INTRODUCTION

The New World otters belong to the genus *Lontra*, which has four species, including the Neotropical otter, *Lontra longicaudis* (Olfers, 1818) (van Zyll de Jong, 1972, 1987). This species is distributed from the North of Mexico to Uruguay; from sea level to 3000 m (Emmons and Feer, 1997). It inhabits rivers, lakes and the sea shore (Blacher, 1987). Their resting sites are referred to as holts, couches, hovers and dens, depending on their structure and use, but there is no consensus about this nomenclature yet (Chanin, 1993). Otter resting sites are generally close to the water and may be built among tree roots in the river bank by other mammals or by otters. Resting sites may be also natural cavities among rocks or structures built by man as bridges or drainage ducts (Chanin, 1993; Melquist and Hornocker, 1983). Considering the width of habitat and broad latitudinal distribution (32°N to 35°S, that is 67°) of the Neotropical otter, the information available is scarce, except for the efforts of Blacher (1987, 1991), Gallo (1991), Schweizer (1992), Parera (1993), Spinola and Vaughan (1995), Colares and Waldemarin (2000), Pardini and Trajano (1999), and Waldemarin and Colares (2000). Due to the insufficient knowledge, the species is considered vulnerable in Brazil (Foster-Turley, 1990). The main threats to the remaining populations are hunting, water pollution, lack of food and shelter, and deforestation along river margins. These threats are even worse in the Atlantic Forest plain near tourist centres. The lack of knowledge about the biology and ecology of the Neotropical otter is a drawback in the devel-
opment of conservation plans, as documented by Foster-Turley (1990). The present study therefore aims at contributing to the knowledge about holts and the use of sprainting sites by the Neotropical otter in an Atlantic Forest area, The Reserva Volta Velha, Itapoá, on the coastal plain of Santa Catarina State.

STUDY AREA

The Reserva Volta Velha (RVV) is a private biological reserve (Reserva Particular do Patrimônio Natural - RPPN) situated in the municipal district of Itapoá, in the northeast of Santa Catarina State (26°04'S and 48°38'W; area 586 ha; altitude 9 m above sea level), southern Brazil. The RVV is bordered on the east, southeast and south by the Sai-Mirim, Braço do Norte and Volta Velha rivers, respectively (Fig. 1). Sai-Mirim and Braço do Norte are rivers of low visibility due to the presence of suspended sediment. The water is rich in bicarbonate ions and has a pH of about 6.0-6.5 (Por, 1986). In the sections studied, the rivers have muddy and silty bottoms, banks are high (up to 7 m) and vegetation is of the alluvial ombrophilous dense forest type (Veloso et al., 1991). On the other hand, the Volta Velha river has dark and clean waters, flows over podzolic soil in the alluvial plain and is rich in chlorates and humic acids resulting from vegetal material lixiviation (pH 4.0-4.5) (Por, 1986). In the studied section of Volta Velha river, the banks are low and during the rainy season water levels rise over the bank, forming a wide flooded area. In RVV the vegetation types are the ombrophilous dense forest in the low lands, the alluvial ombrophilous dense forest and the pioneer formations with fluvial influence (Veloso et al., 1991). The study area is 3 km from the sea and the water level of the studied rivers is tidal. The weather is typically tropical, although the RVV is in a subtropical region. According to data obtained in the reserve over a 19-month period, the highest mean temperature was 24.8°C, the lowest 15.9°C, and the mean air humidity was 86.5%.

METHODS

Sections of the Volta Velha river (VV - 400 m), the Braço do Norte river (BN - 3 km) and the Sai-Mirim river (SM - 2 km) (Fig. 1) were marked every 50 m with a red tag and examined monthly in a rowing boat between September 95 and March 97. Nineteen visits, each of two- to four-day duration, were made over a total of 15 to 16 km of rivers examined each month. Detailed searches for holts and scats were conducted. Margins within a 5-m band on both sides of the river were carefully checked for holts. The name holt here refers to one or more chambers into or under the root systems where otters rest, scratch and defecate. For each holt found the number of chambers was counted, their sizes were measured (width, depth and height) with a metric open reel tape, and photographs were taken. Each holt was numbered and visited monthly for signs of recent use, such as otter footprints, scats and scratches. The frequency of use of each holt was calculated as the number of months with at least one sign of recent use over the total number of months when the holt was visited. The statistical significance of differences observed in the frequencies of use was tested using the chi-square test (Triola, 1999). The presence of signs (footprints and scats) of other mammals in otter holts was noted and signs identified to species level when possible.

