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Progress and problems in Lion tamarin *Leontopithecus rosalia rosalia* reproduction

DEVRA G. KLEIMAN

Reproduction Zoologist, National Zoological Park, Smithsonian Institution, Washington, DC 20009, USA

In 1972 a conference of biologists from diverse disciplines was held at Washington under the auspices of the Wild Animal Propagation Trust (WAPT), the National Zoological Park, and the New York Zoological Society. Its purpose was to review and summarise information pertinent to marmoset and tamarin biology. It was hoped also that the cross-fertilisation of ideas and knowledge would especially benefit the husbandry of the rare and endangered Lion tamarin *Leontopithecus rosalia*, and indeed the proceedings of the conference were published under the title *Saving the lion marmoset*[1] (Bridgwater, 1972).

Of the three subspecies of Lion tamarin (sometimes considered separate species), only the Golden lion tamarin *L. r. rosalia* is known to exist in captivity outside Brazil. Representatives of the other forms, the Golden-headed lion tamarin *L. r. chrysomelas* and the Golden-rumped lion tamarin *L. r. chrysopygus*, as well as of the nominate race, are held at the Tijuca Biological Bank, outside Rio de Janeiro. Situated in the Tijuca National Park, which was once part of the habitat of *L. r. rosalia*, the Bank is a research centre and refuge where the three subspecies can be studied and bred, pending the establishment of secure reserves within their natural ranges to which it is hoped they will ultimately be reintroduced (Magnanini *et al.*, 1975). But despite the efforts of Brazilian scientists and conservationists to promote public and government interest in this rare and beautiful primate, the plight of the Lion tamarins in Brazil still remains grave and their survival uncertain (Coimbra-Filho & Mittermeier, 1973; Coimbra-Filho *et al.*, 1975; Magnanini *et al.*, 1975).

At the time of the 1972 conference, the captive outlook for the species was equally poor. With

[1]Although commonly referred to as a marmoset, the genus *Leontopithecus*, like *Saguinus*, is in fact a tamarin, a term used for callitrichid species where the canines are longer than the incisors (the long-tusked condition). In true marmosets (*Callithrix* and *Cebuella*), the incisors and canines are of similar length.

a steady decline in overall numbers and few second generation births, it seemed likely that inside the handful of institutions maintaining the species it would be extinct within a decade. However, optimists felt that the information exchange and publicity provided by the conference might prove to be a turning point. This paper reviews both the accomplishments of, and the continuing problems attending, the effort to 'save the lion marmoset' in captivity. Other surveys of various aspects of the problem can be found in Perry (1972), Perry *et al.* (1972), Kingston (1974), Kleiman (1976), and Kleiman & Jones (in press).

POPULATION STATUS

The first studbook for *L. r. rosalia* (Jones, 1973) included a summary of the origins of the captive population as of 31 December 1972. At that time there were 46.23 known specimens, of which 14.11 were imported and 32.12 captive born. Thus the captive-born animals comprised 64% of the then known stock. Specimens were distributed in 16 institutions, averaging 4·3 animals per site. In 1973 these numbers were augmented by the transfer from private hands to the Pretoria Zoo, South Africa, of a group of 3.7; these animals are thought to be derived from a single pair wild-caught in 1960 and so by 1973 were probably all captive born.

As of 31 December 1975, there were 74 Lion tamarins in captivity, excluding the 4.5 specimens then held at Pretoria Zoo and the animals at the Tijuca Bank in Brazil; these two groups are not considered in the following discussion in order to facilitate the comparison of numbers in 1972 and 1975. Table 1 summarises their origins and dates of acquisition. It is apparent that about 20% of the current captive population are imported wild-caught animals. Interestingly, of the 59 captive-bred young, 54% have been born during the years 1973–1975. This means that a majority of captive-bred specimens are of a young age and many have yet to enter the breeding population.

