
The Management and Husbandry of Geoffroy's Marmoset

By Val Wakenshaw

9 Park Court, Chillaton, Lifton, Devon PL16 OHN, U.K.

INTRODUCTION

Geoffroy's marmoset (*Callithrix geoffroyi*) originally occurred throughout the Atlantic forest area of southern Bahia, Espirito Santo and adjacent parts of Minas Gerais in south-eastern Brazil. Through habitat destruction and capture for the pet trade, it is now restricted to small forest fragments and has been pushed into the 'endangered' status.

A general husbandry survey was devised and distributed to 15 collections exhibiting the species, of which seven (46%) responded. These were Banham Zoo, Belfast Zoo, Colchester Zoo, Jersey Wildlife Preservation Trust and Shaldon Wildlife Trust, U.K.; Emmen Zoo, the Netherlands; and Zoo de La Palmyre, France.) The survey was designed to be relatively quick and easy to complete, with questions covering the following subjects: group structure, social interaction, breeding, development and care of young, nutrition, feeding, environmental enrichment, housing and behavioural enrichment. Geoffroy's marmosets are relatively uncommon in captivity, and it is hoped that the data collected will continue to encourage and improve the management and welfare of the species.

SOCIAL STRUCTURE

C. geoffroyi are diurnal primates and depend primarily on vision, smell, sound and display for social recognition. Social groups in the wild vary in size from three or four up to 20 individuals. While marmosets typically form groups which contain a number of adults of each sex, breeding is usually restricted to the dominant pair. Infant care and carrying is predominantly by the male, but all group members will participate. This releases the female from the energetic demands of pregnancy, lactation and infant carrying, which she would otherwise be constantly forced to endure. The infants are weaned and independent at about 5-6 months, reaching sexual maturity at about 15-18 months.

In captivity, offspring should remain with their parents for at least this length of time to ensure that they have gained experience in infant care and other normal behaviour. Inexperienced youngsters who have not had the opportunity to care for younger siblings sometimes destroy their first - and possibly successive - litters. However, a family group should not extend to more than about 12 individuals, as above this number stress-related illness may break out or some group members may be evicted. The dominant pair are recognised and respected by all the group. Dominance is enforced by scent-marking, scolding, cuffing or eye command, never biting. This mild form of discipline seems to work well and the offspring never seem cowed. The dominant behaviour of the breeding female, accentuated apparently by pheromones produced in her scent glands, inhibits ovulation in subordinate females, who are thus normally unable to breed as long as they remain in the group. But there is less of a hierarchy among the males. In fact, while only one of the males normally mates with the breeding female, more promiscuous behaviour has sometimes been observed, and marmosets appear to be among the few mammals which may under certain circumstances mate polyandrously (Ferrari, 1989).

There is always a certain amount of upheaval when a dominant animal dies, and incest can occur when the normal group structure breaks down (pers. comm., D. Wormell). At Jersey, after the death of the breeding male, a new male was introduced but was attacked by the original male's sons (see Table 1 [not reproduced]). In the light of this episode, it may be advisable to set up a new alpha pair in a different enclosure from the previous male's sons. No reason was given for the aggression between the breeding female and her daughter at La Palmyre Zoo.

GROOMING

Mutual grooming is an important behaviour in the social lives of *C. geoffroyi*. Not only does it serve a hygienic function in keeping the skin and pelage in good condition, but it may also help to strengthen affiliative bonds within the group. At Shaldon, grooming most often occurred with either the male being groomed by an offspring, or the female being groomed by the male. Mutual grooming sessions appeared to increase when the animals were re-housed to an outside enclosure, although it may have taken place unobserved in the privacy of the nest box when they were housed indoors.

When a 'groomee' solicits grooming, he will lie down flat facing the groomer in an inviting position. As he is being groomed he relaxes completely, with an air of total contentment, only moving to present a different part of his body for inspection. The groomer slowly searches through the fur, separating the hairs with the fingers and claws, watching intently for any foreign bodies, which are picked up with the lips and/or teeth. Groomer-initiated bouts appear to be concentrated on accessible sites, while groomee-initiated bouts generally involve less accessible sites, e.g. head, neck, and back.

VOCALISATION

The following vocalisations were noted in juveniles:

'Phee' - a high-pitched distress call. Response to being forcibly dismounted by an adult carrier. A fundamental vocalisation that develops into the adult contact call.

'Tsik, tsik, tsik' - a sharp, loud distress call. Response to extremely rough treatment by mount. It develops into the adult alarm call.

