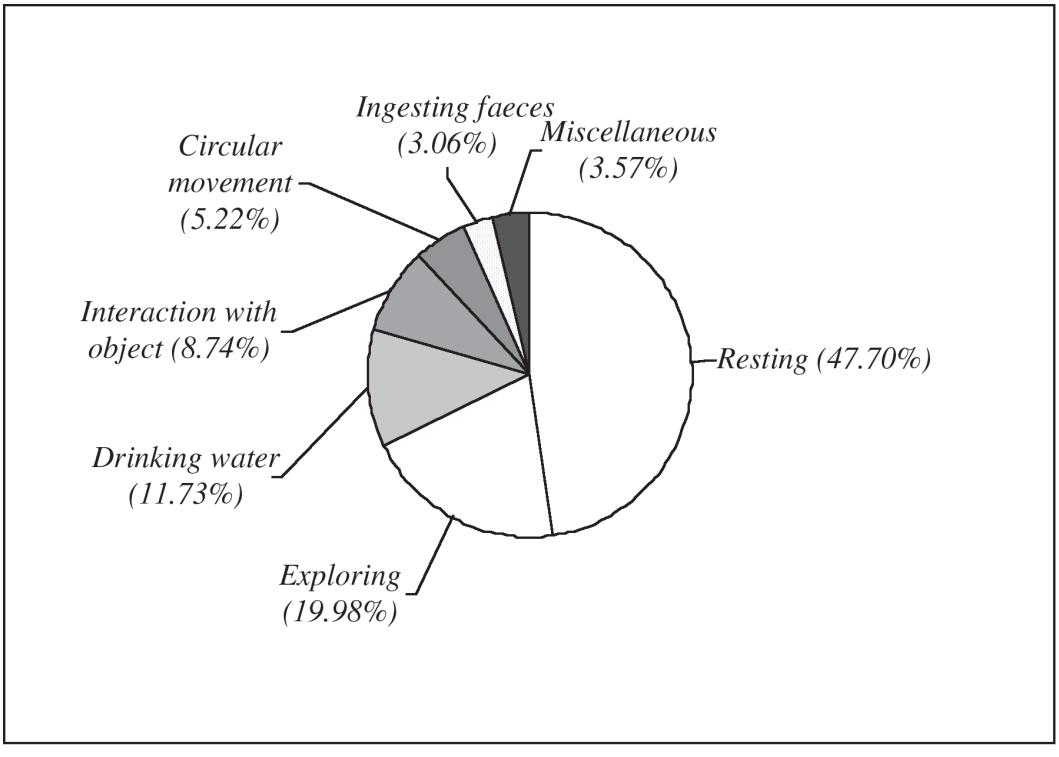

Figure 1. General activity budget for the seven *T. m. manatus* study subjects (n = 84 h of monitoring); for description of categories, see Appendix 1.

behavioural repertoire (Table 3). The remaining four individuals were relatively active overall, although two—Tinga and Zelinha—were differentiated primarily by the proportion of time dedicated to circular movement, which appears to be a stereotypical behaviour, possibly induced by anxiety or stress (Kalueff et al., 2007). By contrast, the two other more active individuals—Artur and Arani—engaged in higher levels of exploration and interaction with an object.

In the case of ingesting faeces, a behaviour typical of periods of resource scarcity (O'Shea et al., 1985), the relatively high general proportion (Figure 1) was due primarily to the behaviour of a single individual, Arani, which was responsible for 77.50% of the total time spent on this category by the seven subjects. All other subjects except Artur (no record) ingested faeces only once, in contrast with a mean of 3.6 bouts/h in Arani. The records available for this subject at CMA/ICMBIO reveal that this behaviour has been observed in this individual from an early age, although it remains unclear what factors may determine this trait.

Only two miscellaneous categories (*pushing* and *interaction with humans*) were recorded for all seven subjects, whereas four categories were recorded in only one subject. *Pushing* was probably a consequence of the dimensions of the enclosure and was relatively frequent (mean bouts/h = 0.4) but of short duration (mean = 0:37 ± 0:30 min).

Interaction with humans is a potentially relevant category here, but despite the considerable variation in percentage values (0.34 to 2.02), interactions were random and unpredictable, and probably not representative of meaningful individual differences in behaviour. Interactions were relatively frequent (mean = 0.5 bouts/h; i.e., once per focal sample) but typically of short duration (mean = 1:19 ± 1:15 min) in all subjects except Atol for which the category was recorded on only two occasions. As interactions were determined solely by the occasional, unpredictable presence of maintenance personnel in the enclosure (no interactions with the observer were recorded), individual differences in this behaviour appear to have been determined by external rather than internal factors. A third category, *touch snout*, was also relatively frequent and short-lived (mean bouts/h = 0.4, mean duration = 0:41 ± 0:35 min), which, once again, was likely due primarily to enclosure conditions.

