

- MITTERMEIER, R. A. & FLEAGLE, J. G. (1976): The locomotion and postural repertoires of *Ateles geoffroyi* and *Colobus guereza* and a reevaluation of the locomotor category semibrachiation. *Am. J. phys. Anthropol.* 45: 235–255.
- MORI, A. (1977): The social organization of the provisioned Japanese monkey troops which have extraordinarily large population sizes. *J. anthrop. Soc. Nippon* 85: 325–345.
- PAHO/WHO REPORT (1980): *The Peruvian primatological program in Iquitos: an overview*. Iquitos, Peru.
- RIJKSEN, H. D. (1974): Orang-utan conservation and rehabilitation in Sumatra. *Biol. Conserv.* 6: 20–25.
- RIJKSEN, H. D. (1978): *A field study on Sumatran orangutans (Pongo pygmaeus abeli, Lesson, 1827): ecology, behavior and conservation*. Wageningen: H. Veenman and Zonen B. V.
- SOINI, P. (1972): The capture and commerce of live monkeys in the Amazonian region of Peru. *Int. Zoo Yb.* 12: 25–35.
- SPONSEL, L. E., BROWN, D. S., BAILEY, R. C. & MITTERMEIER, R. A. (1974): Evaluation of squirrel monkey ranching on Santa Sofia Island, Amazonas, Colombia. *Int. Zoo Yb.* 14: 233–240.
- SUSSMAN, R. & TATTERSALL, I. (1981): Behavior and ecology of *Macaca fascicularis* in Mauritius: a preliminary study. *Primates* 22: 192–205.
- TEMPLE, S. (1974): The wildlife of Mauritius. *Oryx* 12: 584–590.
- TSALICKIS, M. (1972): Trapping, husbandry and transport conditions of South American primates destined for research. *Int. Zoo Yb.* 12: 23–26.
- WALSH, J. & GANNON, R. (1967): *Time is short and the water rises*. London: Thomas Nelson & Sons Ltd.
- WRANGHAM, R. W. (1977): Feeding behaviour of chimpanzees in Gombe National Park, Tanzania. In *Primate ecology*: 504–538. Clutton-Brock, T. H. (Ed.). London: Academic Press.

Manuscript submitted 7 July 1981

Breeding New World monkeys at Miami's Monkey Jungle

ROY FONTAINE & MARK HENCH

Department of Psychology, Bucknell University, Lewisburg, Pennsylvania 17837, USA

Monkey Jungle is a zoological park specialising in primates. Since its foundation in the 1930's it has bred a wide variety of Neotropical species. This report will provide a summarised, comparative assessment of the husbandry and breeding at the two major exhibits which have been built for the propagation of New World monkeys, the Marmoset House and the Rainforest, with an emphasis on the latter. Species have been bred successfully in other enclosures too, the Black spider monkey *Ateles paniscus* being the most notable example. The husbandry at Monkey Jungle conforms to the usual procedures expected of a modern zoo, with perhaps the only unusual feature being the provision of auxiliary feeding cages where access is limited to immature monkeys, which can feed there undisturbed by their elders.

THE MARMOSET HOUSE

DuMond (1971) provides a detailed discussion of the rationale behind his design of the Marmoset House. Although the building was originally intended as a breeding facility for Golden lion tamarins *Leontopithecus r. rosalia* (DuMond, 1971, 1972), young have been pro-

duced and reared by other species which have also been housed there, including Goeldi's monkeys *Callimico goeldii*, Red-bellied tamarins *Saguinus labiatus* and Geoffroy's tamarins *S. oedipus geoffroyi*. A number of unpaired animals, usually surplus or confiscated individuals, have also been maintained in the house from time to time including Silvery marmosets *Callithrix argentata*, Saddleback tamarins *S. fuscicollis* and Cotton-top tamarins *S. o. oedipus*. In June 1981 the Marmoset House held, amongst others, 11 Golden lion tamarins in three groups, seven Red-bellied tamarins in two groups, four Geoffroy's tamarins in two pairs, a pair of Saddleback tamarins and a pair of Cotton-top tamarins.

