

Reproduction, behaviour and biology of the Giant river otter

Pteronura brasiliensis
at Cali Zoo

G. CORREDOR LONDOÑO¹ & N. TIGREROS MUÑOZ²

¹Head, Research Centre for Conservation of Endangered species (CREA) at Cali Zoological Foundation and ²Research Associate, CREA, Carrera 2^a Oeste Calle 14 esquina, Zoológico de Cali, Cali, Colombia
E-mail: gcorredor@zoologicodecali.com.co

The Giant river otter *Pteronura brasiliensis* is endemic to South America and is Endangered. Breeding in captivity is one of the strategies for conservation of the species, despite the fact that historically this has not been successful. Between 1999 and 2004 a study into the behaviour and reproductive biology of a pair of Giant river otters was carried out at Cali Zoo. The ♀ gave birth to nine litters, with 14.6.1 pups born, 6.4 (48%) of which survived to >1 year old. Two litters were reared with older siblings in the family group. Evidence of delayed implantation and pseudopregnancy were observed. The roles of the ♀, ♂ and juveniles in pup rearing are described. Significant features of infant development were recorded and a growth curve was established for *P. brasiliensis* up to 2 months old.

Key-words: behaviour, captive breeding, giant river otter, husbandry, management, reproduction

The Giant river otter *Pteronura brasiliensis* is one of the major carnivores of South America and one of the most threatened mammals in the world (Wünnemann, 1995). Given that the species is Endangered (IUCN, 2004), specific priorities have been defined for its conservation. These include *in situ* and *ex situ* strategies, such as undertaking field surveys, protected-area management, legal protection, public education and captive-breeding programmes (Foster-Turley *et al.*, 1990).

In 2003 the world population of Giant river otter in captivity was 60 individuals at 26 institutions (Sykes-Gatz & Gatz, 2004). Successful captive-breeding has

only occurred in Brazil, Germany and Colombia at six institutions (Sykes-Gatz, 2001). Acoustic and visual protection from human disturbance during the breeding period has been the most significant animal-management factor contributing to successful parent rearing of Giant river otters in zoos (Sykes-Gatz 1998/2002, 2001, 2004). Stress resulting from human disturbance, inadequate management and/or environment, and disease have all caused reproductive failure (Duplaix-Hall, 1975; Hagenbeck & Wünnemann, 1992; Wünnemann, 1995).

Little is known about the reproductive biology and ecology of *P. brasiliensis* (Staib & Schenck, 1994; Carter & Rosas, 1997), and much less about its behaviour. This study focuses not only on the reproduction of the species in captivity but also on aspects of its biology and reproductive behaviour.

METHODOLOGY

Cali Zoo has maintained Giant river otters since 1993 and a stable pair formed in 1998. The reproductive activity of this pair was studied for 5 years consecutively (1999–2004). Management techniques were evaluated and the biology and behaviour of the species were observed.

Observations Reproductive behaviour during the first 4 months post partum was

studied for the litters born in July 2002 and February 2003 (Table 1). General observations were made at 0700–1200 hours and 1300–1700 hours, 4 days per week. The pups were observed using an infrared camera in the nestbox and direct observations of the enclosure area. In August 2003 pups from litter 7 were observed in order to expand and confirm the observations from previous litters.

The effects of rearing neonates with siblings from previous litters were evaluated in February–June 2003 when litter 6 was born. The three (1.2) 7 month-old juveniles from litter 5 remained with the family group throughout the rearing process.

Data about the behaviour of the parents and three juveniles were collected every minute for observation sessions of 5 hours per day (between 0800–1200 hours and 1300–1600 hours), 4 days a week in February–June 2003. Thus, an observation session was a 300 minute-long period. The behaviours of juveniles are presented as averages of the behaviours recorded individually for each animal. Although the data presented some variation in the time spent on each activity there was not a significant difference between the behaviours recorded for the three individuals.

Enclosure The enclosure had a total area of 300 m², with a water:land ratio of 2:1. The walls were constructed of 2 m-high artificial rock, with plants on top of the walls. Three nestboxes were provided: one was made of brick and cement with a wood substrate, another was made of wood and a third of artificial rock with a soil and sand substrate. The artificial-rock nestbox was located in the quietest area of the enclosure, remote from the management area, other exhibits and the public, and this nestbox was used most often during breeding periods. The entrance to this nestbox was a 2.5 m-long tunnel, created from dead tree trunks and artificial rock, ending in a 1.7 m × 1.2 m × 0.7 m-high chamber with a soil and sand substrate. The pool was 25 m × 6 m with a depth that ranged from 1.2 m at the deepest point to 0.30 m at the shallow end.

