

Growth and development of mother-reared Red pandas

Ailurus fulgens

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Although the National Zoo has displayed a number of Red pandas *Ailurus fulgens* over the past 50 years, we have had little success in breeding them. Prior to the establishment of our existing pair we had exhibited nine potential breeding pairs that produced only three litters, none of which lived longer than 130 days (mean age at death 78.5; range 13–130 days). Our present ♂ arrived as an adult in 1966 and with the ♀ which came at the same time produced two cubs that both died; the ♀ died in 1969. The present ♀ was paired with him in May 1971 and the first litter (1.1) was born on 23 June 1972. The second litter (1.1) was born on 30 June 1973, 119 days after the last observed mating.

The breeding pair is housed in a 65 m² circular outdoor enclosure with a 1.2 m retaining perimeter fence. The enclosure contains a log cabin shelter, a large L-shaped nesting box and a 283 litre sunken water trough/pool. A live, hollow sycamore tree is used both as a resting perch and a nesting area. In 1973 a second small tree was added to increase the number of perches. The soil substrate is covered with a variety of local grasses and weeds.

Each panda is fed the following daily: Gruel, consisting of ½ cup Pablum, ½ cup reconstituted cow's milk, 1 raw egg, 1 teaspoon ViDaylin multivitamins and ½ teaspoon dicalcium phosphate; 1 kg plus of broad-leafed *Pseudosasa* or fishpole *Phyllostachys* bamboo; one diced apple and one sliced banana.

Freshly killed mice are occasionally offered and eaten and the pandas have twice been seen eating house sparrows

which they had apparently caught and killed themselves. Green sycamore leaves and a substantial amount of grass are also eaten in season.

BEHAVIOUR OF THE ♀

About two weeks before the first birth the ♀ began arranging nesting material in the base of the hollow tree. Examination of the site a fortnight after birth revealed a bottom layer of hay 25 cm deep, placed there by the keepers, a middle layer of sticks and twigs 15 cm deep and a top layer of leaves 15 cm deep. Sticks, twigs and leaves had been taken from the ground at the tree base, but the ♀ was also observed to break some from the tree and place them on the nest and this she continued to do for several weeks following the birth. Just before parturition she also fashioned a depression in the straw inside the log cabin but no leaves or sticks were ever added to this nest.

We were unable to observe the birth and first became aware of its occurrence at 1400 hours on 23 June 1972, when we saw the ♀ carrying a cub. The second cub was discovered the next morning. The ♀ continued to carry the one cub erratically around the enclosure. Believing that she might be disturbed by human presence or was perhaps dissatisfied with her nest (or both), we decided that no one should approach the cage except to clean, feed or inspect the animals. An L-shaped nestbox was introduced as another nest option; this was used and the following year became the chosen birth site.

During the next three days the zoo was closed and the ♀ grew calmer, perhaps because of the absence of visitors. She

was seen to move the cubs on average five times a day, but only from one nest site to another and not erratically as she had done initially. When the zoo reopened and visitors neared the enclosure, she again began to carry the cubs about, sometimes placing one down for a few minutes only to pick it up and carry it once more. Fearing that she might drop a cub from the tree or exhaust herself in the hot weather, we decided to rope off the area to within 9 m of the cage. The measure proved effective. The ♀ calmed down and the erratic carrying ceased. This behaviour did not recur in 1973, perhaps because the area had been roped off as soon as the birth was noted.

During the first 35 days the ♀ moved the young from one nest site to another on average 3.3 times a day (as well as in the night). Thereafter, the frequency of the moves was reduced and often the young were only transferred overnight. This may have been due to their growing size and/or to the increased tranquillity of the ♀. Although moves occurred at all hours of the day, the majority were seen in the early morning and mid- to late afternoon, which reflected the activity peaks of the adults.

Both the excessive carrying of the young in 1972 and the frequent change of nest site in both 1972 and 1973 suggest that Red panda ♀♀ require isolation from external disturbances and a minimum of three separate and secure dens for effective rearing.

