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Muzzle rubbing in the moustached tamarin, *Saguinus mystax* (Primates: Callitrichidae) – behavioural and histological aspects

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Abstract

Muzzle rubbing (rubbing of the oro-nasal region against the substrate) was studied in a pair of moustached tamarins, *Saguinus mystax mystax*, in an outdoor enclosure. Muzzle rubbing was frequently associated temporally and spatially with anogenital and suprapubical marking and urination. Specialized mono- and polyptychic skin glands were found above the anterior nasal cupula and in the surrounding skin. From this evidence and the comparison with other primates the hypothesis is developed that muzzle rubbing is envolved in scent marking. In the female moustached tamarin, longterm cyclic changes in frequencies of muzzle rubbing were found which are possibly related to the oestrous cycle. Therefore, it is suggested that muzzle rubbing plays a role in the communication of the reproductive status of the female.

Introduction

Communication by chemical signals plays an important role in the social and reproductive behaviour of primates (Epple 1986). Among the New World monkeys, in marmosets and tamarins (Callitrichidae) secretions from scent gland organs in the circumgenital and sternal regions, and urine are suggested to be the main carriers of olfactory informations (Epple 1974, 1978; Zeller et al. 1988). They are deposited at the environment by means of scent-marking behaviours like anogenital, suprapubical and sternal marking. These behaviour patterns have been observed in all callitrichids studied so far (Epple 1986; Heymann 1985).

Many species of callitrichids and some other primates frequently rub their muzzle against the substrate (Table 1). This behaviour is interpreted by French and Cleveland (1984) as scent-marking, whereas Sutcliffe and Poole (1978, p. 53) argue that "the absence of glandular fields militates against muzzle rubbing being a form of scent marking". However, in callitrichids, the histology of the skin of the muzzle, viz. in the area above the anterior nasal cupula, has never been studied in detail. Among the primates listed in Table 1, only in *Tarsius* specialized circumoral skin glands ("Zirkumoralorgan") have been described by Sprankel (1971).

In addition to the lack of studies dealing with the microscopical anatomy of the skin of the muzzle, little behavioural data on frequencies, contexts, temporal and spatial patterning of muzzle rubbing have been presented. Sex-specific differences in frequencies of muzzle rubbing have been reported for howler monkeys *(Alouatta seniculus)* where it is mainly performed by males (Braza et al. 1981). In contrast, no sexual dimorphism in frequencies of muzzle rubbing is observed in the cotton-top tamarins *(Saguinus oedipus)* and in a mixed pair of saki monkeys (*Pithecia hirsuta* and *Pithecia monachus*) muzzle rubbing occurred with equal frequencies in both sexes (French and Cleveland 1984; Bartecki and Heymann 1987). In Goeldi's tamarin *(Callimico goeldii)* and in lesser mouse lemurs *(Microcebus murinus)* muzzle rubbing occurs more frequently in females during the oestrous (Glatston 1983; Heltne et al. 1981).

In the present paper the muzzle rubbing behaviour of the moustached tamarin

Table 1. **Muzzle rubbing and comparable behaviour patterns in callitrichids and other primates**

Species	Behaviour pattern	Reference
Callithrix jacchus	muzzle rub	Stevenson and Poole 1976; Sutcliffe and Poole 1978
Callithrix argentata	muzzle rub	Omedes 1981
Saguinus labiatus labiatus	muzzle rub	Coates and Poole 1983
Saguinus mystax mystax	muzzle rubbing	Heymann 1985
Saguinus fuscicollis nigrifrons	muzzle rubbing	Heymann 1985
Saguinus oedipus	nose rubbing	French and Cleveland 1984
Saguinus geoffroyi	face rubbing	Moynihan 1970
Callimico goeldii	nose-rub marking, nose-rub grooming, sneeze-nose rub	Heltne et al. 1981
Saimiri sciureus	nasal rubbing	Schwartz and Rosenblum 1980
Pithecia pithecia	naso-buccal rubbing	Dugmore 1986
Pithecia hirsuta	muzzle rubbing	Bartecki and Heymann 1987
Pithecia monachus	muzzle rubbing	Bartecki and Heymann 1987
Alouatta seniculus	muzzle rubbing	Braza et al. 1981
Tarsius bancanus borneanus	head rubbing	Sprankel 1971
Tarsius syrichta carbonarius	head rubbing	sprankel 1971
Microcebus murinus murinus	mouth wiping	Glatston 1983
Galago demidovii demidovii	mouth rubbing, labial marking	Voland 1978