All scats found were collected and numbered in order. The date, position on the river and substrate (ground - G, holt - H or fallen tree - FT) were noted. Scats were classified as recent or old according to the presence or absence of a mucous secretion. Three features, in this order of importance, were used to know if scats were actually otter scats: (1) the presence of otter hairs as a result of grooming; (2) deposition substrate; and (3) general appearance (smell, form and prey items). Differences in the frequencies of occurrence of otter scats in each river were tested using the chi-square test (Triola, 1999). Scats were collected and analysed as a means to study otter diet (see Quadros and Monteiro-Filho, 2001). A sprainting site was defined as any fallen tree, a holt or a particular ground area where at least one fecal sample was collected during the field work. Sprainting sites were arbitrarily classified according to their frequency of use, i.e., the cumulative number of scats collected at each site during 19 months of field work: a) occasional use (* - one to eight scats collected); b) frequent use (** - nine to 17 scats collected); c) intense use (** - 18 to 25 scats collected).

RESULTS

Eight holts were identified in the study area, 1H to 8H (Fig. 1). All were situated along the river margins, 1.5 m or less away from water, among tree roots and fallen trees. Holts 1H to 5H were on the Braço do Norte river. Since holts were four to seven meters high on the river bank and were never flooded during the rainy periods, they could have been used by otters throughout the whole period of this study.
These holts were large, with one or two adjacent chambers about 0.30 m$^3$ each, preceded by a shared chamber and with openings to the water and to the ground. Holts 7H and 8H were flooded in at least one sampling period during the present study. These had only one chamber measuring 0.50 m$^3$ to 1 m$^3$ and one opening to the water. There were also small holes on the upper part of the holt that probably enabled air circulation, even when flooded. It is possible that these holts have been used during the rainy periods, although it was impossible to observe signs of occupation during these periods because the main opening was underwater. A higher level of activity in these holts was observed after the flooding period. Holt number 6H had the same structure as holts 7H and 8H, although it was higher and had never been observed flooded.

The number of scats collected was 198 and the total number of sprainting sites identified was 35. They were classified as sites of occasional use (77% of the identified sites), frequent use (14%) and intense use (9%) (Table 1). The three sites with intense use were holts. The shortest distance between adjacent sites was 7 m and the longest 1500 m. Otters concentrated their sprainting activities in holt 5H and its surroundings, including holt 4H (10 m apart) (Fig. 1), as shown by the frequencies of use of each holt ($\chi^2 = 15.817; P = 0.05; $d.f.$=7$) (Fig. 2). The largest number of scats found at any site at a time was nine. The site with the greatest number of scats accumulated throughout the study period (19 months) was holt 4H with 25. Thirteen recent scats were collected in eight holts during the whole study (frequency of occurrence = 1.6), 21 recent scats were collected at the other 27 sprainting sites (frequency of occurrence = 0.8) (Table 1). Otter scats were found more frequently in Braço do Norte river (42 scats/km) than in Sai-Mirim river (31 scats/km) and in Volta Velha river (20 scats/km) (Table 1; $X^2 = 7.8; d.f. = 2; 0.02 < P < 0.05$). Otters defecated also at elevated sites built by scratching the mud or sand along river margins. These scats were not hidden. Indeed, they were more conspicuous.

There were neither evidences of breeding in the identified holts nor cub footprints in the studied sections of the rivers.

On 15 occasions it was possible to observe...
Number of *Lontra longicaudis* scats (N) collected from September 95 to March 97, in Reserva Volta Velha, Itapoã, Santa Catarina State, at each sprainting site, in each river and classification of sites according to their use (intense-***; frequent-**; occasional-*).

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<thead>
<tr>
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<th>Holts (H)</th>
<th>Falen trees (FT)</th>
<th>Ground (G)</th>
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<tr>
<td>1H*</td>
<td>7</td>
<td>6H**</td>
<td>15</td>
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<td>2H**</td>
<td>10</td>
<td>7H*</td>
<td>5</td>
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<td>3H***</td>
<td>20</td>
<td>8H*</td>
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<td>4H***</td>
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<td>4FT*</td>
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<td>Total</td>
<td>82</td>
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**Fig. 2.** Frequency of use of *Lontra longicaudis* holts in Sai-Mirim and Braço do Norte rivers, Reserva Volta Velha, Itapoã, Santa Catarina State, southern Brazil, from September 95 to February 97.
Footprints or scats of other mammals in holts or very close to them; 12 of these occasions otter scats could be observed simultaneously. The visitors were: an unidentified small cat, *Leopardus* sp (3H); the jaguarundi, *Herpailurus yaguarondi* (5H and 6H) and the crab-eating fox, *Cerdocyon thous* (5H).

