

Top 10 things to know about captive marmoset behavioral management (plus resources)

Marmosets are small South American monkeys (Platyrrhines) characterized by secondary dwarfism (an evolutionarily reduction in body size from a larger ancestor), claws instead of nails, lack of sexual dimorphism, cooperative infant care, and the production of litters (most typically twins). Historically, several species of Callitrichids were maintained in captive colonies for research, including Saddle-back



Photo credit: Jeffrey Fite

tamarins, Golden Lion tamarins, Cotton top tamarins, Kuhl's marmosets and Geoffroy's marmosets. These species have played a significant role in research topics ranging from behavioral endocrinology to pediatric obesity to vaccine development for Zika virus. Currently, the primary species available for research is *Callithrix jacchus*, the common marmoset.

Callithrix jacchus are endemic to Brazil and range naturally from the Atlantic coastal forests to the Caatinga. They seem to be particularly hardy and able to take advantage of edge and urban habitats.

In recent years there has been a surge of interest in and support for research with marmosets. The number of research projects supported by NIH and other funding agencies to explore topics in marmoset biology and translational medicine continues to climb. In fact, the current demand for marmosets has resulted in a coordinated effort to expand marmoset availability supported by the NIH. This effort seeks to not only increase the number of marmosets available for research but to provide support for new investigators interested in nonhuman primate (marmoset) research.

Of continuing concern to those who work with marmosets is the lack of standardization in care and behavioral management of the species across colonies. While current captive colonies provide resources to other investigators, there remains almost a mythology to the care and maintenance of marmosets. This mysticism in care is most likely a result of early captive researchers referring to them as frail and challenging organisms. It is imperative that we continue to scientifically evaluate care programs and use data to inform decisions regarding standardization of care for these animals, especially as new colonies emerge.

So here are the top 10 things you should know about the behavioral management of captive marmosets (plus resources!):

1. Marmosets typically live in relatively small family units consisting of the breeding pair and their offspring. While occasional polygynous and polyandrous breeding groups have been reported in the field, the most stable social system in captivity is a monogamous breeding pair and their infants. Infants stay in the social group and cooperatively care for their younger siblings. Caging in captive colonies is widely diverse, but most groups have cages capable of maintaining a family group of 8-10 individuals.
 - Schiel, N., & Souto, A. (2017). The common marmoset: An overview of its natural history, ecology and behavior. *Developmental Neurobiology*, 77(3), 244-262.



