

are not yet cricket-proof, we are obliged to remove the metathoracic legs. Liquid intake is apparently slight, but powdered milk and vitamin-enriched water are provided *ad lib*.

Apparently this species will tolerate any group composition; though adult males do fight (Wharton, 1950), it is thought that the synchronised introduction of several males minimised aggression when our groups were established. Further, two females were introduced to a cage in which a male had been living alone for three months. During the first few hours, very little movement occurred (it was dusk), and no detectable aggressive interactions occurred either then or since. Crepuscular behaviour was observed through a one-way plastic screen; while the tarsiers moved and fed freely, no inter-animal encounters were seen. Obviously, for behavioural studies reversal of their light-cycle is indicated, since activity is greatest between 0100 and 0500 hours (Harrison, 1963). A similar rhythm has been noted in studies of the angwantibos *Arctocebus calabarensis* in this colony (Wallen, unpublished).

Our experience suggests that attempts to

induce *Tarsius* to change over to a predominantly non-living diet should be successful. So far, the condition of our animals does not indicate that they have a critical need for exclusively live and active prey.

The survival of these tarsiers promises to provide material which will help to fill a major gap in the information on primate social behaviour.

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Semi-free-ranging colonies of monkeys at Goulds Monkey Jungle

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The main purpose of Goulds Monkey Jungle is to display primates naturalistically in semi-free-ranging environments and to establish them in social units that closely approximate those of their natural habitats.

The environment consists of a 15-acre 'hammock' or subtropical hardwood patch of jungle. These hammocks or jungle islands dot the extreme southern tip of the lower eastern coastal region of Florida. The jungle ecology is typical of the Caribbean and tropical American rain forest. The hammocks are, in most instances, the northern limit of the range of the broad-leaved trees found in them, whose southern range extends to Central and South America.

The average annual rainfall for this area is approximately 130 cm, with a dry season during the winter and early spring. The relative humidity rarely drops below 30 per cent and rises to above 90 per cent during all but a very few nights of the year. The mean relative humidity averages about 72 per cent throughout the year, and the mean maximum relative humidity averages 92 per cent for the year.

The temperature ranges are subtropical (Lat. 25.3° N) but the lower ranges occur for very brief periods when a mass of polar air may push this far south, usually several times during the winter, when the temperature may drop to below freezing for several hours just before dawn. It is

during these brief cold spells that the humidity may fall to below 30 per cent. While these periods of cool weather have clearly had a bad effect on the more delicate species when caged, they have presented no obvious problems with the same species once they were established on free range in the rain forest area; even such species as the Hairy saki *Pithecia monachus* and White-lipped tamarins *Leontocebus nigricollis* are not affected.

The indigenous broad leaf vegetation provides a considerable part of the diet of the primates, and many of the plant species listed as part of the diet of the howler monkey on Barro, Colorado, in Dr Carpenter's classic field study (Carpenter, 1934) are to be found in the hammock.

I feel that this environment provides the most favourable habitat in the United States for the establishment of colonies of tropical primates; a habitat, moreover, that gives the primates the best opportunity of forming natural societies and exhibiting social behaviour very closely approximating that which occurs in their natural habitats.

At present there are two main primate groups in the jungle. One is a colony of Crab-eating or Javan macaques *Macaca irus*, living in approximately six acres of the available jungle; the other is an attempt at establishing a true ecological group of South American rain forest primates. There are five species of Upper Amazon monkeys, free-ranging in the subtropical jungle, which has been modified so that it resembles a tropical American rain forest.

THE MACAQUE COLONY

In 1933 six Crab-eating macaques *Macaca irus* (two males and four females) were released in the hammock. After they had become accustomed to each other in a community cage for a period of several weeks they were released, one by one, over a period of several days. The island of jungle is surrounded by relatively barren pine woods where the trees are sparse, so that as tree-to-tree travel is not possible beyond the confines of the hammock, they are discouraged from completely abandoning the protective security of the dense vegetation of the hammock. After a period of hiding when they were not seen at all, they began moving about their new environment. Food was placed in certain trees at regular times until they learned to return regularly to be fed.

They began breeding in 1934 and their numbers have increased to the present population of an estimated 150 animals. Although the last of the original monkeys died in 1955, the first monkey to be born in the colony (in 1934) was still alive in 1966, aged 32 years. The young are born during the late summer and autumn. They are given intensive maternal care for the first five to six months, then gradually become more independent of the mother by the time she has the following year's baby. In spite of this increasing independence, a definite bond of relationship exists between mother and offspring, at least throughout the growth period. With females this relationship may be lifelong, so that in intra-tribal disputes the family clans can be seen coalescing to form clan battle groups.