(Saguinus m. mystax) is analysed and histological evidence in favour of the scent marking hypothesis is reported.

Material and methods

A pair of wildborn moustached tamarins (*Saguinus mystax mystax* Spix, 1823) living in a 9 × 13 × 2.5 m outdoor enclosure at the Centro de Reproducción y Conservación de Primates (CRCP) in Iquitos (Peru) was observed by one of us (EWH) during the course of a study on vocal and olfactory communication (Heymann 1985). The outdoor enclosure was equipped with natural plant growth and a system of wooden perches. It contained two small cages in which food was placed twice daily and water was available ad libitum. For further details on the enclosure see Kaumanns (1982). Between October 16, 1982 and March 27, 1983, 252 hours of observation focussing on olfactory behaviour were carried out. Together with records on scent-marking, sniffing, licking and other behaviours related to olfactory communication, all observed events of muzzle rubbing were recorded, stating animal, time, context and spatial position. Ambient temperature was read every 15 min during observation sessions from a maximum-minimum-thermometer placed near the observer's seat at the front side of the enclosure.

Statistical procedures

Individual rates and diurnal variation in frequencies of muzzle rubbing were calculated by the two-way analysis of variance and covariance (ANOVA). Frequencies are given per 15 min (total number of 15-min periods: 1007). Spatial frequency distributions were compared with the χ^2-test. Long-term changes in frequencies of muzzle rubbing were determined with the analysis of autocorrelation. In this analysis, observed values at time t are successively correlated with the values at t+1, t+2, . . . , t+n (time lag). The correlation coefficients are then plotted as a function of the time lag. Thus, periodical variations can be detected and the period length can be determined (for further details see Lienert 1978).

Histological methods

The circumoral skin together with the anterior end of the cartilaginous nasal skeleton (Cupula nasi anterior) of an adult male *Saguinus m. mystax* were excised soon after natural death and fixed in 80 % ethanol at the CRCP in Iquitos. The material was embedded in paraffin, sectioned serially at 12 µm and stained with Hematoxyline-Eosine (H.E.) and Goldner's trichrome at the Zentrum Anatomie, University of Göttingen.

Serial sections of the skin covering the anterior nasal cupula of *Saguinus fuscicollis* and *Saguinus oedipus* were available for comparison.

Results

Description and behavioural context of muzzle rubbing

Muzzle rubbing consists of pressing the oro-facial region onto the substrate and rubbing it with lateral movements of the head (Fig. 1). It is always performed on horizontal or slightly inclined substrates.

Fig. 1. Muzzle rubbing in a male moustached tamarin, *Saguinus mystax mystax*

Muzzle rubbing has been observed to occur in the following behavioural contexts: a. before or during scent marking and urination; b. after feeding; c. before or after sneezing; d. without definable context.

Contexts (a) and (b) occasionally were combined, i.e. the animals muzzle rubbed after feeding and before or during scent marking and urination. The movement patterns were essentially the same in all situations. Table 2 shows the relative frequencies of muzzle rubbing in the forementioned contexts. Clear differences between male and female only exist in the frequency of muzzle rubbing after feeding and before or during scent marking and urination and muzzle rubbing that was observed without definable context.

Individual frequencies and diurnal distribution of muzzle rubbing

Muzzle rubbing was observed totally 602 times, 295 times in the male and 287 times in the female. Average frequency per 15 min was 0.29 (± 0.71) for the male and 0.28 (± 0.61) for the female; the difference is not statistically significant (ANOVA: $F = 0.13$, $df = 1, 1990$, $p = 0.71$).