The house contains eight cages, each c. 6 × 5 × 8 m high, which enclose a central thicket of subtropical hardwoods. The thickest limits, but does not entirely prevent, visual communication between groups. Each living area is equipped with a sleeping-box and feeding area sheltered within a concrete block structure, and accommodates a single social unit, usually a breeding pair with immature offspring. Husbandry procedures follow, on

the whole, DuMond's (1972) recommendations for the maintenance of Golden lion tamarins.

Based on DuMond's (1971) hypothesis that each caged section is a limited group territory, delineated by wire partitions, conspecifics (except to facilitate pair formation) are not housed in adjacent cages, so that a buffer zone is formed by the 'territory' of another species. This has helped to prevent intra-species conflict, although the stress associated with fighting between species has not been eliminated; conflicts between neighbouring groups of *L. r. rosalia* and *Saguinus* spp remain relatively common. Also, since conspecific groups remain in at least partial visual and auditory contact, non-contact antagonistic exchanges between them occur with some regularity.

Diet All the animals are fed at 0900, 1000, 1300 and 1600 hours, a sequence which allows for diurnal fluctuations in hunger, and the variety offered ensures that food preferences are catered for. Total quantities are given in bite-sized portions adjusted to the size, number and reproductive state of the animals. The 0900 feed consists of whole-wheat bread soaked in milk, sweetened with honey and fortified with Vi-Daylin multivitamins. At 1000 hours Holiday Brand Marmoset Science Diet, bananas and Gevral protein are given, with a twice-weekly supplement of oranges, wheat-germ and raisins. The 1300 feed consists of sunflower seeds, apples, celery, carrots, lettuce, bananas, grapes, wheat-germ, string-beans and hard-boiled eggs. Groups containing pregnant and lactating Golden lion tamarins also receive milk sweetened with honey and fortified with Enfamil and Vi-Daylin multivitamins. Bananas, live meal-worms and crickets are given at 1600 and a marked preference is shown for these live insect feedings. The animals also catch insect prey in their outdoor enclosures.

Breeding Red-bellied tamarins Two pairs of these tamarins were purchased from a local animal dealer at the beginning of 1978. Infections of intestinal nematodes of the genus *Strongyloides* were detected and treated with

orally administered Mintezol. In January 1980 one of the ♂♂ died of heart failure; it weighed 267 g. After several stillbirths twin ♀♀ were born in March 1980 and twin ♂♂ in April 1981. Appropriate maternal behaviour was displayed towards all the young and they continue to thrive.

Breeding Golden lion tamarins DuMond (pers. comm. 1975) designed Monkey Jungle's Golden lion breeding project as part of an informal consortium which involved institutions interested in the captive breeding of these endangered tamarins. Over the past decade Monkey Jungle has carried out loans and exchanges with other institutions not only to encourage genetic diversity within the captive population but also to form new pairs in cases where behavioural incompatibility among established pairs resulted in breeding failure.

Nevertheless, the breeding record for *L. r. rosalia* at Monkey Jungle, although following general trends for the reproduction and mortality of Golden lion tamarins (Kleiman & Jones, 1977; see also this volume pp 94–101), may fall below the potential for the species. Since the Marmoset House was completed in 1970 there have been 28 live births including 16 ♂♂ and ten ♀♀. The number of breeding ♀♀ has varied between one and three while the population size has ranged from six to 12. In June 1981 the colony included two active breeding pairs which produced twins in 1980 and 1981. Since these births involved captive-bred parents the problem of multigenerational breeding no longer impedes the continued growth of the tamarin colony, and this is consistent with trends in the total captive population of the species (Kleiman, 1977).

