



Fur rubbing in *Plecturocebus cupreus* – an incidence of self-medication?

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Abstract. Fur rubbing, i.e. rubbing a substance or an object into the pelage, has been described in numerous Neotropical primate species, including species of titi monkeys, but it seems to be a rare behaviour. Here we describe a fur rubbing event in a wild coppery titi monkey (*Plecturocebus cupreus*) with *Psychotria* sp. (Rubiaceae) leaves observed and videotaped during a field study on vigilance behaviour between September–December 2019 in the Peruvian Amazon. Plants of the genus *Psychotria* contain a great diversity of secondary metabolites and are often used in traditional medicine. We suggest that the fur rubbing was an act of self-medication. This is the first record of fur rubbing in coppery titi monkeys in almost 4400 h of observation accumulated over more than 20 years.

1 Introduction

Nonhuman primates are known to manipulate non-food items they find in their surroundings and to ingest or apply them to their bodies. Such items include various plant parts, minerals, arthropods or man-made products (e.g. soap) (Baker, 1996; Bowler et al., 2015; Huffman, 1997; Pebsworth et al., 2021; Peckre et al., 2018). The ingestion or topical use of these items can serve as social communication or for self-meditative purposes, also known as zoopharmacognosy (Rounak et al., 2011). For example, in white-faced capuchin monkeys (*Cebus capucinus*) collective fur rubbing has been proposed as a way to socialise with other group members (Baker, 1996; Leca et al., 2007). In most cases, however, fur rubbing is performed individually and considered self-medication in a broad sense, i.e. a behaviour used for ectoparasite removal, repelling insects, treating skin infections and wounds, soothing or stimulating the skin or even as fur conditioning (Baker, 1996; Gibson, 1990; Mascaró et al.,

2022; Westergaard and Fragaszy, 1987). Plant parts can be rubbed into the fur directly or after squeezing or chewing them (Huffman, 1997). Such plant part manipulation probably leads to the release of secondary compounds, which can then be applied onto the fur more easily when mixed with saliva (Huffman, 1997). Fur rubbing has been observed in a number of primate species, both in the wild and in captivity (e.g. Baker, 1996; Campbell, 2000; Laska et al., 2007; Morrogh-Bernard et al., 2017; Zito et al., 2003). Observations of fur rubbing in different species of titi monkeys are summarised in Table 1.

Here we describe, for the first time, an event of fur rubbing by a coppery titi monkey (*Plecturocebus cupreus*) in the Peruvian Amazon.

Table 1. A summary of fur rubbing with leaves observed in titi monkeys. NA: information not available.

Titi monkey species	Plant species (family)	Mode of leaf handling	Duration (s)	Application on body area	Source
<i>Plecturocebus discolor</i>	<i>Tetrathylacium</i> sp. (Salicaceae)	chewing	NA	NA	Carrillo-Bilbao et al. (2005)
<i>Plecturocebus toppini</i> (formerly <i>Callicebus brunneus</i>)	Undetermined species from Annonaceae and Bignoniaceae	chewing	NA	abdominal area	Francis Bossuyt, personal communication in Carrillo-Bilbao et al. (2005)
<i>Callicebus coimbrai</i> and <i>Callicebus barbarabrownae</i>	<i>Bauhinia</i> sp. (Fabaceae)	squeezing with one or both hands	15–30	chest and abdominal area	Souza-Alves et al. (2018)
<i>Plecturocebus oenanthe</i> (formerly <i>Callicebus oenanthe</i>)	<i>Piper aduncum</i> (Piperaceae)	squeezing with both hands	300–900	chest and abdominal area	Huashuayo-Llamocca and Heymann (2017)
<i>Plecturocebus brunneus</i>	<i>Senna obtusifolia</i> (Fabaceae), <i>Piper tuberculatum</i> (Piperaceae)	chewing	NA	chest	Oliveira et al. (2020)
<i>Plecturocebus cupreus</i>	<i>Psychotria</i> sp. (Rubiaceae)	chewing	~ 300	abdominal area	this report

2 Methods

The observation was made during a study at the Estación Biológica Quebrada Blanco (EBQB), a study site in the north-eastern Peruvian Amazon (4°21' S, 73°09' W), some 90 km south southeast of Iquitos. For details of the study area see Heymann et al. (2019).