								LIVING AS OF			
	IMPORTED			CAPTIVE-BORN				31 December 1972		31 December 1975	
YEAR	♂	♀	total	♂	♀	?	total	imported	captive-born	imported	captive-born
1958	2	2	4								
1959	4	8	12								
1960	6	3	9	4	0	4	8				
1961	1	1	2	1	1	4	6				
1962	3	3	6	1	1	2	4				
1963	16	18	34	2	0	4	6	1.0			
1964	5	4	9	2	1	0	3	1.2		0.1	
1965	11	7	18	2	2	1	5	2.0		2.0	
1966	16	21	37	1	1	10	12	3.2		2.2	
1967	19	21	40	10	7	0	17	6.7	2.1	2.5	1.0
1968	3	2	5	12	12	5	29	1.0	1.1	1.0	0.1
1969	2	2	4	17	12	4	33		5.3		3.2
1970				9	5	7	21		5.2		4.1
1971				20	11	7	38		11.3		6.2
1972				14	6	5	25		8.2		6.1
1973				9	10	1	20				5.6
1974				14	14	0	28				3.7
1975				21	9	9	39				7.2.2
TOTAL	88	92	180	139	92	63	294	14.11	32.12	7.8	35.22.2
								69		74	

Table 1. Survival of imported and captive-born *Leontopithecus r. rosalia* between 1958 and 31 December 1975. Data from Jones (1973) included for comparison. Specimens maintained at the Tijuca Biological Bank, Brazil, and Pretoria Zoo are excluded.

A comparison of the 1972 and 1975 figures (again excluding Pretoria) indicates an overall increase from 69 to 74 individuals. Considering that between 1973 and 1975 there were altogether 87 births, this meagre recruitment suggests that the survival of young still constitutes a major problem. One hopeful sign, however, is the increase in the number of ♀♀, many of which were born during 1973 and 1974.

The species is currently held in 16 institutions (including Pretoria), of which only ten – with one pair or more – have a breeding potential. Whereas in 1972 there were births in seven collections from nine different ♀♀, in 1975 births occurred in eight collections, from 15 ♀♀; this suggests a certain improvement in reproductive output. On the other hand, of the 16 institutions, only six have a collection of eight or more specimens; the remainder have three or less. The result is that breeding potential is concentrated in very few locations, and seven of the eight collections in which breeding took place in 1975 are in the United States. The National Zoological Park in Washington has the largest colony outside Brazil with 22 specimens as of December 1975.

The history of the Lion tamarins acquired since 1958 gives little cause for optimism. Between 1958 and 1975, a total of 487 individuals were imported or born, of which only 17% were still surviving at the last count. Although the probable longevity of the species is about 10–12 years, the majority of imported specimens would not be expected to live this long. However, taking into account captive-born animals only, of those born since 1964 only 22% survived to December 1975, and this poor record has not improved in recent years. Of 39 young born in 1975, only 11 (28%) were still alive at the end of the year. Given the reproductive potential of the species (twin births, one to two litters per year), a population with 15 breeding ♀♀ and a survival rate of merely 50% of young could increase dramatically in a few years. With a net increase of only five animals in three years, the breeding programme to date has had conspicuously poor success. Some possible reasons for this will be discussed below.

HUSBANDRY

One of the committees of the 1972 WAPT conference presented a thorough summary of the known requirements of the Lion tamarin and made recommendations for its husbandry, including minimum cage size, temperature, humidity, diet, social groupings, etc. (DuMond, 1972). Most institutions housing these animals currently adhere to these excellent proposals, but even small deviations can involve risks. I do not want to summarise these recommendations once again – several publications have already done so. However, I do want to take selected examples of past and potential errors which may have serious consequences for survival.

DuMond (1972) recommended that enclosures include several nestboxes, with openings large enough to allow easy access to an adult with young riding dorsally. Recently, Coimbra-Filho (in press) has described the natural shelters, and pointed out that preference is given to tree holes with entrances that are tall and thin. It seems then that the height of the nestbox entrance is important: too low an entrance might result in a broken neck for the infant whose parent when frightened moved too rapidly into the shelter.

DuMond also suggested that enclosure substrates should be of a material that is easily and thoroughly cleaned. For many zoos, this means a concrete floor, even though young frequently fall to the ground during particularly vigorous play. During the rearing phase, therefore, it is essential that these requirements are modified to allow for a softer substrate which will cushion any possible falls.

It is generally recommended that in favourable weather Lion tamarins should have access to outdoor facilities, so as to give them the natural sunlight and ultraviolet rays which they need for vitamin D_3 synthesis. Exposure to the elements, however, involves exposure to a host of disease-carrying organisms, including the zoo visitor. A brief period in the presence of a child recently inoculated with measles vaccine could conceivably result in an outbreak of measles lethal to the colony. Cockroaches and feral mice and rats, common to most zoos, are also disease risks which are only with difficulty eradicated.