'Nga' - distress squeal. A contact call which stimulates adults to nursing response.

'Twitter' - a rapid sequence of short, high-pitched notes. A contact call. The number of notes in the twitter varies according to age, infants giving 2-12 notes, adults 2-20 notes. (Epple, 1968).

Adult calls are very similar to the juvenile ones, but more stereotyped and specific in function.

COURTSHIP BEHAVIOUR

C. geoffroyi establish contact by sniffing each other's muzzles and genitalia. This activity, combined with marking objects, licking, grooming and huddling, is a regular part of pre- and post-copulatory courtship. As the female nears oestrus, both partners will increase associated behaviour. There may be some tension and aggression before both reach their sexual peak. Female oestrus cycles vary from 14 to 21 days. The post-partum oestrus takes place at from two to 14 days after giving birth, at which time conception can take place. Post-partum copulation reinforces the pair bond at a time when the dominant male is essential for the care of the young. The gestation period is usually 140-149 days, with an interval between births of approximately 150-160 days.

Of the zoos surveyed, four (57%) observed courtship behaviour.

BIRTH AND THE NEWBORN

Most births take place at night or in the early hours of the morning. Normally twins are born, but singletons and triplets also occur. Triplets can present problems, as the female only has two nipples. In captivity, hand-rearing would be a possibility, but the constant care and carrying required by the infants would make it unlikely that more than one or two young of a litter of three would survive in the wild. Labour may take up to an hour and infants are born at 2-3 minute intervals. The male is present at the birth and may assist by licking the film of mucus from each baby, before handing them back to the mother for suckling. Other members of the group may watch or assist by helping to eat the placenta. Newborn infants instinctively grasp the mother's fur and find a nipple unaided. She will suckle the infants at the same time. After their feed, the male takes each infant and places them on his back. He alone will carry the infants for the first week. After this, all members of the family group try to take turns in carrying.

In captivity, to allow the female time to recover for the first week after the birth, the group should be disturbed as little as possible, with the exception of a quiet, familiar keeper to ensure that she is receiving adequate nutrition and that all is well.

NUTRITION

In the wild, *C. geoffroyi* eat a wide range of foodstuffs, including small birds and mammals (e.g. nestlings), eggs, lizards, frogs and crustaceans, plus fruit, flowers and tree-buds, insects, and essential amounts of resin.

In captivity a varied and balanced diet should be provided. Food may be presented more than once a day, ensuring that all the essential food groups, minerals and vitamins are given in the first feed of the day when the animals are hungry. Later feeds can supply favourite foods and extras. These can be foraged for to prevent boredom or used in feeding enrichment activities.

The first feed of the day could contain a nutritionally balanced pellet. Although these are not popular with all animals, palatability can be improved by soaking in a fruit drink. This may be preferred by infants. Marmoset jelly is another product designed to provide the majority of the daily nutrient requirements, and can be mixed with pieces of fruit to enhance flavour. This would be beneficial for pregnant and nursing mothers and infants, or animals in poor health, although care is needed not to give too much. Rovimix D3 powder may be given with combinations of Milupa baby cereal or baby milk to provide a sweet nectar breakfast.

Marmosets especially need vitamin D3 in their diet. It is essential for metabolism of calcium and phosphorus for bone formation. In nature, animals obtain Vitamin D3 by conversion of pro-vitamins in the skin, through exposure to ultraviolet light from the sun. In captivity, requirements vary with season, sunlight and temperature. Therefore a supplement has to be added to the diet. A concentrated vitamin D3 powder can be obtained from Roche Products Ltd. Other products that can be given to increase the animals' vitamin intake are Cytaccon B12, Abidec and SA37 (see products list, below).

Wild marmosets may spend up to 70% of their time foraging and processing food. In captivity the animals are provided with a nutritionally balanced diet, but a meal may be consumed in a matter of minutes, leaving long stretches of time before the next feed. More naturalistic feeding can be encouraged by feeding-enrichment activities. This is particularly important for animals which are to be released into a wild environment where a knowledge of how to forage is essential. Foraging behaviour can be encouraged by feeding many items whole or by hiding or scattering food around the enclosure, e.g. on

platforms, wire roof or branches. However, care must be taken not to let the food become contaminated by bird droppings. Live food such as locusts, crickets, stick insects and mealworms can be scattered in the substrate. Retrieving this food requires hand-eye coordination and concentration and is very intensive. Hand-made insect dispensers can be inexpensive to make and effective in use, and also create an element of unpredictability. Marmosets' small size, quick movements, sharp claws and long lower incisors are well suited for effective capture of insects. Wild callitrichids spend 16-39% of their time foraging for, and feeding on, insects. (Terborgh, 1983; Garber, 1984).