We observed four groups of coppery titi monkeys as part of a study on vigilance between September–December 2019. Group 4, in which we observed the fur rubbing behaviour, consisted of one adult male, one adult female and their subadult offspring. Observations were usually made from dawn (06:00 PET, Peru time), when the group left their sleeping site, until almost dusk (17:00 PET), when they retreated to one. Throughout the study, we used instantaneous scan sampling of 2 min for standardised data collection and ad libitum sampling for recording unusual events (Altman, 1974).

3 Results

On the 12 November 2019 at 12:04 PET, the adult male of the group climbed down a liana and, stopping at the height of less than 2 m, ripped a handful of leaves from a *Psychotria* sp. (Rubiaceae) understory tree. Then he climbed back up the liana, sat down and started chewing on the leaves. Then he took the leaves out of his mouth and rubbed them slowly but firmly on his lower abdomen (Video supplement). He continued this action for about 5 min. Then he discarded the leaves and moved towards the group, which had remained < 5 m away during the event.

4 Discussion

We report here the first case of fur rubbing behaviour by a coppery titi monkey using the leaves of *Psychotria* sp. in the Peruvian Amazon. Based on the similarity in the mode of application of the chewed leaves on the body reported in other primates, we suggest a self-medicative function to the behaviour of the coppery titi monkey. In the absence of a species level plant identification, we cannot suggest a specific medicinal mechanism in titi monkeys.

Our interpretation of a self-medicative function is supported by the fact that species of *Psychotria* (one of the largest angiosperm genera with about 1650 species; Nepokroeff et al., 1999), which have been chemically analysed, include a diversity and considerable concentrations of secondary compounds. These compounds show cytotoxic, analgesic, antiviral and antifungal bioactivities (Calixto et al., 2016). This makes *Psychotria* popular in traditional medicine and as herbal medicinal products, used topically in cases of skin disorders, ocular disorders, to relieve fever, headaches and earaches (Calixto et al., 2016). The species identity could not be determined unambiguously, and therefore it is impossible to tell whether this specific plant is used in folk medicine. However, a number of *Psychotria* species are used in Amazonian (and Central and South American) ethnobotany (Benevides et al., 2005; Duke and Vasquez, 1994; see Table S1 in the Supplement). Therefore, it can be reasonably assumed that the plant used by the titi monkey could have some medical properties, too. Although *Psychotria* can include psychoactive tryptamines that show hallucinogenic activity (McKenna et al., 1984), this is unlikely

to account for fur-rubbing, as oral uptake is required for this effect. Our on-field examination of the plant revealed the crushed leaves to have a cinnamon-like scent of ground leaves.

The observation has been made in November during the onset of the rainy season. Although the number of ectoparasites, like mosquitoes and ticks, might have been on the increase, *Psychotria* spp. are not known to have insect repellent properties. Restricting application to the abdominal part of the body is also not compatible with this explanation (Koyama et al., 2008; Simmen and Tarnaud, 2011).

Interestingly, this behaviour has been observed for the first time at the EBQB, despite almost 4400 h of observing copery titi monkeys between 1997–2019. Obviously, it is a rare behaviour, which makes any interpretation difficult. Further detailed behavioural observations and identification of the plant species used are needed before the function of the behaviour can be conclusively determined. Only through the accumulation of this kind of anecdotal observations will it be possible to detect more general patterns that can lead to more conclusive interpretations.

Ethical statement. This work was conducted with all necessary permits (research permit no. 249-2017-SERFOR/DGGSPFFS from the Servicio Nacional Forestal y de Fauna Silvestre of the Peruvian Ministry of Agriculture) and adhered to the IPS Code of Best Practices for Field Primatology.