One option is, of course, a sterile laboratory colony. Yet here the concentration of animals, and potential stress from family groups being too closely confined, in itself constitutes a risk. If a viral infection breaks out under such conditions, its effects may be far greater than where groups

are scattered throughout a zoo, or where they live in a laboratory with a less hygienic regime. Most of the adult deaths of the past two to three years have tended to be concentrated into a short period; i.e. within a single institution, three or four animals may be lost within a few weeks of one another. This suggests a common cause. Although it is easier, from the point of view of maintenance, to keep Lion tamarins close together, e.g. in the same building, with only one or two keepers, the animals are all then susceptible to a disease which only one of them might otherwise contract. At present, only two zoos have made a policy of dispersing groups throughout their facility. And all new facilities constructed in recent years, as well as some recent recommendations for general marmoset and tamarin husbandry (Kingston, 1974), include housing the animals on a single site or in one building. It is not yet clear whether the benefits of close control will outweigh the costs, if we cannot prevent the sudden fatal epidemics of viral or bacterial origin which continue to erupt. The control of disease transmission is probably the single most important problem in the effort to save the Lion tamarin.

Lion tamarins succumb easily to gastro-intestinal upsets from a variety of causes. Unless recognised, diagnosed, and treated rapidly, an individual can be dead within 36–48 hours of the onset of symptoms. Severe diarrhoea may result in rapid and irreversible dehydration. Inattention to small details, such as faecal consistency and food and water intake, can mean an unnecessary death. Although the point may seem obvious, it is probable that many animals are lost through sheer lack of attention. Yet it is often difficult within a group to determine whether all animals are eating properly or which individual has loose stools. Such information can only be collected through close and individual daily observation, a financial strain that most zoos still cannot afford.

SOCIAL GROUPINGS

Since the late 1960's, it has been apparent that *Leontopithecus*, like other callitrichids, reproduce most effectively in pairs or extended family groups (Hampton *et al.*, 1966; Epple, 1970; Snyder, 1974). Field observations have to some extent supported the notion of monogamy (Coimbra-Filho & Mittermeier, 1973). In large captive groups of unrelated Common marmosets *Callithrix jacchus*, for instance, only the dominant pair will breed (Epple, 1970, 1975a; Rothe, 1975), and subordinate animals will be inhibited from reproducing. Reproductive inhibition may also occur in the offspring, if these adolescents are housed with the parents after the age of puberty (14–18 months) (Rothe, 1975). It is likely that Lion tamarins would exhibit similar behaviour under the same conditions.

Within a Lion tamarin family group, as in other callitrichids, both the adult ♂ and older juveniles participate extensively in infant care. It has been suggested that juvenile marmosets and tamarins without experience of parental care themselves become poor parents (Hampton *et al.*, 1966; Epple, 1975b) and there is some supportive evidence for this in *L. r. rosalia* (Hoage, in press).

It is also generally accepted that Lion tamarins are extremely aggressive to extra-familial animals, and that caution must be taken to prevent groups from obtaining access to one another. In fact, it has been suggested that, owing to serious fighting, adults of the same sex can never be housed together (Coimbra-Filho & Mittermeier, 1973). I have not found the latter to be true provided that the introductions are conducted slowly and carefully, but the potential for damaging injuries remains. It is preferable, in my opinion, to permit unpaired animals to have contact with conspecifics of the same sex, rather than to leave individuals isolated for prolonged periods.

Successful propagation therefore requires the maintenance of family groups in isolation from each other, with adolescents removed as they reach puberty. Most institutions follow this procedure, but there are still many questions concerning the development and mechanics of the pair-bonding process which remain unanswered and may hinder or retard successful breeding.

For example, the development of the pair bond is not understood in sufficient detail to determine whether bonding is more successful when a heterosexual pair is simply introduced and left alone, than when individuals within a group of adolescents are allowed to choose mates, and the resulting pairs then isolated. Lion tamarins are individualistic, and a preference situation might cement the bond more rapidly, and so promote more rapid reproduction. Epple (pers. comm.)

suggests that puberty may be advanced and reproduction improved by pairing young animals with experienced breeders; she has been investigating this possibility in White-lipped tamarins *Saguinus fuscicollis*.

