Entsprechend unseren menschlichen Säuglingen haben wir auch bei den Schimpansen Gesamtlänge, Kopf- und Brustumfang regelmäßig gemessen. Dazu ist zu sagen, daß die Längenmaße in einer Meßmulde vom Schädel bis zu den Fersen bei durchgedrückten Knien und gestreckten Hüftgelenken ermittelt wurden (Abb. 13). Vergleichswerte existieren nicht.

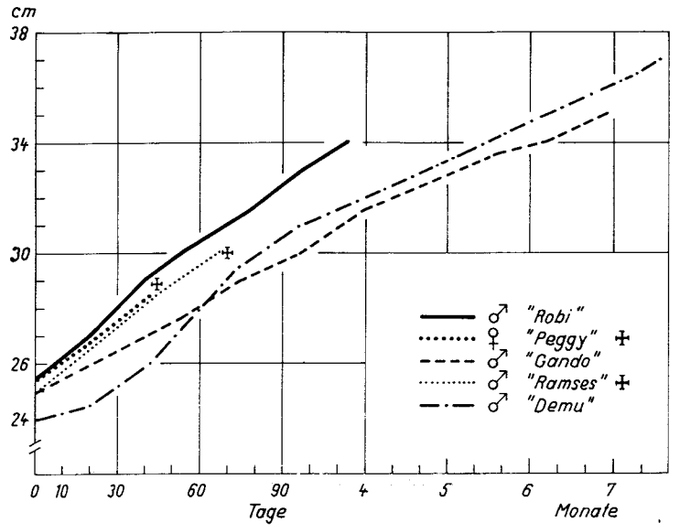

Abb. 15. Entwicklung des Kopfumfanges der 5 Schimpansen

Die Abbildungen der Zunahme des Brustumfanges (Abb. 14) und des Kopfumfanges (Abb. 15) demonstrieren die bekannte Tatsache des wesentlich langsameren Wachstums des Kopfes im Verhältnis zu dem des Brustumfanges (siehe auch CATEL im Vergleich zum Menschen).

Zuletzt haben wir in Tab. 16 noch einzelne Meßdaten zusammengestellt, die zu verschiedenen Zeiten bei den Schimpansen gemessen wurden.

(Fortsetzung folgt!)

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Breeding the Red Panda (*Ailurus fulgens*) at the National Zoological Park

By MILES S. ROBERTS, Washington

With 3 Figures

Introduction

Red Pandas have been popular exhibit animals in zoological gardens throughout the world since 1847 when the first living specimen to be seen in the western world was presented to the Zoological Society of London by Dr. HAROLD SIMPSON of the India Museum in Calcutta (HODGSON 1947). Despite this long history of captive exhibition, breeding and longevity records have been generally poor with only a very few zoos reporting any degree of consistent breeding success in the species (64 births; 43% survivorship 1960–1975; Intern. Zoo Yb., Vol. 1–15). Even the few zoos that have succeeded in breeding Red Pandas have failed ot develop successful long term breeding programs, and multiple generation breeding had apparently not occurred until the birth of a litter of 3 second captive generation young at the National Zoological Park in 1974 (KANTEN 1974).

In many cases, reproductive failures can easily be traced to the adoption of inappropriate management techniques and the subsequent early demise of many newly acquired animals (KENNETH and RITCHIE 1953, MITCHELL 1911, ROBERTS 1978). On the other hand, there remains the fact that in some cases animals exhibiting good longevity simply fail to breed in captivity (CRANDALL 1964, ROBERTS 1978). Successful reproduction in the first captive generation with failure to sustain reproductive into multiple captive generations seems to be attributable, in many cases, to incommensurate management practices, poor longevity and poor survivorship of offspring (EGOSCUE 1975, ZUCKERMAN 1953).

Between June 1972 and July 1977, the National Zoological Park recorded the birth of 13 litters of Red Pandas totalling 31 young with a post-weaning survivorship rate of 65%. This record includes the birth of 5 second generation litters totalling 10 young with a postweaning survivorship rate of 40% (see Table 1).

The present colony of 24 animals descended from one pair of animals that, in 1972 produced 1 litter and subsequently produced 1 litter per year for the ensuing 3 years. Through recruitment, breeding this pair and their offspring and exchanges of NZP born animals with wild caught animals from other institutions, we now have established 6 breeding groups of pandas. Each group consists of at least one animal from bloodline unrelated to original NZP stock in an attempt to eliminate or preclude the deleterious effects of inbreeding.