Frequencies of muzzle rubbing show significant variation during the day (ANOVA: $F = 8.18$, $df = 11, 1990$, $p = 0.000$; Fig. 2). In both animals a pronounced maximum is present in the early morning, but frequencies vary only slightly during the rest of the day.

Table 2. **Behavioural contexts of muzzle rubbing in *Saguinus mystax***
Figures indicate the percentage of muzzle rubbing that was observed within each context

	Male	Female
After feeding	16.3	17.8
Before or during scent marking and urination	29.2	34.8
After feeding and before or during scent marking and urination	1.4	10.5
Before or after sneezing	1.0	1.7
No definable context	52.2	35.2

There is no interaction between individual and time of day ($F = 1.43$, $df = 11, 1990$, $p = 0.15$). This is because the temporal distributions of male and female are essentially similar except for a significant difference between 1400–1500 h (T-Test: $t = -2.21$, $df = 206$, $p < 0.03$).

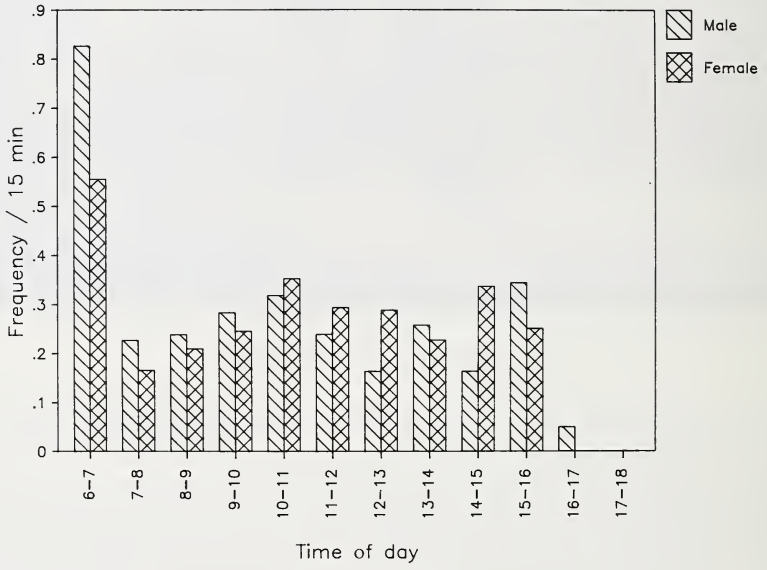

Fig. 2. Temporal distribution of muzzle rubbing during the day

Ambient temperature as a possible covariate has no influence on frequencies of muzzle rubbing (ANOVA: $F = 0.01$, $df = 1, 1990$, $p = 0.94$).

Spatial distribution of muzzle rubbing

The spatial distribution of muzzle rubbing within the outdoor enclosure is shown in Fig. 3. Both distributions are significantly different from a random distribution (male: $\chi^2 = 103.314$, $df = 19$, $p < 0.001$; female: $\chi^2 = 88.378$, $df = 19$; $p < 0.001$) and significantly different from each other ($\chi^2 = 60.253$, $df = 19$, $p < 0.001$). The spatial distribution of muzzle rubbing of the male is significantly correlated with the distribution of its anogenital

marking ($r = 0.51$, $df = 18$, $p < 0.025$), but not with the distribution of the female's anogenital marking. The spatial distribution of the female's muzzle rubbing also is significantly correlated with its own anogenital marking ($r = 0.77$, $df = 18$, $p < 0.001$), but not with the male's anogenital marking. The stronger correlation for the female is a consequence of the more frequent association of muzzle rubbing with scent marking than in the male.

