



Self-anointing behaviour in captive titi monkeys (*Callicebus* spp.)

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Received: 30 July 2017 – Revised: 25 November 2017 – Accepted: 1 December 2017 – Published: 11 January 2018

Abstract. Self-anointing behaviour using *Bauhinia* sp. was reported in two captive titi monkeys (*Callicebus coimbrai* and *Callicebus barbarabrownae*). The study was carried out from October 2013 to May 2014 during an experimental study investigating the gut passage time of these individuals at the Getúlio Vargas Zoobotanical Park, north-eastern Brazil. Although leaves, petioles and flowers of *Bauhinia* contain chemical substances that could affect the presence of ectoparasites, it is unclear if titi monkeys demonstrate self-anointing behaviour as a method of self-medication. However, due to the presence of large glands in *C. coimbrai* and *C. barbarabrownae* chests, and the high frequency of occurrence observed for the adult male, we cautiously suggest that the use of *Bauhinia* may be linked to olfactory communication.

1 Introduction

Non-human animals have been found to self-medicate or to scent-mark most commonly through self-anointing, fur-rubbing and scent-rubbing behaviours in order to alleviate or to control illnesses (Rodríguez and Wrangham, 1993) commonly caused by leaves and/or invertebrates (i.e. zoopharmacognosy). Self-anointing behaviour occurs when a solitary and/or group of animals rub directly or chew and mix plant or insect material with saliva on their fur (Huffman, 2011). Wild and captive primates have been documented to use plants and invertebrates as medicinal agents to repel or kill ectoparasites (i.e. mosquitos, ticks) and microbial pathogens, as well as to treat wounds, and rubbing materials against individuals' bodies, aiming to optimise the coverage of medicines applied to both individuals or groups (Westergaard and Fragaszy, 1987; Baker, 1996; Valderrama et al., 2000; Weldon et al., 2003; Falótico et al., 2007; Verderane et al., 2007; Meunier et al., 2008; Morrogh-Bernard, 2008; Bowler et al., 2015).

Alternatively, self-anointing may be a form of group scent-marking behaviour, just as urine washing, faecal marking and even the use of plant extracts in some primate species (Ueno, 1991; Campbell, 2000; Leca et al., 2007; Paukner and Suomi, 2008, 2012). For instance, non-human primates such as spider (*Ateles* spp.), owl (*Aotus* spp.) and capuchin monkeys (*Cebus* and *Sapajus*) have been found to use self-anointing as a method of scent marking (olfactory communication or enhanced sociality) between individuals (Laska et al., 2007; Lynch-Alfaro et al., 2012; Jefferson et al., 2014). Given that individuals often interact with each other while self-anointing, this behaviour may reinforce social bonds and may be a form of social convention such as handclasp grooming in chimpanzees (McGrew and Tutin, 1978; Campbell, 2000; Carnegie et al., 2006; Laska et al., 2007; Leca et al., 2007; Paukner and Suomi, 2008, 2012) and hand sniffing in white-faced capuchins (Perry et al., 2003). During self-anointing behaviour, the animals may either (i) bite and chew

the plant parts causing the production of saliva, possibly indicating a medicinal function; or (ii) they may only bite and squeeze the plants without the formation of saliva, demonstrating a social function (Baker, 1996; Huffman, 2011). This behaviour may occur in three ways: (i) when only one individual rubs a substance on itself to reach specific body regions (chest rubbing and muzzle rubbing); (ii) socially, when individuals rub their bodies against those of other members of the group in order to cover their whole body with the substance in question (Lynch-Alfaro et al., 2012); and (iii) when they rub substances on scent glands found on their bodies (Campbell, 2000).

Self-anointing behaviour has been reported previously in titi monkeys. For instance, *Plecturocebus discolor* and *Plecturocebus toppini* have been observed to use chewed *Tetrathylacium* (Salicaceae) as well as Annonaceae and Bignoniaceae plant leaves (Carrillo-Bilbao et al., 2005). Recently, an adult male of *Plecturocebus oenanthe* was reported to use *Piper aduncum* leaves (Piperaceae) for fur rubbing after chewing and squeezing the leaves (Huashuayo-Llamocca and Heymann, 2017). Additionally, *Plecturocebus moloch*¹ individuals were reported to rub their chests, likely in order to spread any odoriferous secretion from skin scent glands (Moynihan, 1966). There is still limited data available on in situ and ex situ behaviours for titi monkeys, *Callicebus coimbrai* and *Callicebus barbarabrownae*. Self-anointing behaviour has been studied in capuchins due to their anecdotal behaviour. Reporting this behaviour at an individual or group level helps to increase our knowledge on the range of species within the primate order that presents such behaviour and what the possible behavioural contexts of self-anointing are for a given species. It is therefore essential to identify new behaviours in these species in order to better understand the social behaviour of poorly studied monogamous primate groups. Here, we report the use of leaves, flowers and petioles of *Bauhinia* sp. (Fabaceae) by two captive titi monkeys (*C. coimbrai* and *C. barbarabrownae*) applied during self-anointing behaviour. Our results are discussed in the light of self-medication and olfactory communication hypotheses.