Until 1976 seven of the nine births in the Marmoset House were ♂♂. The occurrence of this apparently chance imbalance, together with a high incidence of stillbirths, limited the breeding potential of the group for several years. Although the reason for the stillbirths remains unknown, stress caused by fighting with other groups was believed to play a role in inducing some of the miscarriages. The installation of a second wiremesh barrier between adjacent groups prevented contact aggression between them, while the placing of

a finer gauge welded wiremesh over the 2.5×5 cm mesh of the original outer structure prevented the callitrichids from fighting with free-ranging Crab-eating macaques *Macaca fascicularis*. The additional barriers did not prevent vocal and visual antagonistic exchanges, however, which continued to occur. Nevertheless, a reduced stillbirth rate followed the modifications although other factors such as differences in the age, parity, health and identity of breeding ♀♀ may also have been influential. A final challenge was infant mortality resulting from the failure of some infants to obtain adequate nourishment from an otherwise competent breeding ♀. A programme of supplemental hand-feeding, which overcame the difficulty while allowing the infants to remain within the family group, proved successful (DuMond, Hoover & Norconk, 1979). From 1976 to June 1981 nine ♂♂ and eight ♀♀ were born and survived.

THE RAINFOREST

DuMond (1968) and Fontaine & DuMond (1977) have provided detailed descriptions of the Rainforest which is a semi-natural environment through which runs a 400 m path which allows the visitor to see all sections of the enclosure. It consists of a 1.6 ha patch of 'hammock' or subtropical hardwoods modified to resemble a Neotropical wet forest by heavy plantings of exotic hardwoods, palms and aroids, and surrounded by a cleared grassy area, 5–10 m in width. The area is enclosed by a 2.1 m high chicken-wire fence with the upper 80 cm covered in sheet metal inclined inwards at a 20° angle. This arrangement provided a useful barrier in the early years when newly introduced wild monkeys persistently tried to escape, and although later some of the established occupants learned to negotiate the fence, they usually remained within 300 m of the enclosure during their wanderings.

In recent years two modifications, similar to features described by DuMond (1968) for the original macaque enclosure, have been made. An electric wire, mounted on offset insulators, has been installed along the top of the fence, and a wire-covered walkway made of creosote-treated wooden poles and 2.5×5 cm 14-

gauge welded wiremesh has been built to protect the visiting public from monkey bites.

Although only Common squirrel monkeys *Saimiri sciureus*, Red uakaris *Cacajao calvus rubicundus*, Red howlers *Alouatta seniculus* and Saddleback tamarins have bred in the Rainforest during the past decade, many other species have lived there since its completion in 1960. These have included Douroucoulis or Night monkeys *Aotus trivirgatus*, Monk sakis *Pithecia monachus*, Dusky titis *Callicebus moloch*, Golden lion tamarins, Goeldi's monkeys and Cotton-top tamarins; most lived in the Rainforest for brief periods during the early- to mid-1960's. With the exception of the titis, no new species were introduced during the 1970's.

Although we concentrate on the four primary Rainforest inhabitants, a brief mention of the species which failed to adapt may be valuable. Golden lion tamarins, Cotton-top tamarins and Goeldi's monkeys seemed initially to adapt well, the two last producing live young within two years. High mortality at introduction, however, plus suspected hawk *Buteo* spp predation (especially in the case of Golden lion tamarins who threatened hawks from exposed perches), and the hazard to infants caused by the summer rains (when up to 50 cm can fall in a single continuous four-day storm) resulted in their being relocated in 1964. Since then the only callitrichids living in the Rainforest have been groups of the common and secretive Saddleback tamarin.

A number of difficulties were encountered while attempting to establish Monk sakis (DuMond, 1967) and Douroucoulis. DuMond suggested that an acute susceptibility to the virus *Herpes saimiri* may have been the primary factor underlying the failure of these species to survive for more than a few years. Consequently, new introductions are limited to those species which are believed to have a resistance to this virus, which is probably carried by the thriving squirrel monkey population.

