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THE BEHAVIOR AND CONSERVATION OF THE GOLDEN LION TAMARIN, *Leontopithecus r. rosalia*

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INTRODUCTION

Lion tamarins are the largest of the callitrichids, with a long silky pelage. The face is almost bare and surrounded by a mane derived from long hairs on the crown, cheeks, and throat which obscures the ears. The hands and digits are extremely long, with a web partially uniting the digits of the hand. Three forms make up the genus *Leontopithecus*; they are currently considered subspecies (Hershkovitz, 1972; Coimbra-Filho and Mittermeier, 1973). The taxonomy of *Leontopithecus* has been discussed by Hershkovitz (1977), Coimbra-Filho (1969, 1970 a) and Coimbra-Filho and Mittermeier (1972).

L. r. rosalia, the golden lion tamarin, was historically found in the coastal forests of the states of Rio de Janeiro (formerly Guanabara) and Espirito Santo (23° S, 44° W to 20.5° S, 40.5° W) south of the Rio Doce. The range is now reduced to remnant forests in the Rio São João Basin in Rio de Janeiro, which are scattered and probably total considerably less than 900 km² in area (Coimbra-Filho and Mittermeier, 1973; 1977 b). There is a new biological reserve, Poço das Antas, about 100 km northeast of Rio de Janeiro, in Silva Jardim County, State of Rio de Janeiro.

Leontopithecus is found in what Rizzini (1963) describes as "lower montane forest", a subdivision of the "Atlantic forest". According to Coimbra-Filho (1977), there no longer exists in this part of the Rio de Janeiro state an entirely primitive forest formation. Instead, remnants of this once diverse ecosystem are found throughout the region and the remaining sections of better quality forest are in various stages of secondary succession. The commercially valuable tree species have long since disappeared as a result of intensive logging. Other human activities, such as agriculture and the creation of pastures for cattle, have contributed to the serious deforestation of this region.

For the past 20 years, Coimbra-Filho and colleagues have been working intensively to ensure the survival of *Leontopithecus* in the wild. These efforts have resulted in (1) the creation of a series of Biological Reserves for each of the three forms of *L. rosalia*, and (2) the development of a primate breeding facility (CPRJ) for the captive propagation of *Leontopithecus* and other rare primate forms endemic to Brazil.

Despite these efforts, the numbers of lion tamarins in the wild have steadily decreased, with the remaining populations being sufficiently small (100-200 individuals of each form) that their survival in the wild is precarious.

During the past decade, *Leontopithecus rosalia rosalia* has been the focus of long-term studies at the National Zoological Park, Smithsonian Institution. A major goal has been the breeding and management of the species thus research efforts have concentrated on reproduction and social behavior (see refs. Kleiman, Mack, Hoage, Green, Rathbun). In this paper, I will review some of the major findings from our behavior and reproductive research, emphasizing how results have been applied to improving the captive propagation of the species. I will also review the current status of the captive population outside Brazil and describe plans for the future rehabilitation and reintroduction of captive-born animals into the wild.

REPRODUCTION

Lion tamarins are seasonal, with the majority of births occurring between February and August in the Northern Hemisphere and between September and February in the Southern Hemisphere (Coimbra-Filho and Mittermeier, 1973; Coimbra-Filho and Maia, 1979; Kleiman, 1977 a; Kleiman *et al.*, in press a). Captive golden lion tamarin females in the Northern Hemisphere who produce a litter early in the season (e. g. February and March) often have a post partum estrus and bear a second litter. There has been a successive increase in the number of captive females bearing two litters per year, based on data in the International Studbook for *L. r. rosalia* (Kleiman *et al.*, in press a). This suggests that improved nutrition has permitted greater productivity. In the wild, females may only bear and rear one litter a year, but reproduce twice if the first litter is lost.

The litter size of *L. r. rosalia* ranges from one to three, with twin litters occurring about 65% of the time. The Los Angeles Zoo (Crotty, pers. comm.) reported the first instance of quadruplets in *L. r. rosalia* in 1981. The percentage of triplets may also be increasing (Kleiman *et al.*, in press a).

Based on the intervals between copulatory activity and birth, the gestation of *L. r. rosalia* averages 129 days (range 125-132 days; Kleiman, 1977 a). Sexual activity often follows a birth by three

to 10 days (Snyder, 1974; Wilson, 1977; personal observations), although conceptions do not always result from post-partum copulations.