Jersey Wildlife Preservation Trust suggests, however, that the phosphorus content of insects needs to be balanced with a calcium intake in order to maintain the ideal Ca:P ratio of between 1:1 and 2:1, as an imbalance in this ratio can retard skeletal development, impair locomotion and decrease reproductive output, and is therefore especially problematic during lactation (Price, 1992; Garber, 1984). One way of increasing the marmosets' calcium intake is to provide plant gums, which are high in calcium and form an important part of the diet of wild marmosets. Gum feeding takes up as much as 34% of their time in the wild (Coimbra-Filho and Mittermeier, 1976). In addition, gums are rich in carbohydrates and may therefore be an important source of energy for marmosets, especially during lactation.

C. geoffroyi are very proficient gum feeders. They gouge small wells with their lower incisors, by using the upper incisors as an anchor in the bark, and lap the exudates which ooze from the holes. Naturalistic gum-feeding behaviour can be simulated by providing an artificial gum tree, by smearing branches with gum, or simply by providing a small bowl of gum.

Six (86%) of the zoos surveyed used some form of feeding enrichment. Four used insects in those activities, three mentioned insects as a preferred food, but only two provided gum. (See Tables 3 and 4 [not reproduced].)

MEDICAL PROBLEMS

Belfast - Original breeding female lost weight and condition and eventually died. Nutritional? (Pers. comm., M.G. Challis, Assistant Manager.)

Colchester - Male had a brief period of appearing 'under the weather'. Symptoms included loss of appetite and condition. He was wormed as a precaution with 0.05 ml Ivomec, and also given 0.05 ml Laurabolin steroid. He responded well to this treatment. In addition, the female had a Caesarean birth for her first litter of twins. Neither survived, but she made a full recovery and has bred since. (Pers. comm., Dr.J. Lewis, International Zoo Veterinary Group.)

Emmen - Problems were experienced in the adoption of a new diet, mainly with animals who came from M. Schwarz, Brazil. The condition mostly proved fatal in the end, in combination with pneumonia and neuritis worm infection. (Pers. comm., H. Hiddingh, Director.)

Jersey - In the past they had bone problems, diarrhoea and pseudo- tuberculosis. These seem to have been related to calcium deficiency. Health improved once gum Arabic was provided. (Pers. comm., D. Wormell, Section Head, Marmosets and Bats.)

La Palmyre - Haemolytic anaemia, possibly related to Vitamin E deficiency and resulting in a wasting disease. (Pers. comm., Dr. T. Petit, Veterinarian.)

Of the medical problems recorded, those related to nutrition were the most common, with incidences of bone problems, wasting disease and anaemia. Vitamin D deficiency and also an incorrect calcium/phosphate ratio can result in rickets and osteomalacia. As already stated, Jersey found that health and also breeding success improved once gum Arabic was provided, in conjunction with the correct ratio of phosphates. At Shaldon, also, gum is provided for the animals, and no health problems have occurred.

Other medical problems were pseudo-tuberculosis and pneumonia, which may be caused by bacteria or viruses, and can be passed on to the animals by humans; early veterinary treatment is essential.

Worm infestation may be more easily remedied as long as there are no complications. Medication can usually be given via food to reduce the stress of handling.

ENVIRONMENTAL ENRICHMENT

A wild marmoset has to avoid predation, interact appropriately with conspecifics, forage and find refuge in an ever-changing environment. Environmental enrichment is an attempt to bring some of this diversity into the enclosure of the captive animals, thus preserving not only genes but also behaviour- an important consideration if the animals are ever to be returned to a wild environment. Enrichment can be applied to all aspects of the zoo environment, and can be achieved through manipulation of group size and structure, feeding behaviour, enclosure design and furnishings, and also through interaction of the captive animal with the keeper and the visiting public.

C. geoffroyi are very active animals and may spend many hours chasing, leaping and foraging. Thus, despite their small size, they need and use a relatively large area. Of course a zoo cannot replicate the amount of space a family of marmosets would occupy in the wild, but physically it should provide enough space per animal to allow them to perform any natural behaviour. Psychologically more important is how that space is filled, and the well-being of the animals within.