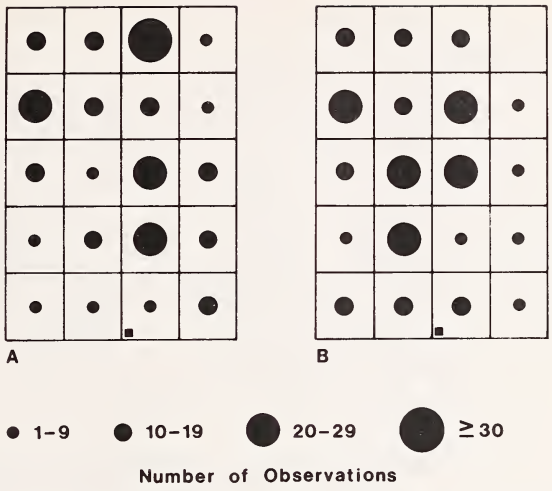

Fig. 3. Spatial distribution of muzzle rubbing in the outdoor enclosure. A: male, B: female; ■ observer's seat)

Long-term changes in frequencies of muzzle rubbing

The time period analyzed comprised 107 days from December 2, 1982 to March 18, 1983. For this period data are available for nearly every day; ten lacking values were substituted by random values lying within the range of variation of the total sample. Since an influence of time of day on frequencies of muzzle rubbing was found (see above) values had to be corrected for this.

Figure 4 shows the long-term changes in frequencies of muzzle rubbing. Whilst the male exhibits irregular fluctuations, a more regular pattern is present in the female.

An analysis of autocorrelation was performed to reveal the significance of the cyclicity. From Fig. 5a it can be seen that no cyclicity is present in the male. In the female a significant correlation is found at a half cycle length of 8 to 9 days ($r = -0.255$, $df = 97$, $p < 0.01$) and at a full cycle length of 17 to 18 days ($r = 0.156$, $df = 89$, $p < 0.1$) (Fig. 5b), which refers well to the interpeak intervalls indicated in Fig. 4b.

Histological findings

As in all platyrrhines, the width of the internarial space of *S. mystax* corresponds to that of the large Cartilago cupularis which forms the anterior boundary of the nasal cavity and, in addition to the Processus lateralis ventralis, is the main part of the anterior nasal cupula. The skin above the Cartilago cupularis is moderately covered with hair. Vibrissae are sporadically found. The Epidermis consists of approximately 5–7 cell layers: the cornified layer is relatively thick. The Dermis is made up of fibrous collaganous connective tissue and is extensively supplied by blood vessels. It is connected to the Perichondrium of the Cartilago cupularis; the Subcutis is lacking in this area.

Lateral to the anterior nasal cupula bundles of smooth muscle cells of the mimic musculature extend into the Subcutis and Dermis. Mono- and polyptychic skin glands are well developed in the skin above the Cupula nasi anterior (Fig. 6). The polyptychic or sebaceous glands have an alveolar structure. Numerous lobules empty into the upper third of the hair follicle. The ducts are short and wide; their walls are formed of several layers of cells. The lobules of the polyptychic glands are larger and their ducts have a wider lumen compared to those of unspecialized areas of the skin, e.g. the skin of the thigh.

The monoptychic apocrine glands have a tubular structure. They are more numerous and larger than in unspecialized areas of the skin. The apocrine glands are situated in a