**DISCUSSION**

Footprints and scats on the river margins were at times difficult to find due to vegetation and changes in the water level. When margins were low, even a small rise of the water level, caused by rain or tides, washed out footprints and scats. The effects of washing on scats were not evaluated in this work, although the data presented by Ruiz-Olmo and González (1997) show that scat survival after a flooding period is only 15% persistent. As a consequence, during field work, the observation of these signs was uncertain and depended on weather conditions. Moreover, it is known that female otters may defecate in the water during the perinatal period (Chanin, 1993; Kruuk, 1995) and it is impossible to collect all scats in the environment (Ruiz-Olmo and González, 1997). Considering that scats do have a major significance in otter intra and interspecific communication, Yoxon (1998) suggests that the collection of scats by researchers may influence the deposition of scats by otters. Nevertheless, the responses of otters to the removal of scats and the communication function time after scat deposition is not well documented yet and seems to vary from 30 days to some hours in the case of the European otter (Kruuk, 1995; Rozhnov et al., 1994 in Yoxon, 1998). In the present work the authors consider that the influence of scat collection may be compared to the natural effects caused by rain or tide washing of scats, especially because it is a tropical environment with frequent rainy periods throughout the year. In addition, the collecting method applied was the same every month so that temporal differences in the number of scats cannot be attributed to the collection, as also observed by Ruiz-Olmo and González (1997). Moreover, if the monthly removal of scats had the effect of stopping the otter from using the area and other individuals from colonizing it, as suggested by Yoxon (1998), data would show a continued reduction of collected scats month after month, which was not observed (pers. com.). The increase in maintenance activity (scratches on the walls) of holts after flooding periods is related to soil humidity and smoothness that makes it easier to scratch; as water rises, it rubs off all territorial demarcation signs, including scratches, requiring new demarcation activities. In this study we state that natural flooding periods were not a problem to otters, but rather a part of their habitat use dynamics.

In the present study, the number of scats collected at holts was higher than the number of scats collected at other sites. Two variables must be considered in the interpretation of this: a) holts represent a more protected habitat against rain and rises in the water level. This means that scats last longer in holts than out of them (the greatest time of permanence of a scat in a holt was three months) (pers. obs.); b) it is likely that the defecation activity in holts and near them is more intense than in other sprainting sites; according to Kruuk and Hewson (1978; *Lutra lutra*) and Arden-Clarke (1986; *Aonyx capensis*), there is a concentration of scats in holts and around them in coastal habitats as a consequence of defense activities and territory demarcation. However, Pardini and Trajano (1999), studying a population of *L. longicaudis*, in a mountain rocky river of São Paulo State, southeastern Brazil, did not observe a concentration of scats in holts or in their immediate proximity. According to Melquist and Hornocker (1983), *Lutra canadensis* uses some parts of its territory more frequently than others, and in these parts the fecal deposition is more intense. In the present study, the three sprainting sites with intense use were holts, and the number of scats collected at these sites was greater than the number collected at the other sites. This could be due to the protection provided by holts to scats against rain washing. However, by using only recent scats, the influence of weather conditions was reduced, thus giving a better indication of whether there are higher activity levels of defecation in holts or not. The number of...
recent scats collected at the eight holts was higher than at the other 27 sites. This indicates that, in the study area, otters defecate more at holts than elsewhere, which could possibly be attributed to territory demarcation and defense.

Differences in the observed frequencies of use of holts show a concentrated sprainting activity in holts 5H and 4H as a core area of the territory. As one goes away from this core area, up and down the river, the sprainting activity gets sparse. Radio-tracking of two European otters (*L. lutra*) corroborates the existence of a centre of activity in the home-range and that it represents about 14% of the total home-range (Ruiz-Olmo et al., 1995). Ruiz-Olmo et al. mention also that each otter used 15 to 13 resting sites during the study period and that the maximum time of consecutive occupation of the same resting site was two days. Considering that radio-tracking data are not available to the Neotropical otter, in the present work the authors can only suggest that the studied area of approximately 5 km of rivers is used by only one individual, and that holts 4H and 5H and their surroundings represent the core area of its territory (Ruiz-Olmo et al., 1995).