Pregnancy is often difficult to detect, even late in gestation, since the long fur obscures the increased size in some females. However, there is a well-defined period, midway through pregnancy (about nine weekes post-conception), when sexual activity is common (Kleiman and Mack, 1977). If the behavior change is observed, it can be used, in conjunction with behavior data at conception, to predict an accurate birth date. The sexual activity occurs shortly after a drop in urinary gonadotropins (Kleiman *et al.*, 1978).

Sexual behavior is more common in recently mated pairs, compared with pairs that have co-habited for a long period and produced offspring (Kleiman, 1977 b). In the latter, estrus may only be detected through changes in other behaviors correlated with sexual activity, such as increased approaches and sniffs by the male (Kleiman, 1977 a), since copulations are so infrequent. Estrus may also be hard to detect in some newly paired animals, since sexual activity may occur after animals are first introduced, independent of the estrous cycle.

The length of the ovarian cycle is not fully known, and, as with other New World monkeys, appears highly variable. Intervals between peaks of sexual activity in several females (some of which did not immediately conceive) were about 14 to 21 days (Kleiman, 1977 a). The ovarian cycle of other callitrichids is about 15 to 16 days (e. g. *Callithrix jacchus*, Hearn, 1977).

Copulatory activity at estrus is correlated with increased approaches, sniffs, and allogrooming by the male. A tongue flicking display may also be given although its expression is highly variable among individuals. Females exhibit increased approaches and sniffs of the male two to four days prior to peak sexual activity, suggesting that proceptive behaviors are well-developd in lion tamarins (Kleiman, 1977 a). At the time of maximum sexual activity, females exhibit an increase in frequency of the arch back display (Rathbun, 1979) and a decrease in scent marking activity (Kleiman, 1977 a). Mating behavior by an adult reproductive pair often results in social tension within a family group.

Data on the reproductive cycle, including the estrous cycle, gestation, and typical breeding patterns, and the behavioral changes correlated with reproduction have permitted better management of the species in that we can predict and anticipate major reproductive events which might require a rapid management response.

SOCIAL BEHAVIOR

Lion tamarins appear to be monogamous, and to live in nuclear or extended family groups. Within a captive group, only a single

pair reproduces, regardless of the age, familiarity, or genetic relatedness of other group members. Thus, reproductive inhibition (both behavioral and physiological) of subordinates (in artificial groups) or relatives (in family groups) is a major characteristic of the species (Kleiman, 1978, 1979, 1980), at least in captivity.

In the absence of the opposite sex, pairs of adult same-sexed animals may co-habit without aggression. Once a relationship is established between a heterosexual pair, a trio of adults can be formed which may prove stable over prolonged periods, e. g. six months to a year. A reproductive pair will emerge and the third animal will assume the role of a subadult or juvenile. Thus, all individuals in the trio will groom, huddle, and rest as a group, without obvious dominance-subordinate interactions (Kleiman, 1978; 1980).

Instability in both artificial and family groups is usually noticeable from an increased frequency of the arch back display (Rathbun, 1979), and not from clear-cut dominance-subordinate interactions. Such instability may appear when young daughters approach 12 months of age, or when the reproductive female approaches estrus. However, some very young females (< 9 mos.) who were hand-reared and being introduced to an intact family group for socialization have been attacked. Conspicuous dominance interactions are infrequent within established groups, although displacements and approach/avoid interactions regularly occur.

Mated pairs are always tolerant, except shortly after birth when the female may exhibit some defensive behavior towards the mate and other family members that approach and attempt to steal young. Newly-formed pairs and pairs without young tend to interact more frequently than long-established pairs (Kleiman, 1977 b). The major social interactions include sniffing, allogrooming, and huddling. Mated pairs who have reproduced rarely play with each other, although each pair member may play with juveniles.

Mated pairs may be more difficult to distinguish in large family groups since they interact frequently with offspring. Two characteristics, however, make the mated pairs stand out from other group members. (1) The mated pair tends to scent mark more frequently than all juveniles, except occasionally subadult male offspring. Moreover, mated pairs may scent mark the same location in alternation (Mack and Kleiman, 1978). (2) Mated pairs duet. The Long Call is usually initiated by one member of the pair, at which point the mate joins in. Although subadults possess all components of the Long Call, and very occasionally join in, the Long Call duet is typically restricted to the adult reproductive pair (McLanahan and Green, 1977; Green, 1979).

Alternation of grooming roles occurs although among mated pairs, the male invariably grooms the female more frequently and for a longer duration than the reverse (Kleiman, 1977 a, 1980).