General management

At NZP, Red Pandas are housed in a variety of outdoor cages ranging from a large circular open enclosure already described (ROBERTS 1975) to a smaller completely enclosed mesh enclosure (see Table 2). 3 of the 6 breeding groups are housed in enclosures

where there is natural grass substrate, live trees, considerable shade and a variety of unheated dens or nest boxes. The other groups are housed in a smaller enclosure with cement floors and heated den enclosed by mesh on all sides including the top.

All pandas are fed a prepared gruel, apples, bananas and 1–2 kg bamboo (*Phyllostachys* spec. and *Pseudosasa* spec.) per animal per day (see Roberts [1975] for diet and feeding schedule). Gruel and fruit intake increases in the winter, decreases in the summer and adjustments are made accordingly. Bamboo intake remains relatively

Table 1. Birth statistics for red pandas at the National Zoological Park

Year	Date Born	Number of Young	Sex ♂:♀	Number Surviving to Weaning Age
1972	6. 23	2	1:1	1:1
1973	6. 29	2	1:1	1:1
1974	6. 30	3	1:2	0
	7. 8	2	0:2	0:2
1975	7. 20	4	2:2	2:2
1976	6. 11	3	2:1	1:0
	6. 20	2	2:0	1:0
	6. 24	2	0:2	0:2
1977	6. 10	2	1:1	1:1
	6. 17	2	1:1	1:1
	6. 20	2	1:1	1:1
	6. 26	1	0:1	0:1
	6. 28	3	3:0	3:0
Totals	13 litters	30	15:15	12:12

Table 2. Red panda enclosures at the National Zoological Park

Enclosures	Configuration	Area	Substrate	Comments
2	Circular	1400 sq ft	Soil and grass	Outdoors. Live trees and shrubs. Completely open except for low retaining fence. 3–5 nest sites per enclosure. Unheated. Abundent perching material in enclosure. 81% survivorship of young in these enclosures
1	Rectangular	1200 sq ft	Soil and grass	Same as above. Visitor viewing on one side of enclosure only. 60% survivorship of young.
5	Rectangular	200 sq ft	Cement	Completely enclosed with 2"X2" mesh. Cut logs for climbing. 1 heated den and 1 unheated nest-box per enclosure. Outdoors. Visitor viewing from 1 side only. 80% survivorship of young.

constant throughout the year, but increases slightly in winter. In the spring, summer and autumn the pandas eat a considerable amount of grass from inside the enclosure. It is a common sight to see pandas, usually in the late afternoon and early morning, graze for long periods like ungulates. In the winter, when the grass in the enclosures dies, little grazing is possible. Therefore it is important to suppliment the available proportion of roughage in the diet by increasing the bamboo provisions.

Occassionally, the animals eat buds, leaves, shoots and tender bark from the trees in the enclosures and also 'root' in the soil as if searching for insects or larvae. Sparrows and the occasional mockingbird are killed from time to time and partially consumed.

Many animals aquired from zoos where bamboo is not fed do not have an immediate taste for this food and adjust to it very gradually. Some never consume the large quantities typical of NZP animals.

Once animal has adjusted to the high fibre diet, stools become much firmer and overweight animals trim down. All animals thus fed have lustrous, lush pelage.

Reproduction

At the National Zoological Park, Red Pandas become sexually mature (the age at which conception first occurs in the ♀♀ and breeding behavior is first seen in ♂♂) during the second breeding season after birth, or, at about 18 months of age. Sexual behavior has been noted at other institutions was early as 6–8 months of age, but without conceptions occurring (Aquilina 1976). Juveniles are first placed in breeding groups at 14–16 months of age, 2–3 months prior to the onset of the next breeding season to acclimate them to their cagemates (see Fig. 1). Young are removed from their parents at 6–7 months of age, 2–3 months, post-weaning, and are kept in peer groups of 2 or 3 animals, separate from breeding adults and newborn animals.