In May 1978 a pair of Dusky titis was purchased from a local primate importer. Although they displayed social behaviour indicative of normal pair-bond formation, it seemed likely that their extreme tendency to avoid humans would lead to problems of

adjustment. In order to adapt them gradually to frequent contact with people and to other aspects of life in the Rainforest, the titis were kept for about two months in a $2 \times 2 \times 2$ m high cage in a quiet section. They were then moved to a similar cage very near the feeding station so they could observe the daily routine for about one month prior to release, and finally, in August 1978, they were set free. Within three days they had escaped into a 4 ha hammock jungle adjacent to the Rainforest where they have been seen regularly by Monkey Jungle personnel ever since, apparently subsisting on food growing in the area. Although neither author has seen them recently, Monkey Jungle employees report their continued presence and offspring were seen in November 1980.

General husbandry A policy of non-interference provides the chief rationale behind many of the practices employed. Animals in the exhibit are not given regular veterinary care because the trauma of capture and separation from the social unit usually serves only to aggravate the original symptoms. Furthermore, sick animals often remain undetected because they hide in the canopy or remain immobile for long periods. Veterinary care, then, is provided only if a suitable opportunity arises. Most monkeys are presumed dead when they are no longer seen, and deliberate searches normally prove unproductive, so autopsies are not usually performed. Also, Rainforest inhabitants are occasionally exposed to predation by native fauna, with hawks and the constrictor *Elaphe quadrivittata* proving the greatest threats.

Husbandry is largely limited to ensuring a constant and adequate food supply, keeping the food pans and feeding area clean, controlling vermin and making occasional attempts at mass control of *Strongyloides* by blending Mintezol into provisioned foods. Nevertheless, the breeding record for most of the species which have established themselves compares favourably to that of institutions offering much greater and more expensive care; squirrel monkeys in particular show a marked response to conditions in a semi-natural environment.

Diet The monkeys are provisioned to make sure that a stable food source is available to compensate for seasonal fluctuations in the abundance of naturally occurring foods, and so that they can be more easily observed by the visiting public. Provisioning takes place at three arboreal feeding stations, which are small framelike structures about 7 m apart. Food is placed in aluminium pans which are then raised about 4 m by a chain and pulley to the waiting monkeys. The feeding times (1000, 1230, 1400, 1500 and 1630 hours), ingredients and amounts reflect overall food preferences, diurnal fluctuations in hunger, seasonal abundance of foraged foods and the reproductive state of the large squirrel monkey colony. The 1000 feed consists of a mash of 1.5 kg whole-wheat bread, 1.5 litres milk, 30 ml Vi-Daylin vitamins, 120 ml honey and six eggs. In addition, raisins, mealworms and a pan containing 1 litre milk, 2 ml Vi-Daylin and 10 ml honey are made available. With the exception of the Red howlers, this feed normally attracts all the monkeys in the Rainforest. At 1230 1 litre by volume sliced carrots, beans and celery, six oranges and 2 litres of Purina Monkey Chow with raw peanuts added are offered. Although only about 70% of the squirrel monkey colony attends this feed, and the tamarins are frequently absent, all the Red howlers and uakaris usually appear. The 1400 feed is made up of 2 litres grapes, 0.2 litres sunflower seeds and 6 litres peanuts. Both the 1500 and 1630 feeds consist of roughly 5 kg bananas and a few chopped apples. These three feeds usually attract all species, although squirrel monkeys may be present in only reduced numbers. After 1700, 10 litres of peanuts and Monkey Chow are placed at the provisioning site so that all monkeys can help themselves throughout the evening and early morning.