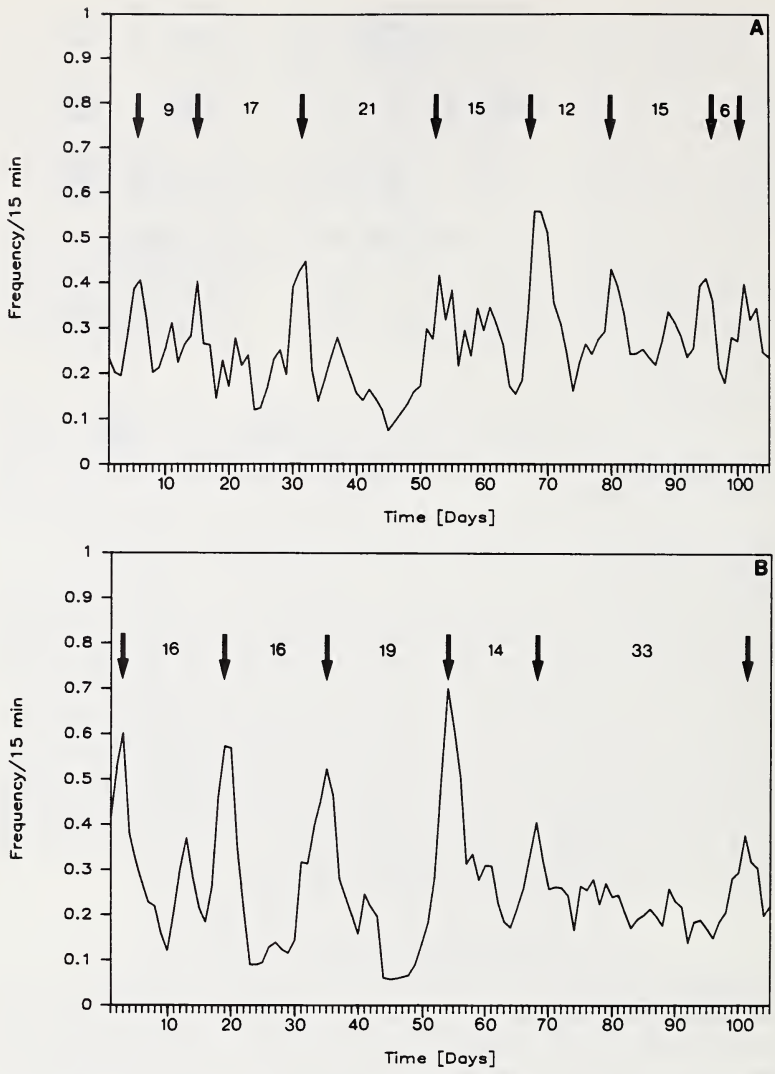

Fig. 4. Long-term changes in frequencies of muzzle rubbing (moving average, N = 3). A: Male, B: Female. Figures between arrows indicate the number of days between subsequent frequency peaks

deeper layer of the dermis below the sebaceous glands. The excreting ducts are elongated and have a narrow lumen; their wall consists of two layers of flattened cells. They closely adjoin the hair follicles and open into the distal, funnelshaped portion of the follicle. The monoptychic tubules form small groups within the connective tissue of the Dermis. Lateral to the anterior nasal cupula they extend into the subcutaneous layer. In segments of the tubules with a wide lumen, the secreting cells are flattened. In those segments with a narrow lumen, the epithelial cells are tall columnar and obviously in the process of secretion.

The mono- and polyptychic glands of the skin adjacent to the anterior nasal cupula are also larger than in unspecialized areas but their number and size rapidly decrease in the lateral direction.