2 Methods

The study, in which the observations were reported, was conducted at the Getúlio Vargas Zoobotanical Park (13°0'23" S; 38°30'20" W) in Salvador, Bahia, north-eastern Brazil. The study subjects were two captive individual titi monkeys, an adult male *Callicebus coimbrai* and an adult female *Callicebus barbarabrownae* (Fig. 1), rescued from the illegal pet trade and included in the study. The animals were monitored between October 2013 and May 2014 (excluding April 2014)

¹The species referred by Moynihan's (1966) study are *Plecturocebus cupreus* and *Plecturocebus ornatus* according to the recent taxonomy (Byrne et al., 2016).



Figure 1. Two captive titi monkeys, *Callicebus coimbrai* (left) and *Callicebus barbarabrownae* (right), monitored during the study at the Getúlio Vargas Zoobotanical Park. Photo: João Pedro Souza-Alves.

for a total of 362 h (monthly average: 51 h 49 min \pm 05 h 16 min). Monitoring took place from dawn (05:00 h) to dusk (18:00 h), with the main goal of verifying the gut passage time of these individuals, in a specific experimental design. However, we deployed “all occurrences” sampling (Altmann, 1974) whenever scent marking did or did not follow the self-anointing behaviours that were observed. During the study period, the animals were kept in a 2 m \times 3 m \times 3 m enclosure. Dry trunks placed on the ground, a pot with fresh water replaced daily and two plant species were (*Eugenia uniflora*, Myrtaceae; and *Bauhinia* sp.) added to the enclosure. In addition, dry lianas were present in the enclosure, with the aim of providing environmental enrichment as well as for the welfare of the animals.

3 Results

Self-anointing was observed on 29 occasions. In all cases only parts of *Bauhinia* sp. were involved. Self-anointing behaviour was observed a total of 25 times for the male and 4 times for the female. The animals bit leaves (21 cases), petioles (5 cases) and flowers (3 cases) from the tree and kneaded them with either one or both hands. There were no observations of individuals rubbing the plant on each other. The

two captive individuals strongly rubbed themselves with the squeezed plant material against the chest–abdominal area. This behaviour commonly involved rubbing only one item of pressed plant parts during each event on the body and lasted between 15 and 30 s, without the scent marking after such behaviour.

4 Discussion

The genus *Bauhinia* is widely distributed across Africa, Asia and South America. In Brazil, the genus occurs throughout the country (61 species) and across a variety of biomes (Atlantic Forest, Amazon, Caatinga, Cerrado, Pampas and Pantanal) (Vaz, 2015). Their leaves and stem–bark have been used frequently in folk medicine as a remedy for a wide variety of ailments such as diabetes, infections, pain and inflammation (Cechinel Filho, 2000; da Silva et al., 2000; da Silva and Cechinel Filho, 2002; Cavalcanti and Favoreto, 2005). The major chemical constituents of *Bauhinia* sp. are flavonoids and kaempferitrin, although additional secondary compounds are present, such as terpenes, steroids, aromatic acids, quinones, lactones, and alkaloids, among others (da Silva and Cechinel Filho, 2002; Mali et al., 2007). Only ingestion (i.e. via infusions or decoctions) of *Bauhinia* sp. extract by humans has been previously described (Pinheiro et al., 2017; Sengupta and Ahmed, 2015). In contrast, the chemical substances (anethole, apiole, carvone, cineole, dilapiole, phenylpropanoids) found in the leaves and fruits (e.g. *Citrus*, *Clematis*, *Piper*, *Sloanea*) used by *Cebus capucinus* and *P. oenanthe* during self-anointing are considered to be insecticides (Baker, 1996; Huashuayo-Llamocca and Heymann, 2017). Although the *Bauhinia* sp. used by titi monkeys has important chemical substances that may have medicinal purposes for humans and non-human primates, it is unclear if its use is related to the self-medication behaviour that occurred in the captive titis.