There is typically more allogrooming between a mated pair than between any other dyad in the family group (Kleiman, unpublished), except during the early post-partum period when juveniles and subadults may extensively groom the new infants and mothers. This attention is often coupled with attempts to "steal" infants.

Adults in different groups are aggressive to one another. As already mentioned, visual contact often leads to high arousal, with considerable locomotion, piloerection, and vocalizing. In our experience, injuries often result when two captive groups have had the opportunity to make physical contact through small openings between enclosures.

In captivity, it is difficult to discern the slow process which would lead to the eventual dispersal of offspring from the family group. Both Rothe (1978), for captive *Callithrix jacchus* and Wolters (pers. comm.) for captive *Saguinus oedipus* have prepared sociograms of family interactions which clearly indicate the differential direction and form of interactions among family members. Some of their conclusions are consistent with our qualitative (and some quantitative) observations on *Leontopithecus*. First, social and potentially agonistic interactions are more common within the same age class, i. e. littermates are more likely to interact than siblings of different ages. Second, social and agonistic interactions are more common among same-sexed than opposite-sexed animals, including the reproductive pair and their offspring. Agonistic interactions seem to predominate in litters of the same sex as they approach puberty, resulting in "twin fights". We have observed a "dominant" littermate attempting to exclude a twin from group huddles by swatting and chasing. The excluded animal may produce the "rasp" vocalization common in disturbed infants and juveniles, and may show evidence of extreme fear such as constant withdrawal from any approach by a family member. Twin fights alone are less serious than other forms of family conflict and usually do not result in serious injury (Evans, pers. comm.).

Females appear to be more aggressive than males (Kleiman, 1979, 1980), in that females are more regularly attacked and killed in social or family groups than are males. The outbreak of aggression is unpredictable, although it seems most common during a change in the reproductive status of the dominant breeding female, i. e. during a regular estrus, a mid-pregnancy "false" estrus or after a birth. It appears as though all group members may participate in attacks on single individuals that result in death although the initial conflict may only be between two animals. Conflict between same-sexed twins may result in parents exhibiting aggression to offspring. We have had a mother fatally attacking a daughter, after conflict between the twin daughters. However, conflict among daughters may also result in injuries to mothers. Two adult breeding females have been attacked by daughters, one fatally.

More serious injuries and deaths to females seem to occur when there are more female juveniles present than male juveniles. The ages of young animals killed or seriously wounded in family groups range from three months to 18 months. Injuries are rarely seen in young prior to nine months of age, but seem most common at the onset of puberty.

It would seem unlikely that family conflicts would lead to death in nature. Instead, peripheralization and eventual dispersal seems a more likely consequence, with increased mortality due to a lack of viability of solitary individuals. However, the consequences of parent-offspring conflicts in captivity, i. e. death mainly of young females, can be avoided by removing daughters from their families before major reproductive changes. Thus, these findings have significantly affected management strategies.

PARENTAL CARE AND DEVELOPMENT

Most births occur at night. Young cling to the mother from birth and crawl from the dorsal surface (where they are carried) to the venter for nursing. Young typically cling close to the nape (Hoage, 1977).

First transfers to the father and/or older offspring occur between Day 2 and Day 27, with triplets and twins being transferred before singletons (Hoage, 1977). Average dates of first transfer for four females were 14.2 days for singletons (N = 6 litters) and 8.6 days for twins (N = 9 litters) (Kleiman, 1980). Other factors which affect the date of first transfer include the previous parental care experience of both parents and the degree to which juvenils (or the mate) attempt to "steal" young. The response of the father and older offspring may vary from gingerly touching infants to deliberately pulling them off the mother, depending on their experience with handling young and "motivational" level. Some mothers aggressively repel family members from approaching, thus precluding early transfers. All mothers eventually begin to scratch and rub off the young, thus facilitating the transfer by arousing the young.

During the early neonatal period, the parents and older offspring are primarily responsible for transfers. An eager individual may literally pull an infant off a carrier, using the hands to dislodge the clinging young. More often the individual nudges the infant, by inserting its nose and head between the back of the carrier and the chest of the neonate, and thus encourages transfer to its head and back. Infants later may climb independently onto a relative after the latter approaches the carrier and presents or "presses" its body against the infant. It is likely that infants gain their first experience of clinging to the father and older siblings at night while in the nest site, when the family members are huddled

together. Aroused infants (e. g. when hungry) vocalize, and the vocalizations appear to elicit a retrieval response, thus facilitating the transfer of young back to the mother for nursing.