Another problem area concerns the process of re-bonding. When pairs are broken up by the death of one mate, or for some other reason, what is the best method of establishing a new bond? And can a new bond be formed if juveniles and infants born to the previous mate are present? Clearly, if such juveniles must be removed, they cannot then acquire experience in parental care patterns within the family group before they form a pair bond as adolescents.

At the National Zoo, we have been attempting to deal with such situations in a variety of ways. But it is still too early to determine the success or failure of such manipulations in improving reproductive success. We have housed single pubertal ♀♀ with two ♂♂ shortly after the ♀'s removal from the parental family group and, in most cases, have found that she rapidly forms a bond with the older or more dominant ♂. When ♂♂ are slowly adapted to one another prior to the ♀'s introduction, such trios can remain stable for many months, although not always. In one case sibling brothers remained non-aggressive through the birth of an infant, and both were involved in rearing, although the dominant brother, who had almost exclusively mated with the ♀, exhibited the greater paternal care (Hoage, in press). In another trio containing one three-year-old and one 21-month-old ♂, the younger had to be removed three weeks after the group's formation owing to tension in the group.

We are also attempting to develop 'corrective measures' for young which have not experienced a normal rearing pattern and thus have not had an opportunity to learn parental care techniques or to be properly socialised. In one instance, after the death of an adult ♂, we left an adolescent ♂ with his mother and carefully introduced a new ♂ to both animals. Although this trio remained stable during and after a stillbirth, the young ♂ had eventually to be removed once the ♀ had borne a live infant; he had begun to mount the elder, unrelated ♂ in an assertive fashion, a behaviour which we feared might result both in serious aggression and in damage to the new infant.

In another trio of a pair and an adolescent ♀ who had been isolated for several months because of a broken leg, the group was stable until the adult ♀ gave birth, whereupon the new mother attacked the second ♀ severely. The consequences of both experiences suggest that such manipulations may never be successful. Thus the only corrective measure possible for animals inexperienced in parental care may be a pairing with an experienced mate, a technique we are also trying.

REPRODUCTION

It is only recently that the essential facts of the Lion tamarin reproductive cycle have been determined (Kleiman, in press). Breeding tends to be seasonal with the majority of births occurring between February and May. Some ♀♀ may have two litters a year, with the second litter being born in July and August, often after an oestrus occurring about one week post partum. Post-partum conceptions appear to be more common in older animals. In the Northern Hemisphere the birth season is the reverse of that in Brazil (Coimbra-Filho & Mittermeier, 1973). The gestation period ranges from 126–132 days, and there is a behavioural oestrous cycle of approximately two or three weeks (Kleiman, in press). The cycle is usually initiated in October and most sexual behaviour is observed between October and January.

Knowledge of the reproductive cycle is important in making decisions concerning the establishment of new pairs. Clearly, the most opportune time for institutions to exchange specimens and pair up pubertal animals is in the early autumn. This is not, however, a widely recognised procedure, and a full breeding season may be missed by a delay of only one or two months.

Sexual maturity is usually reached at about 18 months. Considering the timing of the breeding season, there is no reason why ♀♀ should not produce their first litter at the age of two years. Yet an examination of the age of first conception in ♀♀, based on data in the Studbook, suggests that ♀♀ are not being paired until much later (Kleiman & Jones, in press). Given the small numbers of reproductive ♀♀ that exist, this is a serious loss.

POPULATION SIZE

There is no longer need for concern with the problem of multi-generation breeding in the

Lion tamarin. In 1975, 15 of 21 litters had at least one captive-born parent; in most cases, both parents were captive born. A major problem is, however, the extremely low numbers of reproductive ♀♀ and the effect that the loss of a single successful breeding ♀ may have. In 1975, only eight ♀♀ reared young beyond the age of 30 days. Two of these are imported animals and are nearing the end of their reproductive life. Several young ♀♀ will be entering the reproductive population during the next few years, but, unless they survive and reproduce, the captive Lion tamarin population will ultimately decline and disappear.

The fact that the steady decline in numbers from 1968 to the present has been arrested is encouraging and can be attributed to the increased knowledge of callitrichid biology, especially in the area of nutrition and social structure. Nevertheless, the captive population is probably now at its most critical phase in terms of its long-term survival.

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