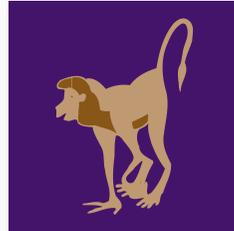


A six-booklet series on providing appropriate enrichment for baboons, capuchins, chimpanzees, macaques, marmosets and tamarins, and squirrel monkeys.



enrichment

for nonhuman primates



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For more information, contact OLAW at NIH, tel (301) 496-7163, e-mail olaw@od.nih.gov.

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Introduction



Nonhuman primates maintained in captivity have a valuable role in education and research. They are also occasionally used in entertainment. The scope of these activities can range from large, accredited zoos to small “roadside” exhibits; from national primate research centers to small academic institutions with only a few monkeys; and from movie sets to street performers. Attached to these uses of primates comes an ethical responsibility to provide the animals with an environment that promotes their physical and behavioral health and well-being. Thus, an obligation is entailed that those individuals/institutions caring for captive primates should make every effort to ensure adequate veterinary care and husbandry are provided, that the animals are housed in appropriate facilities, and that as broad a range of species-typical behaviors are able to be expressed by the animals as is possible for the captive environment.

This book serves as an introduction to the basic behavior and environmental enrichment of several species of nonhuman primates that are more commonly used in education, research and entertainment. In many ways, this book is meant to be a “how to” manual; it is not intended to be a broad scientific review of the primate behavior and enrichment literature. The fundamental premise taken throughout each chapter is that for an enrichment program to be effective, there must be a basic understanding of the biology and behavior of the primate species. The species addressed in this series are: baboons, capuchins, chimpanzees, macaques, marmosets and tamarins, and squirrel monkeys. Each species-section can be read as a stand-alone document without need to reference the other sections. This then allows the user to distribute the different sections to personnel caring for the specific animals.

Each section is divided into five parts: 1) Background, comprised of the habitat of the primate, the physical features of the primate, its psychological and/or



social behavior, and its mating and reproductive behavior; 2) Social World; 3) Physical World; 4) Special Cases, describing any age-related considerations and concerns associated with individual housing; and 5) Problem Behaviors. The content of this series has been provided by members of the Association of Primate Veterinarians (APV) and the American Society of Primatologists (ASP) who have special expertise in the species addressed. This book is intended to be a primer because it is, indeed, an introduction to the subject of environmental enrichment for primates housed in a diversity of conditions. A list of references and/or other resources (principally on-line) is provided at the end of each chapter that provide additional guidance. The use of scientific references has been limited, but should the reader desire more information about a specific subject, the links at the end of the sections will provide direction to obtaining additional detailed information. Readers are also directed to the National Research Council publication, the Guide for the Care and Use of Laboratory Animals (1996) and the U.S. Department of Agriculture's (USDA) Animal Welfare Regulations to review the regulatory requirements of the Public Health Service and the USDA for the provision of environmental enrichment.

The APV and ASP wish to thank the Office of Laboratory Animal Welfare, in particular Ms. Carol Wigglesworth and Dr. Axel Wolff; the U.S. Department of Agriculture/Animal Care, in particular Dr. Chester Gipson; and Ms. Dale Feuer, editor, and Ms. Lori Wieder, graphics and layout production, for their assistance with this project. The authors acknowledge the helpful contributions of Dr. David J. Shepherdson, Conservation Program Scientist, Metro Washington Park Zoo; Ms. April D. Truitt, Director, Primate Rescue Center, Inc.; and Ms. Kathleen Conlee, Program Officer, Humane Society of the United States. Special thanks also go to the chapter authors Dr. Christian Abee, Dr. Kate Baker, Dr. Linda Brent, Dr. Thomas Butler, Dr. Jeffrey Fite, Dr. Dorothy Fragazy, Dr. Jeffrey French and Dr. A. Michele Schuler, and to the reviewers from the American Society of Primatologists and the Association of Primate Veterinarians.

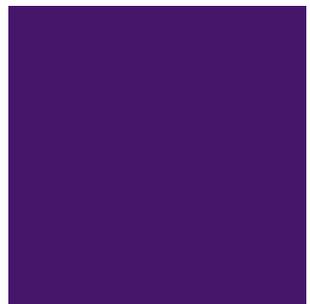
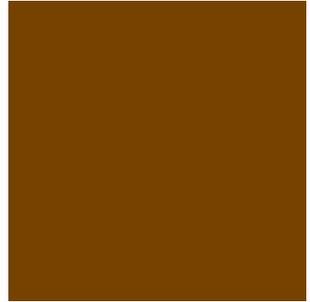
—Kathryn Bayne, M.S., Ph.D., D.V.M., DACLAM, CAAB
Editor, Working Group

This project is dedicated to the memory of Dr. Sylvia Taylor, Veterinary Medical Officer, Animal Care, U.S. Department of Agriculture, who was a proponent of providing enrichment to nonhuman primates and was generous in sharing her knowledge and expertise in this regard.

Baboons

Linda Brent, Ph.D.
Chimp Haven, Inc.
Southwest Foundation for Biomedical Research

Thomas M. Butler, D.V.M., M.S., DACLAM
Southwest Foundation for Biomedical Research



enrichment
for nonhuman primates

Baboons

Background

Habitat

Baboons live in many parts of Africa, primarily in dry savannah woodlands. They are the largest and most terrestrial, or ground dwelling, of the cheek pouch monkeys (Cercopithecines). There are five types of baboons--olive, yellow, red, chacma and hamadryas--which may interbreed to form hybrids in captivity and, in some places, in the wild. Olive and Yellow baboons are found in many areas of equatorial Africa and are typically called savannah baboons. Hamadryas baboons inhabit the highlands of Ethiopia. Red or guinea baboons live in gallery forest and woodland savannas of West Africa. Chacma baboons reside in southern African woodland to semi-desert habitats. Home ranges of baboons may cover approximately 10,000 acres.

Physical Features

Baboons walk on all four limbs, and their forelimbs and hindlimbs are approximately the same size. Males (44 to 53 lbs.) are much larger than females (26 to 35 lbs.) and have long canine teeth. The tail is moderately long and is typically held in a characteristic U-shape. Baboons have prominent ischial callosities, which are bright red in some species. They have a prominent muzzle. The life span of a baboon ranges from 20 to 30 years.

Behavior

Baboons have a number of distinct vocalizations, including:

- Alarm bark – loud, rapid, sound to indicate potential threat or challenge
- Lipsmack – short, repeated clicking of the lips or tongue, associated with friendly behavior and approaches to a dominant individual or infant

- Grunt – low, snort-like sound, often associated with group unity or communication
- Oer – moo-like sound made by infants in distress
- Gek – quick “aaack” indicating disturbance
- Scream – shrill, loud, high-pitched sound made when aggressive or fearful

Other gestures that indicate a threat or aggression include brow raises that display white eyelids, yawns directed at a specific individual, hitting the ground or object rapidly (slapping), teeth grinding, and staring intently at another individual.

Baboons travel and feed during the day and sleep in trees or cliffs at night for protection from predators. Being very good scavengers, baboons can survive in areas that other primates cannot. They spend about half of their waking hours looking for, processing, and eating food. They may dig up roots and eat insects, lizards, small mammals, and even crabs or fish if near water. In captivity, they spend more time in social interaction and much less time feeding. Captive baboons can be fed a complete, commercially available diet, supplemented with a variety of other fruits and vegetables.

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Mating and Reproduction

The female’s skin on her rump, or perineal area, swells greatly according to her menstrual cycle. This is usually referred to as sex skin. Hamadryas females have a particularly large sex skin swelling. During the period of maximal swelling, she will ovulate and be most receptive to mating. The sex



Prominent sex skin on a baboon (photo by E. Glover, Southwest Foundation for Biomedical Research (SFBR)).

skin becomes flat and takes on a bright red or purple hue when she becomes pregnant. Gestation lasts from 18 to 24 weeks. Infants are born black with pink faces and bottoms. They need the mother's protection, milk and transportation to survive. At about four to six months, the infant begins to change to the color of the adults. They are generally weaned by colony managers around five to six months of age, and although the natural weaning process will vary among baboon species, it generally occurs between one to two years of age. They become sexually mature at about three to five years.

Social World

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Baboons live in a strict society. They clearly know their rank in the group and the rank of others, and behave toward others as appropriate for their dominance status. Baboons are very protective of infants and tolerant of juveniles, and males may carry and groom infants on occasion. Friendships have been reported between particular males and females.



A social group of baboons (photo by E. Glover, SFBR).

Baboons are incredibly social animals and should not be kept isolated. Infants should be kept with their mothers for at least a year to develop normal social skills. Compared to most other primates, baboons are fairly easy to put together into groups. Preferably, subspecies should be kept together, or at least in groups with similar structure as found in the wild, which can differ among and within species, probably based on the nature of the habitat in which the animals are found. Groups that combine a single male with multiple females are most common in captivity, but all-male groups also can be formed. Groups with multiple females and males are more difficult unless there is enough space for them to avoid aggression, especially fights over mates.

Physical World

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Housing

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4 In general, baboons are quite hardy and adaptable. They can be successfully housed in a variety of captive conditions, from indoor cages to large outdoor semi-free ranging enclosures. Sturdy cages are required because baboons are



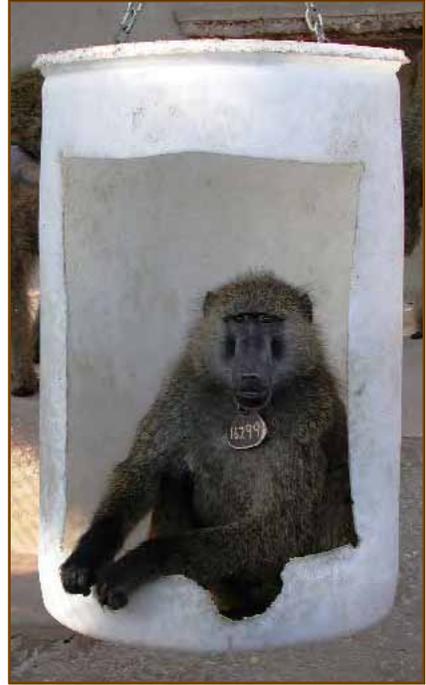
Baboon sleeping off the ground on a high shelf (photo by E. Glover, SFBR).

strong and will manipulate the cage a great deal. Cages should be constructed to prevent the baboons from pulling off pieces of the cage and eating them. Baboons favor high perches. While some facilities have successfully used old tires and ropes for resting areas and swings, others have reported that the baboons eat

the items and become sick. Alternative swings and resting areas can be constructed from metal or polyvinyl chloride. Large areas and/or visual barriers are necessary so that low-ranking individuals can avoid others. If aggression within the group is a problem, elevated resting areas or hiding areas should be added to help mitigate the aggression.

Enrichment

Feeding is a popular enrichment activity for baboons, who are very motivated by food. Due to their strict dominance hierarchy, only the most dominant male and female may eat food items provided to a group. To avoid this type of monopolization, it is best to scatter smaller food items all around the enclosure. In addition to feeding commercially available, nutritionally balanced diets, baboons can be offered food enrichments such as grains, fruits, vegetables, vegetation, bark, coconuts, peanut butter, dry fruit, honey, candy, cereal. The feeding of treats should not compromise the baboon's appetite for the nutritionally balanced food, so the quantity of treats provided should be monitored closely. Baboons will also ingest items that are not healthy for them, such as rocks, wire, metal or other harmful materials. Bloat has been reported if baboons eat too many orange peels or gas-producing vegetables (e.g., broccoli), and they may become impacted if they eat too much hair, hay or wood.



Baboon using a recycled and modified soap barrel for perching (photo by E. Glover, SFBR).

Objects containing food must be heavy or they will be destroyed quickly. Puzzles made of sturdy materials, such as polyvinyl chloride (PVC), can be filled with treats. Toys on short chains can be coated with honey and dipped in grain, then frozen and hung on the cage, for a treat. Once the baboons eat the food, they can then play with the toy that remains. Frozen blocks of juice or water with fruit inside can be given to the baboons in the cage or enclosure, or hung from the roof with a chain. Locking nuts are necessary so the baboons do not unscrew the devices. Also, sturdy clips should be used to attach the device, and puzzles

should be removed when empty to keep the baboons from breaking them.

Since baboons manipulate and chew many objects, very sturdy dog toys make good baboon toys (e.g., rigid plastic balls; large, thick rubber toys; hard nylon dog chews). Hard, nontoxic logs or wood pieces can

be used for chewing and even as perches. Pieces at least two to three inches in diameter are best so that they are not immediately destroyed. Wood items must

be replaced on occasion and should be monitored so that large pieces or slivers do not endanger the baboons.

Other types of enrichment include video-tapes, mirrors, and wind chimes, which are especially helpful enrichment for singly caged baboons. Several commercially available enrichment items, including fleece boards made for grooming and plastic balls with holes in them and filled with treats, are not as useful for baboons and



Baboon with durable toy (photo by E. Glover, SFBR).



Baboon on a shelf in enclosure (photo by E. Glover, SFBR).



probably not worth the expense.

New items may receive a lot of attention, but baboons will quickly tire of them. Replacement of toys or devices at regular intervals is important to keep the animal's interest high.

*Baboon with Kong® toy
(photo by E. Glover, SFBR).*

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Special Cases

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Older animals usually will become more isolated from the troop, but not always. Since they can't climb as well as their younger counterparts, they should have plenty to do at ground level. Food and water must be accessible near the floor, and food will have to be softened by soaking in water if the older baboon has lost some teeth.

Infants are curious creatures and will explore any opening. It is essential to make sure that all possible openings are covered to prevent entrapment or escape.

Problem Behaviors

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Like other monkeys, baboons can develop problem behaviors for a number of reasons. Being taken away from the mother and raised by humans is a major cause of later abnormal behavior patterns, as the infant must learn to cope with the loss of the mother and grow up in an artificial environment. Boredom, stress and, ultimately, problem behavior may result from confinement in small enclosures, lack of enrichment activities, solitary housing, or housing that does not afford the animal ways to avoid more dominant individuals or frightening situations.

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Examples of abnormal behavior patterns to watch for are hair eating and regurgitation. Extra feeding with food or “toys” can help to alleviate these behaviors that are related to boredom and not enough time spent feeding. Orphaned baboons often develop self-directed behaviors, such as self-sucking and clinging. They need appropriate attachment figures if they cannot be kept with the mother. One possibility is a mobile surrogate made of fleece-wrapped, three-inch PVC hung from the top of the cage. Exposure to peers or other friendly adults is critical to the orphan for normal development. It is very difficult to eliminate problem behaviors developed during infancy, but some individuals may be helped by gradually introducing them to friendly, perhaps younger, social partners.

More severe problems, such as self-biting, also have been reported in captive baboons. Intensive efforts are required to reduce or eliminate this problem. A daily program of enrichment, with documentation of items that seem to reduce the frequency of self-biting is required and may need to be continued for the life of the baboon. For individuals that increase self-aggressive behaviors when new enrichment items are provided, enrichment provided outside of the cage (such as in association with positive reinforcement training) can be more effective until the behavior is under control. Abnormal behaviors in baboons housed alone are greatly decreased when the animals are placed into social groups.