Infants are carried almost the entire time until three weeks of age when they begin to climb off the carriers. Carrying is rare after 12 weeks, but startled or frightened infants may occasionally jump onto an adult or subadult up to 24 weeks of age. Hoage (1977, 1978, 1982) summarizes the distribution of carrying behavior as follows: Mothers are the principal carriers through Week 3, with fathers predominating thereafter. Juvenile females may begin carrying earlier than juvenile males; juveniles rarely carry after Week 8. Both adults and juveniles appear to carry infants of their own sex, preferentially. Primiparous parents with previous exposure to infants are most successful as parents. Experience with infants during the juvenile phase may be critical for successful reproduction, especially among females who must carry infants from parturition until first transfer. However, males and females have successfully reared offspring without previous infant experience.

Infants first begin investigating solid food at three weeks of age, by touching and mouthing food held by an adult or older sibling. By six to eight weeks, infants are beginning to take food from parents or older juveniles; they begin to sit and eat at the food dish from Week 8. This is the stage when other animals begin to take food from the infants. As infants mature, they obtain increasingly fewer food items from other group members and more from their environment, especially from the food dish. The development of food sharing and stealing and its function in family social relations is discussed by Hoage (1978, 1982), Green (1979), and Brown and Mack (1978). Weaning occurs at about 12 weeks of age.

The same sex biases that are seen in infant carrying are also seen in other social behaviors, e. g. food sharing, allogrooming, sniffing, and low intensity agonistic encounters between young tamarins and other group members (Hoage, 1978, 1982). Such biases persist through the first year of life and are especially apparent between young and parents.

First occurrences of adult sociosexual behavior in juveniles may occur much earlier than the regular use of such behaviors. For example, circumgenital and sternal scentmarking have been observed as early as 11 and 21 weeks respectively (Hoage, 1978, 1982), but more regular use of scent marking patterns does not occur until much later. Most young males are regularly scent marking before 12 months of age, even within the natal family group, while young females rarely scent mark regularly until after they are paired with a male for breeding (Kleiman and Mack, 1980). Females generally seem to exhibit adult sociosexual behaviors later than do males, suggesting that they are behaviorally inhibited while still living in the family group.

Play is an important social activity engaged in by young animals. Young tamarins engage in play (as both initiators and targets) with adults and older and younger siblings. The number of littermates and older siblings present in a family group determines who will be an infant's principal play partner. A singleton born in a family with older offspring will have older siblings as primary playmates. Most often twins are born, thus, an infant usually plays first with a twin sibling. Parents tend to be infrequent playmates of young lion tamarins (Kleiman *et al.*, in press b). However, although parents and young tamarins play together only occasionally, some contrasts in their play patterns develop between the 28 th week and the 52 nd week postpartum for young. Same sex play between fathers and sons and mothers and daughters remains constant; however, a considerable drop is noted between sons and mothers while a substantial increase is seen between daughters and fathers. These patterns hint at the possibility that as young approach adulthood mothers become increasingly disinterested in interacting with sons while the attraction between fathers and daughters may be increasing. In part, this may account for some of the aggressive interactions described above between mothers and daughters.

STATUS OF THE CAPTIVE POPULATION

Concerted efforts towards the preservation of the golden lion tamarin in captivity were not initiated until approximately 10 years ago. Since then numerous changes have occurred, many of which are based on research results, including:

1. development of an International Studbook for the captive population of *L. r. rosalia*, which provides up-to-date information on annual changes in the captive population and the breeding history and genealogy of any animal;
2. development of an international co-operative breeding program for captive *L. r. rosalia*, which emphasizes the exchange and loan of specimens. Control of the captive golden lion tamarin population is now in the hands of an elected Management Committee, and the vast majority of owners and holders of the species have signed a Cooperative Research and Management Agreement and adhere to a Management Plan as well as the Management Committee's recommendations. This new development permits the sound demographic management of this species, such that the future growth of the population will be controlled and managed, based on sound genetic and demographic principles;

3. preventing communication, especially visual interactions between reproductively active family groups and reducing the number of such groups within a single building to reduce social tension and stress;
4. ensuring that juveniles obtain experience of parental care before they are paired as adults, involving in some cases the introduction of hand-reared juveniles to an unrelated family group;
5. removing pubertal animals from the family at the first sign of intrasexual conflict, which, especially among females, can result in fatalities;
6. developing preventative medicine programs, including screening of individuals for evidence of diaphragmatic hernias (see below);
7. maintaining an outbred population;
8. improving nutrition through ensuring access to Vitamin D_3 (in the diet or through exposure to UV or natural sunlight) and reducing fruit and increasing animal protein in the diet;
9. developing successful hand-rearing techniques;
10. preventing exposure to species which carry diseases of particular danger to lion tamarins, e. g. reducing contact with humans, cebids and some Old World monkeys which may carry *Herpes* and measles;
11. housing family groups at several different sites to prevent disease transmission from one site to another.