Neotropical primates have been recorded using olfactory cues to signal territorial, social and reproductive behaviours (Di Fiore et al., 2006; Heymann, 2006; Jefferson et al., 2014). According to Lynch-Alfaro et al. (2012), restricted locations on the body and lack of sociality for self-anointing behaviour could indicate that medicinal use is less likely to occur. It has also been suggested that captive and wild *Ateles geoffroyi* individuals use scent-marking behaviour as olfactory communication on the fur of specific body parts, for example chest-to-mouth scratching, chest rubbing, and rubbing of sternal and axillary areas over either a vertical or horizontal surface (Klein and Klein, 1971; Campbell, 2000). In contrast, *Piper* leaves were rubbed against the abdominal area of *P. oenanthe* in a possible case of self-medication (Huashuayo-Llamocca and Heymann, 2017). In this study, we observed two adult titi monkeys chest rubbing with squeezed leaves, with a higher frequency of occurrence for the adult male ($n = 25$ events). The high frequency of occurrence observed for the adult male

and the accentuated odour of the flowers and leaves may plausibly support the hypothesis of olfactory communication between the captive individuals. Moynihan (1966) described scent-marking behaviour for *P. moloch* and indicated the presence of large glands that release odoriferous secretions in the centre of an individual's chest. Similarly, an adult male individual of *C. coimbrai* was reported to rub their chest fur when in the presence of another adult male (intergroup) and a pregnant adult female (intragroup) in the wild (J. P. Souza-Alves, unpublished data). During this behaviour, the adult male did not rub any external substances on the fur i.e. the individual only rubbed the sternal gland with the hand, likely inducing scent marking. This aspect reinforces the hypothesis of olfactory communication between captive individuals. Therefore, the self-anointing behaviours reported here may not necessarily be linked to self-medication or to repelling of parasites (Baker, 1996; Morrogh-Bernard, 2008), although some chemical substances found in the plant may act as a repellent. However, we can speculate that they may be associated with olfactory communication between captive titis.

Data availability. No data sets were used in this article.

Author contributions. NMA, LV and TSC made equal contribution to the data collection and manuscript writing.

Competing interests. The authors state they have no conflict of interests.

Acknowledgements. João Pedro Souza-Alves was supported by a PNPd/CAPES fellowship (grant no. 527091) and FACEPE (Fundação de Amparo à Ciência e Tecnologia de Pernambuco: grant no. BCT-0025-2.05/17), Natasha M. Albuquerque was supported by a CAPES masters fellowship, TC was supported by an ICM-Bio/CNPq undergraduate fellowship and Raone Beltrão-Mendes was supported by a CNPq research fellowship (503372/2014-5). We are also thankful to all staff at the Getúlio Vargas Zoobotanical Park for their logistic support. João Pedro Souza-Alves is also grateful to his wife, Renata Chagas, for all her dedication, love and comprehension during the study period. We are grateful to Ute Radespiel, Michael Huffman and two anonymous reviewers for their valuable comments on the manuscript.

Edited by: Ute Radespiel

Reviewed by: Michael Huffman and two anonymous referees

References

- Altmann, J.: Observational study of behavior: sampling methods, *Behaviour*, 49, 227–267, 1974.
- Baker, M.: Fur rubbing: use of medicinal plants by capuchin monkeys (*Cebus capucinus*), *Am. J. Primatol.*, 38, 263–270, 1996.

