ABSTRACT: Environmental and social pressures can result in interspecies differences in marking behaviours. There is a strong relationship between marking behaviour and the environment. Therefore, closely related species that show behavioural differences in the wild may have different scent marking strategies. We conducted a comparative study of the urine-marking behaviours of tigers and lions in captivity (Madrid Zoo, open enclosures of 514 m² and 730 m² respectively, observations of 8 animals for each species). These two closely related species have different natural habitats. We observed interspecific differences in the rates, seasonal variations, and durations of the urine-marking acts. The marking rate was higher in tigers, which also showed seasonal variations not observed in lions. The duration of urine marking was lower in tigers than in lions. These differences seem to correspond to differences between tigers and lions in terms of their natural habitats (forest areas vs open areas), social organizations (solitary vs social), and reproductive biology patterns (seasonal polyoestrous vs annual polyoestrous).

KEY WORDS: captivity, chemical communication, lions, tigers, urine marking

In order to increase their fitness, wild animals must defend valuable resources, such as food, mates, and territories, against their competitors. The defence of resources can involve aggression, threatening, or marking behaviours, which are used to label the environment with visual or scent marks. Marking strategies depend upon the animal's lifestyle, social requirements, and the physical features of their environment. In mammals, particularly nocturnal or crepuscular mammals, chemicals are often used to mark to the environment (Kleiman 1966, Ralls 1971, Brown and Macdonald 1985).

Carnivores, which are mainly solitary animals that patrol wide areas, primarily mark their territories with scent (Kleiman 1966, Gorman and Trowbridge 1989, Barja et al. 2005). Some carnivores also use mixed scent and visual markings. As an example of a mixed marking, the animal scrapes the soil, which is a well documented behaviour in carnivores (Eaton 1970, Schaller 1972, Bekoff 1979, Barja et al. 2005), and adds secretions from its interdigital glands to the visually conspicuous scrapes. Field studies on carnivores have shown than fluctuations in marking frequencies can indicate the onset of the oestrus (Wells and Bekoff 1981, Gorman and Trowbridge 1989). Thus, monitoring marking behaviours can indicate reproductive physiological events and should
be a key component of captive breeding programs.

Marking behaviour has been reported in felines by numerous studies (Schaller 1967, 1972, Eaton 1970, Wemmer and Scow 1977, Brahmachary 1979, Brahmachary and Dutta 1987, Smith et al. 1989, Mellem 1993, Brahmachary et al. 1999, and Brahmachary and Singh 2000). Studies have reported that tigers can perceive one another through dense vegetation by sensing odours (Schaller 1967, 1972, Gorman and Trowbridge 1989). Fresh marks deposited by an animal indicate that it has recently travelled by the marked area, and these markings can attract or drive out visitors. For instance, cheetahs (*Acinonyx jubatus* Schreber, 1975) avoid paths that have been recently marked by conspecifics (Eaton 1970). In some cases the chemical composition of the marks can provide physiological information. For example, females in oestrus mark more frequently than other females (Schaller 1972, Smith et al. 1989).

Since an animal’s marking behaviour is related to its social and physical environment, we hypothesized that closely related species showing behavioural differences in the wild may display different marking strategies. We conducted a comparative study of urine-marking behaviour of Siberian tigers (*Panthera tigris altaica* Temminck, 1844) and Barbary lions (*Panthera leo leo* Linnaeus, 1758) at the Madrid Zoo. Siberian tigers and Barbary lions are closely related species with different natural habitats. To date, there have been no comparative studies on tigers and lions with regard to their scent marking behaviours in the wild or in captivity. We recorded the frequencies and the durations of visual-scent marking behaviours to identify interspecific differences between tigers and lions.

The study was conducted on eight Siberian tigers (one adult male, two adult females, three young males, and two young females) and eight Barbary lions (two adult males and six adult females) at the Madrid Zoo (Spain). The tigers and lions occupied open enclosures of 514 m² and 730 m², respectively.

Our observations were collected between May 1995 and April 1996 and summed 416 hours. Marking events were recorded early in the morning and at dawn, when the animals were most active and the probability of marking was higher. We used continuous behavioural sampling (Martin and Bateson 1986) for two hours per day for two days per week in each enclosure. We only considered urine marking and scraping+urine squatting, since both of these markings have recognizable visual components and serve a communicative function. We also recorded the duration of each urine-marking event.

