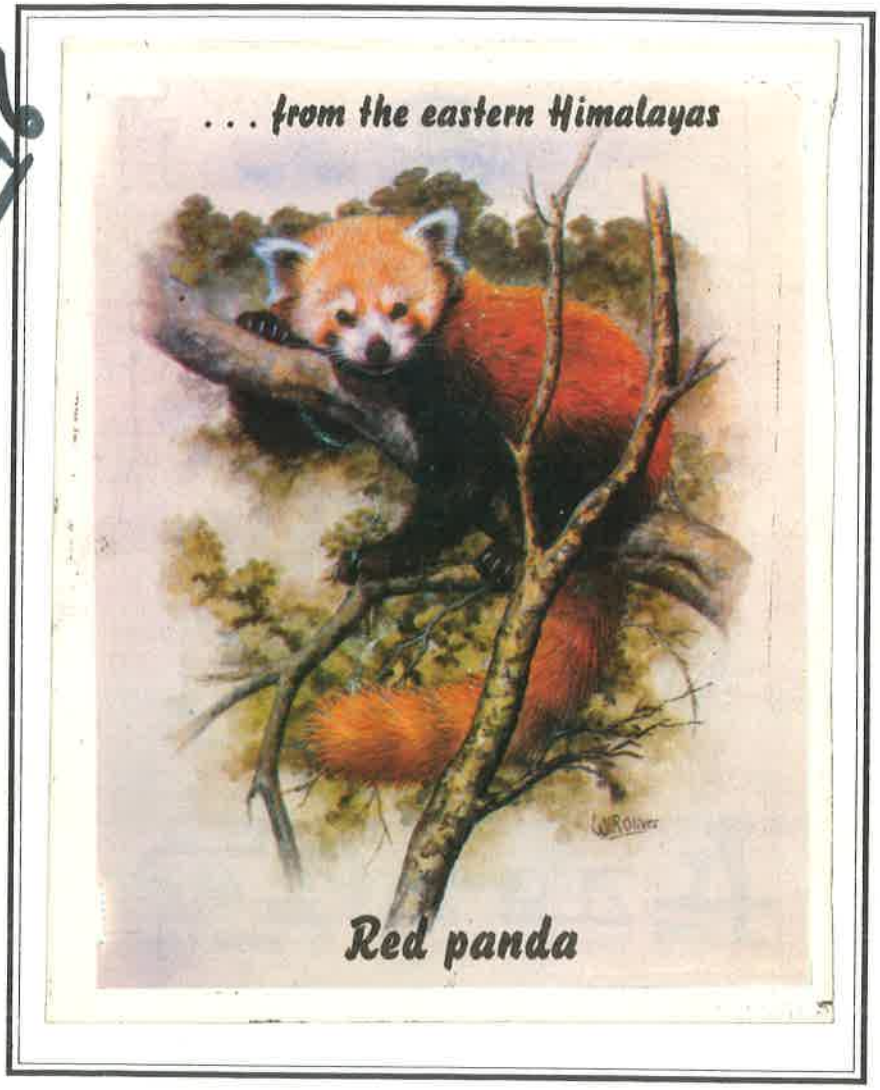
PROCEEDINGS

TRAINING WORKSHOP
Conservation Management of Red Panda
Darjeeling, April 1995



P. N. H. Z. P.
P.N.H. Zoological Park

Central Zoo Authority

Intl Red Panda Mgt. Gp.

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Proceedings

of the

Training Workshop:
Conservation Management of Red Panda

Darjeeling, 1995

P.N. Himalayan Zoological Park
Central Zoo Authority
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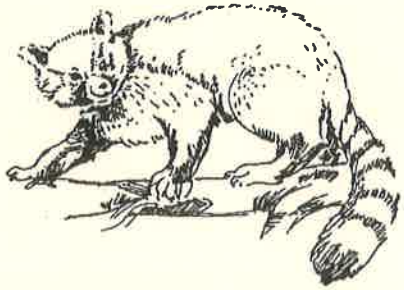

Central Zoo Authority

Edited and published by Zoo Outreach Organisation

August 1996

on behalf of C. Z. A.

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INTRODUCTION

Red panda, (*Ailurus fulgens*) is one of the most attractive animalsfound in India and was a star attraction at several zoos in this country till 1980's. However at present only Darjeeling zoo and Itanagar Zoo have representative of this magnificent species. this species has suffered mostly due to ignorance about its behaviour and morphology. There has been little effort for planned breeding of species. Wherever the species could even breed successfully, the young ones did not survive due to lack of knowledge in neonatal care.

Initatives by European Breeding Programme, Red Panda Specalist Group, the American Species Survival Plan, the international Red Panda Management Group and in particular Dr. Angela Glatston, Gave new direction and thrust to the efforts of ex-situ conservation of the species at Padmaja Naidu Himalayan Zoological park at Darjeeling. The number of founder animals for the programme has been strengthened but the zoo has been able to rear the young ones through appropriate health care and upkeep.

The planned breeding programme of any endangered species can not be carried out by any zoo in isolation. The programme has to provide for housing and upkeep of requisite number of founder animals. The zoos, involved morphology, behaviour and breeding biology of the species. Veterinarians at the zoos have also to acquire skills in the health care for the species.

With these objectives in mind, a workshop on Red panda was organised at Darjeeling Zoo in which invaluable presentations were made by Dr. Angela Glatston And Dr. Peter Burcher from EEP Red Panda Specialist Group and Dr. Miles Robert From the National Zoological Park, Washington from outside India, as wellas from persons within the country. The workshop was attended by several zoo directors, zoo veterinarians, and members of the Centeral Zoo Authority. The Vice Chairman, Gorhka Hill Council, Principal Secretary (Forest), West Bengal have promised all support for the planned breeding programme of the species and reintroduction of the captive bred stock in suitable habitat.

I hope, with the cooperation of all the range state, Centeral Government and the Breeding Specialist Group on Red Panda, the species would be rehabilitated sucessfully. Let us all strive to conserve this magnificent species in perpetuity.

S. C. Sharma.
Member Secretary
Central Zoo Authority

THE HISTORY OF THE RED PANDA PROGRAMME

Angela R. Glatston
International Red Panda Studbook Keeper

Early history

The red panda has been kept in zoos outside of its range states (India, Nepal, Bhutan, Burma and China) since the last century. The first panda to be seen in the west was a male sent to London Zoo in 1869 . This animal was the only one of several pandas to survive the arduous sea voyage from India. It survived only one year in captivity. After that over the years a series of pandas arrived in zoos in Europpe and North America. Hundreds of red pandas made the vovyage from their natural habitat to Europe or America. Marvin Jones records 554 in the period up to 1978 but this may only be the tip of the iceberg. Very few of these animals survived long, the average life expectancy was 3 years. Most succumbed more quickly to a combination of bad diet, stress and innoculation with live vaccines. Those animals which did survive long enough to breed rarely did so. However there were a few bright spots. One of the most successful early zoos holding pandas was San Diego Zoo in the United Stated. In 1940 they imported four pandas from Calcutta. These animals did well and thrived breeding regularly. Their numbers increased and they were sent to other zoos throughout the USA. However despite its success this group and all its descendants died out by the early 1950's.

Early studbook period

It was not until the early 1970's that the breeding of red pandas in western zoos became more successful. One of the most successful of these was National Zoo in Washington, D.C., U.S.A. . But a few zoos in other parts of the world were also achieving a degree of success at this time or shortly thereafter. These included Whipsnade and later Marwell in the UK, Amsterdam and Rotterdam in Holland, Helsinki in Finland and Sydney in Australia.

The International Studbook for the red panda was established in 1978 at the urging of the then director of Rotterdam Zoo, Mr. Van Dam. A first overview of the numbers of pandas in captivity was published later that year and the very first international studbook was published the following year. It contained data on all the pandas living in captivity on the 1st January 1970 and their direct ancestors. The first studbook showed that at the time of the census there were 128 pandas in captivity maintained in 40 zoos. Actually these figures later turned out to be an underestimate as not all zoos had registered their red pandas at that time. We now know of at least 150 pandas living at that time.

During the early years after the studbook was established the zoo population of red pandas was not doing that well. An analysis of the captive population had an unstable structure and the death rate slightly exceeded birth rate. The prognoisis was a population heading slowly towards extinction. These analyses were repeated improvement in the prognosis it was not until the 1990's that the growth became such that the captive population looked secure and expanding. The primary reason for this improvement has been the establishment of well-organised captive breeding programmes in different regions around the world. It is this control which has lead to the ultimate success of the programme.

Breeding programmes

There was some degree of control of the red panda breeding in North American zoos since the mid 1970's and this was repeated in Australia and Europe and Australia in the late 1970's and early 1980's. However these were not formalised into official breeding programmes (SSPs in north America and EEPs in Europe) until some time later. These early informal breeding programmes and the later formalised programmes allowed a degree of control of the red panda

zoo population. Pandas were sent preferentially to zoos which were particularly interested in the species, guidelines were drawn up on the husbandry and management of the species and zoos receiving red pandas were expected to comply with the spirit if not the word of the guidelines. Research on husbandry and management was conducted in a more coordinated fashion and the results were distributed amongst zoos holding red pandas. As the research data grew and developed, so the husbandry and management guidelines changed and developed accordingly. As a result the husbandry and management techniques used in zoos changed and became more suitable to the red pandas needs and as a result the success rate in keeping and breeding these animals improved. There is still room for improvement. Fertility rates could still be improved and infant mortality could be further reduced.

Conferences

The first red panda international workshop was organised in Rotterdam Zoo in 1987. This meeting was attended by people from around the world who shared an interest in red pandas. The meeting essentially focused on zoo breeding and management and on research on captive individuals. There was only one contribution on field research. This meeting in addition to updating the husbandry and management guidelines indicated to all present how little we all knew about red pandas and how much work was required.

A second international workshop was organised four years later in Front Royal Virgina. This meeting formed a milestone in the development of the red panda breeding programme at it was here that the IRPMG or International Red Panda Management Group was founded. This group comprised all the coordinators of the regional red panda breeding programmes, in Europe (mainland and Great Britain), North America, Australia, Japan and China. We hope that in the future N. C. Bahuguna will take his place on this group representing the Indian Programme. Frank Princee of the Dutch Foundation for Research in zoological gardens was the genetic advisor to this group.

The IRPMG was established to fulfil a number of purposes firstly to coordinate the captive breeding of the red panda on a global level, to improve captive breeding, to promote red pandas and to limit to prevent the import of red pandas from the wild into the programme. To support these aims the group decided to produce a global captive breeding masterplan. The parameters which the plan should fulfil were drawn up at the meeting and myself together with Frank Princee proceeded to work on the development of the said masterplan. This plan which was completed in draft form in 1991 from Indian/ Nepali subspecies of red panda and was circulated to IRPMG members for comment. The final version was produced and circulated to all studbook participants in 1992. Shortly after this a red pand PR brochure was also produced to support red panda grant requests, etc. Ths masterplan indicated how the regional red panda population should continue to develop if the red panda global population was to maintain 90% of naturally occurring genetic variability for 100 years. The key recommendations included exchanging particular bloodlines between the regional programmes, limiting the reproduction of certain prolific individuals, encouraging reproduction in certain under represented founder bloodlines and improving infant mortality levels to nearer those achieved in the Japnese programme. As far as India was concerned, one key recommendation was to breed from the red pandas held in Darjeeling zoo as there animals were all wild caught potential founders. This was one of the primary motivation for sending the red pandas from the EEP to Darjeeling zoo.

Since that time a pair of young pandas have been born and reared in Darjeeling Zoo from wild caught parents, a very important edition to the captive population and a further three pandas, two males and one female were sent from the EEP to join the pandas here in Darjeeling. In addition the forest service is responsible for instigating some survey work on the red panda in the local Darjeeling area and has started the first steps towards developing Project Red Panda which I hope will be an important Indo-European (IRPMG) initiative for captive breeding and in situ conservation for red panda in India.

Red panda in the background of Indian Forestry

N.C. Bahuguna, Director, PNHZ Park, Darjeeling.

To assess the population of the animal in Darjeeling, a survey was conducted in Singalila area with the help of Mr. Dhaundyal, Mr. Vyas and Mr. Singhal from Indian Forest Service in west Bengal Cadre. The work was initiated with the help of the existing forest staff, well acquainted with the red panda. A form, asking detail of the direct and indirect signs for the presence of the animal, was circulated among them. After a preliminary report, a detailed survey was conducted by organising 13 teams of 3-6 persons, covering on the average 90m broad strip in different blocks, assigning more priority to the blocks where more changes of finding the red pandas. There were six sightings in the survey.

The survey shows that the population of the animal in Singalila National Park is not more than 26. At present there are no red pandas in Senchal area. There are a few animals available in Neora Valley National Park. However, there may not be more than 50 animals in the district. In Sikkim, the Khangchendzonga National Park (850 Sq. km.), Rhododendron Sanctuary (31.00 Sq.km.) form a typical habitat of red panda. Out of the this 968.10 Sq.km. area more than 70% area is located at very high altitude and therefore unsuitable for the red panda. On the basis of our survey which shows that the usual territory of the animal is approximately 4 Sq.km., we can presume that there are not more than 80 red pandas in Sikkim, even if a few other forest areas are also taken into consideration. We do not have information of the red panda in Arunachal Pradesh. The state forms the eastern boundary of the habitat. In the Takin survey conducted by the Wildlife Institute of India there is not mention of the animal in the Eastern part of the state. Thus a glance in the forest area shows that there may not more than 400 Sq.km. area of area forms a suitable habitat for the animal. thus on the similar assumption we can infer that there are not more than 100 red pandas in Bhutan.

In spite of its rarity, the animal has not yet received sufficient importance. In India, for the first time, this animal was given importance in October 1963, when during the wildlife week a stamp depicting a red panda was issued. Even before the enactment of the Wildlife (Protection) Act, 1972, the red panda was listed in the categories of the 'protected species of wildlife in India'. Later on the animal was declared the State Animal of Sikkim and the State of West Bengal also gave importance to the animal. For insufficient information, the red panda, though considered endangered, was kept in the category 1K' of the red data book.

In captivity, the Indian history of the red panda starts with a great name, Shri Ram Brahma Sanyal, the Superintendent of Alipore Zoo from 1876 to 1908. He has described the animal in the book published in the year 1892. He has given emphasis on proper housing and care of the animal, the concept still considered new. In the book, he gives some tips on housing the animal and he points out that the animal should not be transported except in winter.

The next available record is from Darjeeling, when breeding was recorded in 1908. this was the first successful captive breeding in the world. this was achieved as a result of a pregnant female captured from the wild. Thereafter, the breeding has been reported from Calcutta in the year 1919. The Prince of Wales Zoo, Lucknow is also said to house the animal, but these were sent to Nainital in the summer months. The first Prime Minister of India was gifted a pair of red panda. With the establishment of the Padmaja Naidu Himalayan Zoological Park, Darjeeling, in the year 1958, a flow of wild animals started in the park. In the beginning a few common animals were on display. Red pandas were one of them. After the creation of the PNHZP park, many red pandas visited the zoo. Notwithstanding the fact that the park was created for the preservation of the Himalayan fauna, the emphasis had been on the display only. Although efforts were made to improve the condition of the animal in the zoo, the requirement of the animals were not taken care of. The condition of the animals was considered satisfactory, as long as it was pleasing the the humans. With the strict implementation of the Wildlife (Protection) Act of 1972 in the eighties, there was a sharp decrease in the incoming wild population. On the contrary, only rescued red pandas are housed in Sikkim and Arunachal Pradesh. In most cases, these injured animals succumb to death.

In 1989 a survey was conducted by Ms. Sally Walker and she came out with astonishing facts. She came to the conclusion that there were five facilities holding the red pandas. She reveals that the activities of the dealers were, of late, curtailed. She says that the traders stopped bringing live pandas to dealers without specific order. However, her version that the zoos run by the Forest and Wildlife Department could acquire or retain the animal legally, may only be partially true as there is no record of a law suit being initiated against a zoo. Moreover, the information, in case of the red pandas in India, does contradict this finding.

The idea of red panda captive breeding was generated with the 1989 survey. Through the efforts of Mr. Vinod Rishi and Ms. Sally Walker, an arrangement was made with the Rotterdam Zoo, the Netherlands in 1991 to obtain a panda for breeding. In response to this a male panda, accompanied by Dr. Glatston, was transported to Darjeeling in 1993. Only the male was arrange because there were already three females for a male. Later on this the programme was enlarged to include a programme of reintroduction of the animal to the wild. Shortly, we received a setback when within two months of its arrival the animal died of some disease. Initially, we could not come to any conclusion, but considering the fact that the ill fated red panda did not touch bamboo, its main feed in the wild and his response to the feed provided by us was also not very satisfactory, we concluded that the animal died due to non-adjustment to the new food. There are a few poisonous plants in this area so it is possible that while trying to make an attempt to a new fodder, the animal might have consumed some poisonous plant.

The death was a lesson also because next time we could make improvements. However, in the meantime, with some modifications in the care of the red panda, we could achieve breeding success in June 94. At the same time, we continued our efforts and kept in touch with Rotterdam. For our programme Dr. Glatston agreed to arrange a pair in addition to the male as all our red pandas were already old. To ensure different bloodline, she made contacts with other zoos. On this Madrid and Cologne zoos spared one animals each for the programme., This consignment of the animals arrived in November with a staff from the Marwell Zoo, who made the arrangement of adapting the animals in Indian diet. This time an extra care was taken. The donor zoos were requested to start the feed available the desired results because this time not only the animals survived, but we also observed the mating of these red pandas.

Sucessful breeding alone is is not sufficient : there must be a reintroduction programme and for this we have submitted a proposal to the Chief Wildlife Warden, Forest Department of West Bengal.. Darjeeling is the most suitable place for a captive breeding facility, if reintroduction is to be considered. The presence of red panda habitat, within a short distance, makes the Park ideally situated for the purpose.

Biology of the Red Panda
General Summary

Miles Roberts
National Zoological Park
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Ailurus F. Cuvier, 1825
Ailurus F. Cuvier 1825:3. Type species *Ailurus fulgens* by monotypy.
Arctaelurus Gloger 1841:28. Renaming of *Ailurus* F. Cuvier 1825.

CONTEXT AND CONTENT. Order Carnivora, Superfamily Canoidea, Family Ailuridae (placed by some Procyonidae; see REMARKS). The genus *Ailurus* includes only one species. Classification below the subordinal level follows Pocock (1941).

Ailurus refulgens Milne-Edwards 1874. Type locality unknown.
Ailurus styani Thomas 1902:251. Type locality "Yang-liu-pa, NW Sze-chuen."

CONTEXT AND CONTENT. Context noted above under genus *Ailurus*. Two subspecies of *Ailurus* currently are recognized.
A. f. fulgens F. Cuvier 1825:3, see above. (*ochraceus* Hodgson and perhaps *refulgens* Milne-Edwards are synonyms.)
A. f. styani Pocock 1941:258, see above.

DIAGNOSIS. The genus *Ailurus* includes one living species; thus the following characters (Pocock, 1921, 1941; Thomas, 1902) apply to both genus and species. Readily distinguishable from other Carnivora in coat color: face predominantly white with reddish-brown "tear" marks extending from the inferior region of the orbit to the corner of the mouth (Fig. 1); post-cranial dorsal pelage reddish- or orange-brown and ventral pelage glossy black; legs are black and the soles of the feet are covered with dense, white hair. This is the only Asian carnivore in which the plantar surface of the foot is completely covered with hair. The skull (Fig. 2) is robust (110-120 mm condylobasal length). The sagittal crest is poorly developed and the zygomatic arches widely flared and highly arched. The postorbital process is poorly developed. The palatines extend beyond the level of most posterior molar, the mesopterygoid fossa is constricted anteriorly, the auditory bulla is small and medially inflated and the postglenoid process is robust and anteriorly recurved. The alisphenoid canal is present. The mandible is robust but relatively short in relation to

the height of the ramus. The mandibular symphysis is constricted. The coronoid process is strongly hooked posteriorly and the mandibular condyles are large.

Ailurus possesses extremely robust dentition in contrast with that of the procyonids with which it is compared frequently. The P4, M1, and M2 are wider than they are long and bear accessory cusplets (Fig. 3). Each upper premolar possesses more than one cusp and P3 has a well developed paracone and hypocone; P1 is absent and the p1 is minute or absent.

GENERAL CHARACTERS. Mean mass of captive adult males is 5,0 kg (range 3.7 to 6.2 kg) and is 4.9 kg (range 4.2 to 6.0 kg) for females (Roberts and Kessler, 1979). Length of head and body is 560 to 625 mm and length of tail 370 to 472 mm (Pocock, 1941; Roberts, 1975). The head is rounded, rostrum shortened, and ears large, erect, and pointed. The tail is comparatively long and marked with about 12 alternating red and buff rings (Fig. 1). There is no sexual dimorphism in size or color (Roberts, 1981). Long, coarse guard hairs cover entire body and there is a soft dense, woolly undercoat. Specimens collected from the eastern sector of the range of the species may be somewhat larger and darker in color than those from western areas (Pocock, 1921; Thomas, 1902).

DISTRIBUTION. The red panda is found between 2,200 and 4,800 m in temperate forests of the Himalayas and high mountains of northern Burma and western Sichuan and Yunnan (Fig. 4). The distribution is associated closely with temperate forests having bamboo-thicket understories (Allen 1938; Anon., 1978; Feng et al., 1981; Jackson, 1978; Mierow and Shrestha, 1978; Roberts, 1982a; Sowerby, 1932; Stainton, 1972).

The confirmed western-most range of *Ailurus* seems to be the Namlung Valley in Mugu District and the Lake Rara region of northwestern Nepal (Jackson, 1978). The southern limit is the Liakiang Range of western Yunnan and the northern and eastern limit is the upper Min Valley of western Sichuan. The existence of *Ailurus* in southwestern Tibet and northern Arunachal Pradesh is strongly suspected but has not been documented. A specimen exhibited in the Srinagar Museum in Kashmir; although this could not be confirmed, it would represent a substantial western expansion of the range (Roberts, 1982c).

The red panda seems to be more common in the eastern part of its range, especially along the Burma-Yunnan border, but it cannot be considered a common species (Allen, 1938; Pousargues, 1896).