Management Approximately 1 week before expected parturition, the public-viewing window was visually isolated by erecting a 2 m-high sheet of green polypropylene. Observations were carried out through four 13 cm × 2 cm observation points cut into the polypropylene. After parturition, particularly during the first 2 weeks, every effort was made to keep the area as quiet as possible both near the

LITTER NO.	DATE	NO. PUPS	SUCCESSFUL LITTER
1	2 Nov 1999	1.1.1	no
2	31 Jan 2001	1.0	no
3	20 Apr 2001	2.0	yes
4	13 Nov 2001	2.1	no
5	14 Jul 2002	1.2	yes
6	12 Feb 2003	2.1	yes*
7	12 Aug 2003	1.0	yes
8	7 Feb 2004	2.0	no
9	22 Apr 2004	2.1	yes

* One ♀ survived and two ♂♂ died.

Table 1. Litters of Giant river otters *Pteronura brasiliensis* born at Cali Zoo between November 1999 and February 2004.



Plate 1. Family group of Giant river otter *Pteronura brasiliensis* at Cali Zoo. Pierre Gay, Zoo de Doué, Doué la Fontaine. France.

nestbox and around the enclosure. In the first 3 months after the ♀ had given birth keepers did not enter the exhibit. Food was provided in a small room that was far away from the nestbox, pool water was changed at night and the latrine was cleaned by the frequent addition of sand.

In 2001 the exhibit was closed to the public for 4 months while the pups were reared successfully. In 2002 the exhibit was closed for 3 months and in 2003 for 2.5 months for each litter. The exhibit was reopened to the public gradually over a period of 15 days. During this time public viewing was restricted to about ten people at any one time, viewing the Giant river otters through the open observation points in the polypropylene screen. The isolation measures used at Cali Zoo followed procedures recommended in the literature (Autuori & Deutsch, 1977; Hagenbeck & Wünnemann, 1992; Wünnemann, 1995; Flügger, 1997; Sykes-Gatz, 2001).

Pups occasionally required medical treatment so they were handled periodically. In February 2003 an 8 day-old ♀ with a bacterial infection was successfully treated with Amikin (antibiotic injection) for 6 days. In August 2003 a 17 day-old ♂ had a subcutaneous oedema that was

drained and then treated with Cefazolina (antibiotic injection) for 4 days. While the pups were treated the adults were occupied with live fish in the pool. The medical-intervention procedures, and weighing, measuring and taking the temperature of each pup, did not last more than 10 minutes. If the nestbox was found to be too wet (likely caused by the adults entering the nestbox still wet from the pool) sand was added.

The Giant river otters were routinely offered dead *Trachinotus* spp fish and, occasionally, live *Tilapia* spp fish for

Tilapia, spp 75(-3for)-2kg. REPRODUCTIVE3-118.8(BIOLOGY)-108.96245(Br

NO. PUPS IN LITTER BEFORE THE DELAYED IMPLANTATION	TIME BETWEEN TWO LITTERS (days)	TIME TILL DELAYED IMPLANTATION* (days)
1	180	97
1	180	98
2	208	126
3	216	131
Correlation	$r=0.96, P<0.05$	$r=0.95, P<0.05$

* (Time from last post-partum copulation to next litter)–(gestation period).

Table 2. Correlation between number of pups in the litter before the delayed implantation, and the time between litters and delayed implantation.

adults were observed copulating repeatedly for 8.6 ± 2.5 days (range 5–11 days, $n=7$). Mounting lasted 5–110 minutes. The ♂ always initiated copulation. The dorso–ventral position was used for copulation: the ♂ placed his head and anterior body on top of the ♀, twisting the posterior body (usually the left side) to use a ventro–ventral approach. At the onset of oestrus, the ♂ attempted to copulate with the ♀ on land or in the nestbox but successful intromission always occurred in shallow water where the ♀ could support her forefeet. Copulation was easier to observe when the Giant river otters were isolated from public view because mating occurred in the early morning or late afternoon when visitors were around.