The seasonality of the time of birth has one interesting effect on the development of the baby monkeys: there is a group of young animals with a very close age range that form a peer group for play at a very early age. A group of mothers, usually from the same family clan, all with young only several months old, is frequently formed. While the mothers groom each other, the babies begin to learn to play together and at the same time learn the fundamentals of social behaviour, that later result in the individual becoming an integrated adult member of the social unit. Harlow and Harlow (1965) state that six-month deprivation of the peer or age mate affectional relationship irrevocably impairs the development of normal social heterosexual capabilities. Seasonal birth groups seem to foster the development of very early age mate affectional relationships.

The macaque colony exhibits the autocratic male overlord social behaviour that has already been observed in the very similar Japanese macaque *Macaca fuscata* (Itani, 1959; Kawamura, 1959; and Imanishi, 1957) in the field.

Vegetation in the jungle has not been added to as the macaques, although they are not so much leaf eaters as the new world monkeys in the rain forest, are very much more destructive, immediately destroying any new plantings within their territory. Consequently, though they have not been particularly destructive of the native hammock, it has not been possible to develop the jungle environment in the way that has been done in the rain forest area of the South American monkeys.

In the macaque area wired-covered walkways

had to be erected to protect human visitors as the macaques defend the territorial limits of their tribe. The walkways are 2.2 m high, and 2.4 to 3 m wide, constructed of creosote treated wooden poles covered with 2×12 cm welded mesh of 14-gauge wire. Along the lower 70 cm we had to put up an additional 12×12 mm hardware cloth mesh, to prevent children from poking their fingers through to the monkeys.

At first when the colony was released there were no human residents or cultivated groves nearby, but as time passed residential buildings and groves were developed adjacent to the Monkey Jungle. This presents a problem with the adventurous and aggressively curious macaques. After a number of years employing air rifles with BB pellets to control their raiding and plundering in the adjacent groves and buildings, in 1950 an electric fence was erected round the six-acre territorial area of the macaque tribe. The fence is about 2.1 m high and has three electrically charged wires, mounted on offset insulators, along the top 30 cm of the wire. This has proved effective only in so far as that there is no longer a whole tribal migration into a grove at certain times when it is in fruit. However, small groups still continue to make raiding forays and these have to be controlled with the air rifles.

The macaques are fed by the visitors with peanuts and raisins. They are also fed additional supplementary food at hourly intervals by the lecturer who gives them bananas and other fruits to make them come near and to get them to swim and dive in the pool. The pool is surrounded by stands for public viewing.

SOUTH AMERICAN RAIN FOREST EXHIBIT

The natural hammock vegetation made a good basis for the development of typical American rain forest vegetation. More than 150 species of South American forest palms, 20 species of *Philodendron*, 15 species of surface aroids, and many *Ficus* plants of an unidentified species were planted as a food source. More than 50 other species of tropical American forest trees have also been planted in the hammock. The entire four-acre area has been covered with a sprinkler system that is turned on for two hours every second morning, unless it has rained within the past 24 hours. The annual precipitation (rainfall plus irrigation) is more than 457 cm.

Since the ground supply of water maintains a year-round temperature of approximately 22.2°C , the sprinkler system has been very effective in preventing cold damage to the more tropical plants during our infrequent cold weather. In half the area the sprinklers are in the trees, about 6 m above the ground, to increase the total wetting of the forest. In the other half the sprinklers are placed only 1.5 m above the ground so that on cold mornings, when the system is used as a temperature regulator, the primates do not get wet. They learn where the sprinklers are located in the trees and avoid these areas when they go to sleep at night.

The entire rain forest area is surrounded by a fence, 2.1 m tall, with the upper 80 cm covered with smooth metal to prevent the monkeys from climbing out. This is particularly effective during the critical stage when new monkeys introduced to the area often try to escape from the area. Later, when they become well established, some learn to climb the fence and venture out for brief periods, but they do not leave the general area. This has happened with Squirrel monkeys *Saimiri sciureus*, White-lipped marmosets and the uakaris *Cacajao rubicundus*, but not with the Red howler monkeys *Alouatta seniculus* or the Hairy saki monkeys.

The jungle canopy is as high as 18 to 21 m in areas not destroyed by recent hurricanes, where it is only about 12 m high. The path is 1.2 m wide and is not roofed with wire. The path is about 400 m long and redoubles once in the centre of the rain forest so that all sections of the jungle can be seen and the monkeys are in sight somewhere along the path nearly all the time.

The monkeys in the South American rain forest area are fed six times daily. Pans suspended under racks, 4.5 m above the ground, are raised on to the racks by pulleys. There are two feeding stations in the trees, about 6 m apart. Each has two pans holding three quarts. The diet consists of bananas, apples and peanuts fed three times a day; at the other three feeds the monkeys are given bread soaked in milk and vitamins, whole liquid milk, various fruits in season, green vegetables, sunflower seeds, grapes and peanuts.