Marmoset Caging at Southwest National Primate Research Center

- de Fatima Arruda, M., Yamamoto, M. E., de Almeida Pessoa, D. M., & Araujo, A. (2019). Taxonomy and Natural History. In *The Common Marmoset in Captivity and Biomedical Research* (pp. 3-15). Academic Press.
2. Marmosets are territorial and will respond aggressively to intruders. Response to a same sex intruder tends to be more aggressive than to the opposite sex, with female-female aggression often resulting in severe wounding. One tactic to reduce territorial behaviors (including scent marking and genital displays) is to prevent visual access between cages and family groups. However, this is a hotly debated topic between colony managers, and there is no consensus on best practice. Most cages are designed to provide optional visual barriers between individuals, even if external barriers such as curtains don't obstruct the views between cages.
 - French, J. A., Schaffner, C. M., Shepherd, R. E., & Miller, M. E. (1995). Familiarity with intruders modulates agonism towards outgroup conspecifics in Wied's Black-tufted-ear Marmoset (*Callithrix kuhli*: Primates, Callitrichidae). *Ethology*, *99*(1-2), 24-38.
 - Caselli, C. B., Ayres, P. H., Castro, S. C., Souto, A., Schiel, N., & Miller, C. T. (2018). The role of extragroup encounters in a Neotropical, cooperative breeding primate, the common marmoset: a field playback experiment. *Animal Behaviour*, *136*, 137-146.
 3. Marmosets give birth to litters of 2-5 infants at a time, with twins being the most typical litter size. Most families are only able to care for two infants at a time; reports of triplets surviving without human support are rare. The male is often the primary caregiver in the family group, taking over carrying duties early, with other siblings and juveniles also participating in the care. It is thought that marmosets are more successful parents if they participate in supporting sibling infant care.
 - Tardif, S. D., & Ross, C. N. (2019). Reproduction, Growth, and Development. In *The Common Marmoset in Captivity and Biomedical Research* (pp. 119-132). Academic Press.
 4. Loss of infants in the first two weeks of life is extremely common, with losses at some facilities reported as high as 50%. While many investigators are still exploring the causes, the largest factor that contributes to this is the production of large litters which the parents can't support. Colonies have adopted a number of tactics to help support infant rearing, including infant supplementation, rotational rearing, complete nursery rearing, and fostering of infants. Most of these tactics have been reported to increase infant survival, but losses still occur for unknown reasons.
 - Jaquish, C. E., Gage, T. B. & Tardif, S. D. (1991). Reproductive factors affecting survivorship in captive Callitrichidae. *American Journal of Physical Anthropology*, *84*, 291-305..
 - Ross, C. N., Fite, J. E., Jensen, H. & French, J. A. Demographic review of a captive colony of callitrichids (*Callithrix kuhlii*). *American Journal of Primatology*, *69*, 234-240,
 - Tardif, S. D., Smucny, D. A., Abbott, D. H., Mansfield, K., Schultz-Darken, N., & Yamamoto, M. E. (2003). Reproduction in captive common marmosets (*Callithrix jacchus*). *Comparative medicine*, *53*(4), 364-368.
 - Voelkl, B., & Huber, L. (2006). Hand rearing of infant common marmosets (*Callithrix jacchus*). In *Nursery rearing of nonhuman primates in the 21st century* (pp. 121-129). Springer, Boston, MA.
 5. Marmoset infants mature quickly, with weaning complete by 90 days of age. Marmosets reach adult size between 18-24 months. The young adults remain in the natal group and are reproductively suppressed; the means of suppression varies by species. In the wild, both sexes disperse from the natal group. In captivity, dispersal can be mimicked by moving mature individuals when natal groups reach maximum family size within the cage, aggression from the breeding pair occurs towards the offspring, or there is aggression between siblings. At the time of dispersal, some colonies maintain same sex siblings together, with higher success reported for brothers rather than sisters. Pairings between unfamiliar same sex individuals are rarely

reported as successful. In fact, female-female aggression is typically rapid and fatal. Therefore, the most successful strategy is to pair house marmosets as male-female pairs (with birth control if breeding is not desired).

- Manciocco, A., Webb, S. J. N., & Mulholland, M. M. (2021). Behavioral biology of marmosets. In Behavioral Biology of Laboratory Animals (pp. 377-394). CRC Press.
 - Williams, L., & Ross, C. N. (2017). Behavioral management of neotropical primates: Aotus, Callithrix, and Saimiri. In Handbook of primate behavioral management (pp. 409-434). CRC Press.
6. Marmosets are small prey species, often being preyed upon by birds, snakes, and other mammals. Their behavior in captivity reflects this, with displays of constant vigilance and reactivity to new items, particularly towards items that resemble snakes. Marmosets are often described as neophobic, and additions of novel enrichment to the cage needs to be implemented with care.
- Ferrari, S. F., & Ferrari, M. A. L. (1990). Predator avoidance behaviour in the buffy-headed marmoset, *Callithrix flaviceps*. *Primates*, 31(3), 323-338.
 - Hankerson, S. J., & Caine, N. G. (2004). Pre-retirement predator encounters alter the morning behavior of captive marmosets (*Callithrix geoffroyi*). *American Journal of Primatology*, 63(2), 75-85.
 - Williams, L., & Ross, C. N. (2017). Behavioral management of neotropical primates: Aotus, Callithrix, and Saimiri. In Handbook of primate behavioral management (pp. 409-434). CRC Press.