The monkeys all obtain a substantial proportion of their diet through foraging. The diversity of plant forms in the Rainforest yields a relatively reliable year-round supply, albeit at a level inadequate to sustain the population fully. Nevertheless, foraging remains an important activity. For example, more than 100 foraged items consumed by the uakaris have been recorded (Fontaine & DuMond, 1977),

and observations of the other species suggest that they too consume a wide variety of items. The large number of insects and other prey eaten by squirrel monkeys and tamarins probably provides them with an important protein supplement. In addition to its nutritional benefits, foraging may help reduce stress levels as compared with caged environments because the animals are provided with a wider variety of activity.

Breeding Red howlers DuMond (1967) recorded that the eventual establishment of a group of five Red howlers involved 30 imported specimens in four introductions between 1962–1966. The main difficulty was conflicts between newly introduced Red howlers and established inhabitants, including conspecifics. Malnutrition linked to a failure to adapt to the public feedings constituted a secondary problem.

Between 1967–1971, once the core group was established, there was only one death. The remaining four animals became a successful breeding unit which produced a single young in each of the years 1971–1973. The first-born, a ♂, remains in good health, but unfortunately the ♂ born in 1972 died in its first year. A ♀ born in 1973 died with its mother in the hard winter of 1977; the other wild-caught adults have also died which means that a single captive-bred adult ♂ is all that remains of the Red howler troop.

The difficulty experienced in adapting this delicate species suggests that a captive howler group can probably best be established if a large intact breeding unit can be collected from the wild instead of relying on the stock of unknown quality usually offered by animal dealers.

Breeding Red uakaris The original group of Red uakaris was established during 1961–1963, and Fontaine & DuMond (1977) present a detailed account of their breeding until 1975 when the group consisted of six animals, four of which were captive bred. At that time there was great optimism about the group's future because it included breeding adults of both sexes which were themselves captive bred. Since 1975 three ♀♀ and a single ♂ have been

born bringing the total to 13 births, a number of uakaris equivalent to that used in the formation of the group. Unfortunately, between 1975–1981 the group showed a net loss. In June 1981 it included only three individuals: a captive-bred adult ♂ and a c. 20-year-old wild-born ♀ with her ♀ infant, born in August 1980.

The uakaris, in contrast to the other species, were observed continuously for long periods throughout the 1970s and consequently few significant events within the group have been overlooked. Autopsy data have revealed a wide range of disorders associated with the seven deaths noted since 1975, four of which were young animals. A two-year-old ♂ died with a hepatic cyst yielding compromised liver function complicated by secondary pneumonia. The autopsy of a ♀ aged 16 months revealed enlarged mesenteric and abdominal lymph nodes and an apparently blanched kidney suggestive of renal dysfunction, and also showed some consolidation of the left diaphragmatic pulmonary lobe consistent with pneumonia. A 12-month-old ♀ died of acute tubular nephritis. The autopsy also revealed haemorrhages of the heart and lungs consistent with shock combined with lymphoid and splenic depletion. Two individuals, a ♂ aged ten and a ♀ aged two years and nine months apparently succumbed to acute leukaemia, with the juvenile case complicated by secondary pneumonia. The loss of two breeding adult ♀♀, however, has represented the most serious setback to the group. In 1977 a wild-born ♀ which had produced four young died after 17 years. The autopsy suggested that death resulted from shock caused by inflammatory lesions associated with acute enteritis and glomerular nephritis. In 1978 an eight-year-old captive-bred ♀ died of a myocardial infarct. Autopsy also revealed evidence of a hyperactive parathyroid, a pale liver and very brittle bones. Unfortunately, the autopsy records, which show no consistent trend in the causes of death, suggest no obvious improvements which could be made to the husbandry of the species.

The small size of the Red uakari group probably added to its breeding difficulties. Several years without an adult ♂ obviously

reduced the number of captive births to a level well below the potential of the species. With so few adult $\sigma\sigma$ available, and for such brief periods, the likelihood of behavioural incompatibility between potential mates was increased; also, the small size of the group served to exaggerate the negative effect of each loss, since the death of each adult meant that birth potential was reduced by 25–100%.