During the three years that the rain forest area has been open to the public, visitors have only been attacked on one occasion. The attack was made by two male uakaris which had been semi-tame before

they arrived at Goulds, and when they became sexually mature they became violently aggressive towards people. They were therefore removed from the rain forest to a nearby cage.

SQUIRREL MONKEYS IN THE RAIN FOREST

On 3 August 1960 a male Squirrel monkey *Saimiri sciureus* was introduced in the rain forest to test the newly-constructed fence. After the monkey was seen for the first time on 6 August, two males and four females were introduced to the rain forest. At first they were extremely timid, racing to the far end of the forest enclosure if they saw anyone. On 16 August 11 males and 19 females were released together into the rain forest. About five or six animals died. By 18 August nearly all the monkeys had learned to eat at a temporary feeding station.

The first birth occurred on 24 February 1961 and many other females were observed to be heavily pregnant. Considering that the gestation period is a little over five months, the Squirrel monkeys adjusted to their new environment with unexpected rapidity. The females must have come into oestrus and mating must have occurred within six weeks of the monkeys being introduced to the area. By the first week in April when the birth season had finished about 10 viable births had been recorded.

In the succeeding years until 1964 the birth season was slightly later. In 1962 the young were born from 21 April, in 1963 from 10 May and in 1964 from 30 June. Since then the first births have occurred on 18 June in 1965 and on 12 June in 1966. Thus the mating and birth seasons have changed from autumn mating and late winter/early spring births as is found in the Amazon area, to early spring mating and summer births in the Florida area. I had originally thought that the change might be influenced by the increase in plant growth that takes place in the Florida spring, but similar seasonal change has been recorded in captive animals at primate research centres in the United States, where the monkeys are fed on a constant diet of monkey chow throughout the year. Possibly there could be some phototropic influence involved. At present, until more research has been done, we can only speculate as to the causes behind the changes in the breeding cycles.

The social organisation of the group seems to be very subtle and ill-defined. Unlike so many

primate species, there does not appear to be a well-defined dominance hierarchy. In spatial relationships the adult females tend to associate more closely among themselves than with the other monkeys in the group. This provides a peer relationship environment for the developing young. It resembles the peer relationship already described for the macaques, but appears to be more defined. This could be an important factor, considering the relatively short growth period of the Squirrel monkeys. If seasonality did not exist it might mean new-born young attempting to form peer relationships with individuals a third grown.

The adult males also tend to associate more closely with each other than with the other monkeys. There is also a third group consisting of juveniles not yet independent of the mother but not sufficiently developed to join the adult groups. Any dominance relationship, even within the sub-groups, is very subtle and is still undefined.

Reproductive behaviour is affected by group relationships. As the adult male and female groups come into contact with each other when all or nearly all the females are in oestrus, reproductive activity may be initiated by one or more males. The usual stimulus of observing sexual activity in others seems to induce greater sexual activity on the part of the observer. At times many of the adult males and females are mating simultaneously. Again, there is no apparent dominance hierarchy displayed during courtship or mating and no apparent contests over the females occur. Consort relationships appear to be very transitory. The only tension observed at this time has been a transitory irritability (lasting no more than few seconds) displayed by one male to another that may be in a better position for coitus. It is not uncommon for two or more males to make copulatory thrusts at the same female.

Maternal care seems to be mainly passive. Most of the time the infant is carried, clinging dorsally to the mother's fur. When suckling, the baby moves somewhat laterally and pokes its head under the mother's armpit to reach the nipple. However, if danger threatens the mother becomes more active maternally, and if her baby is separated from her she will rush to pick it up before fleeing herself. The only co-operative group activity observed among the Squirrel monkeys was once when a baby was trapped under one of the rodent

live-catching traps placed round the area to control the rat population. One of the keepers, while I was present, started to release the young Squirrel monkey. When he approached the trap between five and 10 females suddenly became protectively aggressive on behalf of the apparently endangered infant. They vocalised and made threat gestures towards the keepers. The infant was released, grabbed by one of the females (presumably the mother) and the tension rapidly subsided. No males were observed to join in this isolated example of group display.

The young, after several months of play with peers (made possible by the close groupings of the mothers) gradually become more independent and by the time the mother appears to be heavily pregnant again, are more or less independent of the mothers and become associated with a group of juveniles or subadult individuals, when they are observed to spend most of the day playing and foraging as a group.

RED UAKARIS IN THE RAIN FOREST

Over a period of a year when four animals died, a group of eight uakaris *Cacajao rubicundus* (one adult male, four adult females and three juveniles) was finally established in the rain forest. The uakari is a relatively intelligent primate and quickly adapted to the new environment.