- Bowler, M., Messer, E. J. E., Claidière, N., and Whiten, A.: Mutual medication in capuchin monkeys – social anointing improves coverage of topically applied anti-parasite medicines, *Sci. Rep.-UK*, 5, 15030, <https://doi.org/10.1038/srep15030>, 2015.
- Byrne, H., Rylands, A. B., Carneiro, J. C., Lynch Alfaro, J., Bertuol, F., Silva, M. N. F., Messias, M., Groves, C. P., Mittermeier, R. A., Farias, I., Hrbek, T., Schneider, H., Sampaio, I., and Boubli, J. P.: Phylogenetic relationship of the New World titi monkeys (*Callicebus*): first appraisal of taxonomy based on molecular evidence, *Front. Zool.*, 13, 10, <https://doi.org/10.1186/s12983-016-0142-4>, 2016.
- Campbell, C. J.: Fur rubbing behavior in free-ranging black-handed spider monkeys (*Ateles geoffroyi*) in Panama, *Am. J. Primatol.*, 51, 205–208, 2000.
- Carnegie, S. D., Fedigan, L. M., and Ziegler, T. E.: Post-conceptive mating in white-faced capuchins, *Cebus capucinus*: hormonal and sociosexual patterns of cycling, noncycling, and pregnant females, in: *New Perspectives in the Study of Mesoamerican Primates: Distribution, Ecology, Behavior, and Conservation*, edited by: Estrada, A., Garber, P. A., Pavelka, M., and Luecke, L., Springer and University of Chicago Press, Illinois, 387–409, 2006.
- Carrillo-Bilbao, G., Di Fiore, A., and Fernandez-Duque, E.: Dieta, forrajeo y presupuesto de tiempo en cotoncillos (*Callicebus discolor*) del Parque Nacional Yasuní en la Amazonia ecuatoriana, *Neotro. Primates*, 13, 7–11, 2005.
- Cavalcanti, K. M. P. H. and Favoretto, R. F.: *Bauhinia forficata* Link, in: *Coletânea Científica de Plantas de Uso Medicinal*, edited by: Amaral, A. C. F., Simões, E. V., and Ferreira, K. L. P., Fiocruz, Rio de Janeiro, 1–17, 2005.
- Cechinel Filho, V.: Principais avanços e perspectivas na área de produtos naturais ativos: estudos desenvolvidos no NIQ-FAR/UNIVALI, *Quim. Nova*, 23, 680–685, 2000.
- da Silva, K. L. and Cechinel Filho, V.: Plantas do gênero *Bauhinia*: composição química e potencial farmacológico, *Quim. Nova*, 25, 449–454, 2002.
- da Silva, K. L., Biavatti, M. W., Leite, S. N., Yunes, R. A., Delle Monache, F., and Cechinel Filho, V.: Phytochemical and pharmacognostic investigation of *Bauhinia forficata* link, *Z. Naturforsch. C*, 55, 478–480, 2000.
- Di Fiore, A., Link, A., and Stevenson, P. R.: Scent marking in two western Amazonian populations of woolly monkeys (*Lagothrix lagotricha*), *Am. J. Primatol.*, 68, 637–649, 2006.
- Falótico, T., Labruna, M. B., Verderane, M. P., De Resende, B. D., Izar, P., and Ottoni, E. B.: Repellent efficacy of formic acid and the abdominal secretion of carpenter ants (Hymenoptera: Formicidae) against *Amblyomma* ticks (Acari: Ixodidae), *J. Med. Entomol.*, 44, 718–721, 2007.
- Heymann, E. W.: Scent marking strategies of New World primates, *Am. J. Primatol.*, 68, 650–661, 2006.
- Huashuayo-Llamocca, R. and Heymann, E. W.: Fur-rubbing with Piper leaves in the San Martín titi monkey, *Callicebus oenanthe*, *Primate Biol.*, 4, 127–130, <https://doi.org/10.5194/pb-4-127-2017>, 2017.
- Huffman, M. A.: Primate self-medication, in: *Primates in Perspective, Second Edition*, edited by: Campbell, C. J., Fuentes, A., MacKinnon, K. C., Bearder, S. K., and Stumpf, R.M., Oxford University Press, Oxford, 563–575, 2011.
- Jefferson, J. P., Tapanes, E., and Evans, S.: Owl monkeys (*Aotus* spp.) perform self- and social anointing in captivity, *Folia Primatol.*, 85, 119–134, 2014.
- Klein, L. and Klein, D.: Aspects of social behavior in a colony of spider monkeys (*Ateles geoffroyi*) at San Francisco Zoo, *Int. Zoo Yearbook*, 11, 175–181, 1971.
- Laska, M., Bauer, V., and Salazar, L. T. H.: Self-anointing behavior in free-ranging spider monkeys (*Ateles geoffroyi*) in Mexico, *Primates*, 48, 160–163, 2007.