The highest number of scats collected at one site at a time, nine, is very low compared to the results of Chanin (1993) and Ruiz-Olmo and Gonsálbez (1997), who mention, respectively, 250 and 282 scats of *Lutra lutra* at one sprainting site. Since both species are considered solitary, the lower number of scats registered in the present study may reflect a lower activity of territorial demarcation by scats due to behavioural differences between species, a different weather condition between tropical and temperate environments, different population densities or even a combination of these factors. Unfortunately it was not possible to determine the actual contribution of each of these factors in the present study.

The higher number of scats collected in the Braço do Norte river than in the Sai-Mirim river may be related to two facts: the vegetation along the margins of the Braço do Norte river was dense and well preserved, river banks were high and holts were not flooded. The low frequency of use in holt 2H might be related to the fact that the vegetation surrounding the holt was secondary and scarce when compared to other holts in the Braço do Norte river. López-Martín et al. (1998) mention that vegetation is a key factor in the positive selection of habitat by the European otter, *Lutra lutra*. The Volta Velha river presented a low number of scats/km probably due to the fact that no holts were found and river banks are very low, which means that signs, including scats, are easily destroyed by water level rises.

The use of scats and urine by mammals in the establishment and defense of their territories has been widely studied (Johnson, 1973). Compared to other terrestrial carnivores, otters use a fairly restricted area of the environment, that is, the river and its margins. Their use of the habitat is linear (López-Martín et al., 1998). That is why the demarcation of territory by odor is particularly important in the spatial and temporal organization of the populations of otters (Melquist and Hornocker, 1983). In the study area, the importance of scats in the establishment and defense of territory could be especially observed when otters defecated on the ground, not close to holts, where there was nothing conspicuous to defecate on. At all these sites, otters built elevations scratching the mud or sand and defecated on the top, making it conspicuous. On the other hand, terrestrial carnivores defecated on fallen trees and on the ground, but were never seen to build elevations to defecate on (pers. obs.). Indeed, terrestrial carnivores were observed to hide their scats under sand or mud, scratching the ground (pers. obs.). Otter scratches on the ground and on vegetation have been reported by Erlinge (1968), Veen (1975), and Chanin (1993) for the European otter, *Lutra lutra*, and by Olimpio (1992) for the Neotropical otter, *L. longicaudis*.

The presence of scats and footprints of *H. yaguarondi* and of another unidentified small cat at otter holts may be related to the strong smell of fish from recent otter scats deposited inside the holts. The presence of fish in the diet of *H. yaguarondi* had already been reported by Manzani and Monteiro-Filho (1989). The attraction of predators to otter scats is documented by Chanin (1993), who also mentions that female otters stop defecating at holts.
when they contain small cubs, defecating elsewhere and in the water. This strategy avoids predators being attracted by the strong smell of otter scats. It is also possible that holts not in use by otters may be used by the crab-eating fox, *Cerdocyon thous*, to rest, since this canid frequently visits river margins in search for food. According to Melquist and Hornocker (1983), *Lutra canadensis* may use holts built by coyotes and foxes, although less frequently, since these holts are more distant from the river. Holts 2H, 3H, 4H and 5H were built in places that were easier to reach by land, while holts 1H, 6H, 7H and 8H were difficult to reach. This means that the former could be visited by a variety of mammals while the latter could only be visited by very agile and/or small mammals. In fact, holts 5H and 6H were visited only by *H. yaguarondi* and holts easier to reach by land were visited by an unidentified small felid and *C. thous*. Other potential visitors are capybara, *Hydrochaeris hydrochaeris*; water opossum, *Chironectes minimus*; raccoon, *Procyon cancrivorus* and coati, *Nasua nasua* because they occur in the study area and visit river margins frequently (pers. obs.). However, there were no signs of these mammals in holts. Capybara scats were seen simultaneously at the same sprainting site on the river bank.

**CONCLUSIONS**

In an environment of Quaternary sedimentary plains, with rivers of silty or muddy bottom and without rocks, otters defecated on fallen trees, in and near holts and on the ground along river banks. Otters used holts dug among roots and fallen trees. Main holts were identified based on the concentrated sprainting activity in and near them and represent the core area of the territory. These dens were built at densely vegetated sites and were protected from flooding and erosion. The collection of more scats in Braço do Norte river is related to dense vegetation and higher margins along river banks. Otter holts may be used by other carnivores too, such as wild canids and felids. The present work corroborates the need for preservation of the alluvial ombrophyllous dense forest along river banks in Quaternary plains because vegetation keeps the habitat favorable to the presence of the Neotropical otter.

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**LITERATURE CITED**