Sifting through floor litter for insects and other tasty treats is a natural behaviour of wild marmosets, as is play-wrestling on the ground. In captivity space is limited and floor space has great potential for use. Therefore efforts should be made to provide a stimulating, naturalistic ground covering, at least in the outside enclosure. Chamove *et al.* (1982) experimented with the use of deep woodchip litter in the enclosures of different primate species, including marmosets. Results showed that the addition of this type of substrate significantly altered floor use. Time spent foraging for food increased, play behaviour increased and agonistic behaviour decreased. Studies have also shown that deep litter such as bark shavings, chippings and bark mulch absorb more moisture, give off less odour, and have an inhibitory effect on bacteria, and so may be left down for a greater length of time with fewer risks of health problems. However, of course, droppings and excess food should be removed daily.

Of the seven zoos surveyed, one provided deep bark chippings, two provided bark chippings with peat or grass, two provided sand, one provided grass and one provided sand and grass, in the outside enclosures. (See Table 5[not reproduced].)

C. geoffroyi are tropical zone arboreal animals. Their habitat ranges from lowland rainforest bordering the coast and river banks, semi-deciduous forest, dry scrub or caatinga, to areas of forest savanna. They prefer to stay in the dense, impenetrable cover of secondary growths, where there is an abundance of food and protection from larger predators.

Although captive animals are safe from predation, it is important to provide a natural refuge in which they can feel safe, forage and play. All the zoos surveyed provided natural plantings, ranging from young to mature trees, small to large shrubs, evergreens and conifers, to bamboo, pampas grass and climbing plants. The animals' preferred interaction was with bushy shrubs and tall trees. Although tree bark is chewed, there have been no reported problems with plantings, and all have been successful.

It is important to equip the enclosure with an adequate framework of perching, as marmosets prefer to move on horizontal branches. However, they are also vertical clingers and leapers, and a redundant wall may be utilised by attaching netting of very small mesh size; this could be detachable for ease of wall cleaning. The same principle can be applied to smooth ceilings - wire mesh roofs may provide a large area of space on which to climb and hang, and it is far easier to put things in the space by attaching them to the roof. At Belfast Zoo the roof of the outdoor enclosure is "made of three-quarter inch (19 mm) nylon netting supported on nylon ropes. This is the first time this type of construction has been tried for marmosets, and provides a much lighter and less visually disruptive roofing system (pers. comm., M.G. Challis). Branchwork should be changed when possible, or scent-marked perches moved between different species, providing added stimulus. However, when moving marmosets to a new enclosure it may be beneficial to take one or two of their familiar scent-marked perches with them to help settle the animals (Moore, 1989).

At Shaldon I found that fresh foliage was much appreciated by the marmosets, especially the youngsters, who enjoyed chasing and leaping long distances amongst the greenery which moved and swayed on landing, and the thin twigs were ideal for infants to explore and chew. Foliage provides diversity for the animals, and it is especially important if there are no natural plantings in the enclosure. It may also encourage the visitor to look for these small primates.

All the zoos surveyed had aviary-type outdoor enclosures, with access to heated indoor areas kept at temperatures ranging from 18°C to 21°C, with warmer spots of up to 25°C (Table 4 [not reproduced]). No problems were mentioned regarding climatic conditions. As a precautionary measure animals at both Colchester and Emmen are restricted to indoor areas when the weather is extremely cold. A relative humidity of 50-60% is optimal. Low humidity is bad for infants. Moist peat as a substrate helps to maintain a high humidity. (Captive Care Working Party, 1987.)

In the wild environment different species of animal may share the same territory, and although each is adapted to its own particular niche within that area, mutual benefits may be gained. In captivity, providing conditions are suitable and the appropriate species are selected, it should be possible to establish a mixed exhibit. This has been very successful for some species of marmosets and tamarins, although *C. geoffroyi* appear to be less tolerant of other animals than some callitrichid species. 'We [Jersey Zoo] have found Geoffroy's to be unnaturally intolerant of other species. We often house single animals of different species together for company, but Geoffroy's have not agreed to this.' (Pers. comm., D. Wormell.) 'It should be noted that our group [Colchester Zoo] of Geoffroy's attacked and fatally wounded one lesser Malayan chevrotain (*Tragulus javanicus*). They had been living with the animal for approximately three weeks with no problems, and appear to have turned on her for no apparent reason. But they have shared their exhibit with the spur-thighed tortoise, *Testudo graeca*, for about eighteen months with no sign of aggression.' (Pers. comm., J. Lewis.) Colchester is the only zoo in the survey where *C. geoffroyi* share an exhibit with another species of animal.