For the first 20 days the ♀ remained constantly with the young, leaving them only to eat, drink, defaecate or rest briefly in the high branches of the tree. After Day 20 she began to spend more time in the tree and by Day 30 was doing so for most of the time. Periodically she entered and left the nest site, apparently to inspect the cubs ('nest checks'). At other times she would remain in the nest for periods ranging from a few minutes up to an hour, presumably either nursing or grooming the young ('contact bouts'). Until Day 40 contact bouts occur-

red most frequently after the young had been moved from one nest site to another. As the number of moves decreased, so did these associated contact bouts, which eventually took place at random throughout the day. The number of nest checks and moves declined significantly after Day 35 but the observed number of contact bouts remained high until Day 70, after which there was a gradual decline. This indicates that while the ♀'s close maternal concern began to decline as early as Day 35, the young were dependent on her milk until at least Day 70 and probably for some 20 days thereafter.

By Day 30 the cubs began to emit a high-pitched whistle, which we termed a 'wheet', whenever they were handled or moved about. Even when the number of nest checks had already declined the ♀ always responded to this vocalization by inspecting the nest. The call seemed to stimulate her to move the cubs, an action which they often resisted with a more intense wheet, so that she tried to calm them with grooming instead. On three occasions the cubs emitted the wheet without being in apparent distress, but the ♀ still responded by entering the nest. It seems that this call might serve both as a distress and as a contact call.

An upsurge in maternal responses became apparent from about Day 90, as the ♀ began to supervise the cubs' first attempts to leave the nest(s) and explore their environment. They first learned to climb up inside the hollow trunk of the sycamore, and then to explore its branches, the ♀ watching closely from a vantage point usually just above them. If a cub emitted a wheet she responded by grasping it and carrying it back to the nest in her mouth. Sometimes she would retrieve the cubs during play, but in time they began to leave the nest immediately on retrieval and climb the tree again. By Day 110 they were so adept at climbing that the ♀ paid them little attention. However, they still followed her wherever she went, and occasionally she

joined in their play, the three animals chasing and rolling on the ground. Gradually these interactions diminished and the cubs were more frequently seen playing alone. By February 1973 the eight-months-old cubs still tended to follow the ♀, so distracting the adult pair's renewed attempts to mate and several antagonistic encounters between adults and cubs occurred. We removed the cubs to an enclosure some 10 m away and shortly afterwards, on 3 March, a successful mating took place.

Frequent examination of the nests revealed that the ♀ kept them quite clean until Day 75 at least, whereafter faeces gradually began to accumulate. She also continued to add fresh nesting material until the time when the young began to emerge.

BEHAVIOUR OF THE ♂

The ♂ was left with the ♀ after the birth as we felt that his removal might distress her. Before parturition he had often used the log cabin shelter but once the ♀ began to use the nests he rarely entered any of them, and when he did, stayed only briefly. He played no part in rearing the young and interactions between ♂ and ♀ at this time were also minimal, occurring mainly at feeding times and during occasional contacts in the tree. Both before and after the birth the adults generally ignored and avoided each other and the ♂ stayed almost exclusively in the high branches.

Once the cubs began to leave the nest and climb the tree confrontation was inevitable. When one of the three-month-old cubs approached the ♂, apparently for the first time, he leaped forward with paws upraised and mouth agape and swatted the cub, emitting an explosive expulsion of breath which we termed the 'quack'. The cub retreated without a chase. After this the cubs appeared to avoid the ♂ and confrontations occurred only when they blocked his ascent or descent route. He, on his part, seemed deliberately to avoid both ♀ and

cubs in the first weeks of their emergence from the nests; while they were in the tree he stayed on the ground, and *vice versa*.

As the cubs grew independent and spent more time close to the ♂, he became increasingly tolerant and occasionally joined them in the chasing and rolling games. It seemed obvious, however, that he preferred to remain aloof and quickly broke contact when he had had enough.