Some baboons are also very aggressive to one another, causing problems when they are put into new groups. This “hyper aggression” is more common in males and difficult to control, and it may be necessary to try multiple different partners, including females or even juveniles. It is important to observe the individual to determine what sets off the aggression, since it may be related to commotion

in the environment, feeding time, etc. This can help to indicate options that may reduce the behavior (e.g., moving to another cage, separating during feeding).

It is far more humane for the baboon and less work for the person to keep abnormal behavior patterns from developing. This can usually be accomplished by doing two things. First, keep infants with their mothers for about one year. Second, house baboons in social groups in large enclosures with enrichment to occupy their time.

Safety Issues

While they may have a reputation for being aggressive due to their size and large canines, baboons actually are mild-mannered and easy to work with compared to other primate species. They have elaborate threat displays that help to keep the peace in large groups, but actual aggression resulting in injury is not common. Given the size of baboons, it is not easy to “force” them into doing something, such as moving into a new cage. Greater success and a better relationship will develop if the baboons are treated with respect and positive interactions – and they will respond with cooperation and friendly behavior.

Baboons can be trained with positive reinforcement to cooperate during a variety of management procedures, including transferring them to new areas, getting them to show parts of their body for inspection, and performing certain medical tests (i.e., blood pressure measurement). Given their keen interest in food rewards, ability to learn quickly, and generally relaxed attitude around humans, they make good pupils. People can maintain positive interactions with baboons by providing treats to the baboons and taking care not to frighten them by staring at them or moving suddenly.

Baboons should be sedated during physical examinations and other procedures that require physical handling, especially if they weigh more than about 11 to 15 lbs. The best way to move them is via a system of chutes and doors.

References

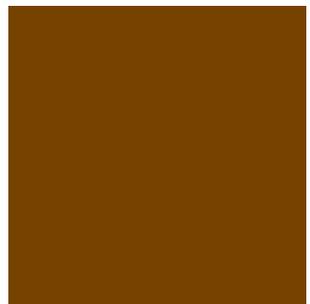
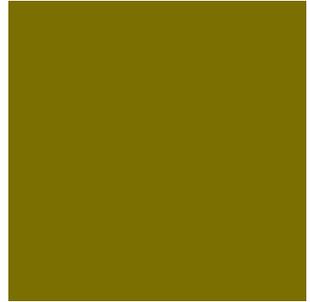
- Altmann J. 2001. *Baboon Mothers and Infants*. Chicago: University of Chicago Press.
- Brent L, Koban T, Ramirez S. 2002. Abnormal, abusive and stress-related behaviors in baboon mothers. *Biol Psychiatry* 52(11):1047-56.
- Brent L, Belik M. 1997. The response of group-housed baboons to three enrichment toys. *Lab Anim*. 31(1):81-5.
- Brent L, Weaver D. 1996. The physiological and behavioral effects of radio on singly housed baboons. *J Med Primatol*. 25(5):370-4.
- Easley SP, Coelho Jr. AM. 1991. Is lipsmacking an indicator of social status in baboons? *Folia Primatol* (Basel) 56(4):190-201.
- Fortman JD, Hewett TA, Bennett BT. 2002. *The Laboratory Nonhuman Primate*. Boca Raton, FL: CRC Press.
- Kessel A, Brent L. 2001. The rehabilitation of captive baboons. *J Med Primatol*. 30(2):71-80.
-
10 National Research Council. 1998. *The Psychological Well-Being of Nonhuman Primates*. Washington, D.C., National Academy Press.
- Primate Lit: A Bibliographic Database for Primatology*.
<http://primatelit.library.wisc.edu>
- Rowe N. 1996. *The Pictorial Guide to the Living Primates*. East Hampton, NY: Patagonias Press.
- Smuts B. 2001. Friendship between the sexes: forming enduring relationships in an olive baboon troop. In *The New Encyclopedia of Mammals*, edited by D. MacDonald, 360-361. Oxford, England: Oxford University Press.

Common Names of the Baboons

- Papio anubis* or *P. hamadryas anubis*: Olive baboon, Anubis baboon
P. cynocephalus or *P. hamadryas cynocephalus*: Yellow baboon, Savanna baboon
P. hamadryas or *P. hamadryas hamadryas*: Hamadryas baboon, Sacred baboon
P. papio or *P. hamadryas papio*: Western baboon, Guinea baboon
P. ursinus or *P. hamadryas ursinus*: Chacma baboon

Capuchin Monkeys

Dorothy Fragaszy
Neuroscience and Behavior Program
University of Georgia



enrichment
for nonhuman primates

Capuchin Monkeys

Background

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Habitat

Flexibility, opportunism, and adaptability are the hallmarks of capuchin success. These monkeys occupy virtually every type of Neotropical forest, including humid and dry tropical forests, swamp forests, seasonally flooded forests, mangrove forests, and gallery forests, as well as dry, deciduous forests where rainfall is absent for five to six months of the year. They range from sea level forest to cloud forest up to 2700 meters above sea level. Capuchins are mostly seen in the middle layers of the forest, but will use all levels from the canopy to the understory, going to the ground to drink, forage or travel.

Physical Features

Capuchin monkeys weigh from six to 12 pounds and can live for more than 50 years. They are physically different from other New World Monkeys (platyrrhines) in that they have robust jaw and dental structures, large brains in relation to their body size, and moderately prehensile tails. Additionally, their hands have strong grips, a degree of opposition of the thumb to index finger, and somewhat independent finger movements. Taken together, these features afford capuchins a wide range of locomotor and foraging actions.

Behavior

Capuchins are active monkeys, agile at climbing and leaping. They use their hands and mouths to explore objects and surfaces, often destroying them in the process. More than other monkeys, capuchins act on their world through coordinated actions of hands, mouth, feet, and tail. They touch, handle, rub, bite, pull, push and pound objects as they explore them and manage to undo latches, untie ropes, unsnap hooks, and unscrew bolts.

Endowed with unusual tendencies to combine objects and string together sequences of actions with objects, capuchins can, for example, successfully order a set of nesting cups. They can use their bodies in innovative ways, such as holding multiple cups with their hands and feet while working with them.

Capuchin monkeys' memory and visual perception are similar to those of other non-human primates. They travel efficiently through familiar spaces from one location to another and they can use landmarks to locate objects they cannot see. They have good memories for significant events, and they perceive objects, object movements, and surfaces in much the same way as humans do.



Cebus mother and infant (photo by D. Fragaszy).

Capuchins are like other monkeys in that they can recognize an abstract relation among objects (e.g., sorting objects by size). Capuchins also can recognize two relations at the same time and use them in a nested or hierarchical fashion, such as sorting pictures by shape and sorting pictures of a given shape by size.

It is important to note that captive monkeys cannot solve everyday problems that wild monkeys can without extensive practice. Individual experience and immediate context powerfully affect capuchins' problem-solving skills and exploratory activities.

Capuchin monkeys express interest in other animals (including human companions) by looking at them, making facial expressions and vocalizing in specific ways to express different emotions, and touching them. Young monkeys cling

to their companions. Adults occasionally groom their companions when they feel comfortable and relaxed, using hands and tongues to touch the skin or hair. They are also quite playful, especially young monkeys. Capuchins of any age tend to be docile, but can become aggressive, even toward human companions, if frustrated or frightened.

Mating and Reproduction

Capuchins reach sexual maturity at four to five years of age. Females have a menstrual cycle of 19 – 22 days. Gestation lasts from 22 to 23 weeks, followed by 22 weeks without menstruation during nursing if the mother rears the baby, or about seven to eight weeks without menstruation if she loses the baby. Infertility while nursing lasts months longer, even after menstrual cycling resumes.

Female tufted capuchins (*Cebus apella*) display their interest in mating using a rich and varied behavioral repertoire consisting of facial expressions, vocalizations, gestures, and body postures. In general, the female actively follows a target male, which, in most cases, is the dominant male in her group. She directs most if not all of her solicitations toward this target male. Initially (for hours and/or days), the sought-after male does not reciprocate and tends to avoid the female by leaving as soon as she approaches him. Later, the target male starts to respond to the female's solicitations with behaviors similar to hers. At this point, mutual sexual interest becomes evident and mating occurs. Females of other species of capuchins express their interest in mating less overtly. In these species, solicitations of the female by the male may be more obvious than the female's solicitations of the male.

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Social World

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Capuchin monkeys in the wild live in groups throughout their lives. Males, females, and immature animals travel, feed, and sleep near one another every day. If a monkey loses sight of its group, it calls loudly and searches actively to find the group again. In captivity, capuchin monkeys live compatibly in pairs or groups, but they do not live happily alone. Spending any amount of time by themselves, without familiar companions, is a hardship for capuchin monkeys. Capuchins can live compatibly with other species, for example, squirrel monkeys.

It is easiest to place capuchins in groups when they are young (three years old or less). Groups may range from pairs to two dozen or more animals, of mixed ages and sexes. Adults can live together in pairs compatibly, and pairs can be formed when animals are adults. Both male and female same-sex pairs are compatible, as are opposite-sex pairs. However, in the case of male-female pairs, one should make sure that the male does not monopolize food or other resources by virtue of his greater size and strength.

Introducing adults to each other as pairs or one adult into an existing group should be done with careful supervision, because the monkeys may injure one another through fighting. Introducing an adult male to a group with a resident adult male is not advised. Allowing monkeys to get to know one another in a space where one can escape or hide from the other until they are comfortable together makes the introduction process safer. For example, one can place the newly introduced individual in visual contact with the group but in a separate cage for several days. The new individual can be placed closer to the group in a gradual manner. If all individuals behave calmly at this point, the newcomer's cage can be placed next to the group's cage, permitting some physical contact through wire mesh, for example. When the newcomer is not threatened by group members, open a doorway between the two. Permit the newcomer to enter the group voluntarily, and leave the release cage in place for a period of days so that the newcomer can return to it (i.e., escape from the group) if need be. There is no certain way to prevent fighting between members of a group and a newcomer, so all introductions must be carefully monitored.

Physical World

Capuchin monkeys in the wild spend most of their time in trees. They spend about half of their waking hours foraging, eating a wide variety of plant and animal foods. In captivity, providing opportunities to travel and rest above the ground promotes healthful exercise and hygiene. Providing perches at two or more heights allows capuchins to move around in a way that is natural for them. In general, the vertical dimension appears more important to these monkeys' use of space than the horizontal dimension.

Capuchin monkeys benefit from additional opportunities for manual activities similar to those used in foraging, including manipulative puzzles and objects to

handle and tear apart. Supplying a variety of objects, such as soft plastic items or cardboard, on a regular basis promotes healthful manual activity. Provision of these items must be monitored to ensure that gastrointestinal obstruction does not result. Providing a variety of foods, including different kinds of fruits and dairy products in addition to a commercial pelleted chow, is another element of good physical care. Fruits, seeds, nuts and eggs can be provided whole or minimally

processed; cracking, peeling, separating, and otherwise processing food is healthful activity for capuchins, so long as they have the teeth and fingers to achieve this. Foods, such as peanut butter and honey, can be hidden in sections of a PVC pipe or a box with holes, and the monkeys will use straw or sticks to retrieve it. Monkeys new to these tasks may take some time to figure out how to solve these problems. Caregivers can provide “hints,” such as placing the stick into the tube, to help them learn. It should be noted, however, that food treats should not be fed in such quantities to discourage the animals from eating their nutritionally balanced diet.

As suggested by the wide variety of habitats in which they live, capuchin monkeys are fairly hardy with respect to temperature and humidity, although they cannot cope with freezing temperatures. Monkeys that are accustomed to a narrow range of temperatures and humidity should be introduced gradually to new conditions to give them time to acclimate. It should not be assumed that animals will spontaneously seek out heated indoor spaces when the outdoor tem-



*White-fronted capuchin (Cebus albifrons) resting on a log
(photo by D. Fragaszy).*



Capuchin retrieving food items from a pool (photo by D. Fragaszy).

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perature falls, especially if they have just arrived in new housing. Particularly if the ambient temperature falls below 68 degrees Fahrenheit, perches and shelves should be constructed of materials that do not conduct heat quickly. Polyvinyl chloride (PVC) and wood, for example, do not conduct heat as quickly as metal.

If outdoor temperatures drop below 45 degrees Fahrenheit, capuchins need access to a heated indoor enclosure. Optimum temperature ranges vary among the different species, but range from approximately 65-85 degrees Fahrenheit. Infants and young juveniles need a heated space at even warmer temperatures. Cold monkeys sit in a huddled position with the tail wrapped around the body and move less frequently than normal. If there is snow on the ground, monkeys may walk in it voluntarily; this can quickly lead to frostbitten fingers and tails, which require amputation.

Capuchins should have enough space to move in a normal manner by walking, climbing, and jumping, and places to sit that permit the tail to hang below the perch without touching the floor. They prefer to spend most of their time well above the floor and flee upward if frightened. However, they will spend much time manipulating a loose floor covering, such as straw or wood shavings. Such bedding materials provide an attractive focus for activity for captive monkeys and enrich the environment in a positive way.

Capuchins housed in social groups, particularly if the groups are large (i.e., 10 or more monkeys), should have enclosures with at least two separate compartments, separated by a wall and with one or more connecting doorways or tunnels. This arrangement reduces injuries by permitting animals to avoid one another, and it makes separating animals simpler for the keeper and less stressful for the monkeys. Capuchins in exhibits such as zoos should have an area available to them that is away from the visitors' view, to allow for occasional privacy.

Special Cases

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There are no particular considerations for older monkeys so long as they are in good health. Infants, on the other hand, require more frequent feeding, a more easily chewed and digested diet, and an object to which they can cling, such as a paint roller attached to a base so that it is stable and can be removed for wash-



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Capuchin sitting in a barrel placed off the ground (photo by D. Fragaszy).

ing. Even more than adults, infants need constant social companionship.

Housing animals individually should be avoided. Extra provisions for manipulative activity should be provided for monkeys that are temporarily housed individually for medical or research reasons, but solitary activities do not substitute for social companionship.



Social group in semi-naturalistic environment (photo by K. Bayne).

Problem Behaviors

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Noticeable changes in posture, movement, and activity level are indicators that a monkey may be ill. Capuchin monkeys can develop stereotypical movement patterns, such as pacing, and they may perform these more persistently when stressed. When captive monkeys persistently make vocalizations known as “chucks” that are used in the wild when predators appear, this means that they are frightened. Monkeys normally give chucks when strangers or people associated with capture, such as veterinarians, appear. Altering care routines or housing arrangements may reduce fear; social companions and alternative activities can help capuchin monkeys return to a calmer condition.

Capuchin monkeys engage in a highly distinctive, self-care behavior, known as anointing, in which they rub pungent and sometimes topically irritating plant or animal materials on their fur. Captive monkeys may do this with oranges, for example. They also rub their bodies with urine, a behavior called urine washing. Although these behaviors may appear aberrant, they are, in fact, normal.