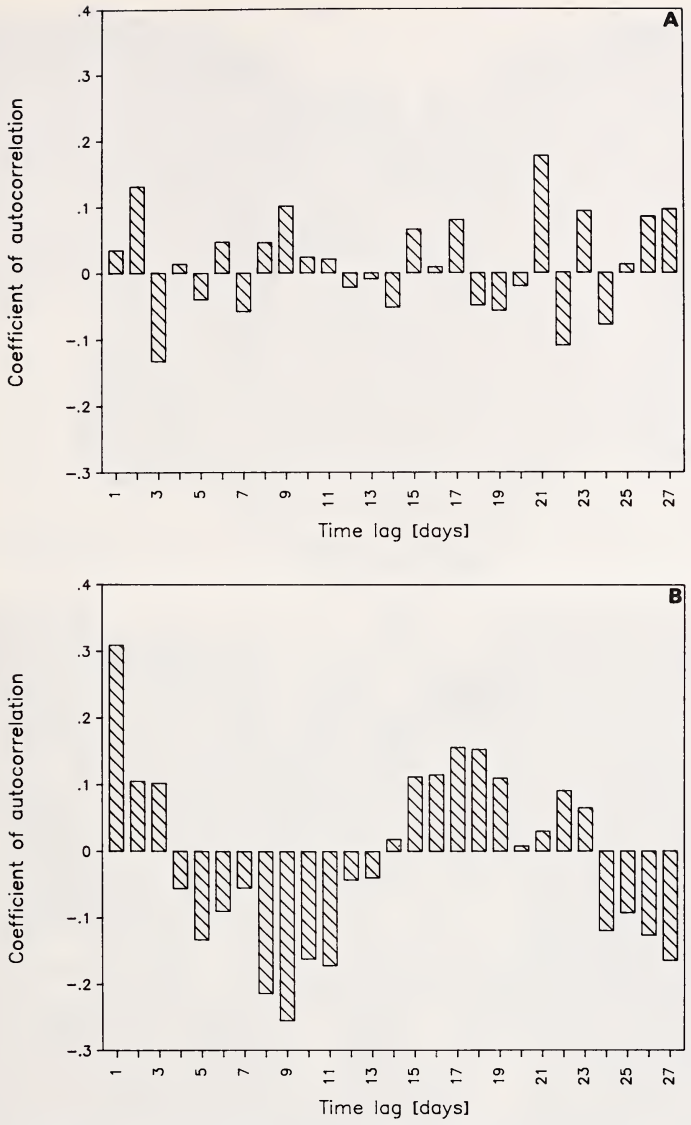

Fig. 5. Coefficients of autocorrelation for long-term changes in frequencies of muzzle rubbing. A: Male, B: Female

In *Saguinus fuscicollis*, the skin glands above the anterior nasal cupula are developed to a similar degree as in *S. mystax*. In *Saguinus oedipus*, however, they are smaller and less numerous than in *S. mystax* and *S. fuscicollis*.

Discussion

The behavioural and histological evidence presented in this study suggests that in the moustached tamarin *(S. mystax)* muzzle rubbing is involved in chemical communication.