Table 2. General activity budget of each *T. m. manatus* study subject (n = 12 h)

	% of activity time dedicated to . . .						
Subject	Resting	Exploring	Drinking water	Circular movement	Interaction with object	Ingesting faeces	Misc.
Aira	51.94	17.15	18.23	--	4.13	1.15	7.40
Arani	35.66	19.41	5.22	0.79	17.85	16.63	4.44
Artur	25.73	33.75	20.76	--	15.70	--	4.06
Atol	81.09	8.14	5.42	--	4.08	0.69	0.58
Potiguar	66.38	15.17	9.05	--	4.62	1.71	3.07
Tinga	34.37	18.69	14.76	21.96	6.09	1.23	2.90
Zelinha	38.71	27.58	8.64	13.79	8.72	0.04	2.52

Table 3. Proportion of activity time dedicated by each study subject to the miscellaneous behavioural categories

	% of activity time dedicated to* . . .												
Subject	Ab	Bnp	Ca	Dp	Cm	Emp	Ip	Ma	Me	Mp	Ra	Tc	Tf
Aira	0.04	0.03	--	3.17	--	0.70	2.02	--	0.24	0.87	0.21	--	0.13
Arani	--	--	--	1.01	--	0.27	0.70	2.10	0.11	--	--	--	0.26
Artur	0.57	--	--	--	--	0.37	0.88	0.10	--	--	0.06	1.71	0.38
Atol	--	--	--	--	--	0.19	0.34	--	--	--	--	--	0.04
Potiguar	1.03	--	--	--	--	0.74	0.55	--	--	--	0.74	--	--
Tinga	--	--	--	--	0.28	0.33	1.22	0.36	0.03	--	0.03	--	0.26
Zelinha	0.15	--	0.01	--	--	0.47	1.22	--	0.15	0.15	0.04	--	0.73

*For categories, see Appendix 1.

Daytime Variation

Overall, the subjects tended to spend significantly more time resting and drinking water during morning samples (Table 4) and significantly less time engaging in miscellaneous behaviours, while circular movement was only observed during the afternoon. The afternoon increase in miscellaneous behaviours derived from an increase in the number of categories recorded (from five to 11), and the time dedicated to two categories in particular—*interaction with human* (increased from 0.50% to 1.48%) and *corkscrew movement*, which was not observed in the morning but accounted for 1.19% of overall activity time in the afternoon. The category was recorded in only two subjects (Table 3), most importantly in Aira, which engaged in corkscrew movement in all three of her afternoon focal samples.

The afternoon increase in interactions with humans was determined by the more frequent presence of personnel in the area of the enclosure during the afternoons. This was related primarily to preparations for the afternoon feed, which took place after 1600 h.

Once again, this general analysis obscures individual differences. One obvious case in point is circular movement, which was exclusive to the afternoon. This is further emphasised by the fact that both Tinga and Zelinha presented the behaviour in all three afternoon samples. As circular movement may reflect stress or anxiety, this suggests that some specific factor present only in the afternoon was influencing the behaviour of these two subjects, although it remains unclear what this factor may have been.

Most other trends were also consistent among individuals. All seven subjects spent more time drinking water during the morning, for example, and all seven dedicated more time to miscellaneous activities during the afternoon samples.

The trend in the ingestion of water was almost certainly due to the supply being turned off overnight. This privation may have been exacerbated by the morning feed, which took place prior to the observation session. The activity was nevertheless frequent at all times of day, which may indicate a stereotyped behaviour resulting from captive conditions (e.g., abundant supply of fresh water).

Contradicting the general trend (Table 4), four of the seven subjects spent more time at rest in the afternoon in comparison with the morning (Table 5), and two of these individuals—Atol and Potiguar—were the least active overall. However, all the morning resters dedicated significantly more time to this behaviour in the morning, whereas, of the afternoon resters, only Artur presented a

Table 4. General activity budgets for morning and afternoon samples, and binomial *z* scores for between-sample comparisons based on minutes of observation time; significant *p* values are shown in **bold** type.

	% of activity time			
Category	1000-1200 h	1400-1600 h	*z*	*p*
Resting	50.93	44.46	6.65	≈ **0.00**
Exploring	19.40	20.57	-1.86	0.06
Drinking water	16.07	7.39	17.99	≈ **0.00**
Circular movement	--	10.44	-32.44	≈ **0.00**
Interaction with object	8.63	8.85	-0.53	0.98
Ingesting faeces	2.96	3.17	-0.85	0.40
Miscellaneous	2.01	5.12	-11.69	≈ **0.00**

Table 5. General activity budgets for morning and afternoon samples, and binomial *z* scores for between-sample comparisons based on minutes of observation time; significant *p* values are shown in **bold** type.