Despite these changes, the survival of the captive population was seriously in question as recently as 1976 (Kleiman, 1977 b). Exports of wild-caught animals from Brazil ceased in 1969 and from then until 1975 the population slowly declined since the recruitment of captive-born animals barely kept pace with the deaths of the imported stock. By 1975 only 19% of the population was still wild-caught as compared with 62% in 1969 and the total number of animals had declined by 13 specimens.

However, management changes and careful monitoring of the population did have an eventual effect. Finally, after six to eight years of stagnation, the population doubled between 1975-1980, as the wild-caught population decreased from 97% (1966) to 4% (1980). This change in captive population status was accompanied by changes in reproductive and other characteristics of the golden lion tamarins which were now into the third and fourth generation born in captivity (see Kleiman *et al.*, in press a).

One of the most noticeable differences is the increased average weight of the population. Most weights recorded from wild-caught individuals and captive-born animals from the mid-1960's to early 1970's ranged from 500-650 g. Recently average adult weights have ranged from 650-750 g and one pregnant female at the National Zoological Park topped 900 g.

Also, since 1967 the average litter size has increased. Currently 20% of all litters born are triplets, and in 1981 the Los Angeles Zoo reported the first recorded birth of quadruplets. In 1975 the average litter size was *ca.* 1.8 but in 1979 and 1980 litter size averaged 2.1.

The average age of the breeding population has altered over time but appears to be stabilizing. The current mean breeding age 4.4 years for females and 5.6 years for males represents the continuation of a recent lowering of the mean breeding age as more captive-born females enter the breeding population.

Also, there seems to be a slight lowering in the average age at first conception (resulting in full-term birth); 17 females born in 1976 and 1977 first conceived at a mean age of 29.3 months, compared with previously published pre-1975 data of 31.3 months. The corresponding age for males for first insemination was 28.3 months ($n = 16$ born 1976 and 1977) compared with 28.7 months previously calculated (Kleiman and Jones, 1977).

Many females now have two or more litters a year, resulting in an expansion of the birth season from six to eight months a year, a factor which has also added to the population expansion.

Infant and juvenile mortality (defined as dying within the first calendar year) have also altered and currently average 40-45% compared with 50-60% between 1970 and 1975. However, this is still high and does not take into account wastage from abortions which have not always been reported to the Studbook and are sometimes difficult to detect.

The captive population has shown some stable trends with respect to birth and death. Throughout the captive history of the species, significantly more males have been born (273:210, $X^2 = 8.22$, d. f.$= 1$, $p < 0.01$) but male infant mortality is generally higher, usually resulting, except between 1967-1972, in a balanced sex ratio. As management has improved, fewer animals of unknown sex have been recorded, i. e. stillborn young are sexed before disposal.

In recent years, the number of captive golden lion tamarins has increased dramatically, and it is now likely that the subspecies will survive, at least in a captive condtion. However, the current captive population of *L. r. rosalia* is derived from limited founding stock and although deliberate outcrosses will control the level of inbreeding for several generations, deleterious effects may eventually arise. Significant inbreeding may eventually occur not only because the origins of the founding stock are unknown and several imported individuals may have already been related but also because some individuals have contributed a disproportionate amount of genetic material to the current population. For example, one female (Studbook no. 67-M) at NZP produced a total of 41 young (18.19.4) up to May 1981, of which 26 (11.15.2) have survived and many are breeding. We recently estimated that four males had contributed

genetic material to 90% of living males and 80% of living females. This realization has resulted in a major effort to conserve and encourage the reproduction of animals with rare genetic backgrounds and to remove from the breeding population many animals with similar genetic backgrounds. In addition, in 1980, the Brazilian Government, through IBDF and Dr. Adelmar Coimbra-Filho of CPRJ permitted the export on breeding loan of five new animals to the United States.

Also, a diaphragmatic defect, in which liver and intestines migrate into the chest cavity, and which results in reduced viability, has already been expressed in *L. r. rosalia* (Bush *et al.*, 1980). By 1982 it had been found in 12 animals from five separate institutions, with apparently unrelated founding stock. The incidence in the whole population is about 6%. It may prove to be a widespread and persistent problem whose eradication will be difficult, if not impossible, if it derives from a single recessive gene.