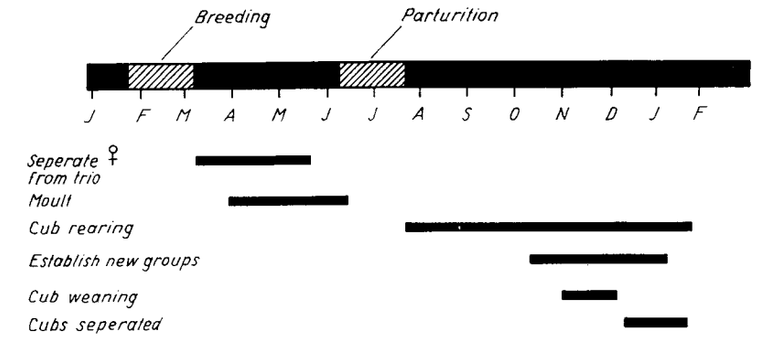

Fig. 1. Annual reproductive and management schedule for red pandas at the National Zoological Park

At NZP the breeding season extends from mid-January to early March. Although copulations are infrequently seen, indirect evidence (i.e. subtracting gestation from birth date) indicates each ♀ varies as much as 2–4 weeks from one year to the next in breeding date. Despite the fact that the breeding season lasts 6–8 weeks (i.e. range of breeding

dates for all years) a ♀ appears to come into estrus only one time per breeding season. Copulations that have been observed have occurred over no more than an 18–24 hour period during the breeding season. Similar breeding behavior has been observed elsewhere (Aquilina 1976; Mottershead 1963).

The gestation period has been recorded in the literature as 90–135 days (Crandall 1974, Dittoe 1944, Egoscue 1975, Mottershead 1958, Munroe 1969, Pocock 1941, Roberts 1975, Zuckerman 1953). Observed copulations at the National Zoological Park have yielded gestations of 114, 128, 131, 135 and 145 days. The gestation of 90 days was recorded at the San Diego Zoo and, if accurate, may allude to a mechanism of implantation delay operating in temperate but not subtropical environments. Such a determination, as well as, the determination if red pandas are induced or spontaneous ovulators awaits further, detailed research.

Births at the National Zoo have occurred from mid-June to late July, but most frequently between the last 10 days in June and the first week in July (Table 1).

Reports from other zoos in the Northern Hemisphere indicate a similar breeding season although a zoo did report a birth in October on one occasion. The single reported birth from the southern hemisphere occurred exactly 6 months out of phase with births in the Northern hemisphere at the corresponding latitude.

Breeding group sizes

We have successfully bred pandas in pairs and in trios consisting of one ♂ and 2 ♀♀. Multimale groups have never been attempted and we find pairs best suited for breeding pandas for the following reasons:

1) Pandas are generally tolerant of one another and ♂♂ may be left with ♀♀ after birth with little or no complication, if left in pairs. But ♀♀ are much less tolerant of one another and severe stress situations may develop if ♀♀ remain together postpartum (Freiheit 1976, Mottershead 1963). Also, the third member of a trio may interfere with a pair during copulation (Fig. 3).

2) Only one of 2 ♀♀ in a trio may breed and conceive.

Both ♀♀ should not be left with the ♂ after breeding because of general intolerance between the ♀♀ and also because ♀♀ may steal, injure or kill another's young after birth.

After birth, ♀♀ become less tolerant of other animals and human intrusions into the enclosure. They may respond to this stress by carrying cubs neurotically about the enclosure, apparently in an attempt to find secure and isolated denning facilities (Freiheit 1976, Mottershead 1963). Such increases in stress may cause the ♀ to cease milk letdown, abandon the cubs, inadvertantly injure them or leave them exposed in the enclosure. There is some doubt that larger groups than those described could be induced to raise cubs successfully, even in larger enclosures (Day 1977, Mottershead 1963).

The young are usually left with the parents until the beginning of the next breeding 'season' (about January). At this time there may be an abrupt increase in agonistic interactions between parents and cubs, usually initiated by the adult ♂, and the cubs are therefore seperated to avoid injuries or their interfering in any way with breeding in the adults.

Reproductive Behavior

With the exception of ♀/infant groups, Red Pandas are believed to be solitary in nature (Hodgson 1947, Pocock 1941). In captivity, individuals tend to avoid conspecifics. They sleep and rest apart from one another and take turns feeding if only one food source is available. This avoidance response is very strong and if one animal violates another's critical distance mild aggressive behavior may ensue.

During the breeding season, there appears to be only a slight hiatus in this behavior. As the ♀ approaches estrus, individuals may seem to be more tolerant of one another in the few days prior to copulation but still exhibit typical spacing behavior for the most part. When the ♀ enters estrus, the ♂ shows increased interest in her and follows her about the enclosure sniffing her all over the body but particularly about the anogenital region. The ♀ is usually tolerant of the ♂'s approaches during estrus but may turn and cuff him on occasion. During estrus, the ♀ becomes significantly more active and moves about the enclosure in an apparently aimless fashion. The ♂'s activity increases accordingly but his movements are not as random as he follows the ♀. The rate of scent marking increases for both animals but is much more dramatic in the ♂.