The mean gestation period was 70 ± 2.1 days ($n=3$). Four pseudopregnancies were observed, during which the ♀'s abdomen expanded and the mammary glands developed but parturition did not occur. On one occasion palpation confirmed that the uterus was empty. The duration of a pseudopregnancy was similar to the gestation period (72 days). This phenomenon has also been recorded in the Asian small-clawed otter *Aonyx cinerea* (Bateman, 2003).

The mean interbirth interval between litters was 180–214 days ($n=4$) and the ♀ gave birth to a new litter when the older pups were 6–7 months old. However, if

neonates died soon after birth, the next litter was born after a period of 77 days or more. Because copulations were only observed post partum, the implication is that *P. brasiliensis* can retain a zygote for delayed implantation whether or not pups survive. It would appear that the retained zygote is implanted either after the pups die or once the litter is 3.7–4.9 months old. The duration of the zygotic retention is directly correlated with the number of pups from the previous parturition ($r=0.95, P<0.05, n=4$) (Table 2). There may be a correlation between the number of pups the ♀ is rearing and the time to next parturition. The action of nursing pups may create hormonal changes in the ♀ that affect the time of zygotic retention. A more intense period of feeding, of the sort that occurs when there are several pups, appears to delay implantation of the zygote (H. Bateman, pers. comm.).

The mean number of pups per litter was 2.33 ± 0.87 ($n=9$) and the sex ratio was 2:1 (♂:♀) (Table 1).

Since the litter of 22 April 2004 the ♀ has not become pregnant again. At that time she was 11 years old, and her oestrous and mating periods were becoming infrequent. After the post-partum mating in 2004, she mated three times in 2005 (February, May and August) but no mating has been observed in 2006. The ♀ had a false pregnancy in October 2005. All these characteristics may be indicative

	% TIME SPENT ON ACTIVITY		
	♀	♂	JUVENILES
Resting	53	33	38
Time in water	18	42	38
Playing	7	12	30

Table 3. Activity budgets of a social group of Giant river otters while a new litter was being reared. Percentages are calculated from the observations of 1.1 adults and 1.2 juveniles in February–June 2003.

of the end of this ♀'s reproductive cycle (Sykes-Gatz, 2004).

REPRODUCTIVE BEHAVIOUR

Activity budgets When the ♀ was nearing parturition, she spent more time in the nestbox and her movements became slower. At the same time, all the Giant river otters were quieter, only vocalizing when stressed (e.g. by strangers or noise). Parturition occurred at 0800–1000 hours ($n = 4$ litters).

The ♀ was less active than the rest of the group while she was rearing pups. For 4 months, she rested 53% of the time during observations, compared to 33% the ♂ and 38% for juveniles (Table 3). When they were not resting the Giant river otters were often observed in the water. The ♀ remained in the water for only 18% of time during observation sessions, compared to 38% for the juveniles and 42% for the ♂. Playing included turning over in the water, chasing each other and biting either an object (e.g. a piece of wood or

branch, or seeds) or a sibling. Play activity took up almost 30% of the time of juveniles during observation sessions but the values were much lower for the ♂ (12%) and ♀ (7%). The ♀ spent more time in the nestbox than the ♂ and juveniles during the rearing period. In the first 2 months the ♀ was observed to spend 56–71% of her time in the nestbox with the pups, nursing and/or sleeping (Table 4).

In 2002, 15 weeks after parturition, the Giant river otters left the artificial-rock nestbox permanently and moved into the wooden nestbox. It is assumed that the artificial-rock nestbox became too wet because the soil and sand substrate did not drain properly. The pups born in February and August 2003 were moved several times to different nestboxes but the original nestbox was not abandoned permanently, perhaps because new sand was added to the nestbox every *c.* 2 weeks.

Development of pups When the pups were 1 month old, principally the ♀ but

	% TIME SPENT IN DEN/MONTH			
	1	2	3	4
♀	71	56	40	23
♂	23	19	19	11
Juveniles	33	40	37	19

Table 4. Time (%) the family group spent in the den during the first 4 months post partum in 2002 and 2003.

also the ♂ and juveniles began to take the pups out the nestbox regularly. In the beginning the ♀ transported the pups in her mouth (Duplaix-Hall, 1975) but after day 65 the pups walked out the den following the adults/juveniles. From then on, the pups spent more time outside the nestbox (Fig. 1). Sometimes young (>30 days old) pups were carried to the pool and put into the water (four times in 2002 and ten times in 2003). This behaviour generally coincided with stress, such as an unusual noise or the presence of a stranger.