7. Marmosets typically nest at night as family groups in holes in trees or groups of branches. In captivity, nestboxes are provided in the cages. These nestboxes take many forms: hammocks, tubes, boxes, or transport boxes. Many cages have been designed that provide a dual-use removable transport box in which the animals will sleep at night and can be removed from the cage for procedures.



Photo credit: Polly Mar

- Caine, N. G., Potter, M. P., & Mayer, K. E. (1992). Sleeping site selection by captive tamarins (*Saguinus labiatus*). *Ethology*, 90(1), 63-71.
 - Manciocco, A., Webb, S. J. N., & Mulholland, M. M. (2021). Behavioral biology of marmosets. In Behavioral Biology of Laboratory Animals (pp. 377-394). CRC Press.
8. Marmosets can be readily trained to perform several research, husbandry, and clinical tasks within the homecage using positive reinforcement training. These include, but are not limited to, weighing, delivery of medications, venipuncture, ultrasound, as well as cognitive research tasks (although many colonies report a longer time needed for training involving touchscreens compared to other primates). Importantly, such training and habituation to tasks allows marmosets to be handled while awake during these research and medical procedures.
- Jaquish, C. E., Toal, R. L., Tardif, S. D., & Carson, R. L. (1995). Use of ultrasound to monitor prenatal growth and development in the common marmoset (*Callithrix jacchus*). *American Journal of Primatology*, 36(4), 259-275.
 - Spinelli, S., Pennanen, L., Dettling, A. C., Feldon, J., Higgins, G. A., & Pryce, C. R. (2004). Performance of the marmoset monkey on computerized tasks of attention and working memory. *Cognitive Brain Research*, 19(2), 123-137.
 - Williams, L., & Ross, C. N. (2017). Behavioral management of neotropical primates: Aotus, Callithrix, and Saimiri. In Handbook of primate behavioral management (pp. 409-434). CRC Press.
9. Marmosets were historically considered a frail species due to the high prevalence of gastrointestinal disease and chronic weight loss labeled marmoset wasting disease. Marmoset

wasting syndrome is now thought to have several etiologies and while it is still reported, it seems to be decreasing in prevalence in established colonies. In fact, many colonies now report an increased incidence of obesity. The impact of obesity and the potential development of diabetes in the colonies remains a concern. A complication of obesity in the colonies is that higher weight females are more likely to produce larger litters which typically results in higher infant loss.

- Yamazaki, A., Nakamura, T., Miyabe-Nishiwaki, T., Hirata, A., Inoue, R., Kobayashi, K., ... & Murata, T. (2020). The profile of lipid metabolites in urine of marmoset wasting syndrome. *PLoS one*, 15(6), e0234634.
- Tardif, S. D., & Bales, K. L. (2004). Relations among birth condition, maternal condition, and postnatal growth in captive common marmoset monkeys (*Callithrix jacchus*). *American Journal of Primatology*, 62(2), 83-94]

10. Nutrition is perhaps one of the most controversial topics in marmoset care. There is no standardization in diets fed or styles of feeding in marmoset colonies. Marmosets are natural exudivores, feeding on tree gum, insects, and fruits. Many colonies feed what is referred to as a cafeteria diet that uses a minimal base diet with supplements to ensure macronutrient provision. These diets are often provided as a rotating presentation, for example cheese and grapes on Monday, cottage cheese and raisins on Tuesday, etc. There are a few commercial sources of base diet, but they each vary in calories, protein source, vitamin C, and sugars. Many colonies feed items that are standard in the natural diet (gum and insects) not as nutritional supplement but rather as enrichment.

- Power, M. L., & Koutsos, L. (2019). Marmoset nutrition and dietary husbandry. In *The common marmoset in captivity and biomedical research* (pp. 63-76). Academic Press.
- Ross, C. N., Colman, R., Power, M., & Tardif, S. (2020). Marmoset metabolism, nutrition, and obesity. *ILAR Journal*, 61(2-3), 179-187.



Photo credit: Jess Greig

While captive colonies differ greatly in their management of marmosets, all agree that further study is needed to derive data for informed decisions to develop best practices. Marmosets are unique and amazing primates that require specialized care.