Recent projections of the growth of the captive population have suggested that there may be as many as 900 captive females (total population about 3500 animals) by 1990 unless growth rate is controlled (Kleiman *et al.*, in press a). Significant efforts to prevent excessive inbreeding, control population growth, stabilize the genetic contribution of the founding stock, and eliminate the diaphragmatic hernia all provide new and very different challenges for the coming decade which are as important to the future of the captive golden lion tamarin population as the efforts of the previous decade.

REHABILITATION AND RE-INTRODUCTION

The availability of surplus captive-bred animals and the formal creation and securing of the Poço das Antas Reserve for *L. r. rosalia* has provided the opportunity for the initiation of a study of the behavioral ecology and population dynamics of golden lion tamarins, associated with a pilot program for the acclimatization and release of captive-born specimens back into the wild. Spare information exists on lion tamarins in the wild. Various ecological and behavioral observations are summarized in Coimbra-Filho (1969, 1970 *a*, 1970 *b*, 1976, 1977) and Coimbra-Filho and Mittermeier (1973, 1977 *a*, 1977 *b*).

The Poço das Antas Reserve for *L. r. rosalia* consists of an area of approximately 5,000 hectares bordered on the north by a major highway, BR 101, on the west by the São João River, and on the east by the Alcela River. Numerous hills and valleys cover the reserve with the range of elevation being between 50 and 150 meters. The northern and southern portions of the reserve contain low-lying seasonally flooded marsh lands. The forest habitat is not continuous and is of several different types. In fact, it is estimated that the Reserve contains only 2,000 hectares of forest, and of this, mature forest comprises only 25%, or 500 hectares (Green, in preparation).

The area for the Poço das Antas Reserve was originally identified in 1971 when more than 70% of the land was densely forested (Magnanini, 1977). The Reserve was not formally created until March 1974, and approval given to expropriate the authorized land. In April of 1975, an aerial reconnaissance showed that the original proposed area of 3,000 ha was then less than 40% forested, and dense forest comprised less than 10%. Thus, the intervening four years had resulted in many plots being deforested and burned, planted with several pasture grasses, or reforested with eucalyptus. In addition roads, trails, drainage channels, homes and fences had been constructed. These changes led to a modification of the original reserve boundaries, excluding some land and adding other adjoining parcels, resulting in a final reserve area of about 5,000 ha. The actual transfer of possession of this area to the responsible governmental agency, IBDF (Brazilian Forest Development Institute) did not occur until 1977. The Poço das Antas Reserve currently requires reforestation and restoration. As part of the behavioral ecology and reintroduction study of *L. r. rosalia*, it is intended that the critical resources of the species will be identified and a restoration program implemented, to increase the carrying capacity of the Reserve.

There have been few release programs for endangered primate species which involved long-term monitoring of the released animals. Konstant and Mittermeier (in press) discuss releases, translocations, etc. of South American primates and caution on any attempts to re-introduce such an endangered species as *Leontopithecus*. While there are many potential problems in developing a *Leontopithecus* reintroduction program, such a project can succeed if the participants are flexible enough to change direction and alter goals, depending on progress. The major issue is the ensured protection of the extant wild population, and no activities which threaten its survival can be permitted.

The currently proposed schedule for the reintroduction program includes:

1. at least six months investigation of the behavioral ecology of the extant wild population of *L. r. rosalia* whose goal is (a) an accurate census, (b) determination of group size and composition, and (c) feeding and shelter requirements of the species. Radiotelemetry will be used to monitor the long-term behavior of selected individuals.
2. determination of the carrying capacity of the habitat in Poço das Antas and initiation of a Restoration program to increase carrying capacity.
3. transport of 10 to 15 captive-born *L. r. rosalia* to a newly built quarantine station at CPRJ, and adaptation of these animals to the climate and natural foods of Brazil. The animals will spend at least six months in quarantine to ensure that they

are disease-free and do not transmit any diseases to the captives at CPRJ. During this period, they will be trained in foraging techniques and anti-predator behaviors will be strengthened, until they perform at least as well as the wild-caught captive *L. r. rosalia* at CPRJ.

4. initiation of a conservation education program locally in the State of Rio de Janeiro and especially near the Poço das Antas Reserve, to sensitize the local population to the importance of this unique endemic primate and its remaining habitat.