The current distribution of *Ailurus* suggests a radiation outward from a central core in the Burma-Yunnan-Sichuan highlands along regions of recent orogenic activity, most

notably the Himalayas (Gansser, 1964; Manadhar, 1978). The zone of highest density includes a region in western China proposed as a Pleistocene refugium for a variety of endemics (Pei, 1974; Pen, 1962). The extensive mountain ranges uplifted during the Pleistocene created substantial new habitat for *Ailurus* and a variety of other species of Indochinese origin (Cronin, 1979; Rau, 1974). Erosive activity by rivers originating in the Tibetan plateau caused the partitioning of the Himalayan Mountain system into a series of blocks separated by deep gorges that pose physical and ecological barriers to transmigration. For this reason, the distribution of *Ailurus* should be considered as a series of disjunct, physically isolated populations rather than a continuous, interbreeding one.

FOSSIL RECORD. No fossil congeners of *Ailurus fulgens* are known. A variety of Old World and New World fossils intimately link *Ailurus* with the Procyonidae. McGrew (1938) described the similarity of the molar patterns of the early procyonid, cynarctine genera *Cynarctis* (Middle Miocene to Lower Pliocene of North America) and *Cynarctoides* (Lower Miocene of North America) with that of *Ailurus*. He concluded that cynarctine affinities were closer to Ailurinae than to Procyoninae. *Phlaocyon* (Lower-Middle Miocene of North America) and *Aletocyon* (Lower Miocene of North America) also bear substantial similarities to *Ailurus* on the basis of molar patterns and the structure of carnassials and auditory regions (McGrew, 1938; Romer and Sutton, 1927). However, Wortman and Matthew (1899) suggested that *Phlaocyon* was more intermediate between *Cynodictis* and *Procyon*. Simpson (1945) agreed with this view and applied the same line of argument to *Aletocyon,* placing both genera in the subfamily Procyoninae and indicating that they were more likely precursors of the New World procyonid radiation than that of the Old World.

Sivanasua of the Upper Miocene of Europe and Lower Pliocene of Asia seems to be the earliest indisputable ailurine and exhibits cranial and dental structures ancestral to and possibly contemporaneous with *Ailurus* (Pilgrim, 1932; Schlosser, 1899). America seems closest to *Ailurus* in general cranial and dental morphology (Dawkins, 1888; Tedford and Gustason, 1977). The available *Parailurus* material suggests that there were possibly as many as three different species (Kurt'en and Anderson, 1980; Tedford and Gustavson, 1977), all larger and more robust than *Ailurus* in dental and cranial characters. The approximate biochron for *Parailurus* is 3-4 m.y.b.p. The *Parailurus* findings indicate an European-Asian origin for the Ailurinae with a subsequent trans-Beringian radiation (Kurt'en and Anderson, 1980; Tedford and Gustavson, 1977).

Intermediate forms between *Parailurus* and *Ailurus* are not known. The smaller size diminished range of *Ailurus* suggests that it may represent a specialized offshoot of the

early ailurine lineage (and possibly even of an Asian form of *Parailurus*) that survived the Pleistocene glaciations in the mountain refugia of southern China (Pen, 1962).

FORM AND FUNCTION. The reddish-orange pelage appears cryptic against the canopy of fir *(Abies)* trees where branches are covered with clumps of reddish-brown moss (Order Bryales) and white lichens *(Usnea)* (Roberts, 1982a). Tufts of facial vibrissae, situated low down on the cheek, are present. A series of small pores from which appear small amounts of clear, colorless, and odorless fluid occurs on the plantar surface of the feet (Roberts, 1981). The pores are contained in slightly raised areas between the plantar pads, and are associated with small, slightly elongated, and thickened hairs. These pores may secrete substances that are used in depositing scent trails (Roberts, 1981). Urine and secretions originating from the anogenital region may be other sources of scent. Adults of both sexes possess paired anal glands each approximately 2 cm long and 1 cm in diameter located bilaterally adjacent to the anal opening (Flower, 1870; Pocock, 1921; Roberts, 1981). Short ducts lead from the glands and empty into the distal portion of the rectum about 2 cm from the anal opening or anal sphincter. The content of the glands is a dark green-black, iridescent, oily fluid with a very pungent odor.

The number of mammae in females is eight, arranged in two rows of four each (Sokolowsky, 1918).

The dental formula is 3/3, c 1/1, p 3/3-4, m 2/2, total 36-38. The fourth upper premolar, a principal discerning dental character in Carnivora, is large with five cusps as in *Procyon* and *Ailuropoda* (Davis, 1964; McGrew, 1938). By contrast, in the Ursidae P4 has only three cusps which are degenerate. The second
and third upper and lower premolars are large and robust. The large cheektooth surface promotes mediolateral movement for a grinding action and correlates with highly specialized diet of bamboo and fibrous plant material (Gregory, 1936; Hodgson, 1848; Scapino, 1981). The symphasis menti is relatively flexible with moderate degree of independent movement of the hemimandibles (Scapino, 1981).

In general, skull size is large compared with that of carnivores of similar body size such as Procyonidae. Greater depth of skull may improve bite pressure at the level of the cheekteeth; particularly high values are found for zygomatic arch width, occipital height, condyle to m1 length and jaw cross-section area (Gregory, 1936; Radinsky, 1981). Relative brain size, measured from cranial capacity, is comparable with that of Procyonidae (Gittleman, 1983). The auditory bulla is relatively small as indicated by the reduced caudal entotympanic elements, and may be correlated with reduced auditory sensitivity (Hunt, 1974). In both juvenile and adult forms the bulla is formed almost entirely by the tympanic

as in ursids, and lutrinae and mephitinae mustelids. Rostral and caudal entotympanics form a small part of the medial wall of the bulla as in Ursidae but in contrast with that in *Procyon*, which possesses a swollen caudal entotympanic (Hunt, 1974).

There are 6 lumbar vertebrae and 14 thoracics (Davis, 1964). The cervical region is short. Relative proportions of the vertebral column are: cervical (22%), thoracic (47%), and lumbar (31%). Forelimbs and hindlimbs are of roughly equal length (Davis, 1964). The five digits on each foot are in a strongly curved line and terminate with curved semiretractile claws, used effectively in climbing. The radial sesamoid of the giant panda, *Ailuropoda* (Davis, 1964). Forepaws are frequently used to pick, manipulate, and pull apart food, particularly bamboo leaves and stalks (Roberts, 1981; Sokolowsky, 1918). The postcapular fossa is moderately large and may be indicative of its arboreality where the forelimbs are more supportive while climbing than the hindlimbs (Davis, 1949).

The left lung is divided into two lobes (Goppert, 1937) similar to Procyonidae, Mustelidae, and Ursidae but contrasting with the remaining carnivore families that have three lobes. Reduction of lobes seems to be associated with a broadening of the thorax (Marcus, 1937), whose functional change is unknown. The right lung is divided into four lobes as in all fissiped carnivores.

The salivary glands are relatively large as in most omnivorous carnivores (Carlsson, 1925). The tongue is similar to *Ursus,* being of moderate length and having numerous foliate papillae (Davis, 1964; Sonntag, 1923). The stomach is simple, as in all fissiped carnivores, with a spherical fundus, no caecum, and a cylindrical, thick-walled pylorus (Hodgson, 1848). The intestinal tract is simple and comparatively short (4.2 times body length). This characteristic is unusual considering the common association between herbivory and an extended gut in mammals.

Males possess a comparatively short penis, the prepuce closer to the scrotum than in Procyonidae (Flower, 1870; Pocock, 1921). The baculum is comparatively short, only about 2 cm long (Davis, 1964; Pocock, 1921).

Red pandas have low basal rates of metabolism approximately one third that of the similarly sized bobcat and comparable to that of tree sloths. They further reduce their metabolic rate at low ambient temperatures without a concommitant reduction in body temperature (McNab, 1989). This strategy appears to be a means of reducing total energy expenditure in an arboreal, sedentary species that feeds on foods with low energy densities (i.e. bamboo). The low metabolic rate for this species is consistent with low fecundity and low rates of growth.

ONTOGENY AND REPRODUCTION. The mean of 17 reported gestations in captivity was 134.2 days (SD=14.7 days; range, 112 to 158 days; Dittoe, 1944; Erken and Jacobi, 1972; Mottershead, 1958; Roberts, 1981; Roberts and Kessler, 1979). Pocock (1941) reported a gestation of 90 days provided by Dr. Vevers of the Zoological Society of London. However, the derivation of this measurement was not stated; therefore, it likely was erroneous. The exceptional length and range of gestations suggests that delayed implantation may occur although this has not been demonstrated.

In captivity, pregnant females become noticeably heavy and lethargic about 6 weeks before parturition (Roberts, 1980, 1981).

Several days before parturition a pregnant female begins to carry nest materials such as sticks, grasses, and leaves into suitable nest sites. Nest building may continue after the young are born but the behavior is highly variable among females (Mottershead, 1958; Roberts, 1981). In the wild, animals may use hollow trees or rock crevices as nest sites (Hodgson, 1847; Pocock, 1941) but in captivity females readily adopt nest boxes placed on the ground, hollow logs, or other artificial dens (Keller, 1977; Roberts, 1975, 1980). Within 24 h of parturition females become more active and move about aimlessly, pausing occasionally to lick the anogenital region or to prop the hindquarters against a vertical object as if to strain during abdominal contractions (Roberts, 1981). All known births occurred between 1600 and 0900 h, the period of highest activity. Parturition occurs rapidly, with females quickly cleaning the cubs and remaining with them for 60 to 90% of the time during the first few days after birth (Erken and Jacobi, 1972; Keller, 1977; Mottershead, 1958; Roberts, 1975, 1981; Wall, 1908). Females may recognize their young by olfactory cues established shortly after birth. After the cubs are about 1 week old, females gradually spend more time away from them, returning every few hours to nurse and groom them (Roberts, 1975, 1981). Mothers move young frequently, presumably in response to nest disturbance; all active nest sites are kept clean by the mother. Lactating females increase food consumption within 24 h of parturition and continue to do so until weaning. Young are nest-bound for approximately 90 days, after which they make their first excursions from the nest at night. At first, mothers attempt to restrain cubs from emerging but cubs soon become too active to monitor closely. Initial excursions from the nest coincide with the first evidence of the young eating solid food (Roberts, 1975, 1981). By 120 days of age, young consistently rest away from the nest area with their mother, Mother-young proximity continues to be close until the onset of the next breeding season when mild aggression between the mother and young may occur (Roberts, 1975, 1980). Young attain adult size at approximately 12 months and are sexually mature at approximately 18 months (Roberts, 1975, 1980, 1981).

In captivity, mating is strictly seasonal with onset in the early winter, usually between early January and mid-March (Dittoe, 1944; Erken and Jacobi, 1972; Keller, 1980; Mottershead, 1958, 1963; Roberts, 1980, 1981; Roberts and Kessler, 1979; Zuckerman, 1953). The onset of sexual activity coincides closely with increasing photoperiod following the winter solstice (Roberts, 1981). The mating season for individuals in captivity in the northern hemisphere seems not to differ substantially from that in the wild although there may be a tendency for prolongation of the mating season in captive colonies (Roberts, 1981). Captive individuals in the southern hemisphere mate in the austral winter, generally in July and August. Roberts (1981) reported that a hierarchy of environmental cues and lunar periodicity is more specific cue, with copulations tending to cluster during the "new moon" phase of the lunar cycle. In the wild, birth occur in spring and summer, but mainly in June (Hodgson, 1847; Pocock, 1941; Wall, 1908). In captivity in the northern hemisphere, 3.5% of 199 liters were born in May, 79% in June, 16% un July, and 1.5% in August. Of 11 liters born in the southern hemisphere 8 were in December, 2 in January, and 1 in March (Glatston, 1980, 1982). In captivity, no synchrony of mating or birth dates is evident among females housed in the same or nearby enclosures. The time of mating and birth also is not affected by latitude (within a hemisphere) or by altitude. Females tend to give birth within 10 days of the date of parturition the previous year (Roberts, 1981).

In captivity, litter size ranges from one to four with a mode of two (Erken and Jacobi, 1972; Glatston, 1980, 1982; Hodgson, 1847; Pocock, 1941; Roberts, 1975, 1980, 1981; Roberts and Kessler, 1979; Wall, 1908; Zuckerman, 1953). Litter size does not affect gestation length (Roberts, 1981). The sex ratio in a sample of 100 infants born in 78 litters was 48 males to 52 females (Roberts, 1981). The mortality schedule is similar to that of other mammals being highest in the youngest (0 to 1 year) and oldest (7 to 12 years) age classes with a decline during middle age (1 to 7 years). Litters of two and three young have the lowest juvenile mortality. Survivorship of the young is independent of maternal age and experience. Generally mortality is higher in males and increases significantly with higher inbreeding coefficients (Roberts, 1981, 1982b).

Neonates weigh 110 to 130 g and grow at a rate of 7 to 20 g/day until they begin to eat solid food at approximately 90 days (Brahm and Bartmann, 1976; Conway, 1981; Roberts, 1975; Roberts and Kessler, 1979; Watson and Barfield, 1982). At birth, eyes and ears are closed, and head, body, and tail are covered with thick, wooly, gray-buff fur approximately 25 mm. The tail is proportionately shorter in young than in adults, averaging about 70 mm or 25% of the total length in contrast to about 40% of the total length in adults. At birth, the skin is pink, plantar surfaces of the feet are unfurred, mysta-

ceal vibrissae are about 20 mm long, and the pelage lacks adult coloration and markings. By day 14, long reddish guard hairs appear giving a slightly reddish tinge. Eyes and ears open by day 18. Adult coloration and coat pattern are discernable at about day 50; the tail is ringed, the face white with a dark track from the eye to the corner of the mouth, and the soles of the feet are fully furred. Adult coloration and patterning essentially are complete by day 70 (Roberts, 1975). Adult size and mass are attained by 12 months of age. Premolars, both upper and lower, first appear about 30 days and complete dentition appears by 6 months (Brahm and Bartmann, 1976; Conway, 1981; Erken and Jacobi, 1972; Gray, 1970; Munro, 1969; Roberts, 1975, 1981; Roberts and Kessler, 1979; Wall, 1908).

Red pandas have extremely protracted postnatal growth rates. A low energy diet and a low energy conversion efficiency of ingested food indicate that mothers may be pushed to energetic limits during lactation and suggest that lactation energetics may be directly responsible for low growth rates (Gittleman, 1989).

For the first 7 to 10 days after birth young remain essentially immobile except when nursing (Roberts, 1975, 1981). The mother remains curled around them when in the nest and, in her absence, the young sleep in a curled or semi-curled position often in contact with one another. Gradually, the young become more active and move about in a uncoordinated fashion. They are able to right themselves when placed on their back by day 12. By day 18, the eyes are open and the young are able to orient toward light. By day 60, siblings are engaging in rough tumble play in the nest and frequently venture to the entrance of the nest box. Young are able to climb proficiently by the time they emerge from the nest box at about day 90 (Keller, 1977; Roberts, 1975, 1980, 1981).

There are few paternal interactions until the young are weaned (Roberts, 1975, 1981). In captivity, some males were observed to enter nest boxes and even sleep with young for short periods. There is no provisioning of the young, however, by either parent at any time. After young emerge from the nest, males may engage in play with them. Males can be left with females year-around in captivity but females left together in the same enclosure may steal or kill young of others (Mottershead, 1958). Prolonged association of both parents with young and apparent tolerance of mixed-sex groups in captivity has led to speculation that the red panda may be gregarious in nature (Mottershead, 1958; Roberts, 1980, 1981; Roberts and Kessler, 1979).

In captivity, red pandas are polyestrus with an estimated cycle length between 26 and 44 days (Erken and Jacobi, 1972; Roberts, 1981; Roberts and Kessler, 1979). The duration of estrus reportedly was between 1 and 14 days (Erken and Jacobi, 1972; Keller, 1977, 1980; Kowalska, 1982; Roberts, 1981; Roberts and Kessler, 1979). Sexual behavior is concentrated over 24 h of a single estrus period suggesting (1) an inherently short

bounding gait. Copulation occurs on the ground following a mount invitation by the female. The male clasps the female about the abdomen and immediately commences thrusting at a rate approximately 120 thrust/min. There is no neck bite although the male may lick the neck and shoulders of the female during copulation. There are extravaginal ejaculations and multiple ejaculations per copulation. Copulations last 3 to 39 min; there is no evidence of a copulatory tie and, at the end of copulation, the male and female separate and engage in long bouts of genital autogrooming (Keller, 1977, 1982; Roberts, 1980; Roberts and Kessler, 1979).

Chemical signals are deposited through sterotyped motor patterns associated with the deposition of urine, feces, and secretions from the anal and circumanal glands. Feces deposited in well-defined latrine areas may serve to delineate home ranges or territories. Scent-marking involves applying the anal or circumanal region to slightly raised objects such as sticks or rocks and rubbing these in a lateral and anteroposterior fashion. Urine also may be applied simultaneously. Males mark more frequently and for longer duration than females at all times of the year. Most scent-marking occurs on the ground but it also can occur in trees (Keller, 1982). Habitually used branches may become coated with a layer of slightly sticky material seemingly deposited by the animals as they move about. These scent trails are smelled intensively by animals newly introduced into enclosures. Red pandas have a series of enlarged papillae on the underside of the tip of the tongue that seem to serve a chemocommunication function. Following olfactory inspection the tip of the tongue is applied to certain areas and either vibrated or drawn along the spot being examined, The tongue is withdrawn into the mouth and the process may be repeated (Keller, 1977, 1982; Roberts, 1981).

Most behaviors of the red panda are typically carnivore-like and offer few clues to the taxonomic placement of the species. Certain categories of behaviors, especially scent-marking, some vocalizations, body postures, foraging, and feeding behavior reveal similarities between the red panda and giant panda (Kleiman, 1983).

GENETICS. The diploid (2n) chromosomal complement of *Ailurus* is 36 including 32 metacentrics and submetacentrics and 2 acrocentrics; one marked pair of satellite submetacentrics is on the short arm as in other carnivores (Hsu and Benirschkle, 1970; Todd and Pressman, 1968; Wurster, 1969). The typical procyonid karyotype is 2n - 38 and that for Ursidae is 2n = 74. The giant panda has a karyotype of 2n = 42. Albumin and transferrin data indicate early divergence from the procyonid line, with some 41 units of change accumulated subsequent to *Ailurus* divergence (Sarich, 1976).

Mitochondrial DNA studies examining levels of allelic variation on minisatellites

suggest that there are at least three red panda haplotypes with those of *styani* being distinct from the two *fulgens* haplotypes. These data confirm a significant level of genetic distinction between the two proported subspecies consistent with zoogeographic, morphological and electrophoretic studies previously conducted (Glenn, personal communication).

REMARKS. The higher taxonomic affinity of *Ailurus* has been a subject of almost as much debate as the taxonomic placement of the giant panda(Chorn and Hoffman, 1978). Since its discovery in the early 1800's, *Ailurus* has, at various times, been placed in the Procyonidae (Gregory, 1936; Hollister, 1915; Honacki et al., 1982; Sarich, 1976), the Ursidae (Mivart, 1882; Trouessart, 1904). with *Ailuropoda* in Ailuropodidae (Flower,1870; Lankester, 1901), and in the monotypic family Ailuridae (Pocock, 1941; Eisenberg, 1981). This uncertainty has arisen because of difficulties in determining whether certain characters of *Ailurus* are phylogenetically conservative or are derived and convergent with species of similar ecological habits. Evidence based on the fossil record, serology, karyology, behavior, anatomy, and reproduction reflect closer affinities with Procyonidae than Ursidae. However, ecological and foraging specializations and a distribution distinct from the modern procyonid radiation warrant classification in a separate family (Ailuridae) derivative of the Procyonidae. Subspecific classification of *Ailurus fulgens* also has been somewhat inconclusive and has received little systematic treatment (Roberts, 1982b).

The common name for "panda" was applied to *Ailurus* when it first was presented to the western scientific community in 1821 (Hardwicke, 1827). *Ailuropoda* was designated the "giant" panda after its discovery in 1869 because of some affinities to *Ailurus;* subsequently the latter was relegated to "lesser" panda. We prefer the designation "red" panda in view of the chronological seniority of *Ailurus* in the scientific literature and the more accurate description given by this term.

The red panda seems to have little commercial value and is of little economic importance in live animal and fur trades. The species is protected in India, Bhutan, Nepal, and China, and is listed in Appendix II of the Convention on the International Trade in Threatened and Endangered Species. Native names applied to *Ailurus* include lesser panda, fire fox, bear cat, wah, ye, nigalya ponya, thokya, woker, sankam, and wokdonka. The origin of the name "panda" is unknown.

MANAGEMENT. **Housing**. Red pandas are to be housed in outdoor enclosures with indoor access where weather and temperature dictate. However, animals are to have access to outdoor enclosures at all times. Enclosures may be mesh, walled, moated, fenced,

glass or any combination thereof that does not endanger the health and safety of the animals. Red pandas are excellent climbers but poor jumpers so moated enclosures contain them well. Enclosures should have a floor area of at least 40 square meters (approximately. 430 square feet), preferably more, and should be at least 4 meters (approximately 12 feet) high or have climbing structure of this height (assuming the enclosure(s) is not entirely open) as red pandas prefer to rest in elevated perches above the level of the viewing public. Natural substrate planted with edible grasses is strongly recommended as animals will graze grasses and forbs; it is recommended that at least 50% of the enclosure is to be planted with edible grass. A varied environment, including rocks, trees, pools, logs and clumps of vegetation is to be provided.

Public access should be restricted to one or at most two sides of the enclosure so that animals Can retreat from public disturbance. Following parturition red panda mothers become increasingly intolerant of public disturbance and provision may have to be made to reduce public proximity to the enclosure after birth. A minimum of three nest boxes are necessary to allow the mother a choice of nest sites and alternative sites if she wants to move her cubs (this happens quite regularly). These should be constructed of insulative material and placed at different shaded locations in the enclosure so as to maintain a temperature not to exceed 75°F during hot weather. Some part of the enclosure is to be in shade throughout the day when temperature is above 75°F to provide animals relief from the radiant heat of the sun.

Enclosures should not be located near aggressive animals which Can disturb red pandas nor should they be in close proximity to heavily trafficked roads or noisy gathering public places. Pairs of animals should not be housed closer than 6 meters (about 20 feet) from one another and visual barriers are to be placed between adjacent pairs.