Safety Issues

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Capuchins do not readily accept physical restraint, such as being held in a gloved hand. They will bite if frightened, as during restraint or imminent capture, and they have a strong bite. It is best to use a sturdy box with a latching sliding door to transport animals or to train them to participate voluntarily (e.g., using a leash and collar). Capuchins can be readily trained using positive reinforcement to perform behaviors required for many routine care procedures, such as moving from one place to another. Chemical or physical restraint should be a last resort only.

As with all monkeys, handlers should be careful about latching cages securely. Capuchins are particularly interested in opening latches; mere springs or harness snaps, for example, will not hold them for long. A padlock is more secure.

Capuchin monkeys are hardy when kept in healthful conditions. They are, however, highly susceptible to the common human cold and other respiratory illnesses. People suffering from these illnesses should not go near the monkeys. Like other monkeys, capuchins also are highly susceptible to measles, chicken pox, and other viral diseases common in humans. Capuchins (primarily *Cebus apella*) may be particularly susceptible to Type II diabetes if fed improperly and not allowed sufficient physical activity.

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Resources

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Bayne K, Dexter S, Suomi S. 1991. Ameliorating behavioral pathology in *Cebus apella* monkeys with social housing. *Laboratory Primate Newsletter*. 30(2):9-12.

Cooper MA, Thompson RK, Bernstein IS, et al. 1997. The integration of stranger males into a group of tufted capuchin monkeys (*Cebus apella*). *American Journal of Primatology* 42:10 (Abstract).

Fragaszy D, Visalberghi E, Fedigan L. 2004. *The Complete Capuchin: The Biology of the Genus Cebus*. New York: Cambridge University Press.

Hayes SL. 1990. Increasing foraging opportunities for a group of captive capuchin monkeys (*Cebus capucinus*). *Laboratory Animal Science* 40:515-519.

Ludes E, Anderson JR. 1996. Comparison of the behaviour of captive white-faced capuchin monkeys (*Cebus capucinus*) in the presence of four kinds of deep litter. *Applied Animal Behaviour Science* 49:293-303.

National Research Council. 1998. *The Psychological Well-Being of Nonhuman Primates*. Washington, DC: National Academy Press.

Nowak R. 1999. *Walker's Primates of the World*. Baltimore, MD: The Johns Hopkins University Press.

Riviello MC. 1995. The use of a feeding board as an environmental enrichment device for tufted capuchin monkeys (*Cebus apella*). *Primate Report* 42:23-24 (Abstract).

Visalberghi E, Anderson JR. 1999. Capuchin Monkeys. In: *The UFAW Handbook on the Care and Management of Laboratory Animals, Seventh Edition*. UFAW [Universities Federation for Animal Welfare] (edited by T Poole and P English), 601-610. Blackwell Science, Oxford, UK.

Westergaard GC, Fragaszy DM. 1985. Effects of manipulatable objects on the activity of captive capuchin monkeys (*Cebus apella*). *Zoo Biology* 4:317-327.

Common Names of Capuchins

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Cebus albifrons ssp: White-fronted capuchin, Brown-faced capuchin, Ecuadorian capuchin, Shock-headed capuchin, Trinidad white-fronted capuchin, Varied capuchin, Andean white-fronted capuchin

C. apella ssp: Black-capped capuchin, Guianan brown capuchin, Brown capuchin, Tufted capuchin, Hooded capuchin, Large-headed capuchin, Margarita Island capuchin, Peruvian tufted capuchin

C. capucinus ssp: White-throated capuchin, White-faced capuchin, Panamanian white-throated capuchin, Gorgona white-fronted capuchin

Cebus libidinosus ssp: Bearded capuchin, Tambopata tufted capuchin, Pale capuchin, Paraguayan tufted capuchin

C. kaapori: Ka'apor capuchin

C. nigrivittatus ssp: Weeper capuchin, Weeping capuchin, Black-horned capuchin, Crested capuchin

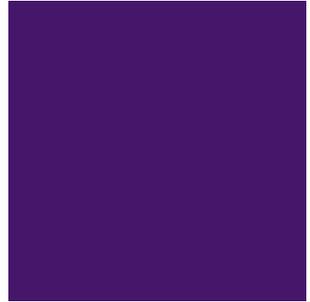
C. olivaceus ssp: Brown weeper capuchin, Chestnut capuchin, Ka'apor capuchin, Kakapo capuchin, Wedge-capped capuchin, Weeper capuchin, Weeping capuchin

C. xanthosternos: Yellow-breasted capuchin

Chimpanzees

Kate Baker, Ph.D.

Tulane National Primate Research Center



enrichment
for nonhuman primates

Chimpanzees

Background

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Habitat

In the wild, chimpanzees live in large forested areas, but they may also inhabit dry savannah and mosaic habitats of grassland-woodland-forest environments, as well as montane forests up to 10,000 feet in elevation. They spend much time in trees and may scatter widely over their territory rather than traveling around in one large group.

Physical Features

Chimpanzees weigh up to 200 pounds, though the normal average weight for an adult female is 130 pounds and for an adult male is 140 pounds. Chimpanzees may grow to a height of 3 - 5 1/2 feet. Adult males generally are larger than females. Reaching their adult size by the time they are 14 to 16 years old, these animals can live to be 60 years old, with an average life span of 40 to 45 years. Chimpanzees are extremely strong and quick. They are omnivores, eating fruits, vegetables, insects and other animals at times.

Behavior

Chimpanzees have many ways of communicating with each other. Facial expressions, calls, and gestures reflect their relationships with other chimpanzees and with people. Understanding these methods of communication is essential for having a good relationship with them and staying safe in their presence.

Chimpanzees make noisy shows of banging, hooting, rocking back and forth, and running, hitting or kicking things as they go. This is called a “display” and is normal for them. They do this because they are excited or trying to impress.



*Chimps at play
(photo by S. Lambeth).*

Displays are common when chimpanzees meet new chimpanzees or people and at the arrival of food. Sometimes chimpanzees will throw feces or spit on people during these displays. Reacting to such behavior (e.g., jumping away, yelling at the chimpanzee) will only encourage it. Walking away slowly or ignoring this behavior will discourage it over time.

It is important to recognize that there is a hierarchical priority among chimpanzees for access to food that must be considered during feeding, foraging activities and access to enrichment foraging devices. Chimpanzees may show their lower status to another chimpanzee by bowing or grunting.

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Chimpanzees make different sounds and expressions depending on what they are doing and trying to communicate. They may make a series of small grunts as they eat and a call that sounds like “WHA-OOO” as a warning of possible danger. If frightened or nervous, they will show their teeth and gums. Alternately, when playful, chimpanzees may show a wide-open mouth with the top teeth covered. They also make snorting or panting sounds when they play. Other gestures/vocalizations include an “open mouth grimace” (to express fear), squeal and pant-hoot (to express excitement).

An angry chimpanzee will press its lips together tightly, a warning to stay out of reach. Chimpanzees threaten each other by gesturing forward violently with an arm or wrist, as if shooing another away.

Friendly contact is extremely important to them. Chimpanzees will spend long periods of time grooming each other or simply sitting in contact. Many chimpanzees are very playful as well, tickling, chasing, wrestling, and gnawing on each other.



Chimps grooming (photo by K. Baker).

Mating and Reproduction

Puberty starts at about seven years of age. Male chimps can breed as young as seven to eight years of age. Female chimps in captivity can get pregnant as young as nine years of age. Because menopause is not documented in chimpanzees, females can remain fertile

for decades. Females in estrus, which happens every four to six weeks, have prominent swelling of the pink genital skin that usually lasts two weeks. When in estrus, they may mate many times a day if housed with a male. There is no breeding season. Chimpanzee pregnancy lasts 33 to 34 weeks. Newborns cannot hold on to their mothers, who need to support them so they can nurse. Infants should be able to cling to their mothers without help after a few days. After several months, infants may start riding on their mothers' backs rather than abdomens. Infants will nurse until they are about three years old.

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Social World

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In the wild, chimpanzees live in large social groups. These groups share a territory and are hostile to other groups. Typically, a wild chimpanzee will know many other individuals, visiting with them on a regular basis. While wild chimpanzees often spend part of the day alone, they are naturally social animals for whom constant solitude is a hardship.

In captivity, housing chimpanzees in social groups is essential to their quality of life. Young animals learn many lessons from the other, older animals in the group.



Tolerance of young animals by adult males (photo by M. Bloomsmith).

However, it is not always easy to form and maintain such groups. One must take great care in introducing unfamiliar chimpanzees to each other, keeping in mind that they are hostile to strangers in the wild. Several steps can be taken to make introductions go more smoothly. First, it is a good idea to let chimpanzees see but not touch each other for a short amount of time. Long periods of seeing but not touching, however, may make them more hostile to each other. Ideally, giving them a day or two of seeing each other should be followed by letting them touch each other but not enter each others' enclosure. This gives them a chance to meet each other and establish dominance more safely than suddenly putting them together in the same enclosure as complete strangers.

Some fighting during introductions is not unusual. A few fights, even those that cause small wounds, are not necessarily cause for separation. The animals need time to establish a hierarchy. It is important to give them time to work this out and reconcile after fights, which they often do. However, if fights become more frequent or more severe over time, then the individuals may indeed be incompatible.

Newly-introduced chimpanzees should be watched carefully for at least a week. It is important to keep things quiet and calm around them, since they will be more likely to attack each other when there is noise, commotion or a stranger nearby. If several chimpanzees are to be introduced into one group, it is best to introduce different combinations of pairs together over several days before putting everyone together. If a male and female are introduced to each other, the introduction will go more smoothly during the time of month when the female has a sexual swelling. The riskiest social introductions involve males meeting each other, or chimpanzees that were housed alone for long periods of time.



Social curiosity/learning (photo courtesy of S. Ross).

Even chimpanzees that know each other well may fight on occasion. Fights often look and sound worse than they are. Trying to stop a fight, for example, by spraying chimpanzees with water, will do no good and may make things worse. Separating them and keeping them alone for a while is also a bad idea. They will remember their dispute and may fight even worse once they are reunited. It



This enclosure provides multiple objects for enrichment to minimize aggression (photo by K. Baker).

is best to let fights take their course unless they are likely to cause significant harm or are life-threatening. It is important to avoid unnecessary separations of chimpanzee groups, since they will often fight during reunions. Subtle changes in body movements and posture often

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Human-chimpanzee interactions that permit limited contact in a safe manner can be achieved (photo by K. Baker).

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signal that an aggressive encounter is about to take place, especially between males. The male may exhibit slow swaying movements, raising of hackles and an increase in the volume of hooting.

While it would be difficult to eliminate all fighting, it is a good idea to avoid giving chimpanzees things to fight over, such as toys and food. Minimizing competition for food can reduce the number of fights. For example, giving a group one watermelon is much more likely to cause fighting than scattering pieces of watermelon all over the enclosure. Similarly, it is a better idea to give a group of chimpanzees several boxes to play with rather than one big piece of cardboard.

In captivity, chimpanzees benefit from social interaction with people (conducted safely), particularly when they lack companions of their own species. Many captive chimpanzees will want to groom humans, be groomed, or play chase or tickle games. While friendly relationships with people can be essential to chimpanzees with few or no companions, there are significant, potentially lethal, physical risks to people associated with such interactions (e.g., bite wounds, scratches, bruising, and possibly the transmission of infectious diseases), and the best approach in most circumstances is the provision of another chimpanzee.

Physical World

In the wild, chimpanzees spend much time in the trees. Thus, in captivity, they need climbing structures and comfortable places to sit up high. Fire hose, strong chain, cargo nets, perches, and tire swings all can be used for this purpose. If rope or chain is used, it should be thick and taut enough to prevent loop-forming and possible strangulation. Structures that provide shade and privacy, such as concrete culverts and small lengths of solid fencing, help avoid overheating in hot weather. They also give chimpanzees solitude if they want it and help to reduce aggression by providing visual barriers. Movable structures such as empty plastic barrels are favored resting spots, and chimpanzees can move them to where they want to sit. Barrels cut in half are popular “toys” for chimpanzees. Enclosures that include an outdoor area will provide the opportunity for chimpanzees to engage in the normal variety of behaviors typical for the species. Letting them choose whether to be inside or outside is important, since it appears that chimpanzees like to make some decisions for themselves.

Wild chimpanzees build nests out of branches and leaves. When caged, chimpanzees will benefit greatly from having nesting material such as blankets, straw or hay (though these materials may be allergenic), etc. Tree branches may be used, although be aware that some common trees, such as fruit trees, magnolia, some oaks, and hickory are toxic. Care also must be taken to avoid providing branches that are long enough for chimpanzees to use them to escape from open-top enclosures. In large enclosures, entire uprooted trees have been provided for enrichment.



*An example of a nest built by a chimpanzee in captivity
(photo by K. Baker).*

One relatively easy way to keep life interesting for chimpanzees is to give them a large variety of healthy foods over time. While the basis of the diet (e.g., commercially prepared feed) should be nutritionally complete, fruits and vegetables, breakfast cereal, eggs, yogurt and other healthful snacks are good supplements. These are best provided as frequent, small feedings, rather than in large quantities once a day. While it is important not to overload chimpanzees on food treats, a sprinkling of “snacks” can help to prevent boredom and abnormal behaviors, particularly if the animals have to move around the enclosure to obtain the snacks (i.e., work for them). In the wild, chimpanzees rarely go very long without eating, regularly snacking on ripe fruits and leaves. Also, the more time-consuming the food is to find and eat, the better it is for the chimpanzee. Foods such as unshucked raw ears of corn and frozen, finely chopped and widely scattered foods help keep chimpanzees occupied. Requiring chimpanzees to climb by placing frozen items on wire mesh ceilings or elsewhere presents a challenge for them and provides exercise.

Another easy way to enrich the chimpanzee’s environment is to provide large, sturdy toys that are sold for children, large dogs and zoo animals. Many vendors sell toys at a lower price than at the local pet store. Rotating toys will maintain the interest of the animals. Providing climbing structures is especially important.

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Chimpanzees like to destroy things. Giving them items they can safely wreck, many of which are free or very inexpensive, is a widely used way of entertaining them. A cardboard box can be played in, squashed, ripped, chewed, and finally used for nesting material. Long sheets of butcher paper are very entertaining (butcher paper is easier on drains and easier to clean up than newspaper). An empty plastic soda or milk bottle, perhaps containing a small food treat, pro-

A food puzzle being used by a chimpanzee (photo by K. Bayne).



vides a good source of entertainment. Such objects, however, must be checked frequently and removed when they become damaged. Because small objects can lodge in the throat or other part of the intestinal tract, objects introduced for enrichment purposes must be monitored to ensure animal safety.

Chimpanzees are extremely intelligent and will benefit from problem-solving and other mental activities. Inexpensive puzzles and projects can be made out of materials available at a home-improvement store. Even something as simple as a piece of polyvinyl chloride (PVC) pipe smeared on the inside with peanut butter, along with a stick or narrower piece of pipe to insert to get at the food, makes a pleasant diversion for chimpanzees. A PVC pipe drilled with a few finger holes and containing a frozen banana is another easy idea. Other safe and effective puzzles are described on the internet (see online resources listed at the end of the chapter.). Many chimpanzees enjoy finger painting or drawing with nontoxic crayons. Finally, training is great stimulation for the smart mind of a chimpanzee and is fun for people as well.