If it has been determined that the Reserve is secure and that the wild population is unlikely to be negatively affected by the introduction of new animals, we will move captive golden lion tamarins to special cages within the Reserve, adapt them to foods within the Reserve and prepare for a release. All such animals will be radiocollared and initially may be released for only a few hours per day and encouraged by food back into the rehabilitation cages at night. Short-term releases and supplemental feeding will continue for as long as is necessary. Moreover, we are prepared to halt the release at any stage, if is determined that the program might be detrimental to the wild population.

CONCLUSION

Ten years ago, the likelihood of extinction of *L. r. rosalia,* both in the wild and in captivity, was high. Research efforts by many individuals and institutions, both in Brazil and abroad, have now given this species a chance to survive. The future of the captive population is ensured, but the future of the wild population depends on careful management and restoration of its habitat, conservation education, and continuous monitoring of the status of the animals remaining in the Poço das Antas Reserve and in other small isolated forest patches. Rehabilitation of captive-born animals and release into the wild may be possible. The coming decade will finally determine the fate of *L. r. rosalia* in Brazil; success will depend on further research and the continued dedication of individuals and institutions to the species' survival.

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ABSTRACT

The three forms of *Leontopithecus* are among the most endangered of Brazil's primate fauna. For the past 20 years Coimbra-Filho and colleagues have been working to ensure the survival of lion tamarins in their original habitat in the unique southeastern coastal forests of Brazil. Simultaneously, both Brazilian and international efforts have focused on the development of management techniques to improve the captive reproduction of *Leontopithecus*. As part of this effort, the National Zoological Park, Smithsonian Institution has been conducting research on the social behavior and reproduction of *L. r. rosalia* for the past 10 years, as well as managing the International Studbook for the species.

The research program has concentrated on the following topic areas, with the following results:

1. The reproductive cycle can be determined by examining changes in the social interactions of mated pairs. Although variable, the estrous cycle ranges from 14-21 days, based on behavior changes, with the gestation ranging between 125 and 132 days.
2. The expression of the pair bond in mated pairs differs, depending on social environment. Pairs living with offspring exhibit fewer social and sexual interactions than do pairs living alone or with a single other animal (Trios).
3. Adult males and maturing offspring, in addition to the adult female, are involved in the care of young, including carrying, playing with and sharing food at the time of weaning.
4. The development of adequate parental care and successful reproduction in adults, especially females, is facilitated by previous experience with infants as a juvenile and subadult as well as proper early socialization. Hand-reared captives are less successful in reproduction overall, even when resocialized in a family group after weaning.
5. Social relations among family members are not equal. Parents tend to interact more with offspring of the same sex.
6. Aggression within families is rare. However, maturing females are the target of more serious and sometimes fatal aggression, initiated by the mother or sisters, than are maturing males or other animals. Fights may also occur among twins of the same sex although these rarely result in serious injuries.
7. Reproduction of offspring is suppressed as long as they remain with the parents. Although sons may show adult social and sexual behaviors while still with the family group, daughters are inhibited in development of these behaviors.
8. Breeding is seasonal with most births occurring between February and July in the Northern Hemisphere. Litter size is one to three. Captive-born females have shown increased

fecundity in recent years. Sex ratios have always favored males.

Our greater understanding of the social behavior and reproductive process of golden lion tamarins has permitted improved captive management. As a result, the captive population has significantly increased in numbers, which has presented new problems. A diaphragmatic defect, possibly genetic in origin, has been identified. Inbreeding has been shown to result in greater juvenile mortality. Recently steps have been taken to ensure that the captive population achieves stability in numbers and maximum genetic diversity, to safeguard the future of the species in captivity.

With surplus captive *L. r. rosalia* available and the Biological Reserve of Poço das Antas established, a collaborative pilot program to rehabilitate and reintroduce captive *L. r. rosalia* to their native habitat has been initiated. Cooperating institutions include CPRJ, IBDF, and FBCN in Brazil and WWF and the National Zoological Park in the U. S. The use of radiotelemetry to monitor movements and behavior of wild and captive-born animals will provide new information on the species' behavioral ecology and permit long-term contact with released animals. Simultaneously, restoration of the Reserve and local conservation education programs will be initiated to ensure the eventual survivorship of the wild population.