For the most part, the ♂ follows the ♀ casually and at a distance, scent marking and sniffing the ♀♀ urine, fecal deposits and scent marks. Occasionally, the ♂ will "pursue" or "drive" the ♀ very closely sniffing the ♀♀ anogenital region intensly. Many of these "drives" result in mounting bouts and copulations. A typical sequence of events during copulation is as follows as described during a copulation observed on February 7, 1976:

> "Female trots around cage with male following 2–3 meters behind, scent marking frequently. Female climbs tree and male follows pressing female closer and trying to sniff anogenital region and placing paw on her hindquarters. Female descends tree with male closely behind, she runs halfway across the enclosure with the male running after and suddenly stops and places the top of her head on the ground as in typical play invitation in the young. The male jumps on her back and adjusts his position frantically thrusting all the while, intromission is not seen but is presumed to have taken place. The male slides off to the side, still thrusting, and pulls the female to the ground. They lay on their sides on the ground, with the male thrusting, for about 5 minutes. The female twitters intermittantly and occasionally omits a sound reminiscent of a female housecat being bred. During copulation the male in gripping the female about the abdomen with his forepaws and constantly adjusts his position. Copulation ends with the female rising and leaving the male while he is still thrusting. The female slowly moves off a few feet and scent marks. The male rises slowly and licks his anogenital region."

Neckbite does not occur. However, the ♂ does lick the ♀'s neck and back copiously throughout copulation. There are multiple ejaculations during a copulatory sequence and the end of copulation occurs when the ♀ leaves the ♂. A variety of vocalizations, primarily the high pitched modulated frequency "twitter", occurring during copulations, are emitted for the most part by the ♂ but occasionally by the ♀.

A variety of copulatory positions are assumed (Fig. 2a–d) and all observed copulations have occurred on the ground. This is probably necessitated by the fact that the ♂'s penis is situated relatively far anteriorly on the abdomen and during copulation a position is assumed where his hindlegs are far underneath the ♀ in order to attain intromission (Flower 1870, Hodgson 1847, Pocock 1941). Such a maneuver may be difficult or impossible to assume on any other than a broad flat surface such as the ground.

The duration of each copulatory bout ranges from 5–15 minutes and the inter-bout interval ranges between 15 minutes and 2 hours. Copulations during estrus seem to be limited to an 18–24 hours period with a ♀ entering and leaving the estrus period very rapidly. Characteristically, the day following copulation little or no interaction occurs

between ♂♂ and ♀♀ and no further copulations occur. Such observations stimulates argument that red pandas are spontaneous ovulators, but the data are too inconclusive at this time to draw this conclusion.

During the second week in March, one of the 2 ♀♀ in a trio breeding groups is separated from the other 2 and placed in an enclosure alone to give birth in isolation. The trio is split for reasons previously described. ♀♀ giving birth alone appear to rear their young as efficiently as ♀♀ giving birth in pairs.

Obvious signs of pregnancy are not evident until about midway through the third trimester. At this time, the animals are moulting and the pregnant ♀'s heavy form is

Fig. 2a

Fig. 2b

readily apparent. As the ♀ approaches parturition she becomes considerably heavier and, without becoming lethargic, moves about with apparant awkwardness. She also exhibits visible signs of discomfort frequently adjusting resting postures. Food intake increases as does fluid intake and urination.

Several weeks prior to birth some ♀♀ begin collecting sticks, leaves and bamboo remains and begin constructing a crude nest in one or more of the available nesting areas. The extent of the nest construction ranges from placing a few fallen leaves in a nest hole to depositing large quantities of leaves, sticks and grasses, often in separable and distinguishable layers, in hollow logs or tree trunks. Nest building activity becomes more intensive as parturition approaches and continues in the form of nest maintenance activity postpartum.