Once the pups were *c.* 1 month old the ♀ began taking them into the pool regularly to teach them to swim. Initially, she would swim with a pup held in her mouth. Soon, however, she would let it go and swim with the pup against her chest, pushing it to the surface as necessary with her snout and forefeet. At 65 days old the pups were able to swim independently.

Feeding the pups The ♀ directed the pups towards her teats using her forefeet. When

the pups began to suckle they emitted an intermittent sound and moved their tails (Sykes-Gatz, 2003). The pups also vocalized and moved their tails when the ♀ cleaned their faeces away by eating them (Fig. 2).

During the daily observation period in the first month the ♀ spent 40% of her time nursing the pups, which gradually decreased to 32% in the second month, 26% in the third month and 19% in the fourth month. The ♀ fed the pups four to five times per 5 hour-long observation session in the first month, about three times in the second and third month, and one or two times in the fourth month (Fig. 3). Although it was not possible to determine the exact age of weaning as it varied for each litter, it appears to be at 16–18 weeks.

The pups began to eat fish at 10–12 weeks of age. The ♂ and ♀ both offered soft pieces of fish to the pups 1–2 weeks before they began to eat solid food. Although initially the juveniles took

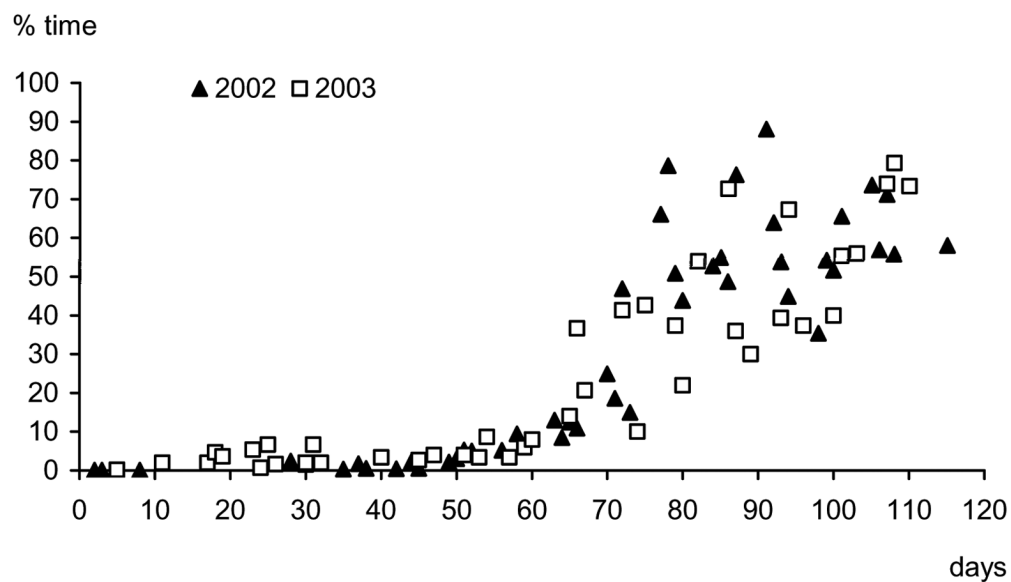


Fig. 1. Time (%) that Giant river otter *Pteronura brasiliensis* pups spent out of the nestbox during the first 4 months of life at Cali Zoo: [$n=3$ pups from litter 5 (2002) and $n=1$ pup from litter 6 (2003)].