	% of activity time spent at rest			
Subject	1000-1200 h	1400-1600 h	*z*	*p*
Aira	61.48	42.41	-3.55	**< 0.00**
Arani	34.25	37.07	0.64	0.52
Artur	15.13	36.32	5.60	≈ **0.00**
Atol	78.66	83.51	0.72	0.72
Potiguar	60.66	72.09	1.88	0.06
Tinga	48.48	19.26	-6.92	≈ **0.00**
Zelinha	56.84	20.58	-7.77	≈ **0.00**

significant trend (Table 5). Coincidentally, the principal morning resters—Tinga and Zelinha—were also the main circular movers, possibly reflecting specific factors as mentioned above.

Discussion

The study subjects were relatively inactive, spending almost half of their time (47.70%) at rest, on average, a pattern typical of the species (Hartman, 1979). There were considerable differences among subjects in all behavioural categories, however, including *resting*, which varied almost threefold between Tinga and Atol. Variation in other categories was similar or even greater, and many categories—principally minor ones—were not recorded in all subjects.

Overall, three broad behavioural models were identified, which may reflect individual differences in the potential for successful reintroduction. Two subjects—Atol and Potiguar—were relatively lethargic, spending a large proportion of their time at rest, and had a reduced behavioural repertoire. By contrast, two others—Artur and Arani—were relatively active, devoting a large proportion of their time to exploration and interacting with objects. The third behavioral model was that of Tinga and Zelinha, which were relatively active but presented unusual behaviour (circular movement) in the afternoon.

The focal animal sampling procedure proved practicable for the collection of detailed behavioural data on the manatee, and it is recommended for future studies of the species. In addition, while sample size (12 h/individual) was relatively small, it was adequate for the identification of individual differences and temporal variations, revealing consistent patterns over the different sampling sessions. Additional data collection may provide new insights into the behavioural characteristics of the different subjects, including longitudinal and age-related variations, which may be especially important for the evaluation of their potential for successful reintroduction. It may also be useful to concentrate on specific aspects of the behavioural repertoire, such as interaction with humans, given that reducing interaction may be a key factor for successful reintroduction.

While the study provides insights into individual behavioural variation in *T. m. manatus*, it remains unclear how such variation may translate into different potentialities for reintroduction into the wild. Whereas more active and exploratory animals might be expected to be more successful under natural conditions, it is equally possible that more sedentary individuals may benefit from reduced contact with humans or from conservation of energy. Hopefully, behavioural monitoring during the reintroduction of these individuals will provide useful insights into the significance of different behavioural traits and their individual variations.

Acknowledgments

This study was authorised by CETAS/CMA/ICMBIO, which also provided infrastructure and logistic support. SFF is grateful to CNPq for a research stipend (Process No. 307506/2003-7). We thank the staff at Itamaracá Island, in particular the veterinarians Luísa Lopes and Fernanda Menezes, Victoria Hoguin and Diana Lima, and the keepers Elias, Marcelo, and Adriano. Caryn Self-Sullivan and an anonymous reviewer provided useful comments on the original manuscript.

Literature Cited

Domning, D. P., & Magor, D. M. (1978). Taxa de substituição horizontal de dentes no peixe-boi. *Acta Amazônica*, *7*, 435-438.

Florin Filho, J. P. (2004). *Relatório de estágio padrão.* Itamaracá, PE: Centro Mamíferos Aquáticos–Projeto Peixe-Boi. 23 pp.

Gannon, J. G., Scolardi, K. M., Reynolds, J. E., III, Koelsch, J. K., & Kessenich, T. J. (2007). Habitat selection by manatees in Sarasota Bay, Florida. *Marine Mammal Science*, *23*, 133-143.

Hartman, D. S. (1979). *Ecology and behavior of the manatee (*Trichechus manatus*) in Florida* (American Society of Mammalogists Special Publication No. 5). Lawrence, KS: American Society of Mammalogists.

International Union for Conservation of Nature (IUCN). (2007). *The 2007 IUCN red list of threatened species.* Retrieved 7 February 2008 from www.iucnredlist.org.

Kalueff, A. V., Wheaton, M., & Murphy, D. L. (2007). What's wrong with my mouse model? Advances and strategies in animal modeling of anxiety and depression. *Behavioural Brain Research*, *179*, 1-18.

Lima, R. P. (1997). *Peixe-Boi marinho (*Trichechus manatus*): Distribuição, status de conservação e aspectos tradicionais ao longo do litoral nordeste do Brasil.* Master's dissertation, Universidade Federal de Pernambuco, Recife. 76 pp.