The mean urine-marking rate was significantly higher in tigers than in lions (0.5 vs

![Fig. 1. Seasonal variation in the urine-marking rates of tigers and lions in captivity.](image-url)
Urine marking in captive tigers and lions

0.1 marks/h, \( c^2 = 211.8, df = 1, n = 362, P < 0.001 \). As shown in Figure 1, the tigers showed the highest urine-marking rate during the winter, followed by the spring and autumn. The lowest urine-marking rate was observed in the summer (\( c^2 = 31.1, df = 3, n = 251, P < 0.001 \)). In contrast, we did not observe a significant seasonal variation in the urine-marking rates of lions (Fig. 1) (\( c^2 = 6.3, df = 3, n = 140, P > 0.05 \)).

We observed interspecific differences in the duration of the urine-marking events. The duration was shorter in tigers (1.95 ± 1.66 s, \( n = 88 \)) than in lions (10.47 ± 7.82 s, \( n = 21 \)). Additionally, the variability was greater in lions than in tigers (lions: 3.5–32 s, tigers: 1.5–2 s), and the distributions were significantly different (Mann-Whitney \( U \) test = 58, \( n = 109, P < 0.001 \)).

The results of our study demonstrate significant differences in the urine-marking behaviours of large felids. We observed that urine-marking rates were significant higher in tigers than in lions. Tigers dwell in forest environments where scent marks, such as urine, constitute an effective communication channel. Tigers have been reported to have a greater proportion of lipids in their anal secretions than lions (Andersen and Vulpianus 1999, Burger et al. 2008), which may play a substantial role in retaining volatiles. These data support the hypothesis that chemical communication is more essential for tigers than for lions.

Tigers showed seasonal variations in their marking rates, while lions showed no significant variations. These differences may be due to differences in the animals’ reproductive cycles. Tigers in the wild show seasonal differences in the frequency of urine markings, and the highest marking rates occur during the reproductive period (Schaller 1967). According to Tilson and Seal (1987), marking increases during oestrus and/or proestrus. Smith et al. (1989) reported that marking by female tigers is indicative of oestrus, although marking ceased during pair-bonding. Males marked more frequently when females were in oestrus. Seasonal patterns in marking frequencies have been documented in other felid species, where increases in markings occur during the mating season (Wielebnowsky and Brown 1998, Mellem 1999). Therefore, we conclude that the urine-marking rate in tigers may serve as a good indicator of both oestrus and the breeding season.

In contrast, lions do not show a seasonal pattern in their marking frequencies in the wild (Schaller 1972). This is likely because female lions are annually polyoestrus, while female tigers are seasonally polyoestrus. Additionally, females who are annually polyoestrus in other carnivorous species, such as spotted and striped hyenas, do not show seasonal patterns in their marking frequencies (Rieger 1981). In these annually polyoestrus animals, marking behaviours are not related to the mating time or the breeding period (Barja 2001).

The differences in the duration of urine marking in tigers and lions may be related to differences in their urine-marking frequencies. Lions urinated with a lower frequency and longer durations. Since tigers live in tropical forests, they rely more heavily upon urine marking. Logically, tigers and other species that mark frequently should use shorter urine-marking acts to avoid exhausting their semi-chemical reserves. For instance, Barja and Miguel (2004) reported that more frequent urination events were shorter in duration in captive wolves. Since lions inhabit more open areas that favour visual marking, they need not urinate as frequently. In the present study, tigers were observed to urinate more frequently and have short marking acts than lions. These results correspond to previous studies, which reported that the urine-marking acts in tigers are brief (Schaller 1967, Brahmacary and Dutta 1987, Smith et al. 1989, Brahmacary et al. 1991).

In conclusion, tigers and lions showed significant differences in their urine-marking patterns despite their exposure to similar conditions in the zoo. One interpretation of these results is that the conditions in the zoo are appropriate for both species, allowing the animals to retain the marking strategies they used in their wild habitats.

ACKNOWLEDGMENTS: We want to express our gratitude to Madrid Zoo by their collaboration. We are also in debt with Cheryl Asa and Avanti Mallapur by its useful comments.
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Received after revision September 2009