DEVELOPMENT OF THE YOUNG

The young were helpless at birth and slept for the entire time curled up in contact with one another. One cub, however, was seen dragging itself by the forelimbs for a short distance on Day 2. During the first week they moved very little even when disturbed or handled, but by Day 10 they had begun to roll and tread the air when exposed to light or after handling. At first the rolling and treading were unco-ordinated and wild, but by Day 8 the cubs were able to right and drag themselves about the nest or back into contact with one another. Between Days 10–16 they learned to right themselves quickly and take unsteady, unco-ordinated steps. On Day 16 one of the cubs retracted violently as it was being lifted, threw itself onto its back and emitted the quack. When it was placed on its abdomen, it began to back up slowly, mouth open, head rising and falling very slowly and emitting indistinct 'huffing' sounds. The other cub did not exhibit this behaviour until Day 18, and in both cubs it occurred simultaneously with the partial opening of the eyes. For several days they reacted in this way whenever they were touched. If picked up, they would curl up and—except for some quiet huffing—would remain perfectly still in this position until put down again. At that point they would exhibit either the violent retraction or the slow retreat already described.

By Day 25 the cubs no longer slept all day and could be seen moving slowly

around the nest, although still in rather an unco-ordinated fashion. On that day the ♂ cub secreted a drop of clear, musky fluid from the anus as it was being handled. The odour was similar to that emitted by the adults when they scent-marked with the anal glands. In the following weeks the fluid was often secreted when the cubs were handled, and in the second litter it was secreted regularly between Days 35–98 while the cubs were weighed and measured. The motor patterns of scent-marking developed much later.

Between Days 25–90, the young continued to become more and more active during daylight hours and could often be seen climbing over one another, although they did not yet leave the nest. By Day 55 they were 'playing' — biting and swatting — and had begun to climb the inside of the hollow tree. By Day 80 they were investigating the various nest entrances and would poke their heads from the openings, but no further. A

night watch was conducted on Day 88, using a light amplifier, and both cubs were seen to leave the nest at the base of the tree and move about the ground and tree for 30 minutes. Their movements were uncertain and gave the impression that this excursion had been made on few, if any, previous occasions. Neither cub ate any solid food that night but two days later a few chewed pieces of bamboo and apple were found at the tree base. More food remains were found during the next three weeks. The night excursions became longer, but the cubs were not seen leaving the nest during the day until Day 118 when they were observed briefly in the lower branches of the tree. From that time they emerged more and more frequently during daylight and by Day 135 slept in the lower branches in much the same way as the adults.

The cubs first ate solids during the day between Days 125–135. Probably as a result of prior weeks of nocturnal feeding, their ability to grasp food such as

DAY	HEAD AND FACE	DORSUM	VENTER	TAIL	FEET	REMARKS
Birth	Buff; nose pink; 'tear track' absent	Uniform buff	Uniform buff-grey	Buff; all ringing absent	Pads pink; plantar surface naked	Eyes and ears closed; mystacial vibrissae 15–20 mm
7	Buff; nose liver-coloured	Predominantly buff, some light grey mixed	Uniform light grey	Uniform buff; no ringing	Pads liver-coloured; soles naked	
14	Uniform buff; indistinct tear track; nose black	Greyish-white; sparse red guard hairs	Uniform light grey	Buff; no ringing	Pads black; soles sparsely haired with grey-white hairs	
18	Back of ears grey, remainder of head buff					Eyes open Days 17 and 18
24	Tear track fairly distinct reddish-brown	Reddish guard hairs thicker; undercoat grey-white	Grey	Indistinct reddish rings alternating with buff-white	Soles fully haired	
50	Sparse reddish hairs; head broader and longer	Uniform reddish-brown	Greyish-black	Distinct reddish-brown and buff rings		
70	Adult colouration and patterning essentially complete.					

Table 1. Pelage development in the Red panda *Ailurus fulgens*.

bamboo, diced apple and banana with the forepaw was already well developed. A modified sesamoid appendage allows *Ailurus* to apprehend food manually in much the same way as the Giant panda *Ailuropoda melanoleuca* (7).

Even after the onset of diurnal feeding the ♀ continued to nurse the cubs, although at reduced frequencies. By about Day 130 her mammae appeared dry and the last nursing bout was observed on Day 163. From the commencement of their extra-nest exploration until their eventual removal from the enclosure, the cubs always oriented strongly towards their mother, particularly once they were able to negotiate all the obstacles in the cage and could follow her everywhere. They usually ate, rested and played in close proximity to her.