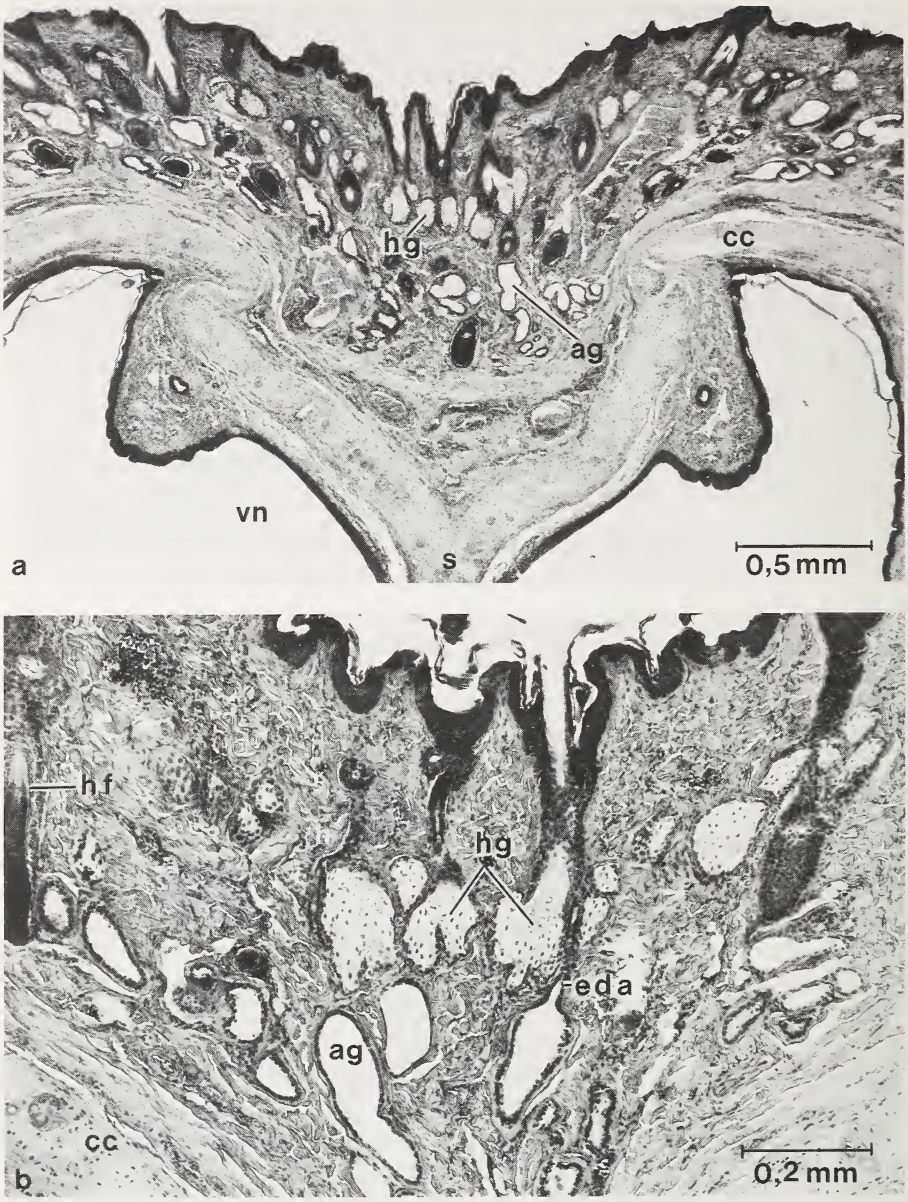

Fig. 6. Saguinus mystax mystax ♂, transverse sections through the nose at the anterior nasal cupula. Note the presence of specialized monoptychic (apocrine) and polyptychic (holorine) skin glands. ag = apocrine gland; cc = Cartilago cupularis; eda = excretory duct of apocrine gland; hf = hair follice; hg = holocrine gland; s = nasal septum; vn = Vestibulum nasi

This is shown by the frequent temporal and spatial association of muzzle rubbing with anogenital and suprapubical scent marking and urination. In addition, specialized mono- and polyptychic skin glands are found in the area above the anterior nasal cupula and the surrounding skin. This part of the face intensively contacts the substrate during muzzle rubbing (Fig. 1).

A temporal association of muzzle rubbing with scent marking has also been observed in *Saguinus labiatus* (Coates and Poole 1983), *Saguinus geoffroyi* (Moynihan 1970) and *Saguinus fuscicollis* (Heymann pers. obs.). In the latter, muzzle rubbing occurs with similar frequencies and in the same contexts as in *S. mystax*. There is no significant difference in the development of the skin glands of the face in these two species. In contrast, *Saguinus oedipus* possesses less and smaller skin glands on the external nose than *S. mystax* and *S. fuscicollis*. Large sebaceous glands have been found only in the lips of this species by Perkins (1969a). The behavioural findings are inconsistent: while French and Cleveland (1984) found high frequencies of muzzle rubbing, it was only seldom observed by Rohrhuber (pers. comm.) during her long-term study on the behaviour of *S. oedipus*. Generally, scent glands are less developed in this species compared to *S. fuscicollis* and are also smaller in the anogenital region (Zeller et al. 1988, in press). Large sebaceous glands are also found in the skin of lips and nose in *Callithrix argentata* (Perkins 1969c), and of lips, nose and cheeks in *Callimico goeldii* (Perkins 1969b). Muzzle rubbing has been described in both species. Quantitative behavioural and histological data are lacking for other platyrrhines.

Among other primates, only in *Tarsius bancanus* and *Tarsius syrichta* large polyptychic (holocrine) and monoptychic (apocrine) skin glands have been found in the upper and lower lips ("Zirkumoralorgan") by Sprankel (1971). Secretions of these glands are deposited by rubbing the face against the substrate, similar to muzzle rubbing of *Saguinus*. Besides, in *Tarsius* and *Saguinus* rubbing of the muzzle also occurs in connection with feeding or sneezing. This suggests that it also functions as a comfort behaviour, that is cleaning of the oro-nasal region, as it is also observed in some Cercopithecidae.