Daily Care. Red pandas require considerable care and attention if they are to thrive and perform well either as breeding or exhibit animals. The daily care requirements include: cleaning enclosures of leftover food and feces, checking animals for condition and normal behavior, and the provision of fresh food and water. Perhaps the best way to monitor condition, short of a complete physical examination, is through daily inspection at the onset of the active period when healthy animals are expected to be most active and searching for food. Analysis of weight dynamic patterns Can also be a valuable tool for managing individuals and populations. Weight changes Can reflect nutritional problems (obesity and undercondition), changes in reproductive condition (e.g. pregnancy or weight loss during lactation) and hormonally or environmentally induced changes in metabolism (e.g. prior to dormancy and the onset of the breeding season). Correlating weight changes with key life

history parameters will enable animals to be managed much more effectively.

Obtaining regular weights is essential to good management. Red pandas Can easily be trained to enter a nestbox or shipping crate for food. Obtaining a weight simply involves simply closing the animal in the box, weighing the nestbox with the animal in it and subtracting the known weight of the nestbox. This precludes stressful (to both animal and handler!) capture by net or other potentially injurious means. A little forethought in nestbox design Can also minimize the potential disturbance of monitoring infants in the nest.

Social Management. Red pandas should be maintained as monogamous pairs which remain together 24 hours per day throughout the year. The male may remain in the enclosure with the female after birth unless there are obvious signs that he is interfering with or inhibiting normal maternal care. Trios of one male and two females may be assembled for breeding purposes providing that one female is separated from the group at least 2-4 weeks prior to parturition. Young may remain with the parents at least through the next breeding season and up to one month prior to the next anticipated birth. Juveniles should not be separated from their parents earlier than February to ensure proper socialization. After separation, juveniles and subadults should remain in social groupings until they are placed in breeding pairs. Every effort should be made to house solitary individuals with similarly aged individuals to ensure socialization. Pair formation should occur no later than six weeks prior to the onset of the forthcoming breeding season. In the northern hemisphere, the breeding season begins approximately at the beginning of winter (i.e. end of December).

Medical Care. Management of Canine distemper requires special attention and care. Red panda should NEVER be vaccinated with live or modified live virus vaccines, only killed virus vaccines should be used. An initial series of vaccines starting at 8 weeks and repeated every 3 weeks until 16 weeks, red pandas continues to be vaccinated twice a year for protection. It should be noted that presently there is a vaccine trial underway to test a modified live Canine distemper vaccine (used in ferrets) in red pandas.

Rabies vaccination with a ***KILLED*** vaccine is used in endemic rabies areas. Red pandas develop titers comparable to protective titers in domestic carnivores following vaccination with a 1 ml dose intramuscularly (IM).

Parasite checks should be conducted on a twice yearly basis. A fecal exam includes a direct smear for the detection of protozoa (e.g., amoeba, ciliates) or motile larvae, and flotation methods for nematodes, cestodes, and coccidia, and sedimentation techniques for identification of various lungworm larva. The lungworm that occur in red pandas are

Crenosoma, Troglostrongulus, and *Metastrongyloides*. Most parasites are easily identified and eliminated with proper anti-parasitic therapy. The patient is treated for parasites and proven free of parasites on two successive exams prior to exiting quarantine.

Stools of red pandas with diarrhea should be examined for parasites and cultured for enteric pathogens and subsequent antibiotic sensitivity of these pathogens to direct appropriate therapy. An important adjunct to treating diarrhea is to reduce various supplements (fruit, vegetables, gruel,etc.) and provide a high quality bamboo. Rodents are potential sources of pathogens such as *Yersinia spp., Salmonella spp.* and *Leptospira spp.* especially for pandas maintained outdoors. Therefore, a rodent control program is part of an overall preventative medical program. It may seem obvious but special precautions must be taken to insure that pandas do not have access to any rodenticides. There have been isolated cases of the following infections reported in the red panda; tuberculosis, erysipelas and salmonellosis, Chagas' disease, Tyzzer's disease, and toxoplasmosis.

. Dental disease is common in red pandas and is a source of bacterial entry which may progress to tissue infection and/or septicemia. Although dental disease may not be listed as a cause of death in pathology records it Can be an important underlying causative factor for poor nutrition and/or bacterial septicemia. Animals fed soft gruel diets high in carbohydrates are very prone to tarter accumulation, gingival problems which lead to generalized dental disease with loss of teeth. Routine dental care is indicated in all older pandas as we see dental problems such as tartar, gingivitis, chronic tooth wear, abscessed teeth and periodontitis in most middle aged pandas which result in loss of masticatory surfaces with resulting chronic weight loss and deterioration of physical condition. Regular removal of tartar with tooth polishing minimizes periodontitis and resultant gingival disease with its tooth loss.

Hair loss is not uncommon in captive red pandas. In young pandas with focal areas of hair loss on the face, head, and feet the diagnosis of a dermatophytosis (*Microsporum gypseum*) should be considered. The lesions are cleared using standard ringworm therapy for domestic pets (i.e. griseofulvin orally) while some infections seem to be self limiting and resolve as the animal gets older. Hair loss in older animals may indicate other skin parasites and should be scraped and/or biopsied. We have diagnosed hypothyroidism as a cause of a non pruritic dermatitis with alopecia and obesity by thyroid biopsy and response to thyroid supplementation.

Restraint and Anesthesia. Some short minor manipulative procedures on red pandas (i.e. vaccinations or injectable medications) Can be accomplished using physical restraint by

a net, heavy gloves or a squeeze cage.

Any prolonged procedure or painful manipulation is performed under anesthesia. Preanesthetic preparations facilitate the procedure and increase patient safety. Food and water are withheld for 12 hours to minimize vomiting which Can cause fatal inhalation pneumonia. Confining the patient to a small dark area during induction of anesthesia minimizes excitement and stress and lowers the amount of anesthetic drug required.

Dissociative anesthetics in combination with sedatives or tranquilizers are the choice of injectable anesthetic agents for red panda[3] since ketamine [11 -14 mg/kg] alone usually results in a patient with extreme muscle rigidity and minor CNS stimulations. Ketamine (6 -9 mg/kg)is therefore combined with Xylazine (0.2 - 0.4 mg/kg). Telazol is the anesthetic of choice for red pandas at a dose of 4.5 - 6 mg/ kg which produces a rapid and safe anesthesia with acceptable muscle relaxation. For prolonged procedures such as major surgery, supplemental injections of Telazol are given or the patient is given an inhalation anesthetic such as halothane.

Physical examination of an ill pandas should include appropriate bacteriologic and cytologic examination of wounds, abscesses, sputum, urine, rectal, body cavity fluids, etc. If septicemia or bacteremia is suspected, blood cultures should be obtained. Blood collection for hematology and serum chemistries aids the initial diagnostic examination and in monitoring the course of the disease during and after treatment.

A complete post-mortem examination is a vital part of the preventative medical program to monitor disease outbreaks, subclinical medical problems and potential nutritional problems.

Diet. Bamboo is an essential part of the diet and should be fed every day. At least 20 leaves per animal per day should be fed but it is preferable to feed bamboo *ad lib.* Red pandas will graze on almost any grasses grown inside their enclosures and most grasses are excellent adjuncts to bamboo. Any other bamboo substitutes should be carefully reviewed for palatability, digestibility and suitable nutritional content before being offered. Supplemental diets (gruels, cakes, biscuits etc.) should contain a high percentage fiber and should be low in cholesterol and fat. The commercially available primate leafeater diets recommended as nutritionally complete diets for red pandas provide an excellent dietary foundation to which other items Can be added if necessary. All diet ingredients are to be fresh and of good quality and every effort must be taken to protect the supplemental diet against spoilage during warm weather and freezing during cold weather.

Food consumption is to be monitored closely and adjustments made in accordance with

the number, size and nutritional condition of the animals. Animals have higher energetic requirements in the winter and during growth and lactation and appropriate diet adjustments should be made during these times. Animals are to be fed at least twice daily with fresh food being added and old food removed at each feeding. Food consumption should be monitored closely and adjustments made to maintain animals in good condition. Red pandas signifiCantly increase energy requirements in the winter and during lactation and appropriate adjustments should be made in the quantity of the diet at these times.

References

Agrawal, R.D., S.S. Ahluwalia, B.B. Bhatia and P.P.S. Chauhan.1981. Note on mammalian coccidia at Luchnow Zoo. Indian Journey Animal Science, 5:125-128

Aho, R. 1983. Saprophytic fungi isolated from the hair of domestic and laboratory animals with suspected dermatophy-tosis. Mycopathologia, 83:65-74

Alikhan, M.G. and N.M. Kamal. 1981. On the longevity of the cat-bear or red panda (Ailurus fulgens) in captivity. Journal Bombay National History Society, 78:364

Allen, G.M. 1938. The mammals of China and Mongolia. Nat. Hist.Central Asia, Amer. Mus. Nat. Hist. 11 (pt.1) 1-620.

Anon. 1839. Proceedings of the Zoological Society of London.Part IV, 87-90.

Anon. 1976. The lesser panda. Tigerpaper, 3:20

Anon. 1978. Newsletter No.43. Nature Ann., 2:150-154

Anon. 1987. Subclinical mastitis and apparent aglactia in lesser panda (Ailurus fulgens). Pp. 459-461 In Proceedings of the First International Conference on Zoological and Avian Medicine, Volume (Anon.). Association of Avian Veterinarians American Association of Zoo Veterinarians

Anon. 1987. Lesser pandas in the Zoo. Wielewaal, 53:252

Bartlett, A.D. 1870. Remarks on the habits of the panda(Aelurus fulgens) in captivity. Zoological Society of London, :769-772

Bartlett, A.D. 1900. The panda, Ailurus fulgens,Life among wild beasts in the zoo, . Chapman Hall, London, pp.

Bartmann, H. and W. Bartmann. 1977. Gelungene kunstliche auf zucht eines kleinen pandas(Ailurus fulgens) in Zoologis chen Garten Dortmund. Zeitschrift Kolner Zoo., 20:107-112

Bircher, P. 1989. Brief history of red pandas at Marwell Zoo. Pp. 123-128 In Red Panda Biology, Volume (A.R. Glatston). SPB Academic Publishing B. V., The Hague.

Bleijenberg, M.C.K. 1984. When is a carnivore not a carnivore?--When it's a panda (Some remarks on the nutrition of the red panda). Pp. 23-36 In The Red or Lesser Panda

Studbook, Volume 3 (A.R. Glatston). The Royal Rotterdam Zoological and Botanical Gardens,Rotterdam, The Netherlands.

Bleijenberg, M.C.K. 1988. Red panda feeding nut. Pp. 17-20 In The Red or Lesser Panda Studbook, Volume 5 (A.R. Glatston). The Royal Rotterdam and Botanical Gardens,Rotterdam, The Netherlands.

Bleijenberg, M.C.K. and J. Nijboer. 1989. Feeding herbivorous carnivores. Pp. 40-41 In Red Panda Biology, Volume (A.R. Glatston). SPB Academic Publishing B. V., The Hague.

Bonney, C.H. and R.E. Schmidt. *. A mixed infection "Chagas" and tyzzer's disease in lesser panda. Journal Zoo Animal Medicine, 6:4-7

Brahm, F. and W. Bartmann. 1976. Problemrieche kunstliche aufzucht eines kleinen panda (Ailurus fulgens) im Tierpark Dorhmund. Erkrankungen der Zootiere. Verhanglunflungsbericht des 18. In-Eernationalen Symposiums und die Erkrankungen der Zootiere Innsbrunck 1976,Ippen,R. Schroder,H-D, Akademie- Verlag,Berlin. 1-405.

Braunitzer, G. and O. Hofmann. 1987. Les hemoglobins des pandas. C R Seances Soc. Biol. Fil., 181:116-121

Brown, K.J. 1986. The use of subterranean nestboxes in Dallas zoo's red panda exhibit. Pp. 5-12 In The Red or Lesser Panda Studbook, Volume 4 (A.R. Glatston). The Royal Rotterdam and Botanical Gardens,Rotterdam, The Netherlands.

Bush, M. 1977. Distemper in captive red pandas. International Zoo Yearbook, : 194-196

Bush, M. and R.J. Montali. 1976. Vaccine induced canine distemper in a lesser panda. Journal American Vet. Medicine Ass., 169:959-960

Carlsson, A. 1925. Ueber Ailurus fulgens. Acta Zoologica Stoc-Rholm, 6:269- 305

Catton, C. 1990. Pandas, . Christopher Helm, London, 152pp.

Chakkravarty, I.B. and A.K. Malhotra. *. A note on Rhipicephalus sanguineus(Latr.) infestation on lesser panda and jaguar(Panthera onca). Indian Vet. Journal, 52:730

Cheng, Z. and S. Tu. 1981. 8 cases of wild animals' diseases. Husbandry and Veterinary, :38-39

Conover, G.K. and J.L. Gittleman. 1989. Scent-marking in captive red pandas (Ailurus fulgens). Zoo Biology, 8:193-205

Conway, K. 1981. Supplemental feeding of maternally reared red pandas. International Zoo Yearbook, 21:236-240

Conway, K. 1982. Incidence of a parasitic lungworm in red pandas and its management implications. Pp. 21-83 In The red or lesser panda studbook, Volume 2 (A.R. Glatston). The Royal Rotterdam Zoological and Botanical Gardens, Rotterdam, The Netherlands.

Crandall, L.S. 1964. The management of wild mammals in captivity, . University of Chicago Press, Chicago, 761pp.

Cronin, E.W. 1929. The Arun, . Houghton Mifflin, Boston, 236pp.

Crook, G.A. 1989. Red pandas(Ailurus fulgens) at Adelaide Zoo. International Zoo News, 36:7-11

Custer, R.W., J.M. Bush, J.M. Smeller and E.E. Smith. 1978. Clinical experience with dissociation anesthesia in lesser pandas (Ailurus fulgens):hematology and blood chemistry values. Journal Zoo Animal Medicine, 9:22-28

Cuvier, F. 1825. Histoire naturelle des mammiferes avec des figures originales, colorees desinees d'apris des animaux vivants. Paris, 1824-42,2:1-3 Plate 203.

David, A. 1874. Journal D'un voyage dans le centre de la chine it dens le Thibet. Bull. Nouv. Arch. Mus. Nat. Hist., 31:285-305

Davis, D.D. 1949. The shoulders architecture of bears and other carnivores. Fieldiana-Zool., Chicago Mus. Nat. Hist., 31:285-305

Dawkins, W.B.Q. 1888. On Ailurus anglicus, a new carnivore from red crag. J. Geol. Soc., :228-231

De Sarkar, S., D.K. Basak and B.K. Majumdar. 1989. Pneumonia in a captive panda due to pasteurella infection. Indian Journal Animal Health, 28:115-116

Ding, Y. 1964. Capturing and rearing red pandas. Chinese Journal of Zoology, 6: 93-94

Dittoe, G. 1944. Lesser pandas. Zoonooz, 17:4-5

Egoscue, H. 1977. Lesser panda thrive and breed in the captivity at national Zoo. Research Report Smithsonian Institution, :4

Erken, A.H.M. and E.F. Jacobi. 1972. Successful breeding of lesser panda(Ailurus fulgens) and loss through inoculation. Bijdragen Dierk, 42:92- 95

Expedition of Rare Animal Species in Sichuan. 1977. Red pandas. Pp. 36-38 In A Report on the Rare Animal Species in Sichuan (in Chinese), Volume (Expedition of Rare Animal Species in Sichuan). Sichuan Forest Bur., Chengdu.

Feng, W., C. Lou, Z. Ye, A. Zhang and G. He. 1985. The electrophoresis comparison of serum protein and LDH isoenzyme in 5 carnivora animals--Giant panda,red panda, asiatic black bear, cat and dog. Acta Theriological Sinica, 5: 151-156

Feng, Z., G. Cai and C. Zheng. 1986. Red pandas. Pp. 142-146 In On Mammals from Xizhang, Volume (Z. Feng, G. Cai and C. Zheng). Science Press, Beijing.

Feng, Z., C. Zheng and G. Cal. 1981. On mammals from southeastern Xizhang. Pp. 1013-1016, in Geological and ecological studies of Qinghai-Xizhang Plateau. Proceedings of the Symposium on Qinghai-Xizhang Plateau (Beijing,China). Science Press. Beijing Gordon and Breach. Science Publishers,Inc.,New York, 2: 1-2138.

Fernandez Gonzalez, C.M.J. 1986. Maternal behavior of red panda (Ailurus fulgens) at Madrid zoo:the first three methods. Pp. 13-18 In The Red or Lesser Panda Studbook, Volume 4 (A.R. Glatston). The Royal Rotterdam and Botanical Gardens,Rotterdam, The Netherlands.

Fiennes, R.N.T.-W. 1961. Report of the pathologist for the year 1960. Proceeding Zoological Society London, 137:173-197

Fleming, W.B. 1988. The elusive red panda. Nepal Traveler, 5:21-23

Flower, W.H. 1870. On the anatomy of Ailurus fulgens. Proceeding Zoological Society London, :752-769

Foimer, C.J. 1957. De bevroren panda. Artis, :88-89

Frankenhuis, M.T. and A.R. Glatston. 1982. A review of pathological findings in the red panda,1979-1981. Pp. 37-42 In The red or lesser panda studbook, Volume 2 (A.R. Glatston). The Royal Rotterdam Zoological and Botanical Gardens, Rotterdam, The Netherlands.

Frankenhuis, M.T. and A.R. Glatston. 1984. A review of pathology of the red panda in captivity. Pp. 45-52 In The Red or Lesser Panda Studbook, Volume 3 (A. R. Glatston). The Royal Rotterdam Zoological and Botanical Gardens,Rotterdam, The Netherlands.

Fulton, K.J., S.D. Crissey, O.T. Oftedal and D.E. Ullrey. 1990. Fiber utilization in the diet of the red panda. Proc. Annu Dr Scholl Conf Nutr Captive Wild Anim, 6-7:73-82

Gansser, A. 1964. Geology of the Himalayans, . John Wiley, London, 283pp.

Gansu Rare Animal Expedition. 1976. Rare Animals in Gansu Province, . Gansu Agr. & Forestry Bureau, Nanzhou, pp.

Gao, Y. 1987. Red pandas. Pp. 103-110 In Fauna Sinica Mammalia, Volume 8 (Y. Gao). Science Press, Beijing.

Gao, Y., C. Lu, C. Chang and S. Wang. 1962. Mammals of The Hsi-shuan-pan-na area in southern Yunnan. Acta Zoologica Sinica, 14:180-196

Gao, Y., H. Lu and N. Li. 1988. Cytoarchitecture of the cervical segment of spinal cone in lesser panda. Zoological Research, 9:98

Garcia del Campo, A.L. and L. Monsalve. 1988. Lesser panda restraint method. Pp. 15-16 In The Red or Lesser Panda Studbook, Volume 5 (A.R. Glatston). The Royal Rotterdam Zoological and Botanical Gardens,Rotterdam, The Netherlands.

Gardiner, C.H., M.R. Loomis, J. Britt O, et al. 1983. Dermatitis caused by Fileria taxideae in a lesser panda. Journal Animal Vet. Medicine Ass., 183: 1285-1287

Gardinier, C.H., M.R. Loomis, et al. 1983. Ulcerative dermatitis in a lesser panda(Ailurus fulgens) caused by Filaria taxidae(Flarioidea: Filavilariidae). J. Amer. Vet. Med. Assoc., 183:1285-1287

Gentz, E.J. 1989. Genetic divergence between the red panda subspecies Ailurus fulgens and Ailurus fulgens styani. Pp. 163-170 In Red panda biology, Volume (A.R. Glatston). SPB Academic Publishing bv, The Hague.

Gervais, M.P. 1870. Memoire sur les formes cerebrales propres aux carnivores vivants et fossiles. Nouvelles Archives du Museum D' Histoire Naturelle de Paris 103-162.

Gittleman, J.L. 1988. Behavioral energetics of lactation in a herbivorous carnivore, the red

panda(*Ailurus fulgens*). Ethology, 79:13-24

Ginsburg, L. 1982. Sur la position systematique du petit panda, Ailurus fulgens (Carnivora, Mammalia). Geobios,Lyon(Mem. Spec.) Memoire Special, :247- 258

Gittleman, J.L. 1982. Studbook listing of red pandas. Pp. 55-79 In The red or lesser panda studbook, Volume 1 (A.R. Glatston). The Royal Rotterdam Zoological and Botanical Gardens, Rotterdam, The Netherlands.

Gittleman, J.L. 1983. The behavioral ecology of carnivores. Ph.D Thesis, University Sussex,England, 372pp.

Gittleman, J.L. 1988. Behavioral energetics of lactation in a herbivorous carnivore, the red panda(Ailurus fulgens). Ethology, 79:13-24

Gittleman, J.L. 1989. Lactation energetics and a general model for protracted growth in the red panda, Ailurus fulgens. Pp. 79-94 In Red Panda Biology, Volume (A.R. Glatston). SPB Academic Publishing B.V., The Hague.

Gittleman, J.L. and P. Harvey. 1982. Carnivore home range size, metabolic needs and ecology. Behav. Ecol. Sociobiol., 10:57-63

Glatston, A.R. 1980. Studbook listing of red pandas. Pp. 64-81 In The Red or Lesser Panda Studbook, Volume 1 (A.R. Glatston). The Royal Rotterdam Zoological and Botanical Garden, Rotterdam, The Netherlands.

Glatston, A.R. 1982. Studbook listing of red pandas. Pp. 55-79 In The red or lesser panda studbook, Volume 2 (A.R. Glatston). The Royal Rotterdam Zoological and Botanical Garden,Rotterdam, The Netherlands.

Glatston, A.R. 1982. The Red or Lesser Panda Studbook, 2. The Royal Rotterdam Zoological and Botanical Gardens,Rotterdam, The Netherlands, 83pp.

Glatston, A.R. 1984. The Red or Lesser Panda Studbook, 3. The Royal Rotterdam Zoological and Botanical Gardens,Rotterdam, The Netherlands, 98pp.

Glatston, A.R. 1984. The red panda breeding program:current position,and future aims. Pp. 5-12 In The Red or Lesser Panda Studbook, Volume 3 (A.R. Glatston). The Royal Rotterdam Zoological and Botanical Gardens,Rotterdam, The Netherlands.

Glatston, A.R. 1984. Hand-rearing red pandas(A survey of methods and success rates). Pp. 37-44 In The Red or Lesser Panda Studbook, Volume 3 (A.R. Glatston). The Royal Rotterdam Zoological and Botanical Gardens,Rotterdam, The Netherlands.

Glatston, A.R. 1986. The Red or Lesser Panda Studbook, 4. The Royal Rotterdam Zoological and Botanical Gardens,Rotterdam, The Netherlands, 104pp.