A chimpanzee manipulates objects provided for enrichment purposes (photo courtesy of S. Ross). As always, caution must be exercised to ensure animals are not harmed by the enrichment devices.



A hand-held mirror provides enrichment to chimpanzees, who are interested in their own reflections (photo by K. Baker).

Chimpanzees should be housed in an environment that gives them adequate ventilation, shade during hot days, and heat during cold days. Providing a fresh flow of air is recommended if the temperature gets as high as 90° F. They may enjoy the flow of water from a sprinkler placed outside their enclosure so that part (but not all) of their housing area receives some cooling. Chimpanzees should never be exposed to temperatures below 50° F. Even at higher temperatures than this, they will need supplemental heat.

Special Cases



Age-related Considerations

Chimpanzees can live for more than forty years in captivity. During the course of their long lifespan, their needs change. Infancy is a critical time behaviorally and will determine whether the animal grows up to be behaviorally normal or have life-long behavior problems. Infants should remain with their mothers as long as possible. In the wild, young chimpanzees need their mothers' care until they are about five years old. Separation from the mother before the age of one or two will result in an adult that may have trouble getting along with other chimpanzees, show a lot of abnormal behavior, and not cope well with changes and stressors. If infants are reared apart from their mothers, exposure to other infant chimpanzees is critical.

At the other end of the lifespan, the needs of chimpanzees change as well. Regular health care through a qualified veterinarian, important throughout a chimpanzee's life, is critical in old age. Aged chimpanzees experience many of the same problems that old people do, including bone loss, joint problems, and undesirable weight changes. Obesity increases the risks of cardiovascular disease and other health problems. Comfortable enclosures with bedding become particularly important. Aged chimpanzees can be expected to be less active, but their needs for a social life and stimulating environment do not diminish.

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Individual Housing

A chimpanzee that must be individually caged due to health problems, severe social problems, the unavailability of social partners, or research reasons will require extra care in the form of enrichment and human interaction. While a chimpanzee may have to be individually caged, it should not be kept alone in a room, unless it is necessary to control the spread of disease. Rather, it should have visual and auditory contact with chimpanzees in other cages.

All the enrichment ideas mentioned above are especially critical for the singly caged chimpanzee. Providing a more interesting diet is another way of reducing boredom, but the fact that individual chimpanzees tend to be inactive means that a lot of attention has to be paid to food quantities and calories to avoid obesity. Freezing fruits and vegetables, or scattering low-calorie items in straw are ways of increasing feeding time without adding too many calories. Singly

caged chimpanzees will make a lot of use of toys and videotapes or live-feed of other chimpanzees (particularly familiar individuals). Very sturdy hand-held mirrors also may provide entertainment. Providing new structures or changing the installation of structures from time to time (e.g., suspending fire hoses in a new position) is another way to vary their environment and induce exploration behaviors. Access to the outside benefits all chimpanzees and provides a great deal of stimulation to singly caged chimpanzees.

Problem Behaviors

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Captive chimpanzees may develop bad habits, including strange behaviors not normally seen in the wild. Some of these behaviors are very harmful to the animal's physical health. The most serious problem behavior is self-biting and self-wounding, collectively referred to as self-injurious behaviors (SIB). Little can be done about this behavior once the chimpanzee is in the habit of hurting itself, although there is some evidence with other primate species that pharmacologic intervention may control SIB. Such chimpanzees need intensive veterinary care and a strong behavioral management program for life.

Other behavioral problems that are difficult to eliminate because they develop early in life can be reduced by enriching the chimpanzee's environment. Examples of these abnormal behaviors include rocking, thumb sucking, eye or ear poking, hair plucking, or odd and pointless motions or postures. Some of the easier abnormal behaviors to eliminate involve strange "eating" habits, such as consuming regurgitated food and feces. Increasing the number of small meals and providing bedding can help to eliminate such behaviors. Adding climbing structures and playthings also can be tried. Positive reinforcement training can be used not only to improve the quality of the chimpanzee's life but to train for behaviors that replace the problem behavior.

Some problem behaviors may be due to physical rather than psychological causes. A sudden change in behavior or the development of a new abnormal behavior calls for a medical evaluation. For example, diarrhea may be a response to psychological stress, in which case changes to the environment might help. On the other hand, it could be the result of bacterial or parasitic infection requiring treatment.

No one technique for dealing with problem behavior is foolproof. Each chimpanzee is an individual. A chimpanzee should be watched to determine the effectiveness of changes made. Several different approaches may need to be tried before a behavior problem improves. Some attempts to fix behavior may backfire as well, so familiarity with the individuals and ongoing observation is essential. For example, one chimpanzee may be unreasonably frightened of something new or different, while another will take to it immediately. Chimpanzees may adjust to something new gradually or avoid it forever. In some cases, the chimpanzee's immediate reaction is different from its long-term response. Observe the chimpanzee to see if it makes use of the enrichment, and if it reduces or eliminates the behavior problem. It is important to keep a record of what changes were made and how the chimpanzee responded.

Safety Issues

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12 Chimpanzees are fast and strong, so great care must be taken when working with them. Chimpanzees that want to be groomed or tickled can press their backs or shoulders against enclosure mesh or bars for you; there is no need to stick your hand in the enclosure and risk getting bitten or grabbed. Indeed, some chimpanzees will appear to invite such contact, only to quickly turn and try to bite the person. Furthermore, always keep an eye on where their hands are and stay away from their mouths.

Chimpanzees can be extremely unpredictable. They are known to trick people into coming within grabbing distance by pretending their arms cannot reach out as far as they actually can. If agitated, they may lash out at familiar people to whom they have never been aggressive before.

Chimpanzees can certainly hurt people, and people can inadvertently expose the animals to harm. For example, chimpanzees can catch the same illnesses humans can, so care should be taken not to expose them to people with colds or the flu. Anyone working around chimpanzees should have a tuberculin test every six months or other documentation of being tuberculin negative (e.g., chest x-rays).

An excellent way for people to interact more safely with chimpanzees is to utilize a training technique known as positive reinforcement, in which a desired behav-

ior is linked to something the animal likes. People can positively reinforce chimpanzees by “catching” them doing something desirable (e.g., sitting down, leaning its shoulder against the enclosure barrier near you, etc.), and praising or treating them with a small food reward. By using a specific word or gesture when the chimpanzee performs the desired behavior, people can eventually use the word or gesture to “ask” for the behavior. Because such training takes some level of expertise, one should be familiar with positive reinforcement training techniques, both in general and specific to chimpanzees, before attempting this procedure.



Through the use of positive reinforcement training, a chimpanzee cooperates with receiving an injection (photo by K. Baker).

Chimpanzees can be trained to play with or groom each other or to stop stealing each others’ food. Many chimpanzees enjoy learning a variety of commands (e.g., show me your shoulder, bring me your toy). While it may start as a game just to stimulate their minds and have fun, these commands may come in handy unexpectedly. For example, it may be possible to command an injured animal to present the body part for inspection. It may also form the basis for training chimpanzees to cooperate with procedures that would otherwise be very stressful for chimpanzees and people alike.

Like all wild animals, chimpanzees will need to be restrained occasionally for clinical care and transport. However, chimpanzees can be trained to cooperate with procedures. Training can be used to make procedures such as receiving an injection or moving from the home cage to a transfer cage less frightening and stressful for the animal. A chimpanzee trained to cooperate with medical procedures such as heart rate or temperature measurement may not need to be anesthetized for those procedures.

Positive reinforcement training should be employed whenever possible and will result in a positive relationship between chimpanzees and their caregivers. Letting chimpanzees know what is needed of them, and giving them a chance to cooperate, gives them some control over their lives. Threatening or punishing chimpanzees, on the other hand, will encourage them to do unpleasant things to people (spitting, throwing feces) and resist their caregivers at every opportunity.

Resources

Brent L (Ed). 1997. *The Care and Management of Captive Chimpanzees*. American Society of Primatologists. 252pp.

Maki S, Bloomsmith M. 1989. Uprooted trees facilitate the psychological well-being of captive chimpanzees. *Zoo Biol* 8:79-87.

Reinhardt V. 1997. The Wisconsin Gnawing Stick. *Animal Welfare Information Center (AWIC) Newsletter* 7(3-4), 11-12.

Chimpanzees in the wild and in captivity:

<http://www.discoverchimpanzees.org/chimps/chimps.php> (Jane Goodall Institute Center for Primate Studies)

<http://www.oaklandzoo.org/atoz/azchimp.html> (Oakland Zoo)

<http://www.honolulu zoo.org/chimpanzee.htm> (Honolulu Zoo)

Enrichment:

http://www.arkanimals.com/ark/e_enrichment_101.html

<http://www.awionline.org>

Training:

http://www.awionline.org/Lab_animals/biblio/jo-6.htm

http://behavior.org/animals/index.cfm?page=http%3A//behavior.org/animals/animals_chimps.cfm

<http://www.nal.usda.gov/awic/pubs/primates/4n4laule.htm>

A useful listserv: ask questions and get answers, exchange ideas:

<http://pin.primate.wisc.edu/infoserv/forums/pef/>

<http://www.primate.wisc.edu/mailman/listinfo/pef>

Primate Organizations:

American Society of Primatologists, www.asp.org

Association of Primate Veterinarians, www.primatetvets.org

International Primatological Society, <http://pin.primate.wisc.edu/ips/>

Common Names of Chimpanzees

Pan troglodytes

P. troglodytes troglodytes: Tschego

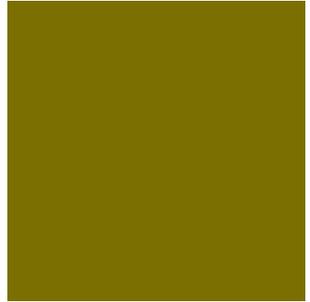
P. troglodytes verus: Common or masked chimpanzee

P. troglodytes schweinfurthii: Eastern or Long-haired chimpanzee

Pan paniscus: Pygmy chimpanzee, Bonobo, Lesser chimpanzee

Macaques

Kathryn Bayne, M.S., Ph.D., D.V.M., DACLAM, CAAB
AAALAC International



enrichment
for nonhuman primates

Macaques

Background

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Habitat

The macaques represent a collection of approximately 20 species of monkeys, most of which are found in Asia. They occupy a wide geographic range that is considered second only to man in its extent. In this range, the habitat occupied by macaques varies from near desert to rainforest, and from sea level to snowy mountain tops. Some macaques spend the majority of their time in trees, while others are predominantly ground-dwellers. Many live in close proximity to human beings; the rhesus monkey is sacred to Hindus and is often found near temples in India and Nepal.

Physical Features

In general, the macaques have a medium-sized body, with a stocky build. Animals belonging to the smallest species weigh approximately 13 pounds, while representatives of the largest species weigh an average of 40 pounds. Tail length varies among the different species. All macaques have long, sharp canine teeth and finger nails that can pose a risk to human handlers through either bite or scratch wounds. They also have cheek pouches and a fully opposable thumb. The opposable thumb gives these animals the ability to manipulate objects (e.g., cage latches) with great precision. They feed on both animal and vegetable resources and have a highly varied diet. Macaques are primarily active during the daylight hours, and most species sleep in trees at night.



Rhesus (Macaca mulatta) monkey with cheek pouches full of food (photo courtesy of K. Bayne).

Behavior

As a rule, the macaques are social animals, living in groups of multiple males and females; the sex ratio typically reflects more females than males in a group. Even for the same species, group size tends to be smaller when the home range size is also smaller (e.g., when constrained by human activities). Within these groups, individuals are ranked according to dominance (hierarchies), with the higher ranking animals doing more of the successful breeding and having first access to food and other desirable resources. Often it is the rank of the mother, rather than the father, that determines the rank of offspring. Young males may be evicted from their birth group as they approach puberty, forming temporary “bachelor” groups until they join a new group. Wounding of animals can occur when challenges for dominance occur.

Because these animals rely in large part on visual communication, they use a number of facial signals, often accompanied by vocalizations, to threaten or to make friendly overtures.

Threat displays include opening the mouth in the shape of an “O”, a direct stare, raising the eyebrows quickly and repeatedly, flapping the ears, a jerky head-bob, shaking an object in their environment such as a tree branch or cage door, slapping the ground, or charging with intent to fight. Occasionally, a lack of compatibility between animals can be detected simply by the increased physical distance maintained between them. Behavioral indicators of compatibility between animals include social grooming, lip-smacking, and sitting in close proximity. Food sharing has also been used to assess compatibility between pairs of animals.



*Social grooming is an integral part of forming affiliations
(photo courtesy of K. Rasmussen).*

Mating and Reproduction

The reproductive cycle of macaques is characterized by a seasonal estrus period, with menstrual cycles occurring throughout the year. Females have been reported to begin cycling as early as approximately 1.5 years, although a more typical age is 2.5 years. Most species of macaques exhibit swelling and reddening of the skin of the rump, perineum, and occasionally arms, legs and face (referred to as “sex skin”). The swelling and reddening becomes more pronounced from beginning to end of the menstrual cycle. Exceptions to this are bonnet macaques and toque monkeys, who do not have marked sex skin. Menopause occurs in the macaques, with the number of menstrual cycles decreasing each year when the animal reaches her third decade of life.



Social defense of territory (photo courtesy of K.Rasmussen).

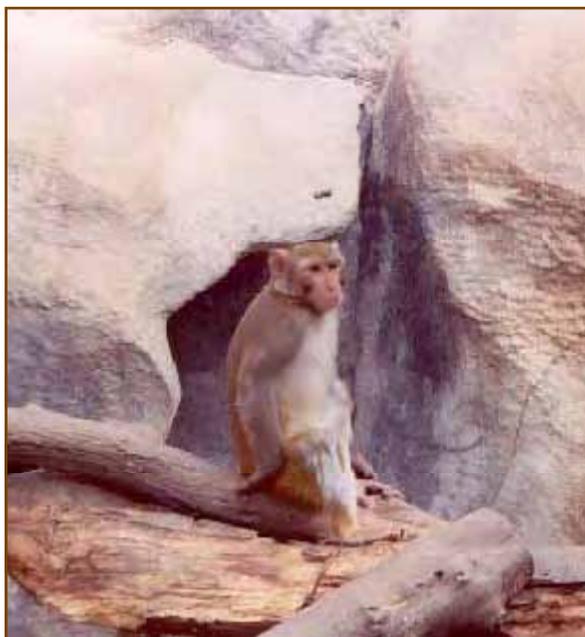
In general, the female actively solicits mating by the male (again, the bonnet macaque is an exception to this). Usually, the dominant males in the group breed the females more often, although less dominant males in a group have been reported to breed and reproduce successfully. The rhesus monkey’s gestation period is between five and six months. The infant is quite dependent upon the mother, and the current preference is to leave the infant with its mother until approximately one year of age to help ensure adequate development of social, particularly maternal, skills by the developing infant.