It is possible that a larger initial stock of Red uakaris (perhaps around 30) would enable a group to become self-perpetuating, for despite various setbacks the original animals appeared to have adapted well (Fontaine & DuMond, 1977). We feel there is good reason to believe, therefore, that the high mortality which characterised the howlers' arrival would not occur in a large single introduction of uakaris.

Breeding Saddleback tamarins DuMond (1971) noted that the Rainforest provided a relatively inefficient model for the breeding of callitrichids since its large area could accommodate only a single social unit which would include just one breeding ♀. After several unsuccessful attempts with small groups, DuMond (1967) released 19 Saddleback tamarins into the Rainforest in 1964, but by 1966 only five remained (Mazur & Baldwin, 1968). From 1966–1971 seven live young were born, apparently to the same ♀. The group increased to 12 tamarins and split into two social units; the breeding ♀ and five others remained behind while six tamarins escaped from the Rainforest and have not been seen since. Following the death of the ♀ the Rainforest group slowly declined so that by 1974 only two animals were left. Eight more tamarins were therefore released into the area but this number fell rapidly, the reason being unknown. Then, from 1975 to June 1981 there were 18 live births, and the total number of tamarins produced (25) was beginning to approach the number used to form the colony (39). As in the case of the uakaris, the basic problem was a population size which was so small that the death of a single individual could bring breeding to a complete halt.

Breeding Common squirrel monkeys Although the breeding record for Red howlers, Red

uakaris and Saddleback tamarins does not compare unfavourably with that of most zoos, only the Common squirrel monkey has truly thrived in the Rainforest. From 1961–1980 there were an estimated 900 live births, more than enough to replace the 47 animals used to form the colony.

DuMond (1967, 1968, 1969) and Baldwin (1968) have described the early history of the Rainforest squirrel monkey colony, and Cooper, Scollay & Bailey (1976) offer a comprehensive assessment of the recent population dynamics and reproductive characteristics of the group.

The colony was started by DuMond in August 1960 with 37 adult squirrel monkeys from Peru (DuMond, 1967). Less than a year later, at the end of April 1961, eight to ten live births had occurred (DuMond, 1968). In 1965–1966 a further 4.6 adult Peruvian squirrel monkeys were added to the troop (DuMond, 1968), and no subsequent introductions have since been made. The population was estimated at 85 animals in July 1966 (Baldwin, 1968) and an annual rate of increase of between 35 (1967) and 80 (1972) young meant that the numbers had swelled to 210 by the time Cooper, Scollay & Bailey made their survey (1976). Since then a few dozen monkeys (mostly young $\sigma\sigma$) have been removed for research and the population has stabilised at roughly 180 individuals.

In the early 1970's the range of the troop began to extend beyond the Rainforest limits to include an additional 8 ha of forested land. The Rainforest proper still remained as the core area within this larger home range, with the monkeys normally returning to sleep and take advantage of the public feedings. DuMond (1968) noted the beginnings of this tendency when he described how groups of 'bachelor' $\sigma\sigma$ spent long periods outside the enclosure. During 1973–1976, however, when the population grew most rapidly and reached its maximum size, the monkeys leaving the Rainforest included the full range of age-sex categories. A common pattern developed: about 150 monkeys would leave around dawn for forested areas to the west and south of the Rainforest and return around 1000 hours to feed; a midday activity period centred around

the exhibit, and after the 1700 feed they departed to the forests to the east and south-east for intensive foraging until dusk, finally returning to the Rainforest for the night. These wanderings have been considerably reduced firstly by the addition of an electric wire to the top of the Rainforest fence, secondly the conversion of 3 ha of land outside the Rainforest into an additional exhibit, and thirdly the introduction of the feed of peanuts and Monkey Chow during the early morning and late afternoon. One of the reasons the monkeys continue to forage beyond the Rainforest's boundaries may be because the supply of small animal prey inside does not meet their demand.