Glatston, A.R. 1988. The Red or Lesser Panda Studbook, 5. The Royal Rotterdam Zoological and Botanical Gardens, Rotterdam, The Netherlands, 116pp.

Glatston, A.R. 1989. Red panda biology, . SPB Academic Publishing B.V., The Hague, pp.

Glatston, A.R. 1989. Demographic analysis of the red panda population. Pp. 153- 162 In Red panda biology, Volume (A.R. Glatston). SPB Academic Publishing B. V., The Hague.

Glatston, A.R. 1990. Pandas, vegetarian carnivores. Dieren, 7:20-24 Glatston, A.R. and M. Roberts. 1988. The current status and future prospects of the red panda (Ailurus fulgens) studbook population. Zoo Biology, 7:47-59

Goldman, D., P.R. Giri and S.J. O'Brien. 1989. Molecular genetic-distance estimates among the Ursidae as indicated by one and two-dimensional protein electrophoresis. Evolution, 43:282-295

Gong, Y. 1981. Breeding Red pandas. China Zoo Yearbook, :19

Goppert, E. 1937. Kelkopf und trachea. Handb. Vergleich. Anat. Wirbeltiere, 3: 797-866
Gourmain, J. 1967. Le plexus lombo-sacre de quelques mammiferes non-primates. Mammalia, 31:148-155

Gray, B.J. 1970. Care and development of a hand-reared red panda, Ailurus fulgens. International Zoo Yearbook, 10:139-142

Gray, J.E. 1864. On the Ursidae. Proceedings of zoological Socicty : 707-709. . ().

Gregory, W.K. 1936. On the phylogenetic relationships of the giant panda (Ailuropoda) to other arctoid carnivora. Amer. Mus. Novrtates, 878:1-29

Gu, W. 1982. Relation between rearing baby red panda and climatic factors. China Zoo Yearbook, :74-75

Gu, W. 1984. Experience about rearing baby red pandas. Chinese Wildlife, :38-39

Hanstron, B. 1965. Wulzen's cone, a capriciously occurring lobe in the mammalian hypophysis. Acta Univ. Lund, 2:1-15

Hardwicke, M.G. 1827. Description of a new genus of the class Mammalia, from the Himalaya chain of hills between Nepaul[Sci] and the snowy mountains. Trans. Linnean Soc. London, 15:161-165
Harwell, G. and T.M. Craig. 1981. Dirofilariasis in red panda. Journal American Vet. Medicine Ass., 179:1258

He, C., S. Liu and X. Cheng. 1984. 3 new records of parasitic worm in China. Pp. 248 In Abstracts of 50 Anniversary of China Zoological Society, Volume (China Zoological Soc.)

He, X. and Q. Sun. 1987. A spectacular view of animals in southern China-- Random thoughts in the study of the red panda, . Shanghai Publishing House of Sci. & Tech., Shanghai, pp.

Heine, H. 1973. Das Herz der Procyonidae,Ailuridae und Ursidae(Carnivora, Fissipedia), Ein Beitrag zur Vergleichenden Funktionllen Mophologie des Saugetierherzens. Z. Wiss. Zool. Leipzig., 186:1-51

Heran, I. 1988/1989. A list of the scientifically valuable specimens preserved in the collection of the Zoological Department of National Museum in Prague Czechoslovakia IV, Skeletons of the specimens near an upper age limit of the species carnivora. Lynx (Prague), 24:87-92

Hillman, G. 1980. Western red panda-special guests in the children's zoo. Zoonooz, 53:8-10

Hodgson, B.H. 1848. Addendum on the anatomy of {Ailurus. Journal Asiatic Society, 17:573-575

Hollister, N. 1915. The genera and subgenera of raccoons and their allies. Proc. U. S. Natl. Mus., 49:143-150

Holmgren, V.C. 1972. The other panda. Animal Kingdom, 75:6-10

Holst, P. 1989. The activity patterns of the red pandas at Copenhagen Zoo: A preliminary report. Pp. 105-122 In Red Panda Biology, Volume (A.R. Glatston). SPB Academic Publishing B.V., The Hague.

Honacki, J.H., K.E. Kinman and J.W. Koeppl. 1982. Family Procyonidae, Ailurus fulgens. Pp. 252 In Mammal Species of the World, Volume (J.H. Honacki and et al). Allen Press Inc., Lawrence.

Hough, J.R. 1948. The auditory region in some members of the Procyonidae, Canidae and Ursidae. Bull. Amer. Mus. Nat., 92:67-118

Hsu, J.C. and K. Benirschke. 1970. Ailurus fulgens (lesser panda). Atlas of Mammalian Chromosomes, 5:1-3

Hu, H. 1983. Treat on Isospora sp. in red pandas using Shangshan Radix Bupleuri Mixture. China Zoo Yearbook, :145-146

Hu, H. 1987. Curing nematode disease in red pandas. Chinese Journal of Veterinary Medicine, 13:18

Hu, J. 1980. Research and development of red pandas. Pp. 203-208 In Documentary Information of Giant Panda, Golden Monkey, Takin, Sika Deer, White-lipped Deer, Red Panda and Musk Deer, Volume (T. Liu). Sichuan Publishing House of Sci. & Tech., Chengdu.

Hu, J. 1981. The animals in natural reserves of Sichuan. Chinese Wildlife, :2-6

Hu, J. 1991. Study of reproductive biology of the red panda. Journal of Sichuan Teachers' College, 12:1-5

Hu, J., K.G. Johnson and G.B. Schaller. 1987. Behavioral ecology of lesser pandas in Wolong Natural Reserve. Journal of Northwest University, 17:80-86

Hu, J. and Y. Wang. 1984. Red pandas. Pp. 64-65 In Sichuan Fauna Ecomomica, Volume 2 (J. Hu and Y. Wang). Sichuan Publishing House of Sci. & Tech., Chengdu.

Huang, G. 1986. Clinical analysis on 3 red pandas' paint poisoning. Husbandry and Veterinary, 18:135

Hunt, R.M. 1974. The auditory bulla in carnivora:an anatomical basis for reappraisal of carnivore evolution. Journal of Morphology, 143:21-76

Ippen, Rudolf, R. Meister, et al. 1985. Several protozoa finds in Zoo Carnivora. MILV, 6:60-68

Itakura, C., K. Nakamura, J. Nakatsuka and M. Goto. 1979. Distemper infection in lesser

pandas due to administration of a canine distemper live vaccine. Japanese Journal Vet. Science, 41:561-566

Jackson, R. 1978. Wildlife in namlung valley. Nature Ann., 2:159-161

Jalanka, H. 1986. Some hematology and serum chemistry data on red pandas (Ailurus fulgens) in Helsinki Zoo. Pp. 29-36 In The Red or Lesser Panda Studbook, Volume 4 (A.R. Glatston). The Royal Rotterdam and Botanical Gardens, Rotterdam, The Netherlands.

Johnson, K.G. and J.F. Johnson. 1990. Mystery of the other panda. International Wildlife, 20:30

Johnson, K.G., G.B. Schaller and J. Hu. 1988. Comparative behavior of red and giant panda in the Wolong Reserve China. Journal of Mammal, 69:552-564

Jones, M.L. 1989. A brief history of the red panda in captivity. Pp. 9-24 In Red Panda Biology, Volume (A.R. Glatston). SPB Academic Publishing B.V., The Hague.

Jong, L.J.D. 1955. Pandas. Artis, :8-10

Kamiya, T. and P. Pirolot. 1988. The brain of the lesser panda Ailurus fulgens, a quantitative approach. Z. Zool. Syst. Evolutionsforsch, 26:65-72

Keller, R. 1977. Beitrag zur ethologie des kleinen pandas (Ailurus fulgens, Cuver,1825). Ph.D Thesis, Univ. Zurich, Switzerland, 122pp.

Keller, R. 1980. The social behavior of captive lesser pandas(Ailurus fulgens) with some management suggestions. Pp. 39-56 In The Red or Lesser Panda Studbook, Volume 1 (A.R. Glatston). The Royal Rotterdam Zoological and Botanical Gardens,Rotterdam, The Netherlands.

Keller, R. 1982. Das markierungsverhalten des kleinen pandas (Ailurus fulgens). Gart. Jena, 52:369-392

Kock, R.A., P. Spala, J.K. Eva, P. Bircher, M. Rickeetts and M. Stevenson. 1989. New ideas for red pandas diets. Pp. 57-72 In Red Panda Biology, Volume (A.R. Glatston). SPB Academic Publishing B.V., The Hague.

Kotani, T., M. Jyo, Y. Odagiri, Y. Sakaribara and T. Horiuchi. 1989. Canine distemper virus infection in lesser pandas (Ailurus fulgens). Japanese Journal Vet. Science, 51:1263-1266

Kowalska, Z. 1982. The lesser panda (Ailurus fulgens) at Lodz zoological Gardens. Pp. 25-28 In The Red or Lesser Panda Studbook, Volume 2 (A.R. Glatston). The Royal Rotterdam Zoological and Botanical Gardens, Rotterdam, The Netherlands.

Kunming Institute of Zoology. 1989. Annals of Yunnan Province, 6. Yunnan People's Publishing House, Kunming,p329, pp.

Kurten, B. and E. Anderson. 1980. Pleistocene Mammals of North America, . Columbia University Press, New York, 443pp.

Lai, C., X. Qiu and S. Lou. 1988. Preliminary survey of wild animal's parasites in Wolong Natural Reserve. Sichuan Journal of Zoology, 7:24

Lateur, N. 1986. Pathological survey of captive red pandas(Ailurus fulgens). Pp. 19-28 In The Red or Lesser Panda Studbook, Volume 4 (A.R. Glatston). The Royal Rotterdam and Botanical Gardens,Rotterdam, The Netherlands.

Lazell, J. 1974. Color pattern of the panda bear (Ailuropoda melanoleuca) and the true panda (Ailurus fulgens). Mississippi Wild. Fed., 4:

Leone, A. and A. Wiens. 1956. Comparative serology of carnivores. Journal of Mammal, 37:11-23

Li, Z., J. Zhu, J. Sha, et al. 1988. Hand rearing animals in raccoon family. Chinese Wildlife, :24-26

Liu, T. 1990. The red panda. Pp. 203-235 In Documentary Information of Giant Panda, Golden Monkey, Takin, Sika Deer, White-lipped Deer, Red Panda and Musk Deer, Volume (T. Liu). Sichuan Publishing House of Sci. & Tech., Chengdu.

Liu, Y. 1979. Breeding red pandas. China Zoo Yearbook, :18-20

Liu, Y. 1983. Preliminary study on canine distemper in red pandas. Chinese Wildlife, :50-51

Liu, Y. and Z. Li. 1988. Preliminary observation on canine distemper in red pandas. China Zoo Yearbook, :75-76

Lu, M. 1982. Successful breeding red pandas in two successive years. China Zoo Yearbook, :36-36

Lu, M. 1984-1985. Some observation on red panda's tuberculosis. China Zoo Yearbook, :130-131

Lu, X. and W. Ma. 1985. The red panda. Pp. 152-159 In Rearing and breeding the wildlife, Volume (X. Lu and W. Ma). Shannxi Publishing House of Sci. & Tech., Xian.

Ma, Z. 1984-85. Report on white-oidiomycetic enteritis in red pandas. China Zoo Yearbook, :120

MacClintock, D. 1988. Red Panda: A Natural History, . Charles Scribners' Sons, New York, pp.

Manandhar, M.S. 1978. Origin of the Himalaya. Nature Ann., 1:1-4

McNab, B.K. 1988. Energy conservation in a tree-kangaroo (Dendrolagus matschiei) and the red panda (Ailurus fulgens). Physiological Zoology, 61: 280-292

McNab, B.K. 1989. Energy expenditure in the red panda. Pp. 73-78 In Red Panda Biology, Volume (A.R. Glatston). SPB Academic Publishing B.V., The Hague.

Miller, P. 1989. Keeping and breeding red pandas at Leipzig Zoo. Pp. 95-102 In Red Panda Biology, Volume (A.R. Glatston). SPB Academic Publishing B.V., The Hague.

Mishra, H. 1976. Wild Animals of Nepal, . Ratna Pustak Bhandar, Nepal, 102pp.

Mivart, St. 1882. On the classification and distribution of the Aeluroidae. Proceedings of Zoological Society of London, 1882:130-208

Montali, R.J., M.S. Roberts, R.A. Freeman and M. Bush. 1984. Pathology survey of the red

panda (Ailurus fulgens). Pp. 128-140 In One Medicine, Volume (O. A. Ryder and M. Byrd). Springer-Verlag, Berlin.

Montali, R.J., R. Wallace, L.G. Phillips, M. Bush, M.S. Roberts, S.D. Crissey, K.J. Warnell, O.T. Oftedal, M. Edwards and L. Rabin. 1989. Hepatopathy and hypercholesterolemia in red pandas associated with diet change. Pp. 31-34 In Red Panda Biology, Volume (A.R. Glatston). SPB Academic Publishing B.V., The Hague.

Morris, P.J. 1987. Subclinical mastitis and apparent agalactia in a lesser panda (Ailurus fulgens). Pp. 459-461 In Proceedings of the First International Conference on Zoological and Avian Medicine, Volume (Anon.). Association of Avian Veterinarians & American Association of Zoo Veterinarians, .

Mottershead, G.S. 1958. Interesting experiments at the Chester Zoo. Zool. Garten, 24:70-73

Mottershead, G.S. 1963. The lesser panda at the Chester Zoological Gardens. Der Zoologische Garten, 27:300-302

Muckherjee, A.K. 1982. Endangered animals of India, . Zoological Survey of India, Calcutta, pp.

Muller, P. 1989. Keeping and breeding red panda at Leipzig Zoo. Pp. 95-102 In Red Panda Biology, Volume (A.R. Glatston). SPB Academic Publishing B.V., The Hague.

Munro, G. 1966. The lesser panda. Zoonooz, 39:3-5

Munro, G. 1969. Breeding the lesser panda in Bremen Zoo, Germany. International Zoo News, 16:281-283

Narushima, E., F. Hashizaki, N. Kohno, M. Saito, K. Tanabe, M. Hayasaki and I. Ohishi. 1984. Dirofilaria immitis infections in lesser panda (Ailurus fulgens) in Japan. Japanese Journal of Parasitol, 33:475-482

Nayak, N.C., J. Samadda and M.K. Bhowmik. 1988. Hemorrhagic septicaemia in red panda (Ailurus fulgens) associated with Pasteurella multocida. Indian Vet. Journal, 65:543-544

Northwest Plateau Institute of Zoology. 1989. Qinghai Fauna, . Qinghai People's Publishing House, Xiling,Pp.605, pp.

Oboussier, H. 1955. Zur bentnis de hypophysis des panda (Ailurus fulgens). Zool. Anz., 154:1-8

O'Brien, S., W. Nash, D. Wildt, M. Bush, et al. 1985. A molecular solution to the riddle of the giant panda's phylogeny. Nature, 317:140-144

Oftedal, O.T., K.J. Fulton and S.D. Crissey. 1989. Bamboo as a source of digestible energy for red pandas. Int. Theriol. Congr. (Abstract) Rome, August 1989.

Orians, W. 1987. Grosse sorge um den kleinen panda. Kosmos(Stuttg), 83:58-59

Ouyang, G., Z. Lu and G. Zhang. 1984. Red pandas. Pp. 74 In Ornamental Animals, Volume (G. Ouyan, Z. Lu and G. Zhang). Sichuan Publishing House of Sci. & Tech., Chengdu.

Pan, W. et al. 1981. Serological study of giant panda and various mammals. Acta Sc. Nat.

Univ. Pekinensis, 1:79-88

Pan, W., F. Li and M. Zhang. 1984. Comparative study on immunity classification characters of giant panda, red panda, black bear, and sun bear. Abstract of 50 Anniversary of China Zool. Soc. Part II, p498. Chinese

Parihar, N.S. and I.B. Chakravarty. 1980. Canine distemper-lik disease in a lesser panda (Ailurus fulgens. Indian Vet. Journal, 57:198-199

Pen, H., Y. Gao, C. Lu, T. Peng and C. Cheng. 1962. Report on mammals from southwestern Szechwan and northwestern Yunnan. Acta Zoologica Sinica, 14:105- 132

Pen, M. 1962. Animals of western Szechuan. Nature, 196:592-597

Peng, D. et al. 1989. A survey on parasitic worm of precious animals in Shanghai Zoological Park. China Journal of Human and Animals' Disease, 5:62-63

Pilgrim, G.E. 1932. The fossil carnivora of Indian. Paleontol. Indian, 18:1-232

Pleticha, P. 1979. Rearing the lesser panda-Ailurus fulgens. Ziva, 27:195- 196

Pocock, R.I. 1921. The external characters and classification of the Procyonidae. Proceedings of Zoological Society of London, :389-422

Pocock, R.I. 1946. The panda and giant panda. Zoo Life,London, :67-70

Pocock, R.I. 1928,1929. The structure of the auditory bulla in the Procyonidae and the Ursidae, with a note on the bulla of Hyaena. Proceedings of Zoological Society of London, :963-974

Poglayen-Neuwall, I. *. New lesser panda exhibit at Louisville Zoo. International Zoo Yearbook, :261-263

Pousargues, E. 1896. Sur la collection de mammiferes rapprortes du Yun-nan par le Prince Henri d'Orleans. Bull. Mus. d'Hist. Nat., Paris, 2:179-182

Prater, S.H. 1980. The Book of Indian Animals, . Bom. Nat. Hist. Soc., Bombay, pp.

Prince, F.P.G. 1988. Genetic Variation in the zoo population of red panda subspecies Ailurus fulgens fulgens. Zoo Biology, 7:219-231

Prince, F.P.G. 1989. Preservation of genetic variation in the red panda population. Pp. 171-182 In Red Panda Biology, Volume (A.R. Glatston). SPB Academic Publishing B.V., The Hague.

Qinghai & Gansu Expedition of Academica Sinica. 1984. A report on Qinghai and Gansu Mammals, . Science Press, Beijing, pp.

Radinsky, L.B. 1981. Evolution and skull shape in carnivores. 2. additional modern carnivores. Biol. J. Linnean Soc., 16:337-355

Reid, D.G., J. Hu and Y. Huang. 1991. Ecology of the red panda Ailurus fulgens in the Wolong Reserve,China. J. Zool. (Lond.), 225:347-364

Reindl, N. and R. Taylor. 1984. The panda exhibit at the Minnesota Zoo. Pp. 14- 23 In The

Red or Lesser Panda Studbook, Volume 3 (A.R. Glatston). The Royal Rotterdam Zoological and Botanical Gardens,Rotterdam, The Netherlands.

Rensenbrink, H.P. 1971. Kleine kieine panda's. Artis, :162-167 Rich, M.S. 1980. Styan's panda. Zoonooz, 53:11-12

Roberts, M.S. 1975. Growth and development of mother-reared red pandas. International Zoo Yearbook, 15:57-65

Roberts, M.S. 1980. Breeding the red panda (Ailurus fulgens) at the National Zoological Park. Zoologische Gart., Jena., 50:253-263

Roberts, M.S. 1981. The reproductive biology of the red panda (Ailurus fulgens) in captivity. MS Thesis, Univ. Maryland, 202pp.

Roberts, M.S. 1982. The fire fox. Animal Kingdom, 85:20-27

Roberts, M.S. 1982. Perspective:A panda is a panda. Animal Kingdom, 85:24-25

Roberts, M.S. 1982. Demographic trends in a captive population of red pandas (Ailurus fulgens). Zoo Biology, 1:119-126

Roberts, M.S. 1982. On the subspecies of the red panda,Ailurus fulgens. Pp. 13-24 In The Red or Lesser Panda Studbook, Volume 2 (A.R. Glatston). The Royal Rotterdam Zoological and Botanical Garden, Rotterdam, The Netherlands.

Roberts, M.S. 1989. A survey and analysis of management practices in the north American red panda SSP. Pp. 129-152 In Red Panda Biology, Volume (A.R. Glatston). SPB Academic Publishing B.V., The Hague.

Roberts, M.S. and L. Collins. 1978. Arboreal folivores in captivity maintenance of delicate minority. Pp. 574 In The Ecology of Arboreal Folivores, Volume (G.G. Montgomery). The Symposia of the National Zoological Park, Smithsonian Institution Press, Washington,D.C.

Roberts, M.S. and J.L. Gittleman. 1984. Ailurus fulgens. Mammal Species, No. 222:1-8

Roberts, M.S. and D.S. Kessler. 1979. Reproduction in red pandas, Ailurus fulgens(Carnivora:Ailuropodidae). J. Zool. (Lond.), 188:235-249

Roosevelt, J. and K. Roosevelt. 1926. East of the sun and west of the moon, . Charles Scribners' Sons., New York, 371pp.

Rush, M., R.J. Montali, D. Brownstein, et al. 1976. Vaccine induced canine distemper in a lesser panda. Journal American Vet. Medicine Ass., 169:959-960

Sacharia, V.B. 1982. Wildlife of India, . Natraj Publication, Dehradun, pp.

Scapino, R. 1981. Morphological investigation into function of the jaw symphasis in carnivorans. Journal of Morphology, 167:339-375

Scapino, R.C. 1976. The jaw symphysis in cats and bears. American J. Physical Anthropology, 44:204

Schaftenaar, W. 1988. Review of pathological finds in the red panda:1986-87. Pp. 7-14 In

The Red or Lesser Panda Studbook, Volume 5 (A.R. Glatston). The Royal Rotterdam Zoological and Botanical Gardens,Rotterdam, The Netherlands.

Schneider, K.M. 1940. Einiges vom grossen (1) und kleinen panda. Zool. Garten Leipzig, :38-48

Schwendler, L. 1875. Ailurus fulgens, note on its habits (almost certainly not carnivorous). P. A. S. B., :98

Seidel, B. 1972. Zu einigen erkrankungen der haut und zhrer anhangsorgane bei zotiere. Pp. 171-181 In Erkrankungen der zootiere wroclaw, Volume (R. Ippen and H.D. Schroder). Akademie-verlag, Berlin.

Shannxi Institute of Zoology. 1974. Red pandas. Pp. 27 In Atlas of Rare Economic Mammals of Shannxi Province, Volume (Shannxi Institute of Zoology). Shannxi Publishing House of Science & Technology, Xian.

Shannxi Institute of Zoology. 1979. Lesser panda. Pp. 27 In Atlas of Shannxi Rare and Economic Mammals, Volume (Shannxi Institute of Zoology). Shanxi Publishing House of Sci. & Tech., Xian.