Social World

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Because of the intrinsic social nature of macaques, pair or group housing of compatible animals is extremely important. It is well-known that raising a macaque alone, without the company of other macaques of the same species, will result in that animal expressing a pattern of abnormal behaviors that can become self-destructive. Even the behavior profiles of adult animals housed alone can degenerate into inciting these abnormal behaviors, which may include repeated pacing, circling, or somersaulting; hyper-aggression; depression; and self-injurious behavior, including hair plucking or self-biting. (See section on “Problem Behaviors”).

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Evidence of hair-plucking behavior, a type of self-injurious behavior (SIB) on the leg of this macaque (photo courtesy of K. Bayne).

While group or pair housing is strongly recommended for macaques, care should be taken in doing so. Since these primates establish dominance hierarchies and space is limited in captivity, the macaque wishing to flee the dominant animal has no place to fully escape. This can result in unresolved, increased aggression between the animals as well as wounding (and possibly killing) of one or more animals.

Larger groups of animals that previously have been living in smaller stable cohorts should not be formed, because this will increase fighting between the smaller, pre-established groups. A better approach is to place unfamiliar animals together in a new enclosure at the same time. In this way, coalitions have not already been formed, and each macaque must establish its own place in the hierarchy without support from other animals.

One approach to forming pairs of macaques is provided at the end of this chapter. The key steps include the following:

- Introducing the animals into an area that they do not consider as their territory
- Assessing facial expressions, postures and physical distance between the animals
- Proceeding slowly in forming pairs
- Planning ahead to have a way of separating animals should the fighting become intense (e.g., a panel to slide between cages, use of water, etc.)
- Ensuring the safety of people performing the animal introductions
- Providing ongoing monitoring of animal interactions, because animal relationships can change over time



Offering vulnerable areas of the body to be groomed by another animal indicates a degree of trust and affiliation between the animals (photo courtesy of K. Bayne).

Using the natural social structure of the macaques will assist in forming compatible



pairs or groups of monkeys. For example, because macaques will form bachelor troops, often males can be pair-housed successfully. Successful pairings of a young macaque with an older animal (so that the dominance hierarchy is clear and fighting is minimized) also have been reported.

Providing three-dimensional space in the primary enclosure, using Primahedrons® (photo courtesy of K. Bayne).

Physical World

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Housing

Macaques have been housed successfully in a variety of types of housing, including island environments, corrals, corn cribs, indoor-outdoor runs, pens and cages. Regardless of the enclosure design or size, it must be sturdy enough to withstand being shaken and chewed on by its inhabitants. Because of the animals' tendency to flee upward when escaping a perceived threat, they benefit from perches, shelves or other structures that increase the three-dimensional space of the enclosure. Generally, older macaques prefer a non-moving shelf or perch, while the younger ones will readily use swings. Because macaques can strangle on lengths of chain, swings should be short in length and/or constructed of materials that cannot loop around the neck, such as flexible polyvinyl chloride (PVC) tubing. Similarly, ropes can be picked apart or chewed on, and this may result in a gastric obstruction. Thus, in most cases, ropes of cotton, sisal or jute should be avoided.

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6 In general, macaques should not be exposed to cold or wet weather without a method for them to conserve body heat. Japanese macaques living in the snowy mountains of Japan manage to stay warm by soaking in natural hot springs. A number of captive macaques, however, have lost parts of their tails or one or more digits to frostbite. This problem can be reduced or prevented by providing them with supplemental heating or a shelter.



A horse water trough, shown here, serves as a swimming pool for young macaques (photo courtesy of K. Bayne).

During conditions of high heat and humidity, macaques may overheat if they undergo a physical stress, such as being chased around an enclosure. Providing macaques with a shallow and indestructible pool in which to swim and cool off can be an asset to macaques housed outdoors in warmer climates. The swimming pool should be shallow, to prevent animals from drowning, and resistant to deterioration from chewing. The pool should be cleaned routinely to provide animals with good quality water for swimming.



Flexible PVC tubing can be installed in the primary enclosure to simulate branches for swinging (photo courtesy of K. Bayne).

Enrichment

The macaques are curious and intelligent animals. Providing them with opportunities to investigate and explore their environment is enriching for them. This can be accomplished by maintaining toys in the animals' enclosures. Since macaques have color vision, the toys (also known as manipulanda) should be of different colors; they can also be of different shapes and texture. Because the monkeys will chew on these toys, they should be relatively durable, such as heavy-duty dog toys. Toys should be removed from the enclosure when they become sufficiently damaged that the primate might swallow or choke on a piece. Rotating different toys in the enclosure and removing them periodically will help to keep the toys novel and increase the animals' interest in them.



A variety of toys used with macaques (photo courtesy of K. Bayne and S. Dexter).



The damage inflicted on toys after usage by macaques. Small remnants can pose a choke hazard to the animals (photo courtesy of K. Bayne and S. Dexter).



Food treats may be dispensed from puzzle balls (photo courtesy of K. Bayne and S. Dexter).

A very successful way to fulfill these animals' inclination to explore and investigate is to give them the opportunity to forage (or search) for food. Since many primates will spend up to 70% of their waking hours in foraging-related activities, offering captive primates the opportunity to engage in this behavior can be important in preventing the development of abnormal behaviors. Numerous in-house and commercially produced devices are avail-

able, including toys that simply hold the food item and require the monkey to fish for or push it out. Also available are containers with finger holes or slots through which the monkey removes the food item, as well as puzzle boards in which the monkeys must manipulate the food item though a maze before it reaches a hole large enough from which the food can be retrieved. Food may be hidden throughout the enclosure to encourage searching behaviors. Food items may also be ground up into small pieces or pre-purchased as "crumbles" and then placed on an Astroturf® or artificial fleece foraging board. The small size of the food particle encourages manual dexterity and extends the amount of time the animal spends searching for and eating the food. Food treats, as enrichment, should not be offered in such quantity that the animal ignores its more nutritional daily diet or gains excessive weight. Many commercially available food treats come in a variety of flavors and are nutritious.



Wedging food treats inside a Kong® toy is another way to extend the animal's time spent in "foraging" (photo courtesy of W. Brandon).



This animal forages for food “crumbles” in an artificial shearling foraging/grooming board (photo courtesy of K. Bayne).

Special Cases

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Age-related Considerations

The macaques are long-lived animals, with reports of some animals living in captivity over 30 years. This lifespan entails a commitment of considerable duration, with substantial, changing needs of the animal over the course of its life. As with other species of primates, the design of the environment should take into account the age of the macaque. For example, older monkeys will develop arthritis, limiting their ability to jump onto perches, swing, or otherwise navigate their enclosure. Older primates can also have reduced vision capabilities, thus further limiting their ability to move around the enclosure and interact with other animals or people.

Conversely, young animals are very active and curious. The enclosure design should allow them to express these characteristics without compromising their physical safety. Young animals also are particularly sensitive to the effects of social deprivation and should be housed with other primates of the same species whenever possible.

Individual Housing

The circumstance in which only one macaque is housed on the premises should be avoided. If several macaques are housed individually in cages, they should

be able to see, hear and smell each other. If possible, individually caged animals also should have access to visual barriers in order to avoid being seen by other animals, should they so choose. It is recommended that if an animal cannot be socially housed, other forms of enrichment (e.g., toys, foraging opportunities) should be provided to compensate for the lack of social stimulation.

Susceptibility to Disease

Because of their close genetic relationship to humans, nonhuman primates can be susceptible to human diseases. Of particular concern is the exposure of macaques to tuberculosis from a human. Tuberculosis is a highly contagious, fatal disease in Old World Monkeys. Routine testing of the animals is highly recommended. Macaques are also susceptible to measles virus, and will show a rash similar to that of people having the disease. Most colonies of macaques are vaccinated for measles virus. Because numerous individuals may be assisting with the enrichment program (including volunteers), close attention should be paid to the possible transmission of diseases from humans to macaques.

Problem Behaviors

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The most appropriate behavioral management program houses macaques in a sufficiently enriched and safe environment to prevent the development of abnormal behaviors. Nevertheless, personnel caring for macaques should be adequately trained and able to recognize the occurrence of abnormal behavior in macaques. It is important to note that not all macaque species exhibit the same types of abnormal behavior or to the same degree. Some abnormal behaviors are initially quite subtle in their expression, but over time can become more obvious and harder to stop. Abnormal behaviors include repetitive movements, such as pacing, circling, rocking, spinning, somersaulting and bouncing. Cage-licking, self-clasping, self-sucking, masturbation, “saluting,” and eating feces are some other aberrant, repetitive behaviors. Abnormal behaviors in macaques also can hurt or injure the animals, as in the case of hair plucking, self-biting and head banging.

Abnormal behaviors are an undesirable consequence of captive housing, reflecting an inadequate environment for maintaining the animal. Preventing the development of abnormal behaviors is critical, because they are difficult to stop once they start. In some cases, socially housing an animal that previously was singly housed can decrease the expression of abnormal behaviors, presuming that the animals are compatible. Progress has been made in reducing the occurrence of hair-plucking behavior by providing the animal with a fleece covered Plexiglas® board or coconut, thereby giving the monkey something else to pluck. However, redirection of an abnormal behavior is not a “cure” and should only be regarded as a temporary correction. Although occasionally self-biting behavior can be redirected to a toy, recent evidence has shown that some drugs will reduce the occurrence of this behavior more reliably. In this case, the veterinarian should be consulted.

Safety Issues

In general, the least amount of restraint necessary to accomplish the task should be used when working with macaques. However, because macaques can seriously threaten people’s safety, the method of restraint should also ensure the safety of both the personnel and the animal. Restraint can be achieved by hand (e.g., with younger animals), by the use of various drugs such as ketamine hydrochloride, or by the use of equipment such as transport cages, the pole and collar system, or tunnels to move animals from one location to another. Macaques can be trained to cooperate in a variety of procedures, thus reducing the amount of restraint necessary. Examples include training the animals to move into a transport box to be removed temporarily from their home cage or training an animal to extend its arm or leg for a blood sample to be withdrawn. Such training is an important part of the enrichment program as it gives the animal some control over the situation and reduces the stress the animal might otherwise experience during basic husbandry and medical procedures in which it was not actively cooperating. Appropriate protective equipment, including gloves, mask, eye protection, etc., should be worn when working closely with macaques.

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In addition, the provision of many types of enrichment devices involve either attaching the device to the cage, reaching into a cage to place the enrichment, or entering the primates' enclosure. These can place the individual at risk of being grabbed, bitten, or scratched. Macaques are a frequent carrier of Herpes B-virus, which is asymptomatic in the animals but can be fatal to humans. This viral infection can be transmitted from animal bites, scratches, splashes, needle stick injuries, and other contact with mucous membranes or broken skin with infected body fluids (e.g., saliva, urine) from the monkey. Personnel should wear appropriate protective equipment, concomitant with the potential for exposure.



home cage, which is then opened, to move an animal without hand restraint or the use of drugs (photo courtesy of S.Dexter).

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Resources

- National Research Council. 1998. *The Psychological Well-Being of Nonhuman Primates*. Washington, DC: National Academy Press.
- National Research Council. 2003. *Occupational Health and Safety in the Care and Use of Nonhuman Primates*. Washington, DC: National Academy Press.
- Nowak R. 1999. *Walker's Primates of the World*. Baltimore, MD: The Johns Hopkins University Press.
- National Research Council. 1996. *Guide for the Care and Use of Laboratory Animals*. Washington, DC: National Academy Press.
- U.S. Department of Agriculture. 1991. *Animal Welfare Regulations*. Title 9, CFR Part 3, Federal Register, Volume 56, No. 32.
- <http://www.bioserv.com> (a company supplying food treats and other enrichments)
- <http://www.ottoenvironmental.com/Default.asp> (a company supplying enrichment items)

<http://www.enrichment.org> (Web site for “The Shape of Enrichment”)

http://www.awionline.org/Lab_animals/biblio/enrich.htm (a bibliography of enrichment articles)

<http://www.brown.edu/Research/Primate/> (Web site for *Lab Primate Newsletter*, a publication with behavior and enrichment articles)

http://www.aazk.org/committees/enrichment/comm_enrichment_title.php
(Web site for the enrichment committee of the American Association of Zoo Keepers)

<http://www.aphis.usda.gov/ac/eejuly15.html> (Web site for the U.S. Department of Agriculture’s “Final Report on Environment Enhancement to Promote the Psychological Well-Being of Nonhuman Primates”)

Common Names of the Macaques

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Macaca arctoides: Stump-tailed macaque, Bear macaque, Brown stump-tailed macaque

M. assamensis: Assamese macaque, Assam monkey, Mountain monkey, Himalayan Macaque, Montane Rhesus

M. brunnescens: Muna-Butung monkey

M. cyclopis: Taiwan macaque, Taiwanese macaque, Formosan macaque, Formosan rock macaque

M. fascicularis: Crab-eating macaque, Cyno, Cynomolgus, Irus monkey, Java monkey, Kra (or Kera), Long-tail macaque, Philippine monkey

M. fuscata: Japanese macaque, Snow monkey

M. hecki: Heck’s macaque

M. maura: Moor macaque

M. mulatta: Rhesus monkey

M. nemestrina: Pig-tail macaque, Pigtail macaque, Pig-tailed macaque, Giant rhesus

M. nigra: Sulawesi crested macaque, Sulawesi black ape, Celebes black ape, Celebes ape, Celebes crested macaque, Black ape

M. nigrescens: Gorontalo macaque

M. ochreata: Sulawesi booted macaque, Booted monkey, Booted macaque

M. pagensis: Mentawai macaque

M. radiata: Bonnet macaque, Bonnet monkey

M. silenus: Lion-tail macaque, Liontail macaque, Lion-tailed macaque, Lion-maned macaque, Wanderoo, Wanderu, Ouanderu

M. sinica: Toque macaque, Toque monkey

M. sylvanus: Barbary ape, Barbary macaque, Gibraltar ape, Gibraltar macaque

M. thibetana: Père David’s stump-tailed macaque, Tibetan stump-tailed macaque, Tibet monkey

M. tonkeana: Tonkean macaque

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Sample Pair Housing SOP – Macaques

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Pair Housing: Following are descriptions of the five different pair housing combinations and the procedure for pairing each combination. It should be noted that on-going, vigilant monitoring is necessary to the successful social housing program. As animals mature, their relationship may change, necessitating separation of the animals and identification of new partners.

Juveniles: Two juveniles (three years of age or younger) of the same sex are paired together.

Place the animals in an appropriate size cage. Check the animals every hour for the first four hours and at least three times per day for the first week.

Adult with Infant or Juvenile: An adult (four years of age or older) of either sex is paired with a weaned infant or juvenile (eight months to three years) of either sex.

Adult Females: Two adult females (generally cynomolgus monkeys, four years of age or older) are paired together, with their unweaned infants (less than one year of age), if applicable.

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Adult Male and Female: An adult male (five years of age or older) is paired with an adult female (four years of age or older), for either breeding purposes or enrichment purposes.

Place the animals in a double cage with a clear Plexiglas® panel between them. If there are no signs of aggression after one hour, open the panel. Alternatively, if a Grooming-Contact (G-C) bar divider is available, use this first. Check the animals at least every hour for the first four hours and at least three times per day for the first week. Initially, the animals may be separated at night, until a compatible relationship is established.