Red pandas defaecate in one spot and the cubs deposited faeces in mounds as early as Day 105. Apparently they developed this trait during their nocturnal excursions. Scent-marking using the anogenital rub was twice noted in the young ♂, the earliest observations at about six months. The young ♀ was never seen to scent-mark.

At birth the young lacked the striking colouration and patterning of the adults but by Day 90 they had already become miniature replicas (Table 1). Both litters were weighted and measured weekly (Tables 2, 3).

MEDICAL HISTORY

None of our Red pandas has ever had a debilitating illness or injury, except for a recent neoplasm in the adult ♂. The adults have been vaccinated against feline and canine distemper annually since their arrival. They receive one dose of inactivated feline distemper virus (Felocine) and one of an inactivated canine distemper/hepatitis vaccine/leptospira bacterin (Fromm, Triod Plus). Both litters were similarly vaccinated at 8, 11 and 14, and 7, 12 and 21 weeks respectively. The 1972 cubs received a yearly booster.

DAY	1972		1973	
	♂		♂	
	WEIGHT (g)	WEIGHT (g)	WEIGHT (g)	WEIGHT (g)
7			205	204
14			241	245
20	354	400		
21			291	302
27	285	420		
28			368	368
34	430	460		
35			443	461
41	485	520		
42			513	521
48	635	605		
49			569	577
56			631	647
62	680	815		
69	690	840		
70			758	768
76	680	895		
77			842	822
83	823	965		
84			896	920
90	980	1105		
97	1050	1442		
98			1027	1125
111	1275	1705		
132	1620	2045		
139	1795	2325		
150			1860	1810

Table 2. Weights of two litters of Red panda *Ailurus fulgens* cubs born at the National Zoological Park, Washington in 1972 and 1973.

DAY	EAR		HINDFOOT		TAIL		TOTAL LENGTH	
	(mm)		(mm)		(mm)		(mm)	
	♂	♀	♂	♀	♂	♀	♂	♀
13					68	72	275	286
20	23	25	43	42	72	78	294	306
27	26	28	45	44	88	96	385	420
34	29	32	54	56	91	102	408	440
41	34	36	60	59	102	111	425	445
48	36	38	60	59	120	127	474	455
62	39	42	63	68	130	128	495	507
69	60	56	68	76	140	161		
76	62	58	70	78	152	183	511	520
83	64	61	78	83	181	202	505	532
90	66	62	83	89	192	215	516	541
97	69	67	85	97	205	232	535	615
111	73	69	89	102	211	341	564	648

Table 3. Measurements of cubs born in 1972.

In September 1972 mild *Trichomonas* and pinworm infections were detected in the adults and Thibenzole was mixed

with their food. The 1972 cubs were drenched with strong prophylactic doses at three months.

	LEFT SIDE (days)		RIGHT SIDE (days)	
	♂	♀	♂	♀
Upper				
i ₁	—	49	54	49
i ₂	—	49	54	49
i ₃	—	49	56	49
c	33	31	—	30
pm ₁	31	36	33	34
pm ₂	36	34	—	34
pm ₃	42	31	43	34
m ₁	—	—	—	—
m ₂	—	—	—	—
Lower				
i ₁	—	53	54	—
i ₂	—	53	54	—
i ₃	—	53	54	—
c	—	47	—	—
pm ₁	32	34	30	32
pm ₂	32	34	51	—
pm ₃	—	30	32	34
pm ₄	—	43	33	34
m ₁	—	—	—	—
m ₂	—	—	—	—

Table 4. Sequence of tooth eruption during the first two months in the cubs born in 1972. Oral examinations were discontinued after Week 8.

The ♂ cub (1972) fell from the tree on Day 68 as the ♀ was carrying him to the tree nest. She made a quick retrieval and he appeared completely unharmed. However, since his respiration was elevated and the weather extremely hot and humid, 4 mg dexamethazone (Azium) was administered subcutaneously. Contrary to reports from other institutions (1; 6), no ill effects were ever observed after the administration of any of these medications.