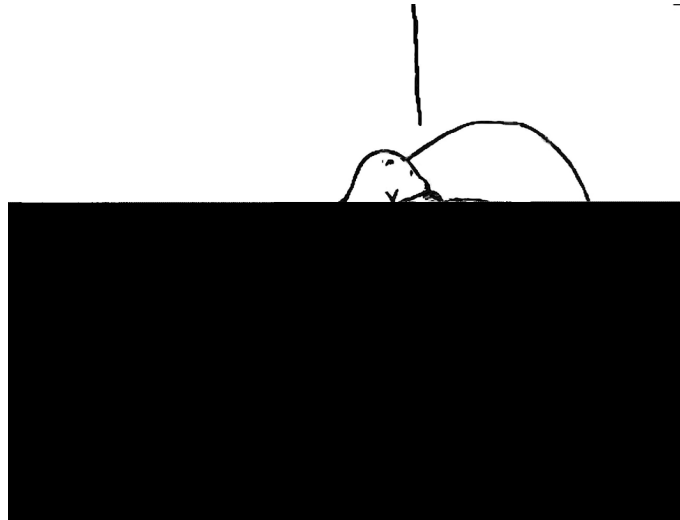


Fig. 2. Giant river otter pups move their tails laterally when suckling and when the ♀ is cleaning away faeces.

the fish away from the pups, after a few weeks they offered food (Fig. 4).

Roles in rearing During the first 4 months the ♀ remained with the pups most of the time. Nursing and cleaning faeces were exclusively ♀ tasks. The ♀ also taught the pups to swim.

The ♂ had little contact with the pups during the first 2 months, particularly when pups were reared with older siblings. However, the ♂ protected the family by patrolling the territory while they slept. He was more alert (head raised, periscope position) and vocalized with greater frequency than the rest of the group (Fig. 5). The ♂ offered food to the pups from *c.* 10 weeks and played with the juveniles and pups > 3 months old.

In August 2003 a pup was reared successfully with two ♀ siblings, 13 months and 6 months old. In general juveniles had a great deal of contact with pups and, when the adults left the nestbox, even slept with them. Juveniles were often observed handling the pups and placing them on their abdomens, imitating the behaviour of the adult ♀. On three occasions a juvenile was observed nursing for

a few seconds. From the outset the juveniles played with both the ♂ and pups, and contributed to the supply of solid food offered to their younger siblings.

NEONATE DEVELOPMENT

Based on the observations of three breeding events (litter 3, litter 5 and litter 6), significant features of infant development were recorded for the first 4 months (Table 5). The neonates open their eyes in week 4 and begin to walk in week 5, although they are more co-ordinated by week 6. By week 9 the pups will follow the adults out the nestbox. Although the mother will take them in the pool from week 5 and they can swim alone at *c.* 8 weeks of age, it is not until the pups are 12–14 weeks old that they swim confidently.

Body-mass measurements were collected for two pups (a ♀ from litter 6 and a ♂ from litter 7) in order to develop a growth curve for the first 70 days (Fig. 6). The neonates that did not survive all had body-mass measurements that fell below the expected value on the growth curve.

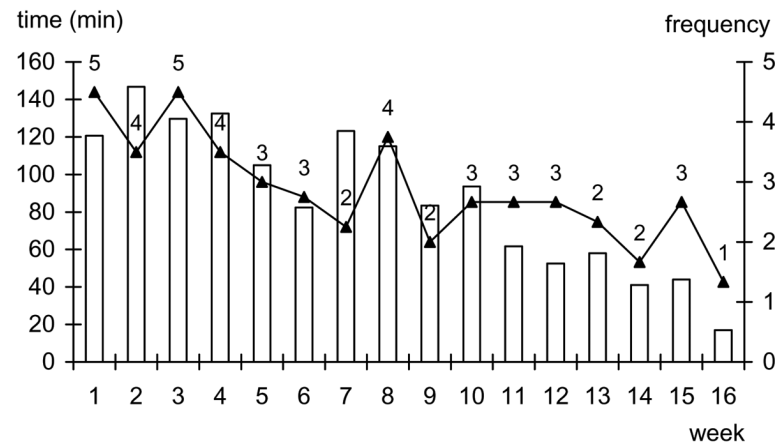


Fig. 3. Time the ♀ spent nursing pups and the frequency of feeding during 300 minutes of observations in the first 4 months.

REPRODUCTIVE FAILURE

The primary cause of death in Giant river otter pups in captivity is parental stress, culminating in inadequate care, caused by human disturbance (Sykes-Gatz, 2001, 2004). In addition, first litters may not receive adequate parental care because the parents are inexperienced. It is likely that many Giant river otters in captivity have been separated from their family group at an early age and may not have previous experience of successful pup rearing after the birth of younger siblings.