Adults Males: Two adult males (four years of age or older) are paired together.

Place the males in a double cage with a clear Plexiglas® panel between them. Alternatively, if a G-C bar divider is available, use this first. If there are no signs of aggression after twenty-four hours, move the animals to a new double cage (to avoid territorial aggression) without a panel. Ensure that the males do not have visual contact with any breeding pairs. Check the animals at least every hour for the first four hours and at least four times per day for the first week. Initially, the animals may be separated at night, until a compatible relationship is established.

Marmosets & Tamarins (Callitrichids)

Jeffrey A. French, Ph.D. & Jeffrey E. Fite, Ph.D.
Callitrichid Research Center
University of Nebraska at Omaha



enrichment
for nonhuman primates

Marmosets & Tamarins

Background

Habitat

In the wild, marmosets and tamarins inhabit diverse habitats, ranging from Costa Rica to southern Brazil and Bolivia. They are principally tree-dwelling animals.

Physical Features

Marmosets and tamarins belong to the New World primate family Callitrichidae, which is characterized by unique morphological and reproductive traits. Callitrichids, among the smallest (.5 to 1.3 lbs.) of the New World primates, often are brightly colored monkeys with little, if any, gender differences in body size or coloration.

Other distinguishing morphological features of marmosets and tamarins include claws instead of nails on all digits except for the opposable hallux, and two molars on either side of each jaw.



Cotton-top tamarin (Saguinus oedipus) with nestbox and perches (photo by K.Bayne).



Adult Geoffroy's marmoset, Callithrix geoffroyi
(photo by H. A. Jensen).

Behavior

Marmosets and tamarins have rich communicative behavioral repertoires that help individuals communicate within their group and with other groups. Chemical communication via scent marking is one important aspect of callitrichid social and sexual behavior. Scent marking increases when marmosets and tamarins are exposed to unfamiliar animals. Callitrichid primates have specialized glands (found in the anogenital, suprapubic, sternal, and perhaps facial areas), which produce oily secretions that are mixed with urine and deposited on branches and, to a lesser

degree, other surfaces. These scents contain information on species, subspecies, and individual identity, as well as reproductive status, social rank, and the age of the marking. Scents are also thought to facilitate reproductive suppression of subordinate females in some callitrichid species.



Marmoset (Callithrix geoffroyi) parents sitting with their infants (photo by H. A. Jensen).

Mating and Reproduction

The social behavior of callitrichids within groups, in many ways, revolves around two aspects of callitrichid reproduction: reproductive suppression, which prevents subordinate males and females from engaging in sexual behavior, and extended residence of offspring in the natal family group. Subordinate females and adult-aged daughters living in their natal family group do not typically engage in reproductive activity and, in most cases, nonbreeding females are endocrinologically suppressed and do not ovulate. Likewise, subordinate males and adult-aged sons typically do not engage in sexual behavior. Reproductive suppression is known to be lifted from subordinate individuals when a new breeding male is introduced and following the death or illness of a breeding male or female.

Cooperative care is another important component of callitrichid social life. Marmosets and tamarins typically produce fraternal twins that are cared for by all group members, including both male and female non-reproductive individuals. This is particularly important because, at birth, litters weigh approximately 15 – 25 percent of adult body weight. Numerous studies have demonstrated that subordinate individuals provide a significant amount of care to infants born into the group. Indeed, the breeding male has been shown to participate less in carrying behavior when there are multiple helpers (e.g., adult offspring), with a concomitant increase in his survivability. The expression of competent caregiving behavior, however, requires experience with infants (either one's own or siblings). It is suggested, then, that individuals remain within their natal groups during the rearing of the next one or two litters.

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Social World

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The social lives of marmosets and tamarins are unique among primates. Marmosets and tamarins are the only primates known to exhibit a cooperative breeding system, characterized by extended residence of offspring within the family group, breeding that is mostly limited to a single breeding pair, and care of offspring provided by group members other than the parents.



Subadult male marmoset (Callithrix kuhlii) carrying infant sibling (photo by C. N. Ross).

In captive settings, callitrichid primates are commonly housed in groups comprised of a single breeding adult male and female, along with the independent (subadult and juvenile) and dependent (infant) offspring of the breeding pair. Captive groups generally do not contain unrelated individuals, because social groups containing unre-

lated same-sex individuals are likely to be unstable. Studies of captive and wild populations of callitrichid primates, however, have revealed that there is some degree of intra-specific variation in social structure that can remain stable over long periods of time. In fact, a variety of different social structures have been found to result in stable social groups, including the following:

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- fathers with offspring
- mothers with offspring
- same- and opposite-sex siblings (note: opposite-sex sibling groups are not recommended for cotton-top tamarins)
- same-sex pairs or small groups of unrelated or unfamiliar individuals
- single same-sex or opposite-sex individuals of different species

Intra-group aggression is generally directed toward non-breeding individuals by their same-sex sibling or same-sex parent. Displacement, threat behavior, chasing, and minor injuries often precede the eviction of an individual from a social group. The victim is easily identified because he/she will often separate from the group, show fearful behavior when approached by group members (especially an aggressor), and generally remain closer to the floor of the cage than other group members. Temporary separation for a period of hours or days may allow an individual that was in the process of being evicted to be reintegrated into a social group. These aggressive events within families are often triggered by periods of fertility in the dominant female, and special care should be taken to monitor group relations in the two to three weeks after the birth of infants, when the dominant females are likely to be ovulating.

Introducing an adult male and female is quite easy. Generally, a brief period of limited contact through mesh or a “howdy cage,” followed by a brief period of close observations once full contact is allowed, is all that is needed. Successfully introducing same-sex unrelated individuals or new adults into breeding groups, however, often is more difficult. In fact, the likelihood of failure increases with the age of the same-sex individuals already present in the group. For these introductions, much longer introduction and observation times are necessary.

Physical World

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Housing

An ideal captive environment for callitrichid primates promotes good physical health, allows for successful reproduction and rearing of offspring, and facilitates the acquisition of skills that the animals would need to survive in the wild. Although there are no clear specifications for optimal habitat size, habitats should be large enough, and rich enough, to allow and promote a full range of naturalistic behaviors, social interactions, and locomotion patterns. The general rule for callitrichid housing is that no housing is too large. Also, as callitrichids are tree-dwellers and range up to 10 meters above the ground in their natural habitats, vertical space is extremely important. If space is limited, narrow, tall housing is preferred to wide, low housing.

Cages often are constructed of wood or polyvinyl chloride (PVC) frames with steel or wire mesh. Many zoological parks also are constructing callitrichid housing from textured rockwork with glass or wire fronting. The primary furnishing for callitrichid housing should be natural tree branches and other surfaces on which the monkeys can climb, leap, and run. Branches should be arranged to provide a network of pathways by which the animals can move about their home. Branches are particularly important because marmosets and tamarins use these as the normal substrate for scent marking. If natural branches are not provided, the monkeys will scent mark on smooth, nonabsorbent substrates, and the marks may soil their fur.

Marmoset and tamarin group members sleep huddled together, so a nest box, placed high in the cage should be provided. Floors should be covered with wood

chips or shredded paper; this provides padding for young animals, which are most likely to fall from a branch onto the floor, and it also encourages animals to forage through the bedding. Food and water should be made available on a feeding platform or in a bowl placed high in the cage in a location that prevents contamination by urine and feces.

Since wild marmosets and tamarins are highly territorial under most conditions, visual and auditory contact between different social groups should be limited. When multiple groups are housed in close proximity to one another, and when overcrowding occurs within social groups, increased aggressive behavior is not uncommon. Further, chronic arousal associated with prolonged exposure to unfamiliar animals can lead to abortions and infant loss. Visual barriers, and sometimes sound absorbing materials, should be used to prevent territorial and aggressive displays between groups.

In light of the important role scent marking plays in social and sexual behavior, it is often suggested that husbandry practices maintain a sanitary, but smell-intact, environment by sanitizing cages less frequently and/or allowing some scent-marked items (e.g., nest box, perch, branches, etc.) to remain unsanitized and, thereby, retain their odor. However, some practical experience suggests that

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Golden Lion Tamarin (Leontidius sp.) using a rope crossing between trees (photo by K. Bayne).

sanitizing these items routinely does not result in adverse effects on the health or reproductive capacity of the animals. Regardless, most guidelines allow for the maintenance of scent-marked branches in cages for periods of several weeks to several months.

Environmental enrichment items and devices also are a necessary part of callitrichid housing. Not only do they promote the development of behavioral and logical skills and mental and sensory stimulation, but they can prompt naturally occurring behaviors in the animals.

The amount, type, and presentation of enrichment should be varied to prevent boredom. Foraging devices, artificial gum trees, cardboard boxes and gallon milk jugs with large holes cut in them, paper towel and toilet paper, are commonly used for enrichment.

Feeding

Meeting the nutritional needs of callitrichid primates is essential to their health and well-being in captivity. The diets of wild marmosets and tamarins include tree exudates (sap or gum), fruits, buds and flowers, nectar, insects, and small vertebrates. Since proportions vary between and within species, only general nutritional issues will be covered here. However, it is important to avoid over-feeding these animals with food treats such that they do not consume a nutritionally balanced diet. Further detailed information can be found in the Callitrichid Husbandry Manual.



Example of basic cage with ladder/swing and polyvinyl chloride (PVC) nestbox. Branches can be added for scent-marking (photo by K.Bayne).



Golden Lion Tamarin (Leontideus sp.) perching on a branch (photo by K. Bayne).

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Young monkeys begin to beg for and eat solid food between three to five weeks of age. Approximately 20 percent of the diet of wild marmosets and tamarins is protein. A canned marmoset diet, which is now commercially available, should provide the foundation of the diet. New World primate biscuits also should be offered, along with an assortment of fresh fruits and vegetables. Two fruits and two vegetables should be offered daily. Cooked and uncooked cereals, and cooked pasta, are ideal sources of carbohydrates. Treats can include gum arabic, marshmallows, raisins, crickets, mealworms, and waxworms.

In the wild, callitrichids spend nearly 60 percent of their day foraging for food. Live food or highly preferred food items hidden in bedding simulates a natural situation and provides an additional opportunity for enrichment. A foraging box can be easily made by placing highly preferred food items into small holes that have been cut into a cardboard box filled with bedding. Callitrichids also enjoy food items suspended from branches, and treat cups with lids and peek holes.

Special Cases

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Age-related Considerations

Healthy marmosets and tamarins maintain good abilities to forage and move about well into their old age. The only major issue with older animals is difficul-

ty in chewing solid food because of tooth wear and loss. In these cases, soaking food in liquids prior to feeding or provisioning animals with softer diets are two easy solutions.

In terms of normal social development, most institutions that rear marmosets and tamarins have a policy of keeping young individuals in their family groups until they have had exposure to and experience with one or more sets of younger siblings. It is assumed that this experience will increase the likelihood of success in rearing young when the animals are placed in a position where breeding is possible. As mentioned above, however, older siblings are sometimes involved in mild to serious fights with same-sex siblings, and may need to be removed from the group. Decisions about removing an individual from a group should be made in light of the need for normal experience with siblings and the seriousness of the aggression.

Rejection of infants by parents and the inability of infants to maintain contact with caregivers are fairly regular occurrences in captive marmosets and tamarins. In some cases, lack of infant success is associated with infant health and vigor (e.g., low birth-weight infants are unable to maintain a grip on their parent's fur). In other cases, parents (particularly mothers) may actively reject and fail to carry and nurse their infants. A number of zoos and research facilities have reported some success in hand-rearing infants. Specific details of hand-rearing protocols can be found in the Callitrichid Husbandry Manual.

It is important to note that hand-rearing is associated with a variety of behavioral problems, particularly as the hand-reared individuals reach reproductive age. Therefore, decisions about hand-rearing rejected infants should involve a careful consideration of the animal's purpose in the facility as an adult. An individual that is highly aggressive toward people may not be a good animal for a zoological exhibit, for example.

Individual Housing

Like other primates, marmosets and tamarins are highly social, and individual or solitary housing is strongly discouraged. In the event that animals need to be housed individually, efforts should be taken to maximize regular social contact with caretakers. Marmosets and tamarins have been housed successfully with birds or rodents. Specific examples of successful mixed-species housing can be found in the Callitrichid Husbandry Manual. However, in no case should



*Infant Wied's black tufted-ear marmoset, Callithrix kuhlii
(photo by J. E. Fite).*

a marmoset or tamarin be housed with a New World primate from the Family Cebidae, including squirrel monkeys, capuchins, spider monkeys. Cebids can carry viruses, such as Herpesvirus saimiri, that do not affect their own health but could be lethal for marmosets and tamarins.

In the event that animals do require

individual housing, efforts should be taken to compensate for the isolation by providing additional enrichment. Increased and regular positive social contact with caretakers should be encouraged, but these people should be familiar and non-threatening to the animals. Increasing the complexity of the physical environment with live plants or other cage furnishings is also a worthwhile endeavor. Marmosets and tamarins rely extensively on vocalizations for communicating both within and between groups, and isolated animals can be stimulated to call by hearing vocalizations from their own or related species.

Downloadable versions of vocalizations can be found in a variety of locations (e.g., <http://pin.primate.wisc.edu/av/vocals/>).

Safety Issues

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As with all primates, marmosets and tamarins do not like handling, and alternatives to handling should be sought. The animals are easily trained to do a variety

of tasks (e.g., present for physical examination, sit on a scale for weighing, voluntarily enter a transport cage). Training works best if the animals are worked regularly and if training occurs before the day's feeding. However, even well-fed animals can be trained with highly preferred food items. Detailed examples and descriptions of procedures can be found in the Callitrichid Husbandry Manual.

Marmosets and tamarins should be handled as little as possible, since they tend to be highly reactive to unusual stressors. For routine procedures that are short (less than five minutes), such as physical examination or biological sample collection, hand-held restraint can work well. Animals can be captured with fine-mesh nets ("butterfly net mesh") and removed by hand. However, the netting procedure can be a major stressor for other group members. Animals can be readily trained to enter a detachable nest box, and removing the animal in a separate procedure room can minimize this distress. Handlers should wear protective leather gloves. A grip from behind the animal's back, with thumb and middle finger underneath the forearms, provides the most secure holding position. Most animals will take treats during this restraint, which can serve as a reward and enrichment during the handling. If handlers are also caretakers, different clothing should be worn during manual restraint procedures to minimize distress for the animals during other routine caretaking activities.

For procedures of longer duration, animals should be given some form of chemical immobilization. Ketamine hydrochloride (intramuscular injection) provides good immobilization for medium-term procedures (5 - 15 minutes) and suggested dosages are provided in the Callitrichid Husbandry Manual. For long-term procedures (more than 15 minutes) inhalable anesthetics are recommended, particularly isoflurane. A cat-sized face mask can be used to deliver the anesthetic. Some facilities have had success in inducing isoflurane anesthesia by placing the animal into an empty 2-liter plastic soda bottle with a removable bottom, and directing the anesthetic gas into the bottle. This procedure minimizes the struggle and stress of placing the mask over an awake and alert animal. For these longer procedures, care should be taken to monitor and maintain core body temperature (warming blanket or warm water bottle) since body temperature can drop quickly in an anesthetized animal.