All the animals in the survey were exposed to moderate to high visitor numbers. Two of the enclosures were only viewed from one side, and three provided off-show indoor areas. All animals appeared to view the visiting public with indifference or curiosity. However, *C. geoffroyi* are sensitive animals and are prone to stress. Older individuals, particularly, appear to habituate themselves less to the presence of visitors, and get very agitated when approached. Therefore enclosures must be designed big enough to allow the animals to achieve a reasonable distance between themselves and the visitors if they so wish. Cover must be available and the opportunity to go off-show must be provided. If possible, high perches should be provided to give animals vantage points from which to look down onto the visitors, restoring some level of control. Barriers between visitors and the edge of the enclosures should be reasonably wide to provide extra reassurance for the animals. (L. Dickie, 1994.)

APPENDIX

In 1991 a reintroduction programme began for the restoration of *C. geoffroyi* populations in some forest fragments in the state of Espirito Santo, south-eastern Brazil. Although none of the released groups successfully established themselves in the area, concurrent studies of behaviour and ecology of the wild marmoset groups, which began in 1993, are providing much important data that will benefit introduced groups from future releases, giving a better basis for the management of the species. (Passamani, M., and Passamani, J.A., 1995).

ACKNOWLEDGEMENTS

I would like to thank the Geoffroy's marmosets at Shaldon Wildlife Trust for enriching my life. With special thanks to Stewart Muir of Shaldon, and to my best friend Guy for the use of his computer and copying facilities. My thanks, too, to all those who participated in the survey.

PRODUCTS MENTIONED IN THE TEXT

Abidec multivitamins, Warner Lambert Health Care, Lambert Court, Chestnut Avenue, Eastleigh, Hampshire, U.K.
Cytacon B12, Duncan Flockhart & Co. Ltd., 700 Oldfield Lane North, Greenford, Middlesex, U.K. Gum Arabic and Acacia Gum (available from pharmacists and specialist suppliers).

Marmoset Jelly and Mazuri Marmoset Diet, Special Diets Services Ltd, P.O. Box 705, Witham, Essex CM8 3AD, U.K.

Milupa Infant Food, Milupa Ltd., Milupa House, Uxbridge Road, Hillingdon, Uxbridge, Middlesex, U.K.

Rovimix D3 Powder, Roche Products Ltd., P.O. Box 8, Welwyn Garden City, Herts. AL7 3AY, U.K. SA37 Multi-vitamin Powder, Intervet UK Ltd., Milton Road, Science Park, Cambridge CB4 4FP, U.K.

REFERENCES

Captive Care Working Party of the Primate Society of Great Britain (1987): *The Welfare of Pet Marmosets*. UFAW, 8 Hamilton Close, South Mimms, Potters Bar, Herts. EN6 3QD, U.K.

Chamove, A.S., Anderson, J.R., Morgan-Jones, S.C., and Jones, S.P. (1982): Deep wood chip litter: hygiene, feeding and behavioural enhancement in eight primate species. *International Journal for the Study of Animal Problems* 3 (4): 308-318.

Coimbra-Filho, A.F., and Mittermeier, R.A. (1976): Exudate-eating and tree-gouging in marmosets. *Nature* 262: 630.

Dickie, L.A. (1994): *Environmental Enrichment in Captive Primates: a Survey and Review*. Darwin College, Department of Biological Anthropology, and the University of Cambridge.

Epplé, G. (1968): Comparative studies on vocalisations in marmosets (Haplorhina). *Folia Primatologica* 8 (1): 1-40.

Ferrari, S.F. (1989): Lilliput in the trees. *BBC Wildlife Magazine* 7 (2): 104. 14

Garber, P.A. (1984): Proposed nutritional importance of plant exudates in the diet of the Panamanian tamarin, *Saguinus oedipus geoffroyi*. *International Journal of Primatology* 5: 1-15.

Moore, M. (1989): Marmosets in Captivity. Basset Publications, Plymouth, U.K. Passamani, M., and Passamani, J.A. (1995): A reintroduction program for Geoffroy's marmoset. *American Journal of Primatology* 15: 367- 371.

Price, E.C. (1992): Nutrition of Geoffroy's marmoset. *Dodo* 28: 58-69.

Terborgh, J. (1983): *Five New World Primates*. Princeton University Press, New Jersey, U.S.A.

Reproduced with permission of *International Zoo News*.