Shannxi Institute of Zoology. 1981. Evaluation on Shannxi Economic Birds and Mammals' Resource, . Office of Shahxi Agr. Division,, pp.

Shi, B. and E. Zhao. 1982. Red pandas. Pp. 64-65 In Sichuan Fauna Economica, Volume 1 (B. Shi and E. Zhao). Sichuan People's Publishing House, Chengdu.

Shou, Z. 1955. Distribution of Chinese fur mammals. Acta Geographica Sinica, 21:405-421

Shrestha, M.K. 1988. Vegetation study of the red panda habitat in Langtang National Park,central Nepal. M.S. Thesis, Tribhuvan University Kathmandu, pp.

Si, X., K. Zhou and K. Li. 1984. Curing mite disease of red pandas. Husbandry and Veterinary, 16:230-231

Sichuan Rare Animal Expedition. 1977. Red pandas. Pp. 36-38 In Reports on rare animal survey in Sichuan, Volume (Sichuan Rare Animal Expedition). Sichuan Forestry Bureau, Chengdu.

Simpson, B. 1869. Note on Ailurus fulgens. Proceedings of Zoological Society of London, 1869:507

Sokolowsky, A. 1918. Zur biologie und stammesgeschichte des katzenbaren (Ailurus fulgens). Zool. Anzeiger, 50:238-244

Sowerby, A.C. 1932. The pandas or catbears. China Journal, 17:296-299

Stains, H.J. 1973. Comparative study of the calcanea of members of the Ursidae and Procyonidae. Bull. South Calif. Acad. Sci., 72:137-148

Stevenson, M., L. Arness, J. Hanning and N. Smith. 1989. Red pandas at Edinburgh Zoo. Pp. 103-114 In Red Panda Biology, Volume (A.R. Glatston). SPB Academic Publishing B.V., The Hague.

Story, H.E. 1951. The carotid arteries in the Procyonidae. Fieldiana: Zool, 32: 477-557

Stott, K. 1940. Bamboo eaters. San Diego Zoonooz, 12:5

Sun, K., T. Wu and K. Tang. 1980. Observation on anatomy of digestive system in red pandas. Journal of Northwest Nationality College, :3-12

Tagle, D.A., Miyamoto and M.M.M. Goodman. 1986. Hemoglobin of pandas: Phylogenetic relationships of carnivores as ascertained with protein sequence data. Nature Wissenschaften, 73:512-514

Tang, B. 1955. Giant and lesser pandas. Science Popular, :413-414

Tang, F. 1987. Living environment effecting red pandas. China Zoo Yearbook, :6-7

Tedford, R.H. and E.P. Gustafson. 1977. First north American record of the extinct panda Parailurus. Nature, 265:621-623

Teng, C. 1982. Red pandas in Nanchang. China Zoo Yearbook, :81-85

Thenius, E. 1979. Die ahnen des grossen panda. Kosmos(Stuttg), 75:478-480

Thomas, O. 1902. On the panda of Szechuen [Sci]. Ann. Mag. Nat. Hist., 10:251- 252

Thomas, O. 1922. On mammals from the Yunnan highlands collected by Mr. George Forrest and presented to the British Museum by Col. Stephenson R. Clark,DSO. Ann. Mag. Nat. Hist. Ser, 9,10:391-406

Tian, X. 1980. Talking about red panda's nutrition lacking from 5 dead pandas. China Zoo Yearbook, :144-145

Todd, N.B. and S.R. Pressman. 1968. The karyotype of the lesser panda and general remarks on the phylogeny and affinities of the panda. Carnivore Genet. Newsl., :105-108

Trouessart, E. 1922. Le panda a fourrure eclatante. Nature,Paris. 2e-sem, 209- 210.

Turner, H.N.-J. 1848. Observation relating to some of the foramina at the base of the skull in Mammalia and on the classification of the order Carnivora. Proceedings of Zoological Society of London, Part XVI:62-88

Vastesaeger, M., H. Gillot and J. Mortelmans. 1959. Thrombose coronarienne ayant entraine la mort chez un panda. Bull. Soc. Roy. Zool. Anvers., :47-51

Veeke, H. 1978. Handbook for red panda program. Unpubl. Thesis, Delft,Technical University, pp.

Veeke, H. and A.R. Glatston. 1980. Computer simulation of trends in the captive population of red pandas. Pp. 11-12 In Red or Lesser Panda Studbook, Volume 1 (A.R. Glatston). The Royal Rotterdam Zoological and Botanical Gardens, Rotterdam, The Netherlands.

Vogt, P., C. Schneidermann and B. Schneidermann. 1980. Hand-rearing a red panda Ailurus fulgens at Krefeld Zoo. International Zoo Yearbook, 20:280-281

Vortman, J.L. and W.D. Matthew. 1899. The ancestry of certain members of the

Canidae,Viverridae and Procyonidae. Bull. Amer. Mus. Nat. Hist., 12:109-138

Vortman, J.L. and W.D. Matthew. 1899. The ancestry of certain members of the Canidae, Viverridae and Procyonidae. Bull. Amer. Mus. Nat. Hist., 12: 109-138

Wall, F. 1908. Himalaya catbears (Ailurus fulgens). Bombay Journal National History Society, 18:903-904

Wang, L. 1955. The red pandas in Kangzhang Plateau. Traveler, 4:16

Wang, S., D. Pan and Y. Zhu. 1982. Preliminary study on red panda's baccilus. Qinghai Husbandry & Veterinary, :69-71

Wang, Y., C. Li and S. Ma. 1990. Status and conservation of mammal resources in juncture areas of Sichuan,Yunnan and Guizhou provinces. Pp. 1-14 In Utilization and conservation of animal resources in Wulingshan areas of southwestern China, Volume (Wulingshan Resource Expedition of Academica Sinica). China Publishing House of Medical Sci. & Tech

Wanxian Xishan Park. 1983. Curing astinoryces disease in red pandas. China Zoo Yearbook, :122-123

Warnell, K. 1988. Feeding intake, digestibility, digesta passage, and fecal microbial ecology of red panda Ailurus fulgens. MS Thesis, Michigan State University, pp.

Warnell, K.J. 1989. Feed intake, digestibility, digesta passage,and fecal microbial ecology of the red panda (Ailurus fulgens). Masters Abstr. Int., 27:354

Warnell, K.J., S.Q. Crissey and O.T. Oftedal. 1989. Utilization of bamboo and other fiber sources in red panda diets. Pp. 51-56 In Red Panda Biology, Volume (A.R. Glatston). SPB Academic Publishing B.V., The Hague.

Watson, J.K. and V.L. Barfield. 1982. Supplemental feeding of infant red pandas at the Knoxville Zoological Park. Pp. 29-35 In The Red or Lesser Panda Studbook, Volume 2 (A.R. Glatston). The Royal Rotterdam Zoological and Botanical Gardens,Rotterdam, The Netherlands.

Wozencraft, W.C. 1989. The phylogeny of the recent carnivora. Pp. 437-465 In Carnivore behavior, evolution and ecology, Volume (J.G. Gittleman). Cornell University Press, Ithaca.

Wu, J. 1959. Occurrence of Ogmocolyle (Bhalerao,1942) in Ailurus fulgens styani. Acta Zoologica Sinica, 11:561-564

Wu, J. 1980. Lesser pandas. Pp. 57, 84 In Survey and Division of Shannxi Precious Animal Resource, Volume (J. Wu). Office of Shannxi Agr. Resource & Agr. Division, Xian.

Wu, J. 1982. Parasites in 10 wild animals. Journal of Veterinary Science & Technology, :18-23

Wu, J. 1988. Ascarid diseases of red pandas. Chinese Wildlife, :15,24

Wu, J. et al. 1984. Study on Isospora sp. in red pandas. Chinese Journal of Veterinary Medicine, 10:2-3

Wu, J., G. He and H. Hu. 1987. Study on a new species of Blascaris in red pandas. Sichuan Journal of Zoology, 6:1-2

Wu, J., H. Hu, et al. 1984. Filaria disease in red pandas. Chinese Wildlife, : 36,27

Wu, J. and Z. Hu. 1980. Resource investigation and geographic distribution of precious animals in Shaanxi province, . Shaanxi Prov. Agric. Nat. Res., Xian, pp.

Wu, J., Y. Tiang and J. Luo. 1985. A survey of parasites in the lesser panda. Chinese Journal of Veterinary Medicine, 11:8-9

Wu, J., D. Zhang, H. Hu and H. Huang. 1985. Description of a new species of the genus Aeleurostrongylus (Nematoda). Sichuan Journal of Zoology, 4:1-5

Wu, J., D. Zhang, H. Huang, H. Hu and G. Zhao. 1984. A new species of Molineus from Sichuan. Sichuan Journal of Zoology, 3:4-7

Wu, Z. 1991. Rearing red pandas. Chinese Wildlife, :21-22

Wurster, D.H. 1969. Cytogenetics and phylogenetic studies in carnivora. Pp. 310- 329 In Comparative Mammalia Cytogenetics, Volume (D.H. Wurster). Springer- Verlag, New York.

Wurster-Hill, D. and D.M. Bush. 1980. The interrelationship of chromosome banding patterns in the giant panda (Ailuropoda melanoleuca),hybrid bear (Ursus middendorfi X Thalarctos) and other carnivores. Cytogenet. Cell Genetics, 27:147-154

Xian, R. 1981. Red panda's canine distemper. China Zoo Yearbook, :73-74

Xiang, P. and Y. Zhou. 1975. Curing tinea diseases of red pandas. Chinese Journal of Zoology, :20

Xiong, Y. 1979. Rearing and breeding red pandas in Lushan Zoological Park. China Zoo Yearbook, :11-18

Xiong, Y. 1980. Problem about low survival rate of second generation red pandas in Lushan,China. China Zoo Yearbook, :15-17

Xiong, Y. 1985. Rearing and breeding the red panda in zoo. Chinese Journal of Zoology, :31-34

Xiong, Y., Z. Li and B. Shong. 1983. Detecting the blood contents of the red panda. Chinese Journal of Zoology, :15-16

Xiong, Y. and B. Zhu. 1982. Ketamine hydrochloride immobilizing 16 cases of red pandas. China Zoo Yearbook, 8:15-16

Xu, L. 1984. Clinical observation on red panda's canine distemper. Journal of Husbandry Science & Technology, :51

Yang, D., X. Lu, B. Zhao, et al. 1983. A survey on parasites of garden animals. China Zoo Yearbook, :151-161

Ye, Z. 1984. A case of serious infection of Ogmococyle indica in red pandas. Sichuan Journal of Zoology, 3:43

Yonzon, P.B. 1988. Complicating issue of development infrastructures: a case study in relation to the red panda conservation. Theme Paper. National Conf. on Sci. & Tech.,Royal Nepal Acad. Sc. Tech., Kathmandu.

Yonzon, P.B. 1989. Ecology and conservation of the red panda in the Nepal- Himalayas. Ph. D. Thesis, University of Maine,Orono, pp.

Yonzon, P.B. and M.L. Hunter. 1989. Ecological study of the red panda in the Nepal-Himalayas. Pp. 1-8 In Red Panda Biology, Volume (A.R. Glatston). SPB Academic Publishing B.V., The Hague.

Yonzon, P.B. and M.L.J. Hunter. 1991. Cheese, tourists, and red pandas in the Nepal Himalayas. Conservation Biology, 5:196-202

Yonzon, P.B. and M.L.J. Hunter. 1991. Conservation of the red panda Ailurus fulgens. Biological Conservation, 56:1-11

Yonzon, P.B. and Kathmandu. 1988. Seasonal livestock grazing,human disturbance and activity pattern of the red panda in Lang Tang National Park. Symposium of Asian-Pacific Mammalogy:Abstracts of Symposium:Beijing.

Yu, Z., Z. Yu, S. Sha, Q. Deng and Y. Cei. 1986. Sichuan natural resource division. Pp. 594 In Sichuan Agricultural Resource Division, Volume 2 (S. Gan). Social and Scientific Institute Publishing House, Chengdu.

Yun, H. 1983. When did the western begin to study the red panda? Chinese Wildlife, :23-24

Zhang, J. and Z. Wang. 1963. Mammal fauna in Qinghai. Acta Zoologica Sinica, 15:125-138

Zhang, S. and Y. Wang. 1986. Anatomy of digestive system in red pandas. Chinese Wildlife, :49-50

Zhang, Z. 1984. Susceptibility of the lesser panda to canine distemper. International Zoo Yearbook, :107

Zhao, B. 1982. Red pandas getting sunstroke. China Zoo Yearbook, 8:143-144

Zhao, B. 1984-85. A case of resection of squamous cell carcinoma in red pandas. China Zoo Yearbook, :133-134

Zhao, T. 1983. A brief accounts on the "original state' of large and medium- size mammals in the northern Ailao Mts. Pp. 341-350 In Forestry Ecosystem Research of Ailao Mts. in Yunnan, Volume (Z. Wu). Yunnan Publishing House of Sci & Tech., Kunming.

Zhou, J., S. Men, et al. 1980. Red pandas' liver poisoning and nutrition lacking. Chinese Journal of Zoology, :37-38

Zhou, X., B. Ai, J. Wang, et al. 1991. Digestive experiments of red panda's food. Chinese Wildlife, :31-33

Zhu, G. et al. 1988. A report on liver cancer in red pandas. Chinese Journal of Veterinary

Medicine, 14:11-12

Zhu, G. et al. 1988. Laennec's cirrhosis complicated by hepatocarcinoma in a lesser panda. Chinese Journal of Veterinary Medicine, 14:11-12

Zuckerman, S. 1953. The breeding seasons of mammals in captivity. Proceedings of Zoological Society of London, 122:827-950

Zwart, P. 1989. Contribution to the pathology of the red panda (Ailurus fulgens). Pp. 25-30 In Red Panda Biology, Volume (A.R. Glatston). SPB Academic Publishing B.V., The Hague.

DESIGNING FOR RED PANDAS

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The natural habitat to which a species is adapted would seem the logical model to use when designing an enclosure for that animal in a zoo. However, a cursory glance at the accommodation offered to the inmates of zoological gardens indicates that this approach has been the exception rather than the rule. The reasons for this are partly historical and partly practical.

When zoos first opened their doors to the public their purpose was to allow the visitor to make acquaintance, at first hand, with as many exotic animal species as possible. In those days animals were readily available from the wild so there was no pressure on zoo staff to breed from their charges. This meant that animals could be displayed alone in relatively small cages so that as many species as possible could be viewed in the confines of the zoo's grounds. The increasing rarity of many species, as much as humane considerations, has put a stop to this practice in more recent years and international legislation has made it virtually impossible for zoos to continue to restock their collections from the wild. Thus, in order to survive, zoos were forced to improve both the longevity and breeding success of their charges.

This change of purpose has had repercussions on the design of enclosures which became more spacious and an emphasis was laid on hygiene. They were often simple in layout, to ensure ease of cleaning rather than provide a comfortable home for the inhabitants. Such a hygienic environment can bear little resemblance to a natural habitat.

Nevertheless, a major reason why zoo enclosure design is not based on the biology or habitat of the species it is intended to house is a lack of information for we have insufficient knowledge about their life in the wild; too few animals have been the subject of good field studies. In general, the information which is available for the majority of species in the wild is confined to their place of origin and possibly a few chance observations of a trapper; it is vague, incomplete and out of date. On the other hand, when information is available it is not always used.

In those cases where sufficient data are available it may prove very difficult for the zoo to translate these into terms of zoo accommodation. It is extremely difficult, if not impossible to duplicate a natural biotope; the space, time and cost of such an endeavour would be prohibitive. In addition, a natural biosystem has many elements which would be regarded negatively in captivity, such as disease, predators and parasites, all of which have a role in keeping the population in a state of equilibrium with its environment. None of these could be accepted in the zoo. Thus, when a zoo wants to use the natural environment as a model it must try to deduce which facets of the natural environment are of importance for the well being of the species and try to duplicate these in captivity.

The red panda *(Ailurus fulgens)* is an example of how a scientific approach can be adopted in designing a zoo enclosure so that the needs of the animal are catered for even in the situation where field data are very limited.

Red panda biology

The red panda is a small-bodied, plantigrade member of the order Carnivora. In common with many of the species maintained in zoological gardens, very few data are currently available on the behaviour or ecology of this species in the wild. The red panda was discovered in the first quarter of the last century and inhabits the slopes of the Himalayas at altitudes varying from 1,500 - 4,000m. Its range extends from Nepal in the west to China and Tibet in the east. From the early field observations made in the last century they are said to be largely arboreal, to inhabit the mixed deciduous, rhododendron and bamboo forested slopes along water courses, to live alone or in small family groups, to nest in hollow trees or rock cavities and to eat bamboo, fruits, roots, eggs, nestlings, small mammals and fish, (Hodgson, 1847; Bhat, 1977; Roberts and Gittleman, 1984).

Red pandas in zoos

Red panda have been maintained in zoological collections periodically since 1869 when the first one arrived at Regent's Park in London (Jones, in press). They have been kept with varying degrees of success but over the years longevity has improved and since the 1970's have bred fairly regularly (Jones, in press; Glatston, 1980a). However this does not mean that red pandas are successful in zoos. On the contrary, fertility is fairly low, many red pandas do not reproduce in captivity, and infant mortality is high (Glatston, in press; Glatston & Roberts, 1988).

Establishing important design features

In establishing the most important parameters for housing red pandas in zoos, a multiple approach was taken:

1. data were collected on the natural habitat during a brief field trip;
2. questionnaires and studbook data were used to compile information on housing conditions, breeding success and longevity in zoos;
3. behavioural studies were undertaken on the red pandas in Rotterdam Zoo;
4. a conference and work-shop was convened to collate the available red panda research data and to discuss husbandry and management in captivity.

Results

1. Natural environment

One of the aims of a brief field trip to Nepal in 1979 was to gain an

impression of the red panda's nadral habitat in order to determine which features might be important to the species in captivity. The habitat utilised by red pandas is characterised by high altitude, relatively dense vegetation combined with typical montane relief and a monsoon climate. Any of these features could have led to specialisations in the red panda's physiology and behaviour and thus might be important.
The effects of high altitude, such as reduced air pressure cannot easily be duplicated in captivity. If these were of importance to the species the only solution would be to confine the keeping of red pandas to those zoos which are situated well above sea level. To date there is no evidence to indicate that red pandas are influenced by altitude.
The combination of forest cover and typical mountain topography means that red pandas have adapted to a fairly cryptic lifestyle. From the literature they are known to be arboreal and in captivity are observed to climb well. In the wild they are difficult to observe and rarely seen.
Facilities for climbing freely and for withdrawing from view were considered as likely important features for red pandas enclosures. The questionnaire and behavioural observations were used to investigate this.
Climate was also thought to be important. Although the range of the panda lies almost within the tropics, the climate is not tropical. Due to the altitude the temperatures in which the red panda lives do not differ substantially from those in northern Europe. The thick pelage of the red panda and the fur on the distal surfaces of the paws are indicative of a life in a fairly cool climate. High temperatures could be expected to have an adverse influence on red pandas held in zoos in warm climates. Thus the effects of heat was also investigated in the questionnaire and from the behavioural observations.

2. Questionnaire

Pandas are known to be housed in a variety of sizes and types of enclosure ranging from small, concrete floored, wire fronted cages to large grassy parks containing one or more living trees, in climates ranging from cool, damp, temperate, to hot and arid. In order to investigate the effects of these factors on red pandas, a questionnaire on group structure and housing was compiled and circulated to panda holding zoos. The results of this questionnaire were compared with breeding success and longevity data in the studbook.
Results from the questionnaire (Glatston, 1980b) indicated that two factors associated with enclosures design influenced breeding and rearing success. In accordance with the conclusions suggested by the habitat observations, quality rather than size of the enclosure appeared to be the most important factor; animals housed in enclosures with more climbing facilities, trees, bushes, and climbing frames had greater breeding success than those housed in more simple exhibits. Nesting facilities were also important; the number of females rearing their young was much higher in enclosures where several nest-boxes were provided.
The susceptibility of this species to high temperatures has been confirmed by several instances of heat stress. However, this does not mean that zoos located in warm climates cannot be successful with this animal. Breeding success with red pandas in Adelaide and Sydney indicate that given appropriate considerations (sufficient shade and mist-sprays) red pandas

can do well despite the heat. Provision of adequate shade even in more temperate climates seems to be an essential prerequisite for successful breeding; many zoos which regularly breed red pandas ensure that parts of their enclosures are shaded and that nest-boxes are located in shadow.

3. Behavioural observations

Behavioural observations were conducted over a number of years. Data were firstly collected on circadian and circannian rhythms. Given the problem of infandmortality, observations were also made on maternal behaviour and on the effect of the environment on it.

Activity patterns: red pandas are essentially crepuscular and nocturnal in their habits. However, their activity patterns vary considerably and in some parts of the year they are periodically active over the whole 24 hour cycle. This means that red pandas should not be shut into or out of nest-boxes or indoor facilities for prolonged periods.

Maternal behaviour: red pandas give birth in the summer. The young are altrical, remaining within the nest-box for the first three months of life. This means that all maternal behaviour occurs in the nest-box and that the time the mother spends with her young is an easily measurable indicator of maternal care. In the first weeks the mother spends almost all her time in the nest with her young; this time gradually declines as the young get older (fig. 1).