References

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- Abbott DH, McNeilly AS, Lunn SF, Hulme MJ, Burden FJ. 1981. Inhibition of ovarian function in subordinate female marmoset monkeys (*Callithrix jacchus jacchus*). *Journal of Reproduction and Fertility* 63:335-345.
- Baker JV, Abbott DH, Saltzman W. 1999. Social determinants of reproductive failure in male common marmosets housed with their natal family. *Animal Behaviour* 58:501-513.
- Baker AJ, Savage A. 1999. Social management of callitrichids and *Callimico*. In *Callitrichid Husbandry Manual*. Brookfield, IL: AZA Neotropical TAG.
- Bales K, Dietz J, Baker A, Miller K, Tardiff SD. 2000. Effects of allocare-givers on fitness of infants and parents in callitrichid primates. *Folia Primatol* (Basel) 71(1-2):27-38.
- Byron JK, Bodri MS. 2001. Environmental enrichment for laboratory marmosets. *Lab Animal* 30(8):42-48.
- de Rosa C, Vitale A, Puopolo M. 2003. The puzzle-feeder as feeding enrichment for common marmosets (*Callithrix jacchus*): a pilot study. *Lab Animal*, 37(2):100-107.
- Emlen ST. 1991. Evolution of cooperative breeding in birds and mammals. In JR Krebs and NB Davies (Eds.), *Behavioural Ecology: An Evolutionary Approach* (pp. 301-335). London: Blackwell Scientific Publications.
- Epple G. 1975. Parental behavior in *Saguinus fuscicollis* ssp. (Callitrichidae). *Folia Primatologica* 24: 221-238.
- Epple G. 1986. Communication by chemical signals. In G. Mitchel and J. Erwin (Eds.), *Comparative Primate Biology, Volume 2, Part A; Behavior, Conservation, and Ecology* (pp. 531-580). New York: Alan R Liss.
-
- 12 Farmerie M, Neiffer D, Vacco K. 1999. Enrichment and operant conditioning of callitrichids. In *Callitrichid Husbandry Manual*. Brookfield, IL: AZA Neotropical TAG. pp. 64-89.
- French JA. 1997. Regulation of singular breeding in callitrichid primates. In NG Solomon and JA French (Eds.), *Cooperative breeding in mammals* (pp. 34-75). New York: Cambridge University Press.
- French JA, Inglett BJ. 1991. Responses to novel social stimuli in tamarins: A comparative perspective. In HO Box (Ed.), *Primate responses to environmental change* (pp. 275-294). London: Chapman and Hall.
- French JA, Pissinatti A, Coimbra-Filho AF. 1996. Reproduction in captive lion tamarins (*Leontopithecus*): Seasonality, infant survival, and sex ratios. *American Journal of Primatology* 39: 17-33.
- Heymann EW, Soini P. 1999. Offspring number in pygmy marmosets, *Cebuella pygmaea*, in relation to group size and the number of adult males. *Behavioral Ecology and Sociobiology* 46: 400-404.
- Inglett BJ, JA French, LG Simmons, KW Vires. 1989. Dynamics of intrafamily aggression and social reintegration in lion tamarins. *Zoo Biology* 8:67-78.
- Kinzey WG. 1997. Synopsis of New World Primates (16 Genera). In WG Kinzey (Ed.), *New World Primates: Ecology, Evolution, and Behavior* (pp. 222-296). New York: Aldine de Gruyter.
- Kleiman DG. 1977. Monogamy in mammals. *Quarterly Review of Biology* 52: 39-69.
- McGrew WC, Brennan JA, Russell J. 1986. An artificial "gum-tree" for marmosets (*Callithrix j. jacchus*). *Zoo Biology* 5: 45-50.
- National Research Council. 1998. *The Psychological Well-Being of Nonhuman Primates*. Washington, DC: National Academy Press.

- Poole TB. 1990. Environmental enrichment for marmosets. *Animal Technology* 41(2): 81-86.
- Rukstalis M, French JA. 2003. Exposure to conspecific vocalizations modulates stress responses in marmosets (*Callithrix kuhlii*). *American Journal of Primatology* 60 (Supplement1): 129-130.
- Santos CV, Martins MM. 2000. Parental care in the buffy-tufted-ear marmoset (*Callithrix aurita*) in wild and captive groups. *Braz J Biol.* 60(4):667-72.
- Snowdon CT, Savage A. 1989. Psychological well-being of captive primates: General considerations and examples from Callitrichids. In E Segal (Ed.), *Housing, Care, and Psychological Well-being of Captive and Laboratory Primates* (pp.75-88). Park Ridge, N.J.: Noyes Publications.
- Snowdon CT, Soini P. 1988. The Lion Tamarins, Genus *Leontopithecus*. In RA Mittermeier, AB Rylands, AF Coimbra-Filho and GAB Fonseca (Eds.), *Ecology and behavior of neotropical primates* (Vol. 2, pp. 223-298). Washington, D.C.: World Wildlife Fund.
- Sodaro V. 1999. Social management of callitrichids and *Callimico*. In *Callitrichid Husbandry Manual*. Brookfield, IL: AZA Neotropical TAG.
- Soini P. 1988. The Pygmy Marmoset, Genus *Cebuella*. In RA Mittermeier, AB Rylands, AF Coimbra-Filho and GAB Fonseca (Eds.), *Ecology and behavior of neotropical primates* (Vol. 2, pp. 79-129). Washington, D.C.: World Wildlife Fund.
- Stevenson MF, Rylands AB. 1988. The Marmosets, Genus *Callithrix*. In RA Mittermeier, AB Rylands, AF Coimbra-Filho and GAB Fonseca (Eds.), *Ecology and behavior of neotropical primates* (Vol. 2, pp. 131-222). Washington, D.C.: World Wildlife Fund.
- Tardif S, Carson RL, Gangaware BL. 1990. Infant-care behavior of mothers and fathers in a communal-care primate, the cotton-top tamarin (*Saguinus oedipus*). *American Journal of Primatology* 22: 73-85.
- Tardif SD, Clapp NK, Hence MA, Carson RL, Knapka JJ. 1988. Maintenance of cotton-top tamarins fed an experimental pelleted diet versus a highly diverse sweetened diet. *Laboratory Animal Science* 5: 588-591.
- Wissman MA. 1999. Nutrition and husbandry of callitrichids (marmosets and tamarins). *Veterinary Clinics of North America: Exotic Animal Practice* 2(1): 209-240.

Other Resources

Callitrichid Husbandry Manual, produced by the American Zoological Association. E-mail: bzadmin@brookfieldzoo.org

The Psychological Well-Being of Nonhuman Primates, produced by the Institute for Laboratory Animal Research of the National Resource Council, at <http://books.nap.edu/books/0309052335/html/index.html>

Common Names of the Callitrichids

Marmosets:

- Callithrix acariensis*: Rio Acari marmoset
C. argentata: Black-tailed marmoset, Silvery marmoset
C. aurita: White-eared marmoset, Buffy tufted-ear marmoset
C. chrysoleuca: Golden marmoset, Silky marmoset, Golden-white tassel-ear marmoset
C. emiliae: Sneathlage's marmoset
C. flaviceps: Buff-headed marmoset, Buffy headed marmoset, White-eared marmoset, White-headed marmoset

C. geoffroyi: White-fronted marmoset, Geoffroy's marmoset, Geoffroy's tufted-ear marmoset
C. humeralifer: Santarem marmoset, Tassel-eared marmoset, Black and white tassel-ear marmoset, White-shouldered marmoset, Golden marmoset, Silky marmoset, Yellow-legged marmoset
C. intermedia: Aripuanã marmoset
C. jacchus: Common marmoset, White ear-tufted marmoset, Tufted-Ear marmoset
C. kuhlii: Weid's black tufted-ear marmoset
C. lucippe: Golden-white bare-ear marmoset
C. manicorensis: Manicore marmoset
C. marcai or *Callithrix argentata marcai*: Marca's marmoset
C. mauesi: Rio Maues marmoset, Maues marmoset
C. melanura: Black-tailed marmoset
C. nigriceps: Black-headed marmoset
C. penicillata: Black-eared marmoset, Black ear-tufted marmoset, Black-pencilled marmoset, Black-plumed marmoset
C. saterei: Satere marmoset
Cebuella pygmaea: Pygmy marmoset

Goeldi's Monkey

Callimico goeldii: Goeldi's marmoset, Goeldi's tamarin, Calimico

Tamarins

Saguinus bicolor: Pied tamarin, Bare-faced tamarin, Pied bare-face tamarin, Brazilian bare-faced tamarin
S. fuscicollis ssp: Ávila Pires' Saddle-back tamarin, Crandall's Saddle-back tamarin, Cruz Lima's saddle-back tamarin, Spix's saddle-back tamarin, Lesson's saddle-back tamarin, Illiger's saddle-back tamarin, Red-mantle saddle-back tamarin, Andean saddle-back tamarin, White saddle-back tamarin, Geoffroy's saddle-back tamarin, Saddle-back tamarin, Weddell's saddle-back tamarin
S. geoffroyi: Geoffroy's tamarin, Rufous-naped tamarin
S. graellsi: Rio Napo tamarin, Graell's black-mantle tamarin
S. imperator ssp: Black-chinned emperor tamarin, Bearded emperor tamarin
S. inustus: Mottle-faced tamarin
S. labiatus ssp: Red-bellied tamarin, Red-chested tamarin, Red-chested mustached tamarin, Thomas' mustached tamarin
S. leucopus: White-footed tamarin, Silvery-brown bare-faced tamarin, Silvery-brown bare-face tamarin
S. martinsi: Martin's tamarin, Martin's bare-face tamarin, Ochraceous bare-face tamarin
S. midas: Midas tamarin, Red-handed tamarin, Golden-handed tamarin, Rufous-handed tamarin, Lacepede's tamarin
S. mystax ssp: Moustached tamarin, Red-capped tamarin, White-rump mustached tamarin
S. niger: Black-handed tamarin
S. nigricollis: Spix's black mantle tamarin, Black-mantle tamarin, Black-mantled tamarin, Black-and-red tamarin
S. oedipus: Cotton-top tamarin, Pinche marmoset, Cotton-head tamarin, Cotton-tops, Liszt monkey
S. tamarin: Negro tamarin
S. tripartitus: Golden-mantled tamarin, Golden-mantle saddle-back tamarin
S. weddelli: Weddell's tamarin

Squirrel Monkeys (Saimiri)

A. Michele Schuler, D.V.M., Ph.D

Primate Research Laboratory, University of South Alabama

Christian R. Abee, D.V.M.

University of Texas MD Anderson Cancer Center



enrichment
for nonhuman primates

Squirrel Monkeys

Background

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Habitat

Squirrel monkeys are inquisitive, predominately tree-dwelling primates that spend the majority of their time in the middle level canopy of the forest. Their distribution includes an isolated population in the rainforest of Costa Rica and virtually the entire Amazon Basin of South America. In the wild, squirrel monkeys inhabit most types of tropical forest including both wet and dry forest, continuous and secondary forest, mangrove swamps, riparian habitat, and forest fragments. They are very flexible in their ability to adapt to different environments and, in some geographic areas, appear to prefer habitats that have been disturbed by humans.

Physical Features

The male squirrel monkey weighs approximately 550-1135 grams, while the female weighs from 365-750 grams. The male exhibits an increase in body weight-- particularly in the arms, shoulders and trunk of the body-- during the breeding season, referred to as the “fatted male” syndrome. This increase in body weight is accompanied by an increase in spermatogenesis. The tail of the squirrel monkey is long, but not prehensile. The legs are longer than the arms. The hair coat is short and dense, with coloring ranging from grey-green on the back of the animal to white, yellow or orange on the underside. There is typically a tuft of black hair on the tip of the tail.



Squirrel monkey in a complex, naturalistic environment (photo courtesy of C. Abee).



Wooden branch used as a perch (photo courtesy of C. Abee).

Behavior

Squirrel monkeys are omnivores that eat insects, eggs, and small vertebrate animals, in addition to various fruits, flowers, and tender leaves. In captivity, squirrel monkeys can live to be 25 years of age.

Squirrel monkeys primarily use all four limbs to move, employing their tails for balance as they navigate along tree branches. They occasionally stand on two limbs to walk short distances and to grasp food items with both hands. As a tree-dwelling species, they make use of vertical as well as horizontal space. Although they often descend to the ground or floor of their enclosure, they prefer to leap from perch to perch. Lacking the bone structure for sitting, they perch rather than sit, frequently using their tails for balance. Perches should be round in shape rather than flat shelves, as the development of pressure sores on the tail has been associated with flat shelves.

Social interactions frequently observed within squirrel monkey groups include grooming behaviors, “calling” (i.e., vocalizations), play, displays of aggression, and huddling. Vocalizations help to maintain the social organization of squirrel monkey troops. Squirrel monkeys use calls to enhance group coordination and cohesion. It has been suggested that squirrel monkeys can differentiate individuals using vocal cues and communicate within the troop even when they cannot see each other.

Communication between animals within a given social group includes olfactory, visual, and vocal signals. Olfaction is most important during the breeding and birthing seasons. Males use scent to determine the receptivity to mating of females. In addition, female monkeys use scent to identify individual infant animals. When cleaning the animals' enclosures, it is beneficial to the monkeys to avoid strong, artificially scented products.

Visual cues are of primary importance in visual displays. Squirrel monkeys make these displays in an attempt to assert dominance or reduce tension between individuals. Visual cues involving facial expressions can be associated with fear or aggression. A penile display, associated with spreading of the thighs, is considered to be a dominance gesture. Enclosures should provide a place for a submissive monkey to break the stare of a more aggressive monkey. Such places are called "hide-boxes" and can be made from a piece of a large-diameter polyvinyl chloride (PVC) pipe or another impervious material.

Vocal signals are of the utmost importance for squirrel monkeys. Infants possess a wide repertoire of sounds, including grumbles, cackling, purrs, chucks and peeps. These sounds communicate the well-being of the infant to the mother. In adults, calls are used to signal alarm, to display general disturbance or excitement, and to establish contact with the group when visually separated.

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Mating and Reproduction

Social behavior in squirrel monkeys depends on the phase of the reproductive cycle. These monkeys become sexually mature at approximately three to four years of age. While reproductive efficiency declines beginning at about 12 years of age, they can continue to reproduce for several more years. During breeding season (December through February in the northern hemisphere), male monkeys tend to be more inquisitive, aggressive, and active. At the same time, receptive female monkeys are less likely to respond with an aggressive display or facial expression when approached. After the breeding season, males become less involved in the social group, often remaining on the perimeter of the group. Females tend to perch with other females of similar age. These female-female interactions may include infant-care sharing and grooming behaviors.