Monkey Jungle's striking success with squirrel monkeys has important implications for the breeding of these animals for research, particularly in their native countries. The Rainforest arrangement provides an example of an 'intermediate technology' (Schumacher, 1973) applied to the husbandry and breeding of a primate species. As such, it involves neither great capital expenditure nor the need for highly trained personnel. Indeed, most of the capital expenditure at Monkey Jungle is a result of the need to make it an attractive place for visitors rather than the need to make it suitable for squirrel monkeys.

In 1978 the first author was privileged in being able to tour the Common squirrel monkey breeding colony of Proyecto Primates at Iquitos, Peru. Although the project has enjoyed some success with *Saimiri*, the breeding record fell well below that reached at Monkey Jungle. The project, using models developed by more affluent countries, had invested heavily in concrete and plumbing without apparently having taken full advantage of the relatively cheap land and labour available. It seems possible that a high yield of squirrel monkeys might be produced if the Rainforest model could be adapted to local conditions.

ACKNOWLEDGEMENTS

The authors are grateful to Monkey Jungle, Mrs Mary DuMond and the late Frank V. DuMond for supporting our research activity at Monkey Jungle by providing housing and unrestricted access to the study site. We also wish to thank Peter Balcaen, Tom Farrell, Mary

DuMond and the Monkey Jungle staff for providing us with information about Monkey Jungle's many breeding programmes.

PRODUCTS MENTIONED IN THE TEXT

Enfamil: human infant formula, manufactured by Mead Johnson Nutritional Division, Mead, Johnson & Co., Evansville, IN 47721, USA.

Gevral protein: powdered protein concentrate, manufactured by Lederle Laboratories Division, American Cyanamid Company, Pearl River, NY 10965, USA.

Mintezol: Thiabendazole, MSD, manufactured by Merck, Sharp & Dohme, West Point, PA 19486, USA.

Purina Monkey Chow: prepared dry pellets, manufactured by Ralston Purina Company, St Louis, MS 63188, USA.

Holiday Brand Marmoset Science Diet: manufactured by Hill's Division, Riviana Foods, POB 148, Topeka, KS 66601, USA.

Vi-Daylin: multivitamin supplement, manufactured by Ross Laboratories, Division of Abbott Laboratories, Columbus, OH 43216, USA.

REFERENCES

- BALDWIN, J. D. (1968): The social behaviour of adult squirrel monkeys (*Saimiri sciureus*) in a seminatural environment. *Folia primatol.* 9: 281-314.
- COOPER, R. W., SCOLLAY, P. A. & BAILEY, R. C. (1976): *A study of the population dynamics and reproductive characteristics of squirrel monkeys in the semifree-ranging, provisioned environment of the Monkey Jungle in Goulds, Florida.* Final report, [PD-270684] to Animal Resources Branch, National Institutes of Health.
- DUMOND, F. V. (1967): Semi-free-ranging colonies of monkeys at Goulds Monkey Jungle. *Int. Zoo Yb.* 7: 202-207.
- DUMOND, F. V. (1968): The squirrel monkey in a seminatural environment. In *The squirrel monkey*: 88-146. Rosenblum, L. A. & Cooper, R. W. (Eds). New York: Academic Press.
- DUMOND, F. V. (1969): A further note on the behaviour of semi-free ranging squirrel monkeys *Saimiri sciureus*. *Int. Zoo Yb.* 9: 149.
- DUMOND, F. V. (1971): Comments on minimum requirements in the husbandry of the golden marmoset (*Leontideus rosalia*). *Lab. Primate Newsl.* 10: 30-37.
- DUMOND, F. V. (1972): Recommendations for a basic husbandry program for lion marmosets. In *Saving the lion marmoset*: 120-136. Bridgwater, D. D. (Ed.). Wheeling, WV: Wild Animal Propagation Trust.
- DUMOND, F. V., HOOVER, B. L. & NORCONK, M. A. (1979): Hand-feeding parent-reared golden lion tamarins *Leontopithecus rosalia rosalia* at Monkey Jungle. *Int. Zoo Yb.* 19: 155-158.
- FONTAINE, R. & DUMOND, F. V. (1977): The red ouakari in a seminatural environment: potentials for propagation and study. In *Primate conservation*: 167-236. Prince Rainier of Monaco & Bourne, G. H. (Eds). New York & London: Academic Press.