Stress can affect infant rearing in most mammals in captivity and in Giant river otters this may show itself as excessive 'carrying behaviour', which tires the pups and may result in their death (Baker *et al.*,

1996). Although juveniles handled and played with their younger siblings, they generally did not mistreat them at Cali Zoo. This may have been because the parents had significant experience of infant rearing, and stress and disturbance were kept to a minimum around the enclosure area. However, the death of a litter in February 2004 was believed to have been caused by a 6 month-old juvenile that continually carried the pups.

Several neonate deaths in river-otter species have been caused by disease (Duplaix-Hall, 1975; Hagenbeck & Wünnemann, 1992). Medical treatment can be provided if the pups are monitored regularly (e.g. by camera) and if there is safe access to the nestbox. Checking the

WEEK	DEVELOPMENT
4	neonates open their eyes
5	pups begin to walk, raising their bodies a little
6	movements are better co-ordinated
9	pups leave the nestbox, walking out the entrance following the adults; about this time pups also start using the latrine
8	pups swim by themselves, initially with their heads held out of the water
10-12	pups begin to eat fish; use the latrine
12	pups submerge totally for short and intermittent periods in the pool
14	pups observed playing and turning over in the water

Table 5. Summary of observations of the development of Giant river otter pups at Cali Zoo.

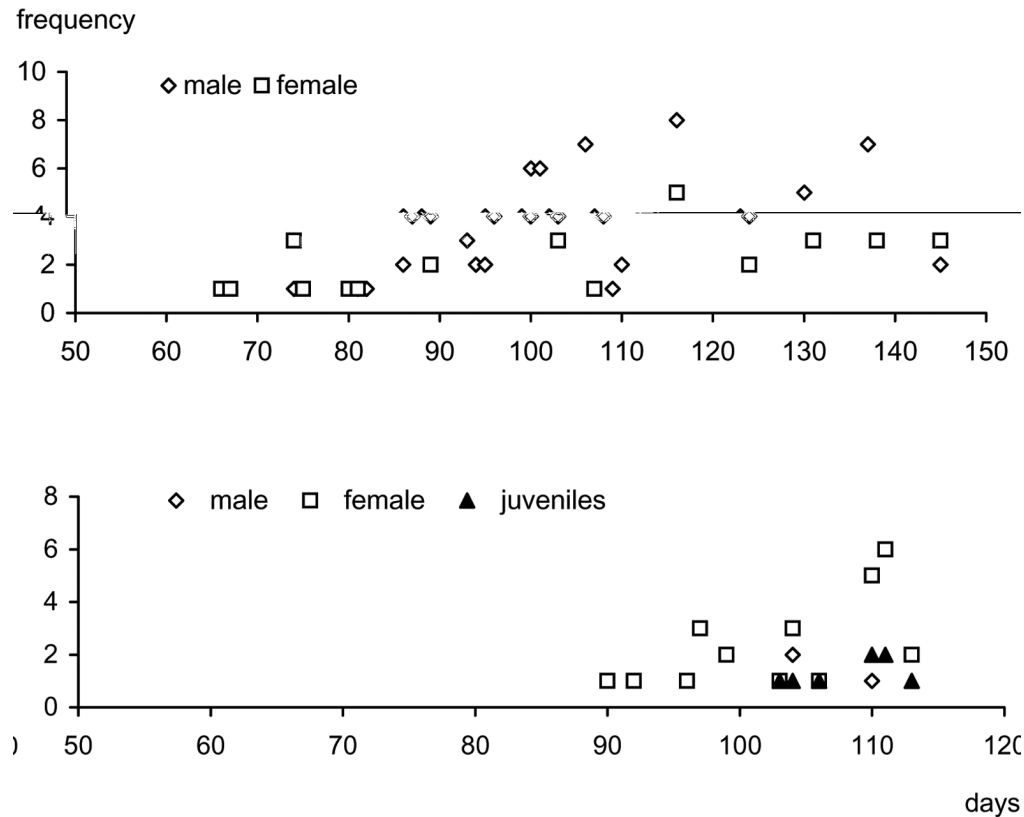


Fig. 4. Frequency that parents and juveniles offered fish to pups during the first 4 months post partum: *top*. litter 5 (2002), $n = 3$ pups; *bottom*. litter 6 (2003), $n = 1$ pup.

development of the pups and measuring body mass may be crucial for the early detection and treatment of some diseases. However, medical treatment should only be carried out if necessary so as not to cause stress to the adults or pups.