- Leca, J. P., Gunst, N., and Petit, O.: Social aspects of fur-rubbing in *Cebus capucinus* and *C. apella*, *Int. J. Primatol.*, 28, 801–817, 2007.
- Lynch-Alfaro, J. W., Mattheus, L., Boyete, A. H., Macfarlan, S. J., Phillips, K. A., Falótico, T., Ottoni, E., Verderane, M., Izar, P., Schulte, M., Melin, A., Fedigan, L., Janson, C., and Alfaro, M. E.: Anointing variation across wild capuchin populations: a review of material preferences, bout frequency and anointing sociality in *Cebus* and *Sapajus*, *Am. J. Primatol.*, 74, 299–314, 2012.
- Mali, R. G., Mahajan, S. G., and Mehta, A. A.: Rakta Kanchan (*Bauhinia variegata*): chemistry, traditional and medicinal uses – a review, *Phcog. Rev.*, 1, 314–319, 2007.
- McGrew, W. C. and Tutin, C. E. G.: Evidence for a social custom in wild chimpanzees?, *Man*, 13, 243–251, 1978.
- Meunier, H., Petit, O., and Deneubourg, J. L.: Social facilitation of fur rubbing behavior in White-faced capuchins, *Am. J. Primatol.*, 70, 161–168, 2008.
- Morrogh-Bernard, H. C.: Fur-rubbing as a form of self-medication in Pongo pygmaeus, *Int. J. Primatol.*, 29, 1059–1064, 2008.
- Moynihan, M.: Communication olfactory in the titi monkeys, *Callicebus*, *J. Zool.*, 150, 77–127, 1966.
- Paukner, A. and Suomi, S. J.: The effect of fur rubbing on the social behavior of tufted capuchin monkey, *Am. J. Primatol.*, 70, 1007–1012, 2008.
- Paukner, A. and Suomi, S. J.: Social after-effects of fur rubbing in tufted capuchin monkeys (*Cebus apella*): increased antagonism and reduced affiliation, *Primates*, 53, 297–301, 2012.
- Perry, S., Baker, M., Fedigan, L., Gros-Louis, J., Jack, K., McKinnon, K. C., Manson, J. H., Panger, M., Pyle, K., and Rose, L.: Social conventions in wild white-faced capuchin monkeys, *Current Anthropol.*, 44, 241–268, 2003.
- Pinheiro, E. A. A., Pina, J. R. S., Feitosa, A. O., Carvalho, J. M., Borges, F. C., Marinho, P. S. B., and Marinho, A. M. R.: Bio-prospecting of antimicrobial activity of extracts of endophytic fungi from *Bauhinia guianensis*, *Rev. Argent. Microbiol.*, 49, 3–6, 2017.
- Rodríguez, E. and Wrangham, R. W.: Zoopharmacognosy: The use of medicinal plants by animals, in: *Recent Advances in Phytochemistry, Phytochemical Potential of Tropical Plants*, Vol. 27, edited by: Downum, K. R., Romeo, J. T. and Stafford, H., Plenum Press, New York, 89–105, 1993.
- Sengupta, R. and Ahmed, A. B.: Evaluation of anti-diarrheal activity of ethanolic extract of *Bauhinia variegata* (Leguminosae) stem bark in wister albino rats, *Int. J. Pharm. Phytopharmacol.*, 5, 2–7, 2015.
- Ueno, Y.: Urine-washing in tufted capuchins (*Cebus apella*): Discrimination between groups by urine-odor, in: *Primateology today*, edited by: Ehara, A., Kimura, T., Takenaka, O., and Iwamoto, M., Elsevier, Amsterdam, 297–300, 1991.

- Valderrama, X., Robinson, J. G., Attygalle, A. B., and Eisner, T.: Seasonal anointment with millipedes in a wild primate: a chemical defense against insects?, *J. Chem. Ecol.*, 26, 2781–2790, 2000.
- Vaz, A. M. S. F.: *Bauhinia* in Lista de Espécies da Flora do Brasil, Jardim Botânico do Rio de Janeiro, available at: <http://floradobrasil.jbrj.gov.br/jabot/floradobrasil/FB22811> (last access: 14 July 2017), 2015.
- Verderane, M. P., Falotico, T., Resende, B. D., Labruna, M. B., Izar, P., and Ottoni, E. B.: Anting in semi free-ranging group of *Cebus apella*, *Int. J. Primatol.*, 28, 47–53, 2007.
- Weldon, P. J., Aldrich, J. R., Klun, J. A., Oliver, J. E., and Deboun, M.: Benzoquinones from millipedes deter mosquitoes and elicit self-anointing in capuchin monkeys (*Cebus* spp.), *Naturwissenschaften*, 90, 301–304, 2003.
- Westergaard, G. and Fragaszy, D.: Self-treatment of wounds by a capuchin monkey (*Cebus apella*), *Human Evol.*, 2, 557–562, 1987.