The gestation period lasts approximately 168-182 days. During the birthing season (usually May to August in the northern hemisphere), older females without

infants will act as “baby-sitters” or “aunts,” often carrying infants for the mother. This maternal behavior by females other than the mother may include nursing another female’s infant. This is a common characteristic of squirrel monkey breeding groups. Occasionally, juvenile animals can pose a threat to nursing infants as they can be aggressive to the new babies. Care should be taken when housing expectant/new mothers with juvenile animals.

Social World

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Consideration of the needs of squirrel monkeys in captivity should extend beyond their basic physiologic requirements. These animals possess a host of behaviors that define their species. Putting forth the effort to enhance psychological and physical well-being of squirrel monkeys is essential to meeting the needs of this species. Through a well-conceived plan of environmental enrichment, good husbandry practices and a sound program of veterinary medical care, anxiety and boredom can be alleviated and natural behavior typical of this species can be promoted.

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*Carrying of an infant squirrel monkey
(photo courtesy of C. Abee).*

In the wild, squirrel monkeys live in large social groups (“troops”) containing 20 to 200 animals. In captivity, social group size and age and sex ratios differ depending on the limitations of the housing available and purpose for maintaining the animals.

Efforts should be made to house the highly social squirrel monkeys in pairs or small groups whenever possible. Social groups should be maintained with animals born into the social group remaining in

the group as long as is possible. Generally, it is recommended that social groups maintained in captivity include only one or two adult males per group, because



A social group of squirrel monkeys (photo courtesy of C. Abee).

fighting may develop among males if more than two are housed together within the social group. Most of the time, females of varying ages can be housed in social groups of two or more with only occasional difficulties with incompatibilities of group members. In fact, housing multiple females per group provides breeding animals the social structure necessary to reproduce efficiently. To maximize breeding efficiency, as many as 20 females can be housed with a single male. An optimal ratio, however, is one male per eight to ten females.

Groups that have access to a semi-natural environment with more living space are able to accommodate more adult males within the same groupings due to the increased complexity and size of the environment, the possibility of emigration to an adjacent group within the enclosure, and the increased provision of hiding areas.

Physical World

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Housing

Both indoor and outdoor group pens can be designed for squirrel monkeys. Physical comfort of the animals is important in reducing stress and promoting the well-being of colony members. Animals in outdoor pens have the opportunity to control aspects of their environment by moving through their pen (e.g., sun or shade). The animals are generally free to seek the place they wish to spend their time. Animals in these pens can also self-regulate the amount of exposure to other animals by moving

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within their pen. Perches should be positioned at several levels within the living area for climbing and jumping. These perches can be constructed of PVC pipe, which is impervious to water, easily cleaned and not highly thermoconductive. Wood perches can also be used as long as they are replaced once they become excessively soiled or become otherwise deteriorated. As noted previously, flat shelves should be avoided due to the potential development of pressure sores on the tail of the animal. Large PVC pipe sections can be provided for animals to “hide” in, allowing them to break eye contact with other members of their social group during aggressive encounters. Finally, certain positions within the pen allow the monkeys to view, and be viewed by, other social groups, while other positions will greatly restrict the number of other animals the individual can see or be seen by.



*A hiding area for squirrel monkeys
(photo courtesy of C. Abee).*

Animals housed in indoor cages, on the other hand, have a limited ability to regulate their exposure to animals housed in other cages by positioning themselves in such a way as to limit their ability to view other animals. Cage configuration will determine the number of monkeys that can be housed. Rack caging can be used to house small groups, pairs, or single animals.



A plastic chain swing (photo courtesy of C. Abee).

These cages should also have perches at varying heights to enable the animals to maximize their three-dimensional use of space. The *Guide for Care and Use of Laboratory Animals* (NRC 1996) and the Animal Welfare Regulations (1991) provide minimum cage space guidelines and requirements.

In the laboratory setting, it is best to allow the animals to communicate through olfactory, visual, and vocal signals. Even in singly-housed animals, this communication can be preserved by arranging the cages to enable the animals to smell, see, and hear each other. Outside noise should be kept to a minimum so that the group-housed monkeys can hear each other's vocalizations. By group-housing animals whenever possible, communication becomes an important form of social enrichment.

Each cage should be provided with swings, moving perches, or objects hanging within the cage. These can be made of either a plastic chain, looped PVC tube, or other similar materials. Smaller, rack-mounted cages will need to have at least one such device, while larger group cages should have two or more, depending on the number of monkeys in the cage. Loose hanging devices should not be included in individual cages where the room taken up by the swing would limit movement of the animal or where the swing is not appropriate for clinical reasons.

Being neotropical primates, squirrel monkeys thrive in warm temperatures. In captivity, temperatures should be maintained between 78°-85°F. Relative humidity should be maintained above 50% if possible. If relative humidity falls below 30%, squirrel monkeys can develop crusts around the nostrils and frequent sneezing. Special care must be taken in cooler climates to prevent hypothermia.

Enrichment

In all caging conditions, a number of different food items and perch arrangements can be used to vary the environment of the animals and consequently increase activity levels and sensory stimulation. Perch arrangements with hanging objects, such as infant toys and practice golf balls, should be rotated and replaced routinely.



An enrichment item that can be manipulated by the animals (photo courtesy of C. Abee).

Objects must be large enough to prevent swallowing and sturdy enough not to be broken into small pieces. Food treats should be nutritious. Fruit and vegetables must be selected for quality and should be washed prior to feeding.

Occasionally, squirrel monkeys can experience anxiety when exposed to novel stimuli. Care must be taken, particularly with animals in smaller enclosures, to ensure that changes are not distressing to the animals. Animals should be observed after introduction of new objects to determine whether they show signs of fear or avoidance of the object. If this occurs, the object should be

removed. In larger enclosures, this is less of an issue, as the monkeys can move away from new objects and acclimate slowly.



Food items can be suspended, to make them more challenging to consume (photo courtesy of C. Abee).

Feeding

The animal's primary diet should be an appropriate, commercially available diet. In addition, each monkey's diet should be supplemented with fruit and vegetables according to what is seasonally available (although squirrel monkeys can have problems with their teeth associated with a high sugar diet; therefore, vegetables are preferred over sweet fruits). Items may include melon, oranges, apples (note that there is some evidence that apples may be associated with bloat, a frequently fatal disease where the stomach fills with gas), Kiwi fruit, strawberries, pears, bananas, grapes, celery, bell peppers, tomatoes, carrots, and sweet potatoes. Additional items, such as various flavors of Gatorade®, multi-vitamins, and food-pellet rewards for correct responses may be added for experimental or clinical reasons. To encourage foraging, food items can be placed in the cage or pen floor after daily cleaning. This encourages the animals to move about the cage to select their food. Additional food items can be placed in hanging PVC tubes that require the monkeys reach into the tube to find food items.

Highly desired food items should be handed out by caregivers at least twice daily, for example during daily observations of the animals. This positive interaction with caregivers allows the animals to habituate to the caregivers and allows the caregivers to interact in a non-threatening, positive way with the animals.

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Sanitation

Standards for the sanitation of caging for squirrel monkeys housed indoors are well-described in the National Research Council's *Guide for the Care and Use of Laboratory Animals* (1996). However, many squirrel monkeys are housed in semi-naturalistic environments, where they may be exposed to numerous parasite hosts, such as mollusks, frogs, and small snakes as well as soil and water that may have been contaminated by rodents carrying transmissible diseases such as leptospirosis. Sanitation programs should include diligent exclusion of slugs, snails, frogs, rodents, and as many insects as possible—particularly in tropical environments—to minimize exposure of the animals to these parasite and disease hosts.

Special Cases

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Age-related Considerations

If possible, infants and young juveniles should be housed with their mothers and remain within their natal social group. Attempts should be made to find appropriate foster-mothers for newborn infants that are rejected or orphaned. Failing this, or if the newborn is clinically compromised and unable to cling normally to a female, it can be housed in a separate nursery. Nursery infants can be housed in small, wire-mesh cages. They should be given a cloth surrogate mother approximately the same diameter as an adult female monkey to provide contact comfort. Infants in the nursery need frequent, positive contact from the caregivers as part of the feeding schedule. This contact varies from every hour to every four hours depending upon the age of the animal. As the infants grow older and strong enough to interact with other infants, they can be moved to a larger enclosure with other similarly aged infants. The cage should be equipped with multiple levels of perching and swings for the animals to move and jump from one to the next. When nursery-reared infants become old enough (6 - 12 months of age) to eat on their own and move about within a social group with adults, they can be introduced into a social group within the general colony.

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A surrogate "mother" for a nursery-reared infant squirrel monkey (photo courtesy of C. Abee).

Abnormal social behavior (e.g., over- or under-aggressiveness) that is the result of incompatible social partners can result in an individual being removed from its current social group to another social group or individual housing for a period of time. If the animal is a danger to other animals, a qualified veterinarian should determine whether the animal should be placed in an individual cage. In addition, individual housing should be considered when animals cannot defend themselves from the normal dominance-related aggression that occurs in this species and for acute or chronically sick and debilitated animals.

All individually housed animals should be provided with multiple perches, varied foods, and frequent contact with familiar caregivers. The U.S. Department of Agriculture requires that exemptions (e.g., for health or behavioral reasons) from social housing must be recorded by the attending veterinarian. In research programs, the Institutional Animal Care and Use Committee may exempt individual animals from participating in the social enrichment portion of the enrichment program when such housing is justified for experimental reasons. Every attempt should be made to ensure that there is direct visual, auditory, and/or olfactory contact with other squirrel monkeys. Animals that are unable to see and hear other squirrel monkeys may be given access to auditory stimuli from another room containing squirrel monkeys via a microphone-speaker arrangement or a pre-recorded audio tape. Extra contact with familiar caregivers should be provided. In addition to frequent visits, caregivers should provide much-desired food treats. Live prey, such as mealworms and crickets, can be used to increase the stimuli that food treats can provide. Toys, perches, swings, and other hanging devices should be rotated more frequently. Mirrors can also be used to provide sensory stimulation.

Attempts to socially house squirrel monkeys should be documented for both internal tracking purposes and for government regulatory agencies. Some animals that do poorly in large social groups can be housed together with a small number of other animals that similarly can not live in large social groups. This arrangement will allow social contact with other squirrel monkeys while reducing the level of competition for resources.

Problem Behaviors

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Abnormal non-social behavior, including stereotypical movements and self-injurious behaviors, may necessitate a change in housing structures, enrichment objects or reinforcement techniques. For example, “pacing” may be eliminated by increasing the animal’s available travel paths by installing additional perches. Self injurious behavior, such as self hair-pulling and self-biting, often are the result of unusual stress. If such behavior is seen in an animal, an evaluation should be made of the animal’s current social status and housing environment. These animals should also receive a physical examination by a veterinarian to determine their health status.

Safety Issues

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By far the most effective method for restraining squirrel monkeys is the use of leather gloves designed for handling small primates. These gloves provide protection to the human worker while preventing injury to the monkey. As with any restraint technique, technicians must be adequately trained to assure that the animal is restrained without injuring it. With practice and continued vigilance, the use of heavy leather gloves is a safe method of restraint for both the handler and the monkey. The use of nets to catch/restrain squirrel monkeys is not recommended. These animals are prone to fractures of the appendages when nets are used.

Squirrel monkeys can be trained to jump from cage to cage during rack changes. For cleaning of larger enclosures, it is not necessary to remove the animals prior to cleaning as long as noxious chemicals are not used and if the animals can perch above or away from the area being cleaned.

Chemical restraint may be considered by the veterinarian to restrain squirrel monkeys for transport and medical care in an attempt to reduce the stress and hazards associated with working with these monkeys. Ketamine hydrochloride, either with or without xylazine, can be used by the veterinarian for brief sedation.

Squirrel monkeys are wild animals and must be treated as such. They can injure caregivers through bites and scratches. But because they do not carry *Cercopithecine herpesvirus 1* (*Herpesvirus simiae* or B-virus), a bite or a scratch from a squirrel monkey can be treated much like the bite from a domestic dog or cat. Regardless, care must be taken when handling these animals to prevent injury to both the caregiver and the animal.



Use of a leather glove for manual restraint of a squirrel monkey (photo courtesy of C. Abee).

While it is unlikely that infectious diseases would transfer from squirrel monkeys to humans, and vice versa, common-sense precautions should be taken when working with any animal: immunocompromised workers should not handle animals with any known illness; masks should be worn when aerosols are present; any worker with an active upper respiratory infection should not handle animals; and consultation with a health professional may be necessary. Finally, although current human vaccination protocols include vaccination against measles, should an infection occur in any individual who resides with the animal caregiver, that caregiver should avoid any contact with squirrel monkeys until the infection has resolved. Measles spreads rapidly and is fatal in squirrel monkeys.

References

- Abée CR. 1985. Medical care and management of the squirrel monkey. In LA Rosenblum and CL Coe, eds., *Handbook of squirrel monkey research*, 447-488. Plenum Press: New York.
- Abée CR. 2000. Squirrel monkey (*Saimiri spp.*) research and resources. *ILAR Journal* 41:2-9.
- Brady AG. 2000. Research techniques for the squirrel monkey (*Saimiri sp.*). *ILAR Journal* 41:10-18.

DuMond FV. 1968. The squirrel monkey in a seminatural environment. In L.A. Rosenblum and R.W. Cooper, eds. *The Squirrel Monkey*, 31-68. New York: Academic Press.

Dunn FL. 1968. The parasites of *Saimiri*. In L.A. Rosenblum and R.W. Cooper, eds. *The Squirrel Monkey*, 31-68. New York: Academic Press.

Napier JR and Napier PH. 1967. *A Handbook of Living Primates*. New York: Academic Press.

National Research Council. 1998. *The Psychological Well-Being of Nonhuman Primates*. Washington, DC: National Academy Press.

National Research Council. 1996. *Guide for the Care and Use of Laboratory Animals*. Washington, D.C: National Academy Press.

Reinhart V (ed). 1997. *Comfortable Quarters for Laboratory Animals, 8th edition*. Washington, DC: Animal Welfare Institute.

Rosenblum LA, Coe CL (eds). 1985. *Handbook of Squirrel Monkey Research*. New York: Plenum Press.

United States Department of Agriculture, Animal and Plant Health Inspection Service. 1999. *Final Report on Environmental Enhancement to Promote the Psychological Well-Being of Nonhuman Primates*.

.....
14 Williams LE, Abee CR, Barnes SR, Ricker RB. 1988. "Cage design and configuration for an arboreal species of primate." *Laboratory Animal Science*. 38: 289-291.

Common Names of Squirrel Monkeys

Saimiri boliviensis: Bolivian squirrel monkey, Peruvian squirrel monkey

S. oerstedii: Grey-crowned Central American squirrel monkey, Black-crowned Central American squirrel monkey

S. sciureus: Humboldt's squirrel monkey, Ecuadorian squirrel monkey, Common squirrel monkey, South American squirrel monkey

S. ustus: Bare-eared squirrel monkey, Golden-backed squirrel monkey

S. vanzolinii: Blackish squirrel monkey, Black squirrel monkey, Black-crowned squirrel monkey, Black-headed squirrel monkey

enrichment for nonhuman primates



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For more information, contact OLAW at NIH
tel: (301) 496-7163, e-mail olaw@od.nih.gov



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