DISCUSSION

The breeding activity of this pair of *P. brasiliensis* at Cali Zoo is one of the most successful in the history of maintaining the species in captivity. The isolation provided and restricted management of the enclosure, plus the compatibility of the pair and their breeding experience have been key to this success.

The reproductive biology of this species is highly complex. The pair repeatedly copulated post partum, at a similar frequency and duration to that recorded in the literature (Trebbau, 1978; Hagenbeck & Wünnemann, 1992). As has been described for the North American river otter *Lutra canadensis* and other mustelids (Duplaix-Hall, 1975; Foster-Turley *et al.*, 1990; Lewis, 1995; Partridge, 1997), zygotic retention or delayed implantation, suggested by Flügger (1997), has been confirmed in *P. brasiliensis* in the study reported here. Pseudopregnancies have been observed in *P. brasiliensis*, North American river otters and Asian small-clawed otters (Duplaix-Hall, 1975; Bateman, 2003; Sykes-Gatz, 2003).

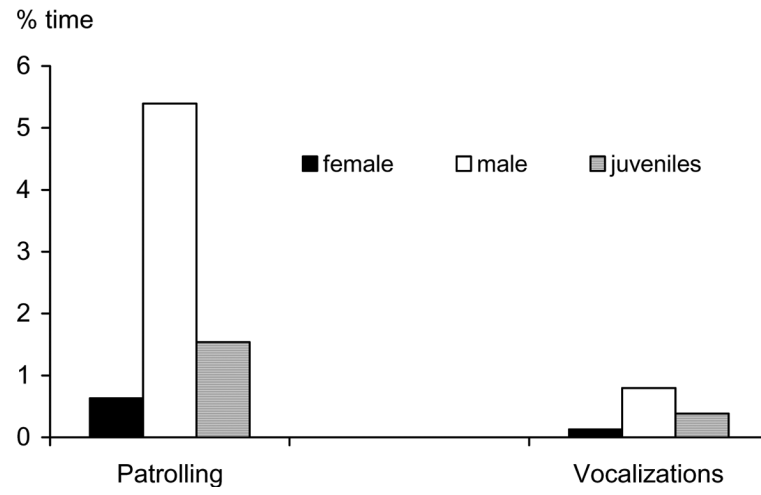


Fig. 5. Time (%) spent patrolling the area or giving warning vocalizations in a group of Giant river otters in the first 4 months post partum in 2003.

During the breeding period, the ♀

- tridge, J. (Ed.). Bristol: Association of British Wild Animal Keepers.
- PARTRIDGE, J. (1997): North American river otters at Bristol zoo. *International Zoo News* **44**: 466–472.
- STAIB, E. & SCHENCK, C. (1994): *Lobo de Rio*. Frankfurt: Alemania.
- SYKES, S. (1998/2002): Historical reproductive and rearing success of giant otters (*Pteronura brasiliensis*) in zoos. In *Proceedings of the VIIth international otter colloquium: 14–19 March 1998. IUCN Otter Specialist Group Bulletin 19A/2002*. Dulfer, R., Conroy, J., Nel, J. & Gutleb, A. (Eds). Gland: IUCN.
- SYKES-GATZ, S. (2001): *Husbandry and management of the giant otter* (*Pteronura brasiliensis*). Münster: Schüling.
- SYKES-GATZ, S. (2004): *International giant otter studbook husbandry and management guidelines: husbandry and management of the giant otter (Pteronura brasiliensis)* (2nd edn). Dortmund: Zoo Dortmund.
- SYKES-GATZ, S. & GATZ, V. (2004): *International studbook for the giant otter Pteronura brasiliensis (Gray, 1867)* (1st edn). Dortmund: Zoo Dortmund.
- TREBBAU, P. (1978): Some observations on the mating behaviour of the Brazilian giant otter (*Pteronura brasiliensis*). *Zoologische Garten* **48**: 187–188.
- WÜNNEMANN, K. (1995): Giant otter husbandry. In *Husbandry handbook for mustelids*: 181–184. Partridge, J. (Ed.). Bristol: Association of British Wild Animal Keepers.

Manuscript submitted 20 March 2004;
accepted 22 March 2005; revised 28 February 2006