A viable baby was born on 23 June 1963 and this was probably the first recorded birth of the species outside the Amazon valley, the uakari's natural habitat. In the summer of 1964 two more babies were born to different females and both survived. Since then no more young have been born. The adult male is in poor condition and has had periodic bouts of diarrhoea. We are hoping to add another adult wild-caught male to the group.

RED HOWLER MONKEYS IN THE RAIN FOREST

We had considerable more difficulty in establishing a group of Red howler monkeys *Alouatta seniculus* in the rain forest. In 1962 a pair was introduced but never learned to eat from the feeding station. They subsequently died of malnutrition during the winter when the plant growth they had been eating virtually ceased. Although much of the rain forest is green throughout the year, growth decreases during the winter and old leaves do not have the food value (in particular protein) of the growing tips. In July

1963 nine howler monkeys were introduced. At first they were put in a cage very near the feeding station so that they could observe the daily feeding routine for several days before they were released. However, all but two of them died, most of them following falls after being chased by one of the two aggressive uakari monkeys. At postmortem they were discovered to have badly fractured skulls. This was the only case of inter-specific conflict observed among the species in the rain forest, except among the marmosets. Since the two aggressive uakaris were removed, inter-specific aggression has ceased.

In July 1963 five howler monkeys (two adult males, two adult females and one young male) were added to the two surviving females of the previous group. These immediately solicited contact with the two adult males. One pair was observed copulating within 10 minutes of release. The two original females undoubtedly helped the two males to adjust to the rain forest, but they aggressively chased the two new females away and these subsequently died. One of the females adopted the young male, exhibiting much of the maternal behaviour recorded by Carpenter (1934), bridging large gaps with her body, allowing the baby to cross on her body, carrying it, and rushing to it if it were alone for a short period and started making 'mother calls'. On one occasion the female was seen chasing a small grey squirrel away from the path of the baby which had appeared too frightened to cross the squirrel's path. Unfortunately the young male died several months later from an intestinal infection.

By the winter of 1965-66 only one female remained alive. One male died as the result of Hurricane Betsy, the others died from unknown causes (apparently in excellent health). In March 1966 14 new Red howler monkeys were introduced. Again the solitary adult female was responsible for the adjustment of the four that survived, and for the rejection that led to the death of the remaining 10. A group of five apparently healthy and well-adapted howler monkeys has now been formed and it is hoped that they will reproduce.

WHITE-LIPPED TAMARINS IN THE RAIN FOREST

The only other group sufficiently well established for me to be able to report on it is the group of

White-lipped tamarins *Leontocebus nigricollis*. After several attempts with small groups that were eventually decimated by hawks and owls, a group of 19 was introduced. The population has stabilised at an estimated 10 marmosets. One viable birth was recorded on 10 July 1965 and another on 22 April 1966. Both of these births appear to have been single young, rather than the expected twins. In both cases the mother was seen to transfer her young from time to time to another adult marmoset in the group, possibly the father, though the sex was not identified. (In captivity the father marmoset has been observed sharing in the parental care of the offspring.)

The White-lipped tamarins show marked defensive group behaviour when one individual is endangered or threatened from outside. On one occasion a tamarin that had injured itself on a thorn and could not keep up with the group was captured for treatment. It started making cries of terror. The remainder of the group immediately appeared and, making threat calls, gave every indication that they would attack me had I not sought cover in a nearby building. The separated tamarin failed to respond to treatment and died.

OTHER SPECIES IN THE RAIN FOREST

We have had great difficulty in establishing the Hairy saki monkey *Pithecia monachus* and at present there are none in the rain forest. The last one was apparently caught by a hawk or an owl. One pair survived for more than two years. One was killed by the hurricane in 1965 and the other died, presumably because of the loss of its companion. Although the saki monkeys adapt more readily than some of the other primates to the feeding station system, they must have a

companion or they seem to lose interest in living. However, the survival record indicates that potentially there is good chance of establishing these fragile primates in a viable social unit.

There are two Cotton-headed tamarins *Leontocebus oedipus* that have more or less associated themselves with the White-lipped tamarins. We do not intend to add any more to the rain forest as they do not seem to be suited to the Peruvian Amazon ecology that has been developed in the rain forest.

In general, the project has provided us with a unique opportunity to observe the social behaviour of South American primates in an environment that approximates very closely to their natural one. Valuable information is being collected on primate husbandry and on the techniques of establishing self-perpetuating colonies of species of primates that until now have never been kept or bred successfully. The future implications of this experiment in the establishment of colonies for providing primates for research colonies or for breeding endangered species for conservation is obvious.

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