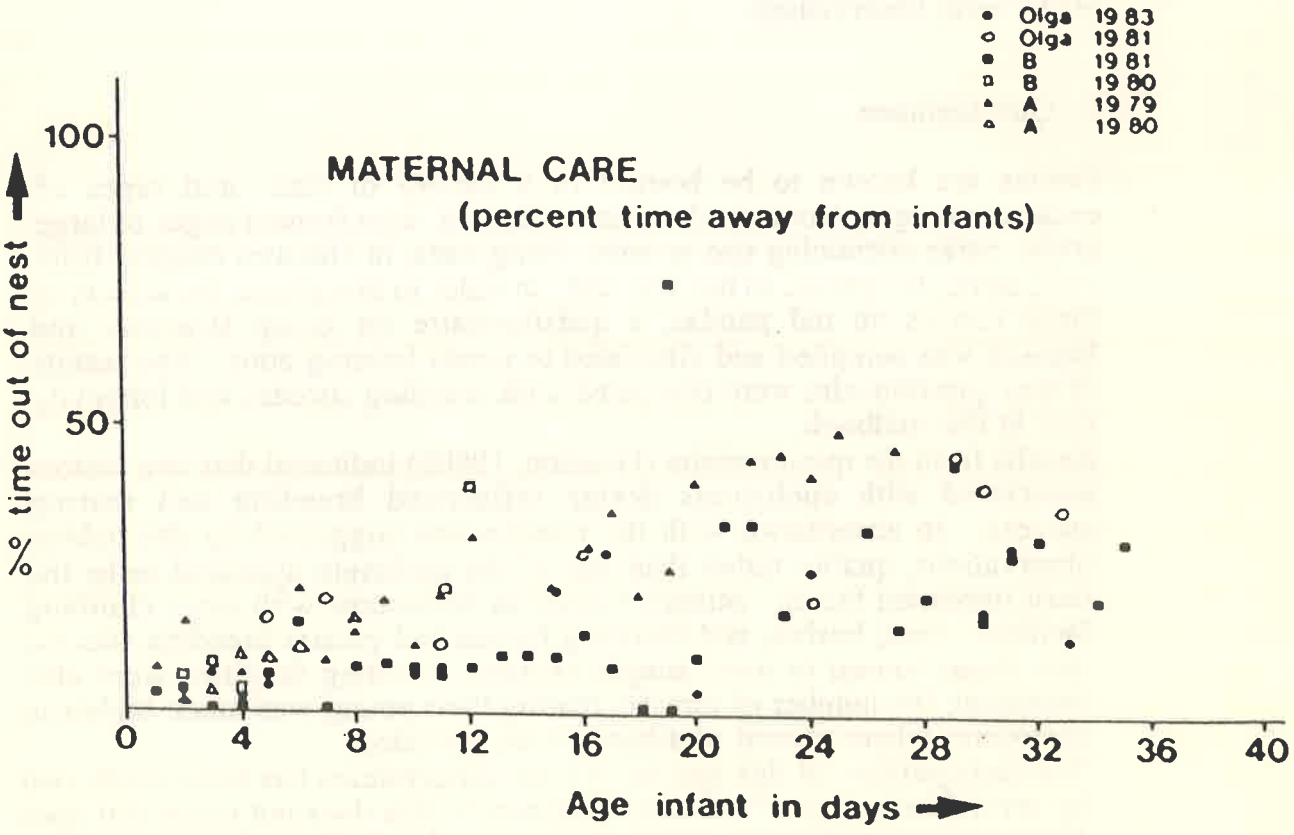

Figure 1 Maternal Care

Environmental influences: the amount of time that the mother spends with her young was taken to indicate the quality of maternal behaviour. Two factors were found to influence the amount of time that the mother spent in the nest: temperature and human disturbance. As the external temperature rose the female spent less time in the nest-box with her young (fig. 2). There is a significant positive correlation between temperature and the amount of time spent away from the nest. The other factor, disturbance, is the result of visitors. However, the effect of visitors is difficult to quantify for a small group of noisy visitors is more disruptive than a large group of quiet people. Nevertheless, there appears to be a relationship between the number of visitors and the amount of time a mother spends carrying her young around the enclosure.

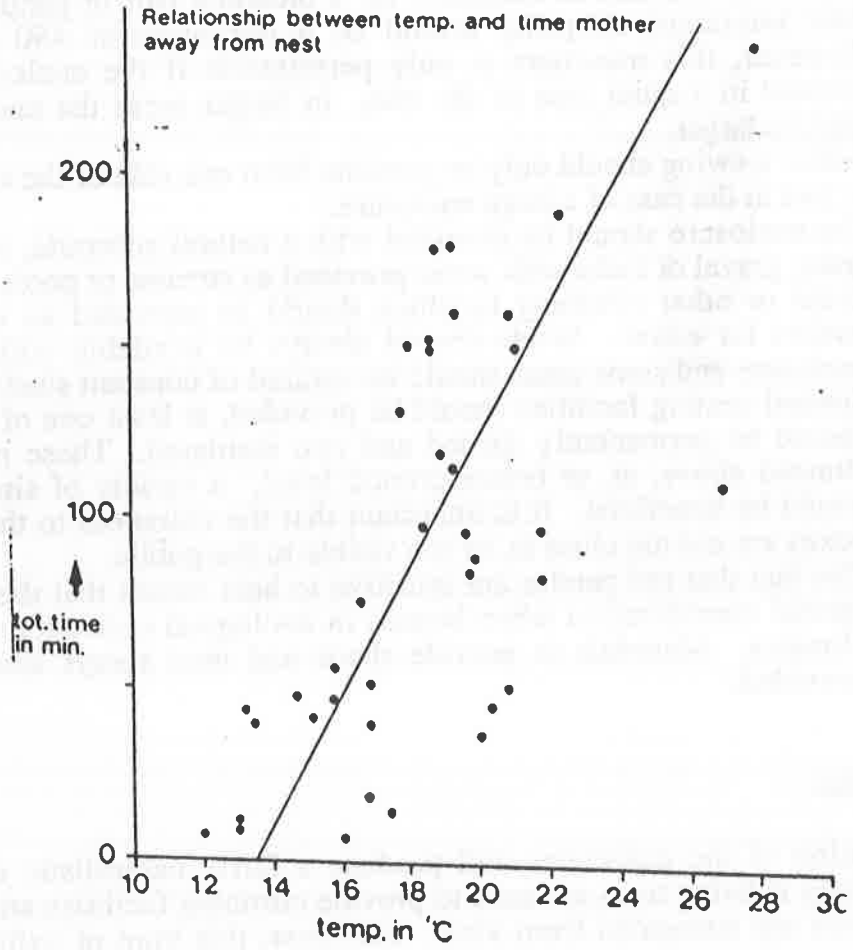

Figure 2 Relationship between temperature and time

Both these effects are potentially important, for postmortem reports indicate that neonatal mortality is usually the result of neglect or trauma and so could be attributed to one of these factors.

Finally, it was also observed that females were reluctant to enter nest-boxes to attend their young when they were being watched. This problem was alleviated when the entrance to the nest-box was concealed, e.g. by plants.

4. Conference and workshop

In 1987 a conference was organised at which papers were presented on various aspects of red panda biology. These data together with the results of the studies discussed above and the expertise of the delegates were used to compile guidelines for the minimum requirements for holding red pandas. These now make up a part of the red panda husbandry and management guidelines which are published in the studbook. (Glatston, 1989) The guidelines cover the size and furnishing of a red panda enclosure and the siting of, and public access to, such an exhibit.

To summarise the key points:

1. It was decided that an enclosure for a breeding pair of pandas and their immature offspring should be a minimum of 450 sq. ft. However, this minimum is only permissible if the enclosure is situated in a quiet area of the zoo; in busier areas the enclosure must be larger.
2. Public viewing should only be possible from one side of the exhibit, or two in the case of a large enclosure.
3. The enclosure should be provided with a natural substrate, such as grass, gravel or rocks with water provided as streams or pools.
4. Trees or other climbing facilities should be provided as well as bushes for cover. Shade should always be available within the enclosure and some areas should be assured of constant shade.
5. Several nesting facilities should be provided, at least one of which should be permanently shaded and two insulated. These may be situated above, at, or below ground level; a variety of situations would be beneficial. It is important that the entrances to the nest-boxes are not too close to, or too visible to the public.
6. The fact that red pandas are sensitive to heat means that they need special consideration when housed in zoological collections in hot climates. Materials to provide shade and mist sprays should be provided.

Discussion

Application of the guidelines will produce a fairly naturalistic exhibit, particularly if living trees are used to provide climbing facilities and if the nest-boxes are concealed from view. However, this kind of exhibit can have some drawbacks. In the case of the red panda, one particular problem is that when the animals are not active it is difficult for the visitor to see them. Zoo personnel may try to remedy this by preventing access to the trees or by shutting off the nest-boxes during the day. This kind of action is contrary to the theory behind the guidelines and is counter-productive. It is also difficult to monitor food intake accurately in this kind of enclosure or to maintain the animals on a particular diet as they eat the vegetation available in the enclosure. The pandas are also open to more contact with the indigenous animal population which can lead to injury or infection, (rabies, heart worms, fights).
On the other hand, a naturalistic type of presentation has positive advantages; these are numerous and more than outweigh disadvantages.

Firstly, the animals exhibit more natural behaviour patterns; they are free to develop their own activity rhythm rather than being restricted to activity at certain times. They can also select natural food stuffs available in the exhibit to supplement their zoo diet and thus demonstrate natural forraging behaviours, and use material available in the enclosure to construct nests.

The public also benefits from the experience offered by this type of exhibit in that it is more like the situation in the wild. The visitor has to look hard to locate the animal. The difficulty with which this is achieved indicates how well camouflaged this brightly coloured animal can be under natural conditions; their patience will be rewarded by a real glimpse into the world of the red panda and its normal behaviour.

The educative role of the zoo is very much enhanced by naturalistic exhibits which demonstrate the various aspects of biology in a natural setting where they can be seen to be functional. In particular, the problems of conservation can be more clearly illustrated. In the case of the red panda it is possible to show how dependant this animal is on the forest and how vulnerable it is to deforestation if it can be seen climbing trees and eating leaves and buds rather than eating gruel out of a metal bowl on a concrete floor. Finally, public sympathy and appreciation for a species and its intrinsic value is greater when it is seen behaving naturally. They are more able to appreciate and respect the relationship between animal and environment.

Finally, zoos themselves will benefit from developing a more natural approach towards housing exotic species. The large scale televising of sophisticated wild life documentaries has meant that people have been able to see details of the private lives of many species brought directly into their living rooms. This means that when they see the same species sitting in the traditional zoo enclosure it is an anticlimax. A natural type of enclosure could counteract this and make the zoo a more exciting place to visit. In addition, criticism by the anti-zoo lobby could not be justified.

The fact that zoos are moving towards a natural style of exhibit is clear from the terminology used in zoos today; zoo staff speak of biotopes and habitats rather than cages, enclosures and exhibits. The advertisements filling zoo magazines from companies such as those offering "designer rocks" and the titles of many papers in this publication are also indicative of this trend. It has been pointed out elsewhere that as the "wild" shrinks and becomes more managed, and as zoos become more sophisticated, the distinction between them will become blurred. This is nowhere clearer than in the new trends in zoo design.

References

Bhat, D.D., 1977. Natural History and Economic Botany of Nepal. Orient Longman, Calcutta.

Glatston, A.R., 1980a. Introduction. The Red or Lesser Panda Studbook, Number 1. pp. 1-10. A.R. Glatston ed.

Glatston, A.R., 1980b. Captive Management, a review of the 1978/79 questionnaire. The Red or Lesser Panda Studbook, Number 1. pp. 31-36. A.R. Glatston ed. Stichting Koninklijke Rotterdamse Diergaarde, Rotterdam.

Glatston, A.R., 1989. Husbandry and Management Guidelines. The Red or Lesser Panda Studbook, Number 5. pp 33-52. A.R. Glatston ed. Stichting Koninklijke Rotterdamse Diergaarde, Rotterdam.

Glatston, A.R., in press. Demographic analysis of the red panda population. Red Panda Biology. A.R. Glatston ed. SPB Academic Publishing, The Hague.
Glatston, A.R., & Roberts, M., 1988. The current status and future prospects of the red panda *(Ailurus fulgens)* studbook population. Zoo Biology, 7, 47-59.
Hodgson, B.H., 1847. On the cat-toed subplantigrades of the sub-Himalayas. J. Asiatic Soc., 16, 1113-1129.
Jones, M., in press. A brief history of the red panda in captivity. Red Panda Biology. A.R. Glatston ed. SPB Academic Press, The Hague.
Roberts, M. & Gittleman, J.L., 1984. *Ailurus fulgens*. Mammalian Species, 222, 1-8.

Veterinary Management of the Red Panda in Captivity.

Introduction

(a)

The Red Panda (A.fulgens) has been known to western science since the early nineteenth century, but we still have very little information about it's biology, especially in the wild state.
This lack of knowledge applies not only to the red panda, but with A. fulgens it is more evident because of the special interest in the species which is typified by this workshop in Darjeeling.
From a taxonomic viewpoint, we have a medium sized cat-like creature, classically assigned to the Order Carnivora, Family Procyonidae. Whilst scientific opinion is now moving away from the procyonid classification more research is still required to fully explain the behavour, physiology and eating habits of the species.
It is not the purpose of this paper to examine such issues, but any discussion about the Health & Welfare of red pandas in captivity must consider at least some aspects of this specialisation. That we have a carnivore, with a simple cat-like digestive system - eating with pig-like teeth - a vegetarian diet and whose metabolic rate reduces quite dramatically at low ambient temperatures ..... must be considered a special animal with some special needs in terms of its general management and Veterinary treatment.
Establishing captive born pandas from Europe in Darjeeling which is such a short distance from their natural environment, may provide us with an excellent opportunity for further study of their complex biology . Easy access to a plentiful supply of their bamboo diet and being subject to natural seasonal changes may also have significant benefits in terms of general health and disease susceptibility.

Veterinary & Health Considerations

(b)

To the best of my knowledge there has been no comprehensive survey of the clinical histories of either living or dead panda's where the type and frequency of illness or their response to treatment has been analysed in detail.
However, since the red panda studbook was established in 1978, post-mortem data has been published as a regular feature. From this information comes most of our present knowledge of the diseases to which the species is susceptible.

Post-mortem data and literature review.

Those involved in the management and veterinary care of red pandas should pay particular attention to the review of post-mortem data published in each issue of the International Studbook. During the period 1978\93 the findings of over 400 post-mortems have been reviewed listing deaths by age, sex, tissue or system affected and also organisms which may have been a contributory cause of disease.
The importance of this sort of data cannot be underestimated. Only by detailed PM examination will we gain a full understanding of disease in the species and also note any changes resulting from improved husbandry. A full PM protocol was published in Vol 7 of the Studbook and copies are available from the Studbook Keeper and should be used to record all findings. Details on general management should also be reported especially with respect to diet and routine treatments.
Since the early 1980's there has been a move away from wild caught animals, which were reported to have suffered heavy losses within the first four months of their arrival (1), to a population of mainly captive bred animals living under modern husbandry conditions (7). The reviews published in the Int. Studbook since it was introduced in 1978 have concentrated on *A.f.fulgens*, a more recent review notes that there are now some 70 records dealing with the subspecies *A.f.styani* (9).

Perinatal mortality (less than 30 days of age)

It is clear that the first few days of life of a cub are critical, as it is considered that a high rate of infant mortality is typical of the species. Although there is considerable variation in the figures given in the literature, in excess of 50% of those cubs that die within their first year die within the first seven days of life. Most of these die within the first three days with survival remaining low up to seven days (8). Thereafter losses are fewer and if the cub reaches one month of age then its chances of survival are good, barring traumatic injury.
There are a number of factors that may contribute to this high rate of loss:
(a) congenital abnormalities - a small number of offspring can be expected to have such abnormalities.
(b) malnitrition - a frequently reported finding from post mortem reports (6).

* The bonding process that takes place between mother and cub immediately after birth is a critical factor in the provision of adequate maternal care. It is difficult to determine what the are the appropriate requirements for the pregnant dam as there are those that are content to rear their cubs under public scrutiny, whereas others indulge in excessive handling of the cub(s), leading to ultimate rejection and may even result in cannibalism.

* insufficient milk production - may be dependent upon the dams condition.

* poor sucking reflex - this may be a reflection of low birth weight, congenital defect or infection. There have been a number of reports of toxoplasmosis (5). Although the host is a felid, infection in secondary hosts can produce abortion or the birth of underweight and weakling offspring. There may be a case for the blood sampling of females for toxoplasmosis serology where possible and considering the histological examination of the brains of dead neonates.

* There is a clear correlation between infant weight and mortality with the body weight of infants dying within the first 180 days being significantly lower than surviving counterparts (8). Young pandas grow fastest during the first month of life and then have a more regular weight gain up to one year old (8). This provides a major dilemma because although it suggests that neonatal cubs should be regularly weighed to ensure that thay are gaining weight this would probably result in greater stress for the female and could lead to the rejection of her offspring. It is therefore very difficult to decide when it is necessary to intervene and provide some degree of artificial support.

(c) pneumonia - there were widespread reports of pneumonia in young cubs (6) (7). Somewhat unusually aspiration pneumonia appeared to be quite common (7) and it is difficult to ascertain why this should be. Aspergillus pneumonia was not uncommon and this may have been a reflection of the quality of the bedding or the dampness of nest boxes.

A wide variety of potentially pathogenic organisms were reported to have been isolated however none would be regarded as particularly pneumotropic in other mammalian species. It was suspected that the reported cases of acute pneumonia seen in the carcases of neonates was probably due to complex aetiology, involving malnutrition, lack of thermoregulation, stress, lack of hygiene and infections by oppertunist organisms.

(d) There were several reports where partially eaten carcases had been recovered

(5) although it was not clear whether the cannibalism was primary or of secondary nature. The question as to whether behavioural problems are related to the type of housing or or the degree of other disturbance remains unresolved.

Juvenile and adult deaths

In the early 1980's when the captive population consisted of a high proportion of animals that had been wild caught there were numerous reports of hepatic and renal problems that implicated dietary problems. However in recent years such reports have considerably declined and the current population, mainly captive bred, is surviving for much longer.

The literature suggests that red pandas are particularly susceptible to infectious diseases (6), however caution should be exercised with such generalisations and any listing of potential pathogenic organisms found on post mortem examinations should be interpreted with care. In many cases, and in particular where endo and ectoparasites are involved, these are likely to be incidental findings and not contributors to the demise of the the animal unless present in such large numbers that further pathology results, e.g. intestinal obstruction.

Without direct access to the post mortem reports it is difficult to review the significance of the wide range of organisms that have been isolated at post mortem, however there does not appear to be any specific bacterial pathogen of particular significance to the species. The situation is quite different with viruses and it has been known for some time that red pandas are particularly susceptible to canine distemper and in the late 70's and early 80's many died from the use of live distemper vaccines.
There are also sporadic reports of deaths due to rabies and feline infectious peritonitis,although the latter may have been due to vaccination or close association with infected felids (5).

Juveniles (30 days upwards - one year old.

Notwithstanding the above there apper to be three main problems with juveniles:

(a) trauma (3) - this is a particularly significant cause of juvenile losses. The figures for the percentage of juvenile deaths due to trauma range between 18 - 61%. In this category are included deaths due to cannibalism, both inter and intraspecies aggression and accidental injuries (6).
(b) pneumonia (4) - again a wide range of organisms have been isolated from pneumonic lesions.
(c) early periodontal disease (6) - especially where fed on a soft, high carbohydrate diet.

Adults.

Over the past 20 years there has been a changing pattern in the disease problems seen at the post mortem examination of adult red pandas. The hepatic and renal problems seen in recently caught animals in the early 80's have been much reduced although liver lesions were reported in 6/27 animals over six years of age that underwent post mortem examination in 1991 (7). Over the ten year period to 1991 the most common liver lesions were of fatty degeneration and hepatitis of an unspecified nature. Dietary problems were frequently implicated as contributing to the liver pathology and much work has been carried out with regard to improving diets.

Reports received up to 1991 (6) would suggest that red pandas are prone to gastrointestinal tract disturbances. Primary causes of death in adults were attributed to gastritis and erosion and

ulceration of the the stomach and to enteritis and erosion and ulceration of the intestines respectively. In other mammalian species gastric ulcers have been associated with deficiencies in vitamin A,D and E and zinc and copper. It has also been suggested that high fibre diet is essential in the prevention of gastric disorders (10).

A major problem in adults is that of periodontal disease (4) (6), which can lead to gingivitis, abscessation and a failure to feed. Such disease in the pregnant female would have significant influence upon the developing foetus and consequent survival of the neonate.

As the population survives in captivity for longer than would normally be so in the wild state then it is to be expected that there will be an increase in the number of post mortem reports noting chronic disease conditions such as cardiovascular problems.
Whereas wild red pandas feeding mainly on a diet of bamboo would have a relatively low fat diet, captive pandas often receive artificial diets which are highly digestable, low in fibre and high in fat (10). High lipid diets in other mammalian readily lead to obesity and cardiovascular problems, however it is too early at this stage to draw many conclusions from the limited number of reports of such disease problems in red pandas in the literature.

Clearly there as been a steady improvement in the health status of red pandas in captivity since the early 1980's. However, there is still an urgent need for further research in to the dietary needs of pandas from weaning to adulthood. Also the importance of good husbandry in the prevention of disease cannot be over stressed.

Preventative Treatment

Prevention is better that cure. This saying is certainly true in the case of the red panda if treatment is delayed. Unfortunately, wild animals can sometimes be very seriously ill and only show minor symptoms eg. lack of appetite. The next report may be that the animal has died.

From my own personal experience and from reviewing the husbandry guidelines published in Vol 5 of the International Studbook I list the following items as being essential for the prevention of illness and disease in the species.

(1) **Well trained Keeping Staff.** All zoological collections should implement keeper training programmes in order to ensure that a good standard of animal management is maintained. Staff should also be encouraged to spend some time observing their animal each day and reporting to management any abnormalities however minor.

(2) **Enclosure design.** A well designed enclosure can reduce the incidence of stress related disease. Most important in hot climates is the provision of shaded areas and well ventilated nest boxes . Guidelines for enclosure design and nest box construction
can be found in the International Studbook and also Red Panda Biology.

(3) **Adequate level of Nutrition.** See report on nutrition.

(4) **Good standard of Hygiene.** The daily cleaning of food & water containers in a suitable disinfectant solution and the removal of all un-eaten food and faecal material is essential for the prevention of disease. Pest Control measures should be considered if an enclosure becomes infested. **The use of clean food containers will minimise the risk of contamination by infectious organisims.**

(5) **Routine Health Care.** A regular programme of health care checks should be carried out at least once a year or prior to transportation.

Check : (a) Body weight..
(b) Teeth & Gums.
(c) Blood - Haematology/Biochemistry.
(d) Ecto. Parasites.
(e) Ears.
(f) Treatments if required - Vaccination.
- Anthelmintics

Treatments & Other Procedures.

Vaccination Policy. All Procyonids are highly susceptible to Canine Distemper & Panleucopenia virus and must be vaccinated in order to maintain their immunity.

In high risk situations :
(a) Vaccinate Adults & Cubs in accordance with the manufacturers instructions. **Please note that only dead vaccine (not attenuated) may safely used in the red panda**.
(b) Check immune status of animals yearly if possible.
(c) Re-vaccinate yearly.
(d) Monitor and eliminate any source of infection eg. stray dog & cat populations, wild mustelids etc. **This must be a priority if red pandas remain un-vaccinated**.