Data availability. Data sharing is not applicable to this article as no datasets were generated or analysed during the current study.

Video supplement. A video that documents the observed fur rubbing is available on <https://doi.org/10.5446/56632> (Theara et al., 2022).

Supplement. The supplement related to this article is available online at: <https://doi.org/10.5194/pb-9-7-2022-supplement>.

Author contributions. GKT collected the data; JRM and RZG identified the plant; GKT, EWH and SD wrote the paper.

Competing interests. The contact author has declared that neither they nor their co-authors have any competing interests.

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References

- Altmann, J.: Observational study of behavior: sampling methods, *Behaviour*, 49, 227–266, 1974.
- Baker, M.: Fur rubbing: use of medicinal plants by capuchin monkeys (*Cebus capucinus*), *Am. J. Primatol.*, 38, 263–270, 1996.
- Benevides, P. J. C., Young, M. C. M., and Bolzani, V. D. S.: Biological activities of constituents from *Psychotria spectabilis*, *Pharm. Biol.*, 42, 565–569, <https://doi.org/10.1080/13880200490901780>, 2005.
- Bowler, M., Messer, E. J., Claidière, N., and Whiten, A.: Mutual medication in capuchin monkeys—Social anointing improves coverage of topically applied anti-parasite medicines, *Sci. Rep.*, 5, 1–10, <https://doi.org/10.1038/srep15030>, 2015.
- Calixto, N. O., Pinto, M. E. F., Ramalho, S. D., Burger, M., Bobey, A. F., Young, M. C. M., Bolzani, V. S., and Pinto, A. C.: The genus *Psychotria*: Phytochemistry, chemotaxonomy, ethnopharmacology and biological properties, *J. Brazil. Chem. Soc.*, 27, 1355–1378, <https://doi.org/10.5935/0103-5053.20160149>, 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.
- Carrillo-Bilbao, G., Di Fiore, A., and Fernández-Duque, E.: Dieta, forrajeo y presupuesto de tiempo en cotoncillos (*Callicebus discolor*) del Parque Nacional Yasuní en la Amazonia Ecuatoriana, *Neotropical Primates*, 13, 7–11, 2005.
- Duke, J. A. and Vasquez, R.: Amazonian ethnobotanical dictionary, Boca Raton, CRC Press, ISBN 0-8493-3664-3, 1994.
- Gibson, K. R.: Tool use, imitation, and deception in a captive cebus monkey, in: “Language” and intelligence in monkeys and apes: Comparative developmental perspectives, edited by: Parker, S. T. and Gibson, K. R., Cambridge University Press, 205–218, <https://doi.org/10.1017/CBO9780511665486.009>, 1990.
- Heymann, E. W., Culot, L., Knogge, C., Smith, A. C., Herrera, E. R. T., Müller, B., Stojan-Dolar, M., Ferrer, Y. L., Kubisch, P., Kupsch, D., Slana, D., Koopmann, M. L., Ziegenhagen, B., Bialozyt, R., Mengel, C., Hambuckers, J., and Heer, K.: Small Neotropical primates promote the natural regeneration of anthropogenically disturbed areas, *Sci. Rep.*, 9, 1–9, <https://doi.org/10.1038/s41598-019-46683-x>, 2019.
- 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.: Current evidence for self-medication in primates: A multidisciplinary perspective, *Am. J. Phys. Anthropol.*, 104, 171–200, 1997.
- Koyama, N., Aimi, M., Kawamoto, Y., Hirai, H., Go, Y., Ichino, S., and Takahata, Y.: Body mass of wild ring-tailed lemurs in Berenty Reserve, Madagascar, with reference to tick infestation: a preliminary analysis, *Primates*, 49, 9–15, <https://doi.org/10.1007/s10329-007-0051-4>, 2008.