DISCUSSION

What information is available on the biology of the Red panda in its natural habitat suggests that it belongs to an aberrant but highly specialized sub-family of the Procyonidae adapted to a largely folivorous, solitary and at least partially arboreal existence in the somewhat harsh but stable environment of the highland regions of Tibet, Nepal, south-west China and northern India and Burma (7; 8; 10; 11; 12; 14; 15).

Data obtained from captive animals tend to substantiate this view (2; 4). In addition, we have found that the species is largely crepuscular and nocturnal and has adopted a conservative reproductive strategy, including seasonal reproduction, low fecundity, high survival of offspring, relatively long maternal dependence and no paternal involvement in infant care.

Twins are usual and are altricial at birth (4; 5; 16). Functional weaning (13) begins at about 11 weeks of age and complete nutritional weaning occurs at about 18 weeks. Social weaning (the period when social ties with the parent are broken) begins at about eight months. Comparison of growth curves of maternally-reared and a hand-reared panda (9) shows a close correlation in rate of development, but with the hand-reared animal about ten days ahead of the maternally-reared ones. However, the age of the hand-reared panda on removal from the mother may have been misjudged as other developmental indicators (pelage colour, etc.) were also advanced by about ten days.

Although Red pandas have been bred in captivity (4; 5; 16), the young are rarely raised to maturity. The major reasons for failure seem to have been that inadequate facilities were provided for the expectant mother (either too small an enclosure or too few or inadequate nesting facilities) or that the offspring succumbed to one of the strains of distemper either from a natural outbreak or induced through inoculation with an improper vaccine (1; 3; 6; 9). With improvements in facilities and health programmes based on present knowledge, many currently unsuccessful Red panda breeding projects could see almost immediate success.

AUTHOR'S NOTE

At exactly two years of age, on 30 June 1974, the 1972 offspring produced a litter of three. Two of the cubs were of average size. The runt - which also had a disproportionately small head - died three days later and the other two on 6 and 19 July respectively. Causes of death are at this stage speculative: an unusually hot spell in early July could have been a contributing factor, whilst the

possibility of canine distemper cannot be ruled out. It may be that first litter mortality is naturally higher, or that the sibling mating had deleterious effects. In any case it appears that Red pandas reach sexual maturity by the second breeding season after birth (at c. 18 months) and are capable of producing normal and even above normal sized litters in their first breeding year.

ACKNOWLEDGEMENTS

I wish to thank Dr G. G. Montgomery, Mr Harold Egoscue and Dr John Eisenberg for their help in this project. I also would like to thank Dr Devra Kleiman, without whose aid and encouragement this paper would not have been possible. Thanks also go to Dr Kleiman and her team of research assistants for allowing me access to their notes and insights.

PRODUCTS MENTIONED IN THE TEXT

Azium: manufactured by Schering Corp., Bloomfield, New Jersey, USA.

Felocine Inactivated Feline Distemper Virus: manufactured by Norden Laboratories, Lincoln, Nebraska, USA.

Fromm Canine Distemper/Hepatitis Vaccine/Leptospira Bacterin Triod Plus: manufactured by Fromm Laboratories Inc., Grafton, Wisconsin, USA.

Thibenzole: manufactured by Merck Chemical Division, Merck Chemical Co. Inc., Rahway, New Jersey, USA.

Vidaylin M: multivitamin pediatric drops manufactured by Ross Laboratories, Columbus, Ohio 43216, USA.

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Manuscript submitted 8 April 1974

Exhibiting and breeding the Asian small-clawed otter

Amblonyx cinerea

at Adelaide Zoo

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The Adelaide Zoo first exhibited an otter in 1890 and thereafter at infrequent intervals. Knowing what a high exhibition value otters have, it was decided to obtain a number and build a series of enclosures specially for them. In August 1967, four (3.1) Asian small-clawed otters *Amblonyx cinerea* were received from Singapore and in April 1969, 11 more

from Bangkok. Some were quite young and four died within two months of arrival. A pair was sold to Melbourne Zoo, leaving us with a group of nine animals (5.4); we divided them into three pairs and a trio. The otters are housed in six relatively small enclosures, the smallest measuring approximately 16 m² in area and the largest 75 m², and