Special Note ;

The vaccination of a pregnant dam may result in high maternal antibody levels in the cubs this may cause the rejection of any vaccine given to the cubs at 9-12 weeks of age.

Therapeutic Drugs

(a) **Antibiotics.** A wide range of antibiotics can be safely used without side-effects.
(b) **Vitamins.** Useful at times of stress eg. illness, transportation and pregnancy.
(c) **Anthelmintics.** A selection of anthelmintics is widely available for use in the domestic and non-domestic animals.

(1) Piperazine Citrate (Citrazine) 0.5g\kg BWt.
(2) Fenbendazole (Panacur) 20mg\kg BWt. x 5 days treatment. 100mg\kg BWt. x 1 day treatment.
This drug is a broad-spectrum anthelmintic effective against wide range of common intestinal nematodes and is also a useful in the treatment of cestodes and lungworm

(3) Mebendazole 22mg\kg BWt. x 5 days treatment.

(4) Ivermectin. (Ivomec) This product is a general anthelmintic which is also effective against ecto-parasites eg. lice, mange etc. Flea infestations may also be controlled with this product but other measures must be taken to prevent re-infestation from bedding and nest boxes.
The use of powder insecticides may be contra-indicated for the treatment of fleas on red panda.

Sedation.

Whilst netting and manual restraint can be used to carry out simple procedures eg. vaccinations, the use of sedative drugs is to be recommended for longer periods of handling.

Several safe drugs are now available for small mammals and have been used on the red panda.

A total of 15 animals were sedated at Rotterdam Zoo using :

(1)	83ug\kg BWt	Medetomidine
	6.6mg\kg	Ketamine Hydrochloride.

Other Drug Combinations

(2)	7mg\kg BWt.	Ketamine
	0.2 mg\kg	Acepromazin.
(3)	7mg\kg BWt.	Ketamin
	4mg\kg	Xylazine Hydrochloride

The use of the reversal agent Atipamezole (Antisedan) 0.2mg\kg BWt. can now be used to aid recovery when using Medetomidine, Ketamine - Xylazine combinations.
Animals must be deprived of food and water for at least 5hrs prior to sedation.

Isolation of Imported Animals.

Animals imported into India from European countries or the USA are unlikely to carry any significant diseases.
However, some protection may be required against local pathogens - because of lack of natural immunity. Some period of acclimatisation may be advisable and during this period all keeping staff should pay particular attention to food hygiene and drinking water should be boiled before use.

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Post Mortem Literature References - International Studbook.

1. Frankenhuis, M.T. & Glatston, A.R. (1980)
A review of pathological findings in the red panda
Pp. 31 - 35. Int Studbook No 1.

2. Frankenhuis, M.T. & Glatston, A.R. (1982)
A review of pathological findings in the red panda
Pp. 37 - 41. Int Studbook No 2.

3. Frankenhuis, M.T. & Glatston, A.R. (1984)
A review of the pathology of the red Panda in captivity
Pp. 45 - 52. Int Studbook No 3.

4. Lateur, N. (1987)
Pathology Survey of captive red pandas (Ailurus fulgens)
Pp. 19 - 27. Int Studbook No 4.

5. Schaftenaar, W. (1989)
Review of pathological findings in the red panda: 1986 - 1987
Int. Studbook No 5. Pp 7-13

6. Machin, K.L. (1991)
Red panda pathology
Pp. 7 - 24 Int Studbook No 6.

7. Lubbert, J. Schaftenaar, W. & Glatston, A.R. (1993)
A review of the pathology of the red panda (Ailurus fulgens)
Pp. 10 - 19. Int Studbook No 7.

8. Yinghong, Li. (1994)
Infant mortality in the red panda (Ailurus fulgens)
Pp. 18 - 35. Int Studbook No 8.

9. Schaftenaar, W. & Glatston, A.R. (1994)
Patterns of pathological findings in the red panda
Pp. 37 - 49. Int Studbook No 8.

10. Red Panda Biology (1989)
Ed. A.R. Glatston
SPB Academy Publishing, The Hague, Netherlands

Acknowledgement

My special thanks to Brian Preece, MRCVS, SVO Ministry of Agriculture, Tolworth, for his help in compiling the pathology data in this article.

RED PANDA DIET

In respect of diet the red panda remains, despite observation of their eating habits in the wild state and some research in zoos, still something of an enigma.
Kuno Bleijenberg, Rotterdam Zoo, in Vol 3 of the International Studbook, summed up the situation well by entitling his article. **When is a carnivore not a carnivore (answer) .... When its a panda.**
Of course many species assigned to the order carnivora eat items of plant material, eg. bears - eating roots and fruit.... foxes eating wild berries and grass. Highly carnivorous species like the lion and tiger will often consume pre-digested plant material by eating the digestive tract of their prey.
However, in most cases we would have no difficulty in describing them as carnivores - the main item of their diet being other creatures. Those mammals that do specialise in eating plant material have evolved a complex digestive system that is capable of delaying the passage of food a nd also supporting bacteria and protozoan populations that are capable of breaking down cellulose.
Therefore, it is rather surprising that the red panda with its pig-like teeth and cat-like gut should specialise in the eating of bamboo - some would say almost exclusively..
From observations in the wild state (Yonson & Schaller) and dietary trials in zoos, it is fairly clear that the red panda like eating bamboo and will eat it in preference to other food items. **Why this choice ?**
Well I will leave that question to others to answer... but it is interesting to note that its intake of low energy food is matched by an apparent low basal rate of metabolism and that at low ambient temperatures it can even further reduce it energy expenditure
So low energy expenditure .... low energy requirement. (1) (B K. McNab)
On a personal note I still support the view that the red panda is an 'opportunist' and will in nature take some animal protein in the form of eggs, young birds and small mammals if it gets the chance.

So if the red panda eats bamboo ...what is it eating in terms of nutrient value.? **Fig 1**

From this analyses and from our scant knowledge of a pandas energy requirement then we can make some deductions in terms of intake of its natural diet. Once again the panda does not make things easy for a relatively simple calculation of its energy requirement shows that its intake of bamboo would need to be in the order of at least **10%** of its body weight daily,on a dry matter basis, in order to stay at a maintenance level. Remember that the water content of fresh bamboo is around 90% - so the total intake with all other consideration eg.non-digestibility, must be very high. Very few European zoos would be in a position to provide such an amount on a regular daily basis.

So what do we feed to captive Red Pandas.

At the present time there is still no final answer to that question - despite research in the USA and Europe.

However, some positive ideas have emerged that have resulted in diets specific to Pandas.
In Vol 6 of the International Studbook a survey of diets fed in European zoo's was published and the analysis shown in **(fig 2)** was used as a norm for comparison . A similar survey carried out in the USA is published in Red Panda Biology.
The motivation behind these surveys was not only the concern that pandas in captivity may not be receiving an adequate diet` in terms of basic nutrition, but also some of the sweet gruel's that were commonly fed in many zoos may be the cause of obesity and dental problems. **Decaying teeth have resulted in the death of several animals due to untreated tooth root abcesses.** The survey reveiled a wide variation in dietary items fed and nutrient values ... some of which were very imbalanced and likly to cause health problems long term.
In the United Kingdom some reasearch has been carried out on trying to create diets that were both nutritionally complete, was as satisfying to eat, and that might even taste like bamboo. Several diets were subsequently tried which reflected our understanding of energy requirement and with some diet formulations there was a marked weight loss.
In the wild a pandas av. weight is around 4kg. (Yonzon) in the dietary study animals it was over 5.5kg. All the diets were lower in fat and higher in fibre than most captive Pandas diets. A full review and detailed analysis of the trial diets can be found in Red Panda Biology (1987) (1)

The Marwell High Fibre Panda Cake - Brief History.

Marwell Park has no supplies of bamboo available to feed its pandas and must rely on the use of artificial diet. Over a period of 15-20 years several diets have been tried using commercial concentrates with fruit and vegetables and in addition our animals have access to grass and Oak browse. On analysis most of these diets fell within the parameters now recommended and historically no serious nutritional problems were encountered and good breeding results were achieved. So why change.? Whilst our infant mortality rate was very low, we were concerned that the cubs were very selective in their eating habits, taking mainly fruits eg. banana, apple etc, and not items that were nutritionally balanced. Interestingly, when a small quantity of bamboo or favoured browse was available it was eaten in preference. It was also noted that the ability to pick up and manipulate food in the paws did influence what was readily eaten. With some animals selective eating habits would remain into adulthood and subsequent changes to diet were often rejected. **Could selective feeding be one reason for the mortality rate seen in cubs from weaning to 12 months of age.?**
After a period of research a High Fibre, Low Fat Cake was manufactured by SDS Ltd, in powder form which was then mixed with water and refrigerated to solidify. **Fig 1.**
Since its introduction several pandas have been fed this diet with mixed success. Some eat it in preference to other food items, some will eat small quantities and others reject it totally. One litter of cubs has been raised on this diet without any problem.
We now intend to look at various flavour additives to see if this improves palatability.

Some Reccommendations

(1) Those institutions that have an abundant supply of bamboo should use it as the main source of diet.
Valuable research could be carried out to determine quantities eaten daily, species selection and other selective or seasonal preferences.

(2) From research in Western Zoos, most of which is published in the International Studbook and RP Biology, useful guidelines on diet analysis and formulation can be obtained.

(3) The use of sweet gruels should be stopped.

(4) Any dietary change should be carefully monitored by regular weight checks, and also if possible the chemical analysis of faecal material, haematology / blood biochemistry.
PM examination can also yield valuable information eg. fat reserves, liver chemistry, dental problems and diseases of the digestive system.
Many conditions can only be identified by histopathology and every effort should be made to preserve a cross section of tissue following the guidelines published in the studbook on pathology.

(1) Red Panda Biology. A.R. Glatston SPB Academic Publishing bv 1987.
ISBN 90 5103 026 6

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Figure 1

Proximate analyses		Moist	Compare with		
		High fibre	Bamboo General	Bamboo Old Shoot	Bamboo Leaf
Dry matter	%	53.80	9.00	20.00	10.00
Crude fat	%DM	6.30	3.30	.60	3.30
Crude protein	%DM	22.30	28.80	4.30	17.30
Crude fibre	%DM	15.60	7.80	46.00	24.80
Ash	%DM	7.20	10.00	2.60	8.10
N.F.E.	%DM	48.70	50.10	46.50	46.50
Carbohydrate	%DM	12.50	28.90	27.41	26.25
Calcium	%DM	1.05			
Phosphorus	%DM	.70			
G.E.	MJ/KgDM	17.58	16.68	16.40	16.58
M.E. (est)	MJ/KgDm	8.23	10.76	4.97	8.21

M.E. estimated from G.E. (Fat + Protein + Carbohydrate) × 90%
Bamboo: Sinarundinaria (Schaller *et al.* 1985).

Figure 2

Crude protein	15-20%	Pantoacid	15-60 mg/kg
Crude fibre	>8%	Choline	1,250-5,000 mg/kg
Fat	3-7%	Biotin	0.1-0.5 mg/kg
Linoleic acid	0.8%	Calcium [2]**	0.75-1.4%
Vitamin A [1]*	8.0-15.0 IU/g	Phosphorus **	0.60-0.90%
Vitamin D3 *	0.8-2.5 IU/g	Magnesium	0.1-0.2%
Vitamin E	150 mg/kg	Potassium	0.65-1.3%
Thiamin	2.5-10 mg/kg	Sodium	1.5-3.0%
Riboflavin	5.0-20 mg/kg	Iron	100-200 mg/kg
Niacin	30.0-100 mg/kg	Zinc	50-200 mg/kg
Pyrodoxine	2.0-10 mg/kg	Copper	8-30 mg/kg
Folacin	0.6-2.5 mg/kg	Manganese	40-150 mg/kg
Vitamin B12	0.03-0.15 mg/kg	Selenium	0.18-0.5 mg/kg
		Iodine	0.8-3.0 mg/kg

1. * ratio vitamins A:D3 must be in the range 5:1-10:1

2. ** ratio Ca:P must be in the range 1.1:1.0 - 1.5:1.0

DIET OF THE RED PANDA IN DARJEELING ZOO

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P.N. Himalayan Zoological Park, Darjeeling

Since inception, the Padmaja Naidu Himalayan Zoological Park, has been maintaining Red Panda but the nutrition had been ignored. As this animal was maintained for exhibit only, not much attention was given for breeding, nutrition etc. From the beginning the red pandas used to get the following diet.

Suji	75 gm
Sugar	50 gm
Egg	1 pc
Milk	1.5 (litre)

This was made into a mixture for each animal, given in the morning and late afternoon

In addition to the above, pandas are used to get bamboo leaves of about 3 kgs/ animal. This diet was not proper and there was no supplementation of vitamin and minerals which was evidenced by lack of reproduction. No breeding was observed till 1993.

Now this zoo has initiated a captive breeding programme as a part of the International red panda captive breeding project. To achieve breeding success in the last two three years, different aspects of the red panda management (including nutrition, animal enclosure, animal behavior) has been reviewed.

In improving the enclosure design, one achievement was noticed when one of our female pandas came into heat and mated with a male in 1993, however conception took place. From this result it was concluded that although the enclosure design had been merely perfected, the physiological status required improvement as well, including proper nutrition. Actually it was quite difficult to make any changes in the diet of these pandas. They are not used to take any fruit or other solid food, preferring milk and eggs which are also good food and make up a balanced diet for pandas in captivity. (Hodgson, 1847).

To make up the dietary deficiency and to reduce the dependency on milk, an effort was made to incorporate fruit and other solid food in the diet. Fruits and berries are found to make up a larger proportion of this animal's diet in the wild. The pandas in Darjeeling Zoo did not relish it and refused to eat it. From 1993 Protinex (protein supplement) at the rate of 10 gm was added along with Tab Supradin, Aquasol and Evion. The above nutrition resulted in mating of two females to a male in 1994 and one successful birth of a female. This birth was felt to have been a result of additional nutritional supplements. Bamboo is given in the maximum quantity because in the wild bamboo accounts for the 95% of their food and is treated as first choice (Smith 1932).

Since the arrival of three pandas, two diet charts are followed for the old and new animals. The diet is different for the old animals from Darjeeling Zoo and the new ones from European zoos.

DIET (A) Diet for red panda (Old stock) (For one individual)
Suji 75 gms
Sugar 50 gms
Egg 2pcs
Milk 325 gms
Bread 15 gms
Cornflakes 10gms
Vitamin mineral supplement
Vit A 60000IU Cal Phos 129.0mg
Vit D 1000IU Mag Oxide 60.0mg

Vit Bl 10mg Ferous Sulph 32.0 mg
Vit B2 10mg Mang Sulph 2.03 mg
Vit B6 3 mg Copper Sulph 3.39 mg
Vit B12 15mcg Zinc Sulph 2.2mg
Cal Pantothanate 16.30mg
Vit C 150mg
Vit E 225mg
Protinex 10gms (in a mixture for each animal was given in the morning and later afternoon)

Bamboo leaves 3kg (Per day)

The changes in the diet of the native stock is going very slowly by trail and error process. Fruits like Apple Papaya and Banana are being supplied in addition to their usual food. They are maintained with the new animal so that they can adapt to feed sold food and fruits. The cornflakes, bread etc. whice are now being supplied will be excluded from the diet in course of time.

DIET (B)

Diet for the new pandas (For one individual)

Papaya 200gms
Carrots 200gms
Apple 200gms
Banana 3pcs (150gms) (1 pc in the morning 2 pcs. in afternoon)
Eggs 2 pcs.
Cornflakes 20gms
Milk 150 ml. (skimmed milk)
Bread 15gms
Honey 10gms p73.
Bamboo leaves 800gms. (Per day)
Vitamines and minerals As above

As bamboo is sufficiently not available to the western zoos that is why nutrients with high fibre content are most preferable. The diet given to the pandas in most of the European zoos are perfectly balanced pellets and high-fibre red panda cakes. This zoo is not very keen to feed them this type of diet because of availability of different natural feed ingredients. Moreover the commercial cereal grains like oat, wheat germs and the cakes are not available. As the pandas main nutrients in the wild is bamboo, every effort has been made to feed bamboo leaves as much as possible. The zoo is in the vicinity of the habitat of this animal which insures a supply of bamboo is easily available. The different nutrients available to the animal from the present diet has been shown in Table-1. which seems quite sufficient.

Computing the diets of red panda in this zoo, needed more serious consideration when it became listed for possible reintroduction. To formulate the diet several factors are being considered like:

1) to take the scope of availability of natural nutrients;
2) nutritionally balanced diet;
3) to make them fit for reintroduction
4) very special food habit (Herbivorous carnivore)
5) Geo climatic variation

In other zoos like Marwell Zoo, Madrid zoo and Cologne Zoo, pandas are used to get computerised ration (mash, pellets, red panda cake). The pandas have to be dependent on such a diet due to lack of natural nutrient, primarily to increase the captive population. At present, captive breeding is going on successfully. Every effort is being made to give the animals as much as possible

natural nutrients. It is advised to avoid the dependency on commercial balanced diet so that reintroduction could be successful.

The present diet for the red panda is not standardised. The total caloric requirement is not still established. the protein requirement has to be calculated in terms of digestible crude protein.

Table 1
Target Nutrient levels for red pandas

Crudeprotein (C.P.)	18.0%	14.32% 2.42
Carbohydrate	34%	11.6
Fat (EE)	5.0%	13.5% 2.1
Fibre (ADF)	10.0%	Not estimated Not estimated
Calcium	0.75%	0.81% .046%
Phosphorous (P)	0.6%	0.63% .1642% p73
Sodium(Na)	0.15%	Not estimated Not estimated
Magnesium (mg)	0.1%	10.90
Iron (fe)	100.OPPM.	5.81%
Copper (cu)	8.0ppm	61.63%
Maganese(Mn)	40.0ppm	0.36%
Selenium(Se)	18ppm	Not estimated
Zinc(zn)	50.0ppm	.04%
Thiamin	2.5ppm	1.81%
Riboflarin	5.0ppm	1.81%
Vitamin B6	2.0ppm	0.54%
Vitamin B1230.0 ppb		2.72%
Niacin	30.0 ppm	Not estimated
Folate	600.0 ppb	Not estimated
Biolin	100.0ppb	Not estimated
Choline	1250.0ppm	Not estimated
Pantothenate	15.0ppm	Not estimated
Vitamin-A	80001U/Kg	9090 IU
Vitamin-E	220 IU/Kg	45.45%
Vitamin-D	800 IU/Kg	181.8 IU

Record Keeping System for Zoo Animals

S.C. Sharma*

Zoos are institutions which provide animal by animal care for wild creatures, sustaining them generation after generation. As such, zoos provide a unique opportunity for scientists and wildlife managers to collect biological data for management of species which they could not collect in the wild. Zoos function as centres for conservation research and provide invaluable scientific data for accomplishing the demanding task of wild life conservation in constructed habitats.

Increasingly zoos are being acknowledged as reservoirs of genetic material for strengthening small, isolated wild populations : this is the most significant contribution of zoos, the planned breeding of endangered species for augmentation of declining *in situ* populations.

In order that the animals supplied for restocking or reintroduction, either by living animals or infusion of genetic materia, are fit, zoos have to insure that that the stock raised by them is genetically and demographically viable. These goals as well as successful breeding for any reason require data on the longevity of the species, age of sexual maturity for either sex, and maximum age up to which the male and female of the species can breed. Reliable data is also required about the gestation period, parturition cycle, the number of young ones produced per litter, sex ratio among new born and mortality rate of the animals in various age classes and particularly in the neonatal stage. In addition to this, information for the proper upkeep and husbandry, data regarding clinical parametres, common diseases that affect the animals particularly, details of microorganisms/parasites that are responsible for these diseases are also required.

Interactions between field biologists and wild animals are, and should be, minimal. It is very difficult to collect the aforesaid data from the wild population because chances of a scientist/field worker coming across animals in the wild are remote. Even if they are successful in observing a few animals, the period of observation is short. Detailed observation on the morphology, physiology and biological behaviour of the species in such short encounters are almost impossible. The conscientious field worker also is always aware that his presence may disturb the animals with ill effects. The task is much more difficult when dealing with an illusive animal like Red panda. Because of its arboreal nature and dense habitat, the Red panda is even difficult to sight. Thus, even the census of this species is done on the basis of counting scats. Therefore, the only source of data for implementing any conservation project on most species of wild animals is the records of the observations made by the zoo staff on the biology, behaviour and health of the animals.

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Though many people may say that the behaviour of animals in captive conditions, or zoos, is aberrant, there is no substitute for the data that can be collected on various aspects of animals life at zoos. Zoos all over the world maintain meticulous records of such observations, and the science of observation, recording and record keeping is ever improving and searching more more objective and non-invasive methods of collecting data.

The typical zoo record system includes three sets of documents, namely :

1. Daily report of the zookeeper: the report covers the daily observations regarding physical condition and behaviour of the animal, amount of food taken by it, ingestive and eliminative behaviour if any, changes in diet, interaction between male and female (particularly mating, etc, and growth of young ones.

2. Veterinary records : these records comprise of treatment cards and postmortem reports. The cards could be replaced by individual files also.

3. Curatorial records : these records comprise of animal history sheets and studbooks in respect of all the animals of endangered species. Animal history sheets are chronologically recorded summary of the observations made by the keeper as well as that of the veterinary records.

A typical studbook provides the list of all specimens born and registered, both living and dead, their sex, dates of birth, parentage, location and -- where appropriate -- place of death.

The format for collecting and collating the information mentioned above has been fairly standardised and circulated to zoos from time to time. The advantages of maintaining the aforesaid records are immense and can not be illustrated at length in this paper. However they are briefly summarised :

1. Records at the keeper level help the curator to take management decisions expeditiously as well as summarise the observations on behaviour and the biology of the animal for future use by the zoo and the zoo community.

2. Veterinary records - the postmortem reports provide invaluable diagnostic data for future treatment of animals as well as for taking preventative and prophylactic measures.

3. Curatorial records - the studbooks help in compilation of the detailed inventory of animals of the species at national level and international level. The information so compiled helps the zoos in locating a new specimen of the correct age and sex for inclusion in collection of the zoos and also helps in safeguarding against inbreeding. Any lapse in proper upkeep of curatorial

data can defeat the entire objective of the breeding programme. Proper analysis of studbook can also be utilised in removal from the programme the animals carrying deleterious genes. The studbook information can even be used for improving the husbandry of the species, provided longevity and fertility rates for animals are maintained under different conditions and in different climates.