Lima, R. P., Caldas, S. T., & Candisani, L. (2001). *Peixe-Boi: A história da conservação de um mamífero brasileiro.* São Paulo, Brazil: DBA Artes Gráficas.

Linhares, K. V., Souto, A. S., & Pontes, A. R. M. (2001). *Processos associativos e estratégias de conservação em Peixe-Boi marinho*, Trichechus manatus manatus *(Mammalia, Sirenia)*. Graduate monograph, Universidade Federal de Pernambuco, Recife. 56 pp.

Marmontel, M. (1993). *Age determination and population biology of the Florida manatee*, Trichecus manatus latirostris. Ph.D. dissertation, University of Florida, Gainesville.

Martin, P., & Bateson, P. (1993). *Measuring behaviour: An introductory guide.* Cambridge, UK: Cambridge University Press.

Ministério do Meio Ambiente (MMA), Brasília. (2007). *Conservação da biodiversidade.* Retrieved 11 August 2008, from www.mma.gov.br/port/sbf/index.cfm.

O'Shea, T. J., Beck, C. A., Bonde, R. K., Kochman, H. I., & Odell, D. K. (1985). An analysis of manatee mortality patterns in Florida, 1976-81. *Journal of Wildlife Management*, *41*, 1-11.

Parente, C. L., Vergara-Parente, J. E., & Lima, R. P. (2004). Strandings of Antillean manatees (*Trichechus manatus manatus*) in northeastern Brazil. *The Latin American Journal of Aquatic Mammals*, *3*, 69-76.

Ronald, K., Selley, L. J., & Amoroso, E. C. (1978). *Biological synopsis of the manatee.* Ottawa, ON: International Development Research Centre.

Rosas, F. C. W. (1994). Biology, conservation and status of the Amazonian Manatee *Trichechus inunguis. Mammal Review*, *24*, 49-59.

Appendix 1. Behavioural categories used in the present study; definitions follow Linhares et al. (2001), except where indicated.

Major categories	
Category	Definition
Resting	Subject motionless with eyes closed, either at the surface, with head and tail pointing downwards, or at the bottom of the pool, making only unconscious movements to the surface to breathe at regular intervals (normally 2 to 5 min, but up to 25 min).
Exploring	Subject moves slowly in search of food, water, or other individuals.
Drinking water	Subject ingests fresh water from pool-side source.
Circular movement	Subject moves around the enclosure continuously in a circular fashion. May include rotation around the body's own axis.
Interaction with object	Subject investigates inanimate objects present in the enclosure, including freshwater pipes, gates, and pool edge.
Ingesting faeces	Subject ingests pieces of faeces submerged or floating on the surface of the water.
Miscellaneous categories	
Category (code in Table 3)	Definition
Embrace (Ab)	Subject uses one or both pectoral flippers to grasp other individual's back or side.
Hit with flipper (Bnp)	Subject hits other individual forcefully with one of its pectoral flippers (adapted from Rosas, 1994).
Head butt (Ca)	Subject pushes other individual with movements of the head (adapted from Linhares et al., 2001).
Copulation (Cp)	Male subject exposes penis and penetrates genitals of female individual.
Corkscrew movement (Dp)	Subject moves forward while rotating its body around the longitudinal axis.
Walk on bottom (Cm)	Subject moves along the bottom of the pool supported by alternating movements of the extremities of its pectoral flippers.
Push away (Emp)	Subject pushes other individual with its body or a pectoral flipper, impeding its approximation to a food item or another individual (adapted from Linhares et al., 2001).
Expose penis (EP)	Male subject approaches another individual (male or female) and embraces it with a pectoral flipper as it exposes its penis.
Interact with person (Ip)	Subject advances to the edge of the pool to investigate approaching human, normally remaining at the edge until the human moves away, and occasionally mounting the edge of the pool.
Autogroom (LC)	Subject rubs itself against a surface of the pool or uses its pectoral flippers to remove pieces of food or excess skin from its body.
Suckle (Ma)	Subject maintains its snout in contact with the base of the pectoral flipper of other individual (Rosas, 1994).
Diving with tail exposed (Me)	Subject dives under the water holding its tail flipper above the surface of the water.
Mount (Mo)	Male subject positions himself over the back of a female and, normally, exposes its penis (Rosas, 1994).
Corkscrew (Mp)	Subject rotates its body around the longitudinal axis without forward movement.
Tail slap (Ra)	Subject repels other individual through horizontal or vertical movements of the tail flipper, which may or may not make contact with the body of the other individual (adapted from Linhares et al., 2001).
Attempted copulation (Tc)	Male subject attempts to slot his body together ventrally with that of other individual (male or female) without successful penetration (adapted from Linhares et al., 2001).
Touch snout (Tf)	Subject touches back, head, or snout of other subject with its own snout.