Fig. 2c

Fig. 2d

Fig. 2a–d. Mating postures of the red panda

Partum behavior has been seen in the morning, afternoon and evening. Typically, the ♀ initially appears quite restive and jogs or trots around the enclosure, in an agitated fashion. She may carry nesting material aimlessly to and from the nest as she moves about. Scent marking is frequent. Abdominal contractions may first be seen 3–4 hours prior to birth. Typically, contractions occur while the ♀ is in a stationary position. The ♀ appears to brace herself against a vertical object and during contractions the back and tail arches for 5–10 seconds per contraction. There are usually 4–6 contractions per each contraction series which lasts 5–10 minutes. Following a contractions series, the ♀ begins moving or pacing rapidly about the enclosure and scent marking frequently. Because births occur in June and July when the weather is usually quite warm and humid the ♀ pants quite heavily as a result of all of the attendant activity. Fluid consumption increases markedly at this time.

Although actual parturition has never been observed, ♀♀ have been observed on 2 occasions within a few minutes postpartum. On both of these occasions, the ♀♀ are quitely resting with the cubs. Alternate grooming of the cubs and her own anogenital region continues for 2 to 3 hours postpartum and occasionally the ♀ manipulates the infants in an exploratory fashion with her forepaws.

The period immediately postpartum is characterized by the ♀ resting in a curled semicircular position around her cubs for several hours, grooming them, and presumably, allowing them to nurse.

For the first 2 to 3 days postpartum, the ♀ spends 60–80% of her time in the nesting area with her cubs and the remaining time away from them either eating or resting. Following these first few days, the ♀ spends gradually less and less time with them and correspondingly more time resting in other parts of the enclosure, returning to the cubs periodically to nurse, groom and clean them (6–10 times per day). For the first 2 to 3 weeks postpartum, the ♀ moves the cubs frequently from one nesting site to another, sometimes as frequently as 6–8 times per day. The frequency with which she moves the cubs drops steadily after the first week and by the 4th week she moves them no more than once or twice in a 24 hour period. These moves occasionally take on an alarming character as the ♀ carries first one cub and then another around the enclosure, up and down the trees for as long as 30 minutes before finally depositing it in a nest area. Increasing the distance of the public from the enclosure usually reduces the amount of time a ♀ carries the cubs, but such carrying behavior is also common at night when the zoo is empty and thus cannot be attributed exclusively to stress from the public.

After the birth of the cubs, the ♂ typically exhibits increased avoidance behavior towards the ♀ and rarely approaches areas where the cubs are nested. One ♂, however, began spending considerable amounts of time sleeping in the same nest box as the cubs during the second week after birth. The ♀ tolerated his behavior and he would leave the nest box when she approached or entered it. Usually, the first interactions between the cubs and their ♂ parents occur during the cubs' first excursions from the nest box at about 10–12 weeks of age. During these encounters the ♂♂ typically exhibit extreme avoidance behavior at first and only gradually begin interacting with the cubs. These first, tentative encounters may eventually evolve into play bouts which are among the most charming and alluring to be witnessed between a ♂ parent and offspring of any species.

Growth and development, frequency of nursing, the ages of nutritional and social weaning as well as interactions between young and adult has been previously described (Roberts 1975, Wall 1908).

Fig. 3. ♀ red panda attacking mating pair

Important management practices

Red Pandas are highly susceptable to canine distemper as has been described elsewhere (Anon. 1960; Bush et al. 1976, Bush and Roberts 1977, Egoscue 1969, Erken and Jacobi 1972, Fiennes 1961, Roberts 1975). It is extremely important to first protect the pregnant ♀ prior to birth so that passive, albeit short-lasting, protection can be transferred to her offspring. Subsequently, it is important to start the young on a vaccination program at about 2 weeks of age with a killed virus vaccine. This vaccination program has been described elsewhere and will not be repeated here (Bush and Roberts 1977).

Discussion

The keys to the successful breeding of Red Pandas at the National Zoo are as follows:

1) Groups or pairs are established well before the beginning of the breeding season in outdoor enclosures.

2) A diet, low in carbohydrates, of approximately 75% fibre with considerable bulk is provided.

3) Enclosures are large enough to allow individuals of this essentially solitary species to space themselves comfortably. Enclosures allow animals to keep a comfortable distance from the public, especially at birthing time.

4) Trios are split after the well defined breeding season but well before birthing.

5) Parturition is anticipated and the appropriate measures taken, such as providing several den sites choices for the ♀ and keeping the public at a comfortable distance from the animals.

6) Normal postpartum behavior is not do be confused with neurotic behavior, and premature removal of the young is avoided.

7) Vaccination protection of adults and cubs against canine distemper is instituted.

8) Removal of young prior to the following breeding season is programmed.

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