RESUMO

O comportamento e a conservação do mico-leão-dourado, *Leontopithecus rosalia rosalia*

As três formas de *Leontopithecus* constam entre as espécies dos primatas brasileiros mais ameaçadas de extinção. Durante os últimos 20 anos Coimbra-Filho e seus colegas têm trabalhado para assegurar a sobrevivência de micos-leão no seu habitat original nas florestas costeiras da região sudoeste do Brasil. Neste período outros esforços brasileiros e internacionais tomaram por foco o desenvolvimento de técnicas de manejo para o melhoramento da reprodução de *Leontopithecus* em cativeiro. Participando nesse esforço o Jardim Zoológico Nacional (U. S. National Zoological Park) do Smithsonian Institution tem efetuado durante os últimos 10 anos pesquisas sobre o comportamento social e a reprodução de *L. r. rosalia,* bem como a administração do "International Studbook" para a espécie.

O programa de pesquisas tem sido concentrado nas seguintes áreas tópicas, com os seguintes resultados:

1. A expressão da relação duradoura entre indivíduos de um casal ("pair bond") depende do ambiente social. Casais que convivem com seus filhotes exibem menos relações sociais do que casais que moram sozinhos ou junto com um solteiro (trios).

2. O ciclo reprodutivo pode ser determinado pelo exame de mudanças nas relações sociais entre os indivíduos de um casal. Apesar de ser variável o ciclo do cio dura de 14 até 21 dias, baseado nas mudanças de comportamento. A gestação dura de 125 a 132 dias.
3. Machos adultos e filhotes adolescentes bem como a fêmea adulta, se envolvem no cuidado dos filhotes, carregando-os, brincando, e repartindo alimentos com eles na época de desmamar.
4. O desenvolvimento de "parental-care" (o desvelo dado aos filhotes pelos pais) adequado e o sucesso de reprodução quando adultos, principalmente fêmeas, se facilita por experiência prévia com filhotes novos quando foi jovem e sub-adulto, bem como a socialização apropriada durante a infância. Indivíduos criados em cativeiro têm menos sucesso na reprodução, mesmo quando ressocializados num grupo familiar depois de desmamar.
5. Relações sociais entre membros de uma família não são iguais. Os pais relacionam-se mais com os filhotes do mesmo sexo.
6. Agressão entre membros de uma família é rara. Porém, as fêmeas adolescentes são as vítimas de agressão mais séria e algumas vezes fatal (iniciada pela mãe ou pelas irmãs) do que são machos adolescentes ou outros animais. Brigas podem ocorrer também entre gêmeas do mesmo sexo mas raramente resultam em ferimentos graves.
7. A reprodução é suprimida em filhotes enquanto moram com os pais. Embora os filhotes machos evidenciem comportamento social e sexual de adultos enquanto ainda morando com o grupo familiar, as filhotes fêmeas ficam inibidas no desenvolvimento destes comportamentos.
8. A reprodução se relaciona à estação do ano. A maioria dos nascimentos ocorrem entre fevereiro e julho no Hemisfério Norte. Em cada ninhada há de um a três filhotes. Nos últimos anos as fêmeas nascidas em cativeiro têm mostrado fecundidade maior. Nas proporções dos sexos ("sex-ratios") os machos são mais comuns.

Nosso melhor entendimento do comportamento social e dos processos reprodutivos dos micos-leão-dourados permite melhor manejo em cativeiro. Como resultado, a população em cativeiro tem aumentado significativamente assim criando novos problemas. Um defeito do diafragma, possivelmente de origem genética foi identificado. Demonstrou-se que a procriação consangüínea ("inbreeding") resulta em maior mortalidade de jovens. Recentemente tomaram-se providências para assegurar o equilíbrio no número total de indivíduos e a máxima diversidade genética para proteger o futuro da espécie em cativeiro.

Com um excesso de *L. r. rosalia* disponível em cativeiro e com a Reserva Biológica Poço das Antas já estabelecida no estado do

Rio de Janeiro, iniciou-se um projeto-piloto para reabilitar e reintroduzir *L. r. rosalia* nascidos em cativeiro ao seu habitat nativo. As instituições brasileiras participantes incluem o Centro de Primatologia do Rio de Janeiro — FEEMA, o Instituto Brasileiro de Desenvolvimento Florestal e a Fundação Brasileira para a Conservação da Natureza; e dos Estados Unidos, o World Wildlife Fund — U. S. e o National Zoological Park. A utilização de radiotelemetria para observar os movimentos e o comportamento de micos silvestres ou nascidos em cativeiro fornecerá novas informações sobre a ecologia do comportamento animal e permitirá contato a longo prazo com animais soltos. Ao mesmo tempo, iniciaram-se a restauração da Reserva e programas educativos sobre a conservação da natureza no local para garantir a sobrevivência eventual da população selvagem.

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