AUTHOR'S NOTE

The two breeding ♀♀ in the group have since each given birth to a further infant which they also successfully reared. The observations made on the original births, particularly on the second, were supported by the subsequent births.

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Hand-feeding parent-reared Golden lion tamarins

Leontopithecus rosalia rosalia [Plate 47]

at Monkey Jungle

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With the very real threat that the Golden lion tamarin *Leontopithecus rosalia rosalia* could become extinct in the wild through habitat destruction (Magnanini *et al.*, 1975), the importance of captive breeding populations is obvious. Unfortunately success to date is limited and the small number of reproductive ♀♀ in captivity is cause for concern (Kleiman, 1977).

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Too frequently parents fail to care for their offspring, but there have been comparatively few recorded successes of hand-rearing. Even where hand-rearing is successful, hand-reared adults may not reproduce or may themselves prove inadequate as parents. A method of improving the survival rate of infants threatened by a mother's incompetence, without removing them from the family group, is therefore highly desirable.

'Josephine', a captive-born ♀ at Monkey Jungle, after successfully rearing a single young, lost the twin infants of her two subsequent pregnancies after five days. Observation of the mother/infant behaviour and post-mortem results indicated that the young were not receiving sufficient nourishment, although it was not clear whether this was due to the ♀'s producing insufficient milk or whether she was not allowing them to nurse.

It appears that once very young infants weaken enough to detach from the mother, they may have already suffered irreversible damage from dehydration and electrolyte imbalance. Any action therefore needs to be taken almost before there is any real indication that the problem exists.

Josephine did not reject her infants as long as they gave the appropriate clinging response and her mate, obtained from the National Zoological Park, Washington, had an excellent history of carrying infants. It was decided that should any future infants appear to have difficulty in nursing, we would leave them with the parents while attempting to hand-feed. To our knowledge this technique had not been tried before with this species.

The tamarins are housed in a wiremesh enclosure, measuring $4{\cdot}6 \times 7{\cdot}6 \times 5{\cdot}5$ m high with a floor of cobbled rock and foliage of varying density which reaches the full height of the cage. Indoor sleeping and feeding quarters are provided at the back of the cage and the front borders a walkway from which visitors may view the animals. Throughout the year the animals spend most of the daylight hours out-of-doors, entering the detachable nightbox only at dusk.

As soon as Josephine showed signs of pregnancy, one of the authors (BLH), who was already known to the ♀, began spending three to four hours a day feeding and grooming the pair. Through this direct contact it was hoped to establish a rapport between handler and animals which would facilitate the routine removal of the young if this proved necessary.

During the night of 29 March twins, both ♂, were born. Since the authors believed that irreversible damage from lack of nourishment would not occur until the fourth or fifth day, the family was left undisturbed until the end of the second day. By then, however, it had become apparent that the young were not being allowed to nurse and the family were confined to their nightbox for removal to their handler's home the following morning.

By this time the infants were making no attempt to nurse and were taken from their mother with little difficulty. After the first feed they responded with increased strength and activity.

Following the example of the Oklahoma Zoo, where Golden lion tamarins had been successfully hand-reared, we offered Similac with iron formula with the tip of a syringe. As it is essential that the infant does not inhale any of the formula, the syringe should not be placed in the mouth but used to place a small drop on the infant's lip. They adapted well to this and quickly learned to lap the milk from the tip of the syringe (Plate 47). Details of the feeding schedule are shown in Table 1. The feeds were given every two hours around the clock for the first seven days. Thereafter, the young were fed on demand, approximately every three to four hours during the night and every two to three hours during the day.

The ♀ called frequently during feeding sessions and readily received the satiated infants when they were returned within twenty minutes. They then slept, clinging to her, until the next feed. Josephine usually co-operated remarkably well, although occasionally she did refuse to relinquish or accept back the infants. Fortunately these bouts of independence were of short duration.

The ♂, which previously had limited exposure to human handling, did not become as tolerant as the ♀ during the prenatal 'training' period. He was therefore separated from the ♀ and young and placed in an adjacent cage with full visual and auditory but limited tactile communication. During feeding sessions the infants were held near his cage and he was allowed to fondle them.

DAY	WEIGHT (g) A	B	MEAN INTAKE/FEED (ml) A	B	NO. FEEDS/DAY A	B	TOTAL DAILY INTAKE (ml) A	B
1	53·65	50·2	1·75	1·83	3	3	5·25	5·50
2	61·9	56·2	2·22	2·03	9	9	20·0	18·25
3	62·2	59·5	2·43	2·48	7	6	16·97	14·87
4	62·6	59·4	2·56	2·30	8	9	20·50	20·75
5	66·1	61·5	3·34	3·34	8	8	26·75	26·75
6	65·1	60·7	3·58	3·07	8	8	28·62	24·59
7	65·9	62·2	3·69	3·78	8	8	29·50	30·25
14*	70·3	67·2	3·57	3·20	7	7	25·0	23·0
21	76·5	71·4	3·71	3·56	7	6	26·0	21·38
28	80·1	76·5	4·40	3·75	5	4	22·0	15·0
35	92·1	83·1	6·62	2·40	4	5	26·5	12·0
42	107·5	91·3	5·63	3·38	5	4	22·5	13·5
56**	157·0	103·0						
63	172·0	116·0						
70	188·0	131·0						
77	208·0	150·0						
80	211·0	162·0						

* started to take solid food
** weaned—reintroduced into enclosure

Table 1. Feeding schedule and weight record of two ♂ Golden lion tamarins *Leontopithecus r. rosalia* hand-fed from three days of age. During the hand-feeding period, the weights were recorded daily before the morning feed at 0800 hours.