- 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, <https://doi.org/10.1007/s10329-006-0019-9>, 2007.
- Leca, J. B., Gunst, N., and Petit, O.: Social aspects of fur-rubbing in *Cebus capucinus* and *C. apella*, *Int. J. Primatol.*, 28, 801–817, <https://doi.org/10.1007/s10764-007-9162-4>, 2007.
- Mascaro, A., Southern, L. M., Deschner, T., and Pika, S.: Application of insects to wounds of self and others by chimpanzees in the wild, *Curr. Biol.*, 32, R112–R113, 2022.
- McKenna, D. J., Towers, G. H. N., and Abbott, F.: Monoamine oxidase inhibitors in South American hallucinogenic plants: tryptamine and β -carboline constituents of ayahuasca, *J. Ethnopharmacol.*, 10, 195–223, 1984.
- Morrogh-Bernard, H. C., Foitová, I., Yeen, Z., Wilkin, P., De Martin, R., Rárová, L., Doležal, K., Nurcahyo, W., and Olšanský, M.: Self-medication by orang-utans (*Pongo pygmaeus*) using bioactive properties of *Dracaena cantleyi*, *Sci. Rep.*, 7, 1–7, <https://doi.org/10.1038/s41598-017-16621-w>, 2017.
- Nepokroeff, M., Bremer, B., and Sytsma, K. J.: Reorganization of the genus *Psychotria* and tribe Psychotrieae (Rubiaceae) inferred from ITS and rbcL sequence data, *Syst. Bot.*, 24, 5–27, <https://doi.org/10.2307/2419383>, 1999.
- Oliveira, B. L. P., Souza-Alves, J. P., and Oliveira, M. A.: Potential self-medication by brown titi monkeys, *Plecturocebus brunneus*, in an urban fragment forest in the Brazilian Amazon, *Primate Biol.*, 7, 35–39, <https://doi.org/10.5194/pb-7-35-2020>, 2020.
- Pebsworth, P. A., Gruber, T., Miller, J. D., Zuberbühler, K., and Young, S. L.: Selecting between iron-rich and clay-rich soils: a geophagy field experiment with black-and-white colobus monkeys in the Budongo Forest Reserve, Uganda, *Primates*, 62, 133–142, <https://doi.org/10.1007/s10329-020-00845-y>, 2021.
- Peckre, L. R., Defolie, C., Kappeler, P. M., and Fichtel, C.: Potential self-medication using millipede secretions in red-fronted lemurs: combining anointment and ingestion for a joint action against gastrointestinal parasites?, *Primates*, 59, 483–494, <https://doi.org/10.1007/s10329-018-0674-7>, 2018.
- Rounak, S., Apoorva, K., and Shweta, A.: Zoopharmacognosy (animal self medication): a review, *International Journal of Research in Ayurveda and Pharmacy*, 2, 1510–1512, 2011.
- Simmen, B. and Tarnaud, L.: Utilisation des sécrétions de myriapodes chez les lémurs et les sapajous: fonction curative ou signalisation sociale?, *Revue de primatologie*, 3, <https://doi.org/10.4000/primatologie.644>, 2011.
- Souza-Alves, J. P., Albuquerque, N. M., Vinhas, L., Cardoso, T. S., Beltrão-Mendes, R., and Jerusalinsky, L.: Self-anointing behaviour in captive titi monkeys (*Callicebus* spp.), *Primate Biol.*, 5, 1–5, <https://doi.org/10.5194/pb-5-1-2018>, 2018.
- Theara, G. K., Ruíz Macedo, J., Zárate Gómez, R., Heymann, E. W., and Dolotovskaya, S.: Fur rubbing in *Plecturocebus cupreus* – an incidence of self-medication?, TIB AV-Portal [video], <https://doi.org/10.5446/56632>, 2022.
- Westergaard, G. and Frigaszy, D.: Self-treatment of wounds by a capuchin monkey (*Cebus apella*), *Human Evolution*, 2, 557–562, 1987.
- Zito, M., Evans, S., and Weldon, P. J.: Owl monkeys (*Aotus* spp.) self-anoint with plants and millipedes, *Folia Primatol.*, 74, 159–161, <https://doi.org/10.1159/000070649>, 2003.