The occurrence of specialized skin glands in the oro-nasal region indicates that during muzzle rubbing secretions (and possibly saliva) can be released and deposited at the environment. Therefore, it is concluded that muzzle rubbing plays a role in scent marking. In addition, the presence of a functioning vomeronasal organ in platyrrhines (Maier 1980) suggests that muzzle rubbing is also involved in the perception of chemical signals. Belcher et al. (in press) demonstrated that close contact of the external nose to the substrate is a prerequisite for the discrimination of scent marks in *S. oedipus*.

The functions of chemical signals encoded in secretions of skin glands of the oro-nasal region are still unknown. However, the long-term cyclic fluctuations in frequencies of muzzle rubbing in a female *S. mystax* suggest that information on the reproductive status (e.g. oestrous) of the female can be released. The average length of the oestrous cycle is not exactly known for *S. mystax*. In the closely related *S. fuscicollis* average cycle lengths of 17.5 days (Epple and Katz 1984) and 14.6 days (Hampton and Hampton 1977) have been observed. For *S. oedipus* 15.2 days (Hampton and Hampton 1977), 15.5 days (Preslock et al. 1973), and 22.7 days (Brand 1981) are found. The data presented here for *S. mystax* are suggestive: the intervals between peaks in frequencies of muzzle rubbing in the female (except the last one) lie within the range of oestrous cycle length in related species. Additional support for the hypothesis that muzzle rubbing plays a role in the communication of the reproductive status of the female is lent by the observation of increased frequencies of muzzle rubbing during oestrus in female *Callimico goeldii* (Heltne et al. 1981) and in female *Microcebus murinus* (Glatston 1983).

Future studies on the social and reproductive behaviour of *Saguinus mystax* and other callitrichids will further elucidate the biological importance of muzzle rubbing.

Zusammenfassung

Reiben der oro-nasalen Region beim Schnurrbarttamarin, Saguinus mystax (Primates: Callitrichidae)

Reiben der Mund-Nasen-Region am Substrat wurde bei einem Paar von Schnurrbarttamarinen *(Saguinus mystax mystax)* in einem Freigehege untersucht. Dieses Reiben war häufig zeitlich und räumlich mit anogenitalem und suprapubischem Markieren und Urinieren assoziiert. Spezialisierte mono- und polyptyche Drüsen wurden in der Haut über der vorderen Nasenkuppel und im unmittelbar angrenzenden Bereich nachgewiesen. Diese Befunde deuten darauf hin, daß das Reiben der oro-nasalen Region bei *Saguinus mystax* dem Funktionskreis der olfaktorischen Kommunikation zuzuordnen ist. Beim Weibchen wurden langfristige zyklische Häufigkeitsschwankungen des Reibens festgestellt, die einen Zusammenhang mit dem Östruszyklus vermuten lassen. Möglicherweise dient diese Verhaltensweise auch der Kommunikation des Reproduktionszustandes des Weibchens.

Resumen

Frotar la boca en el pichico de barba blanca, Saguinus mystax (Primates: Callitrichidae) – aspectos etológicos e histológicos

Frotar la boca sobre el substrato fue observado en una pareja de pichicos de barba blanca *(Saguinus mystax mystax)* en un galpón al aire libre. Este comportamiento estuvo asociado temporalmente y espacialmente con marcaciones olfatorias y urinación. Glandulas mono- y poliptijas especializadas fueron encontradas en la Cupula nasi anterior y en la piel circundante. Estos resultados indican que frotar la boca en pichicos de barba blanca forma parte de la comunicación olfatoria. En la hembra, fluctuaciones a largo plazo de las frecuencias de frotar la boca fueron observadas, lo que indica posiblemente una correlación con el ciclo de estro. Posiblemente, con este comportamiento la hembra dé informaciones sobre su estado de reproducción.

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