Later, when he was admitted into the group, if an infant could not be removed from his back, Josephine would take it from him and allow the handler to take it from her.

The young progressed rapidly, gaining weight, strength and co-ordination. They were weighed daily. As a weight loss of up to 1 g during a 24-hour period may not be an accurate reflection of progress, such a loss was not regarded with alarm. Over a 48–72-hour period there was always a net gain (Table 1).

The infants were observed carefully for listlessness, upper respiratory drainage or congestion, loss of weight, and constipation or diarrhoea. No special efforts were made to force-feed them, stimulate bowel function or place them on prophylactic antibiotics. Except for the brief feeding periods, the infants were on the parents throughout and, as the ambient temperature never fell below 21°C, provisions for additional warmth were unnecessary.

After the first week, when the adult ♂ would normally play a more active role in infant care, Josephine tended to be less tolerant, pushing the young away frequently and refusing to accept them back after feeding. As soon as the infants started taking solid food and we felt confident that they had the strength to survive if we were unable to recover them for one or more feeds, the ♂ was reintroduced. He integrated immediately and carried one or both infants for long periods. They appeared to be alert to his eating habits and fed more frequently from his hands than from their mother.

SUMMARY OF FEEDING PRACTICES

1. The infants rarely took more than 25 ml of formula in any 24-hour period, yet consistently gained weight.
2. Both infants continued to take a substantial amount of formula even after starting on solid food.
3. The largest feed for both was between midnight–0200, when infant A would take up to 10 ml and infant B up to 7 ml.
4. Infant B not only gained weight more slowly than his sibling but, over a period, it was apparent that his motor skills developed more slowly.
5. The syringe feeding was discontinued at eight weeks after the infants were observed taking formula from a pan and regularly taking solid food. On day 58 the family was returned to the permanent enclosure.
6. Measurements were taken frequently up to 18 days of age (Table 2) and were similar for both infants. The difference in weight therefore

	DAY 1		DAY 3		DAY 6		DAY 8		DAY 16	
	A	B	A	B	A	B	A	B	A	B
Overall length	22·5	21·6	23·3	23·3	23·5	23·4	24·4	24·1	26·3	25·7
Brow-heel	13·5	13·5	14·2	13·6	14·5	14·0	14·4	14·6	16·0	16·0
Brow-ischium	9·0	9·0	9·6	9·6	9·6	9·7	9·7	9·7	11·5	12·0
Tail	13·6	12·0	14·2	12·8	13·9	13·5	14·0	13·1	15·2	14·5
Right foot	3·4	3·1	3·35	3·3	3·45	3·4	3·45	3·4	4·3	4·2
Right knee-heel	3·15	3·3	3·5	3·5	3·5	3·5	3·6	3·6	3·8	3·8
Right femur	2·7	2·8	2·7	2·65	2·8	2·9	2·9	3·0	3·3	3·5
Right humerus	2·5	2·8	2·8	2·95	3·0	3·0	2·9	3·0	3·0	3·5
Head: width	2·3	2·2	2·3	2·2	2·35	2·3	2·5	2·4	2·6	3·0
depth	3·3	3·3	3·4	3·3	3·5	3·4	3·6	3·5	3·6	4·0

Table 2. Measurements (in cm) of twin ♂ Golden lion tamarins from three days of age (day 1 of hand-rearing) to 18 days of age (day 16 hand-rearing)

seemed to be related to food intake. This was particularly evident after the fifth week when infant A began to accept live food (mealworms and crickets) while infant B showed a marked reluctance to do so.

7. Attempts at feeding the infants through the cage while they were on the mother's back were unsuccessful.

8. Some solid food was accepted from day 14, first from the hand of the human handler, then from the adult ♂.

CONCLUSION

The two infants were hand-fed from day 3–58. The method was relatively problem free and its success was undoubtedly made possible by the close rapport established with the ♀ during the 30 days prior to delivery. She was already semi-tame, and once accustomed to the type of contact which would be necessary to remove the infants, she relinquished her young to a human handler as readily as she would normally have done to her mate.

We would not expect the inability to nurse to correct itself with this mature ♀ and now that she has been conditioned to accept the procedure, it should be possible to use it successfully with future infants.

Although the authors sought to keep human contact to the minimum, it has apparently created a special bond between the infants and humans and it will be important to monitor the animals' future reproductive and paternal behaviour. It is hoped that the procedure will allow the social and mating behaviour of the young to develop normally and, if so, it might be applied in other situations. For example, although a ♀ will not usually reject normal vigorous infants which cling normally, it can happen and an experienced ♂ might be trained to care for the young while they are being fed by hand.

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PRODUCT MENTIONED IN THE TEXT

Similac with iron: liquid (ready to feed) milk substitute manufactured by Ross Laboratories (Division of Abbot Laboratories), Columbus, Ohio 43216, USA.

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