KLEIMAN, D. G. (1977): Progress and problems in lion tamarin *Leontopithecus rosalia rosalia* reproduction. *Int. Zoo Yb.* 17: 92–97.

KLEIMAN, D. G. & JONES, M. (1977): The current status of *Leontopithecus rosalia* in captivity with comments on breeding success at the National Zoological Park. In *The biology and conservation of the Callitrichidae*: 215–218. Kleiman, D. G. (Ed.). Washington, DC: Smithsonian Institution Press.

MAZUR, A. & BALDWIN, J. (1968): Social behavior of semi-free ranging white-lipped tamarins. *Psychol. Rep.* 22: 441–442.

SCHUMACHER, E. F. (1973): *Small is beautiful*. New York: Harper & Row.

Manuscript submitted 24 July 1981

The management and breeding of New World monkeys at London Zoo 1972–1981

BRIAN C. R. BERTRAM

Curator of Mammals, The Zoological Society of London, Regent's Park, London NW1 4RY, Great Britain

Among the 48 species of primates kept at London Zoo over the past ten years have been 16 species of New World monkeys (Table 1). The choice of species depends on several different and often conflicting factors. As the national collection, we aim to keep a wide and representative range of species. We also aim to keep especially those species for which we can perform a useful conservation function. At the same time, being dependent on gate revenues for almost all we do, exhibits must be attractive and interesting to our visitors. Species which thrive well in the accommodation we can provide are, not surprisingly, particularly well represented. Finally, an important factor is the availability of the species, especially since legislation against rabies means that any primate imported into Great Britain must spend its first six months in quarantine. The accommodation for this is in short supply and often rather cramped.

ACCOMMODATION

The primates at London Zoo are housed in two types of accommodation. The Michael Sobell Pavilions for Apes and Monkeys, described in detail by Toovey & Brambell (1976), are more suitable for larger species and at present only two South American species are held there. The outdoor enclosures, c. 40 m² and 3·65 m high, are constructed from a metal space-frame system covered with 100 × 40 mm weldmesh. Each leads to a glass-fronted indoor enclosure c. 30 m², off which (and off-

view) are three small temporary holding dens. During the day, the animals have free access both to the outdoor and main indoor enclosures through doorways which are fitted with plastic flaps to retain heat; the doors are operated from outside the enclosures. The indoor accommodation is heated by a warm-air system and in the viewing dens the air is blown down the inside face of the windows and extracted through the rear service area. In cold weather condensation on the windows is a problem, and at certain times reflections may make viewing less than perfect.

Most of the New World monkeys in the collection are housed in the Charles Clore Pavilion for Small Mammals (Brambell, 1970) in indoor glass-fronted cages which range in size from 2·2 × 1·8 × 2·2 m high to 3·4 × 2·5 × 2·2 m high. The walls are fibreglass coated and the asphalt floors are covered in a layer of peat some 30 cm deep. A limited amount of sunlight enters through a skylight in each cage, and can be supplemented with fluorescent electric light. Furnishing and decorating the cages has become almost an art form; using rocks, logs, gravel, sand, branches, twigs and growing plants, the keepers produce some superb environments which meet their inmates' needs while being attractive and providing good visibility for the public. The heating and ventilation system is similar to that in use in the Sobell Pavilions; i.e. a single air supply enters at the front of the cage and is drawn out via the service pass-