In India, the work of maintaining studbooks has not received the attention it deserves. Even a system for marking the animals is yet to be adopted. The studbooks therefore tend to be unreliable as they are based on hearsay from the keepers. While it is important to be a member of international studbook programmes like ISIS, we should refrain from providing incorrect and imperfect information.

Developed countries for their part may like to help by providing technical skills and animal marking equipment to the developing countries. Dr. Angela Glatston and Dr. Miles Roberts are bound to take some initiatives in this regard.

The 'Recognition of Zoo Rules, 1992' provide that every zoo should maintain a studbook, animal history-sheet and treatment card in respect of the animals of endangered species. There is also a provision that the animal keepers submit a daily report on their observations regarding the behaviour of various animals under their charge. If those are properly maintained, they can provide a very reliable and valuable data on the various aspects mentioned above. Darjeeling Zoo has made a special arrangement for recording of behavioural observation of Snow lepord round the clock and the Ex-Director of Darjeeling Zoo. Shri Vinod Rishi tells that the breeding success in Snow leopard was possible only through detailed records maintained at the Zoo.

The meticulous and careful upkeep of in-house data can help us in providing reliable information to the International Studbook keepers or ISIS. If we fail to do this, all the information furnished bythe zoos to various agencies would be unreliable and would lead to wrong presumptions and surmises about the behaviour and biology of the species. Although it may appear to be cumbersome and time-consuming, there is no substitute for proper maintenance of studbooks, animal history sheets, treatment cards and enclosure logbooks by zoos.

TOWARDS DEVELOPING A SPECIES BASED EDUCATION PROGRAMME IN A ZOO: RED PANDAS

Sanjay Molur

The zoo is an almost perfect place for conservation education. Compared to a Wildlife sanctuary or a National Park, the zoo is not so abstract to a layman. The animals on exhibit are right there in front of the visitor's eyes in a zoo. The wild enthralls one's mind for the beauty and freedom that surrounds it, but it is not always possible to see the animals. The wild necessarily an ideal place to educate people about conservation. The zoo on the other hand has advantages, such as easy animal access for the visitors, thus attracting their attention, exciting their senses and thus encouraging the learning process. Education therefore becomes easier.

Education in the zoo is a full-time job for the zoo professionals. Newer and innovative styles and forms of education are required to attract the attention of media-sophisticated visitors and convey the message we want to convey. Visitors don't come to learn. They come to the zoo to have a nice time; therefore, theyneed to be wooed to learning what the zoo has to teach. This involves total dediciation and many man hours.

Indian zoos have minimum educational facilities. Of the 350 and more zoos in India, only 4 or 5 have an education officer, or a person responsible for education full-time. Even this much is a welcome change from few years ago, and a good beginning, athough systematic education programmes ideally require a team of people working full-time to achieve the objective of the zoo.

In the present context in India, zoo directors, veterinarians, keepers and biologists busy with other tasks are doing double duty as educators. They need certain guidelines or easy points of reference to carry out education programmes in the zoo. A simple but systematic approach is to identify the whats, whos, whys, hows, wheres and whens before initiating a programme.

This paper is with reference to a particular species - Red Pandas and on evolving a methodology for education on this species. The exercise for this species also limits to the three zoos that maintain these animals in the North-east. The concept could however be applied to any other species in any other zoo.

What?

The first and the foremost question to be asked by the zoo personnel is "what should the zoos teach"? There are a host of "whats" to teach depending on the location,environment, theme, visitor number and type, and exhibits of the zoo. Conservation education is a universal theme, but there are other themes such as ecology, habitat, behaviour, biology, etc that a programme could take up to teach the visitors.

In the case of Red Panda zoos, because of their specialisation as a high-altitude species, the Himalayan region could be a theme.

The Red panda habitat is found very close to the Darjeeling zoo in Singhalila National Park. Dwindling numbers of the species in the wild due to various man induced reasons, make it a strong case for conservation education. The uniqueness of the species to the area

is an added feature in making it an interesting species for conservation education. The Red panda also has the advantage of attracting people's attention for being 'cute' and 'cuddly. The look of the animal alone will do half of the job.

Who and Why?

Who to educate and who to depute to educate are the two 'whos'of zoo education?

To be able to answer the first who 'who to educate' and why, the zoo has to study its visitors - the kind of visitors, age groups, number, profession, educational levels, language, interestsm etc, This can be done by conducting systematic visitor surveys over different periods of time for several days each time.

Some of the target groups for a Red Panda education programmes are:

(i) Tourists - the Red Panda is a curious and a new animal for tourists from outside the state of Red Panda habitation. It can become an important tool of education.

(ii) Students - they are a potential group for education for the very same reason of Red Panda habitat, uniqueness, etc apart from being a perceptive group and an important one. The students can also have a major impact on their parents and relatives and a strong force to enforce conservation.

(iii) Army personnel - the Red Panda habitat near Darjeeling is a very sensitive area and the army is deployed permanently. Entry into the Red Panda habitat requires army permission. This to an extent has helped Red Pandas from poachers. Army personnel can be excellent ambassadors for Red panda. This group is therefore a prime target for education.

(iv) Villages - villages in and around Red Panda habitat are a target group to be considered for their daily interaction with the Red Pandas or its poachers.

There are other target groups like the general visitor, school teachers, voluntary organisations, friends of the zoo, volunteers, zoo keepers themselves and others who could be educated. The zoo has to decide priorities amongst these different target groups and focus its attention on the most important ones.

The second who " who is the educator " is extremely important from the point of view of non existant education departments or staff. In the absence of a professional educator, an effective educator from among the regular zoo staff has to be selected. This depends on the target audience.

A zoo director is an apt educator for a sophisticated group like army personel or students or politicians or a group of teachers for which the programme could be held either on site at the zoo or an outreach programme is developed. A zoo director can focus on conservation while addressing such an audience. For groups such as general interested visitors, tourists and student groups visiting the zoo, everyday knowledge of the Red Pandas and their behaviour may be more of an attractant and the person who has a 'personal' contact with the animal may be the best person to talk to them. The animal keeper becomes the educator in this case. He can hold an audience of illiterate visitors with his story of the Red Panda and the mundane happenings.
A veterinarian becomes an educator to another kind of audience; so also do volunteers,

though the latter can assume the role of an educator in many different circumstances. In essence everyone at the zoo is, or should be, an educator for some target group. The success of any educational venture depends on some or all of the above educators working as a team to cover all social and educational levels.

Where?

An ideal place to teach, of course, is the zoo amidst the surroundings and the comfort of having living animals on exhibit, with staff and infrastructural support, etc. but zoo education doesn't have to take place in the zoo. The zoo can organise trips to the natural habitat of Red panda, to natural history museums or even botanic gardens to teach related subjects.

Combined with on-site education is the outreach programme. For a large school group, en masse education in a zoo would involve a tremendous effort by the zoo staff with inherent risks. Outreach programmes with development of school packets about the species and slide presentations are a good medium of education. Give away packets for schools make a strong impact on the students for the teachers get involved. This system also has the advantage of reaching teachers and parents. Such programmes are also good to prepare students for a zoo visit, informing what they will see and how to get the most out of their visit. The importance of good behaviour at the zoo can be communicated well before the zoo visit with good effect.

Similar outreach programmes for army personnel, civic groups, societies, orphanages, hospitals and villages can create awarenes and respect for the Red Panda and its habitat. while possibly encouraging group activity and second stage outreach programmes on behalf of the species.

When?

Species based education can be conducted everyday but is largely dependent on the target group composition and numbers. It could be on specific days of the week in arrangement with the school authorities, on holidays (weekends), on special occassions such as festival days or celebration days or national holidays, on specially arranged days for army personnel, on an eventful occassion for villagers, on free entry days for general, poor and illiterate visitors, etc.

Zoo education needs to be everyday, but given the resources, staff and involvement, special educational programmes can be conducted only on certain days. The decision is that of the management or senior staff in prioritising the target groups and educators and the days suitable for both the parties.

How?

Depending on the level of activity and the type of education the zoo staff must involve in devising a methodology and an action plan. Daily activities involving education are quite different from the programmes developed for educating target groups, such as species based education programmes. Such species based education programme with very specific goals in mind may have to be carried out over a several years until the goal is achieved.

For effective education, evaluation of the methodology and impact assessment needs to be carried out. As wildlife managers or zoo personnel or conservation activists, our perspective is different. We may assuming too much of a particular audience and need to know if we have pitched the information we are trying to convey at just the right level.

If our methodology or language is found to be impractical or ineffective, it should be changed. After a thorough evaluation we can understand if it needs to simplified, supplemented or completely transformed. No particular methodology will be effective for years together. It may lose its impact through overuse (both for the target audience as well as for the person imparting the message) or conditions and educational methods may change.

A good mix of ideas and methodologies with constant changes and additions can lead to a wider and better target impact.

A species based education programme with a good team of zoo professionals, with a mastar plan for education and with proper identification of all the above points and more can create enough awarenes to mobilise the entire community. Thus species can be saved from extinction by well crafted, cooperative management plans which have good community support. The latter can be achieved only by education, and the zoo may be the best institution to carry it out.

APPENDIX - I

HUSBANDRY AND MANAGEMENT GUIDELINES

HOUSING:

1. Red pandas must be housed in outdoor enclosures. Indoor access to a cooled area should also be provided where the climate is very hot. Where indoor quarters are provided the animals must have access to the outdoor facility at all times (24 hours/day).

2. Enclosures should have a minimum floor area of 500 sq.ft. preferably more. Where a roofed exhibit is used it must be at 12ft. high. Open enclosure must give the animals the possibility to climb to a height of 12 ft.

3. It is recommended that the enclosure is situated in a QUIET area within the zoo.

4. A second barrier to keep the public back from the exhibit should be considered.

5. The ground in the enclosure should be natural soil planted with edible grasses.

6. The enclosure should not be flat; hillocks, ditches, rocks etc should be provided.

7. The enclosure should be provided with a variety of climbing structures with resting perches (eg. trees or climbing frames) at various locations in the enclosure.

8. The enclosure should provide a varied environment, including rocks, trees, pools, logs, clumps of vegetation etc. This provides adequate shade and allows the animals to hide.

9. Some part of the enclosure should be in the shade throughout the day.

10. Public access should be restricted to one or two sides of the enclosure so that the animals can retreat from public disturbance.

11. After giving birth, red panda females become increasingly intolerant of public disturbance. It may be necessary to keep the public away from the enclosure for one month or more after birth.

12. Enclosures should not be located near predators (leopards, tigers etc). A distance of at least 150 ft is recommended between a panda and a carnivore exhibit.

13. Red panda enclosures should not be situated close to busy traffic routes or noisy gathering places.

14. Red panda enclosures should be at least 30 ft. apart. Where this is not possible visual barriers should be placed between adjacent pairs.

15 Zoos holding pandas for the first time should submit plans of their proposed enclosure to the regional coordinator for approval BEFORE they receive the animals.

NEST BOXES

1. A minimum of three nest boxes should be provided which should be situated at different locations within the enclosure.

2. Nest boxes should be well insulated for temperature (half-buried concrete pipes can work well).

3. All nest boxes must be placed in the shade. The interior temperature must not exceed 25°C (80°F).

4. No specific recommendations are available regarding size but it is suggested that a choice of sizes should be available.

ENCLOSURE BARRIERS

1. Red pandas are not only very good climbers and but they can also swim well, enclosure barriers must be constructed with this in mind.

2. Barriers should be AT LEAST 4ft high and the surface should be very smooth or they should be topped with a smooth overhang.

3. Water moats should only be used in combination with other barriers. In the winter, moats should be drained to avoid freezing unless the surrounding barrier meets the criteria outlined above.

4. Do not let the branches of trees overhang the boundary fence.

5. Barriers function not only to keep the pandas in but also to keep unwanted visitors (humans, dogs etc) out. Injury and deaths can arise when zoo visitors, domestic cats or endemic species enter red panda enclosures.

SOCIAL GROUPINGS

1. Red pandas should be maintained in monogamous pairs. Pairs should remain together 24 hours per day throughout the year. The male should remain in the enclosure with the female after birth unless there are obvious signs of aggression.

2 If sufficient males are not available it is possible to keep pandas in trios; one male and two females. However, one female must be separated from the group before the birth season (i.e. by April). Holding facilities for these single females must meet the same criteria as those for breeding pairs, see HOUSING.

3 Young can remain with the parents until the onset of the following birth season. However it is recommended that they are

removed from their parents in the january or February after their birth.

4 If possible keep the young together in a group after separation from their parents. Every effort should be made to locate other similar aged young for this purpose. When young of more than one litter are housed together they should be individually marked.

5 Holding facilities for both young animals must meet the same criteria as those for breeding pairs, see HOUSING.

6 Adult males (males of more than 18 months old) are not to be housed together in the presence of a female.

7 Changes in pairings are to be discussed with the Regional Coordinator.

DIET:

(see also article by Peter Bircher)

1 Red pandas should be provided with a nutritionally balanced diet of a composition such as that shown in table 1.

2. Dietary ingredients should be as fresh and of good quality. Every effort should be taken to avoid spoilage of the food during warm weather and freezing during cold.

3. Red pandas should be fed at least twice per day. Old remaining food should be removed from the exhibit when the new fresh food is presented.

4 Under normal circumstances red pandas should not be provided with gruel/porridge. The exceptions to this are points 9 and 10 below.

5. In order to monitor food uptake and prevent disease it is recommended that food be presented in such a way that it is inaccessible to vermin.

6. Food consumption should be monitored closely and adjustments made in accordance with the number, size, weight and nutritional condition of the animals.

7. Red pandas require more food in the winter months, during pregnancy and lactation and during growth. During these times sufficient food should be offered so that at least 3% of the total is left uneaten.

8 Food should be offered in more than one bowl and at several locations.

9. Red pandas which are off their food can be tempted to eat by a sweetened gruel/porridge. It is important that the sweetener/ gruel is withdrawn from the diet as soon as possible to avoid dental problems.

10. Young pandas around the time of weaning (5-7 months old) are susceptible to death through starvation. It is important to check young pandas regularly at this time. Young animals which are not eating enough should be provided with sweetened gruel/porridge and extra bamboo at this time. They can then be weaned onto the normal diet gradually.

11. Bamboo should be provided daily.

12. Fresh water must be available to all animals at all times of day. Care must be taken so that sufficient water is available and freezing is avoided. Sturdy ceramic bowls are suitable for providing water as they are not easily tipped over.

13. Animals with restricted water intake will also decrease food intake.

HAND-REARING

This is difficult and should be avoided. Where unavoidable detailed information can be obtained from the studbook keeper on request.

MEDICAL CARE

1 Red pandas are highly sensitive to canine distemper. They will contract this disease if inoculated with either live or modified canine distemper vaccine. USE ONLY VACCINES RECOMMENDED NY THE STUDBOOK KEEPER. ONLY A KILLED VACCINE CAN BE USED TO INOCULATE RED PANDAS AGAINST CANINE DISTEMPER

2 Similarly KILLED vaccine products should be administered when vaccinating against rabies and feline enteritis. The necessity for these vaccinations must be determined by the attending veterinarian.

3 Vaccination protocol issued for domestic species would seem adequate for protecting the red panda. However, practical considerations are also of importance, it is best to vaccinate young red pandas when it is least likely to disturb maternal behaviour. This may mean in some cases that vaccination is delayed until at least 16 weeks.

4 Adequate, qualified medical care must be provided by the exhibiting institution. Care is to be provided by qualified veterinarians either on a full time or a consulting basis. The institution's veterinarian is encouraged to contact other holding zoos to discuss medical practices.

5 Zoos should notify the (regional) studbook keeper of significant medical problems. Optional medical procedures should be discussed with the (regional) studbook keeper's veterinary consultants.

6 Adequate, regular parasite checks are to be made by qualified medical technicians.

Table 1. Target Nutrient levels for red pandas

NUTRIENT	RECOMMENDED MINIMUM LEVEL (dry matter basis)
Crude protein (CP)	18.0%
Fat (EE)	5.0%
Fibre (ADF)	10.0%
Calcium (Ca)	0.75%
Phosphorous (P)	0.6%
Sodium (Na)	0.15%
Potassium (K)	0.65%
Magnesium (Mg)	0.1%
Iron (Fe)	100.0 ppm
Copper (Cu)	8.0 ppm
Manganese (Mn)	40.0 ppm
Selenium (Se)	0.18 ppm
Zinc (Zn)	50.0 ppm
Thiamin	2.5 ppm
Riboflavin	5.0 ppm
Vitamin B_6	2.0 ppm
Vitamin B_{12}	30.0 ppb
Niacin	30.0 ppm
Folate	600.0 ppb
Biotin	100.0 ppb
Choline	1250.0 ppm
Pantothenate	15.0 ppm
Vitamin A	8000 IU/kg
Vitamin E	220 IU/kg
Vitamin D	800 IU/kg
Linoleic Acid	1%

7 Thorough physical examination of animals 3 years and older, including weighing and dental check-ups, should be performed on a regular basis, preferably annually.

8. It is recommended that whenever an animal is caught for transport that is anaesthetized, weighed and these examinations undertaken.

9. Qualified personnel must be employed to carry out all sedation procedures.

10. Tiletamine hydrochloride administered in a 1:1 mixture with zolazepam is recommended for sedation. The dosage used 4mg/kg bodyweight (intramuscular). Alternative agents for sedation are ketamine hydrochloride (Vetelar)/ acetylpromazine or ketamine hydrochloride/ xylazine hydrochloride (Rompun) combinations which seem to give good sedation for most veterinary procedures. Dosage (intramuscular) to be used:

7mg/kg Ketamine with 0.2mg/kg acetylpromazine

OR

7mg/kg Ketamine with 4mg/kg xylazine hydrochloride.

11. Red pandas are susceptible to flea infestation especially in warm weather. There have been several instances recorded of red pandas dying from flea infestation. Measures against flea infestation are outlined in the Hygiene section, point 5. Even in cases of severe flea infestation red pandas should NOT be treated with a flea bath as this can result in death.

POST-MORTEM PROVISIONS

1. All animals are to be autopsied by qualified medical staff and a full determination of the cause of death made.

2. The post-mortem should be conducted in accordance with a standardised protocol. (A copy of the recommended protocol is provided by the (regional) studbook keeper on request.

3. Detailed post-mortem reports should be forwarded to the (regional) studbook keeper.

4 Special attention is to be paid to neonatal deaths (contact (regional) studbook keeper for guidelines)

5. Tissues are to be submitted to the Regional studbook keeper for special projects upon request.

HYGIENE

1. Faeces should be removed from the enclosure every day.

2. Animals should be provided with clean (running) water.

3. Left over food should be removed form the enclosure each

time fresh food is presented.

4. Food should be presented in such a way that it is not accessible to vermin.

5. Fleas can be a problem.
- It is therefore advisable that the keepers caring from red pandas are not in contact with common flea carrying species such as cats.
- It is advisable to change red panda bedding regularly. When birth is imminent it is advisable to treat the floors of the nest-boxes with some preparatory anti-flea preparation to avoid this problem.
- NEVER GIVE YOUR RED PANDAS A FLEA BATH

CAPTURE AND TRANSPORT

1. Red pandas can be safely and easily captured using a net.

2. Prior to capture is helpful if the trees are made inaccessible to the animals. This can be achieved by tacking a flexible sheet of metal/plastic, 50 cm wide, around the trunks of the climbing trees.

3. Red pandas should be transported in the IATA recommended wooden crate (50cm x 40cm x 45cm, lxbxh). One of the short sides of the crate should be open (made of cage wire).

4. The crate should contain a layer of wood wool or similar bedding material.

5. In the event of a longer journey sliced fruit should be provided. Red pandas do not need to be sedated during transport.

6. After capture red pandas should ALWAYS be weighed.

7. When animals are transferred to a new exhibit/zoo, the tattoo and/or chip should be checked and the gender of the animals should be checked.

INDIVIDUAL RECOGNITION

1 It is recommended that all animals be provided with transponders.

GENERAL

1 All animals should be weighed on a regular basis. Suggested weights for red pandas of different sizes are presented in the Appendix I.

2. Animals weighing less that 90% of the above weights should be considered underweight and in need of diet enhancement.

3. Pandas are often mis-sexed, especially as infants. It is

strongly recommended, whenever a red panda is transferred to your zoo from outside, or even when it is transferred between exhibits in your own zoo, that its sex is checked.

APPENDIX I

Suggested weights for red pandas of different size are:

Head & body length (cm)	Weight (kg)
45	4.3
50	4.8
55	5.3
60	5.7
65	6.2
70	6.7

Pregnant females should weigh approximately 25% more than indicated above

APPENDIX - II

RED PANDA HAND-REARING PROTOCOL

Ideally, all red panda cubs should be parent-reared. A few precautions can be taken before a birth that may prevent having to pull and hand-rear cubs from a mother with a poor track record. Allowing her access to several different nest boxes of varying sizes and heights will allow her to choose where she is most comfortable and also allows her to move the cubs if she feels threatened or stressed. Creating a temperature controlled environment can also help. High humidity and overheating may possibly cause direct cub mortality. The stress it imposes on the mother may cause her to abandon, neglect or injure her cubs. If it becomes necessary to pull the cubs for hand-rearing, their chance for survival will be greatly increased if allowed to stay with their mother for at least 24 hours. In this period they will hopefully receive colostrum to give them enough passive immunity. Cubs should always be raised with siblings or other cubs of similar age as socialization is very important. Contact the red panda ssp coordinator to locate other cubs if necessary. Once the cubs are pulled, every effort should be made to re-introduced them to their parents. The following is a guideline for hand-rearing and by no means replaces common sense and good judgment in individual circumstances. Adapting this guideline to fit your situation may be necessary.

INITIAL EVALUATION OF CUBS

As soon as the cubs are taken from their mother they should be weighed (average birth weight is approximately 100 grams) and checked for hydration. Body temperature should be monitored every few hours for several days, then once daily as the cubs adjust to the new environment. This should be done rectally, making sure to lubricate the thermometer each time. Normal temperatures are about 98° F. If possible the cubs should be kept in a human infant incubator until they become too active or outgrow it. A warm box will also suffice. The temperature in the incubator or box should be kept between 80° or 82° F, and a heating pad should be placed on one side to raise the temp. to about 90° F on that side. This allows for a temperature gradient and the cubs can move towards or away from the heat as needed.

FEEDING

Initial feeding attempts should be based on the cubs' condition. If the animal is dehydrated and weak, it should be tube fed a sterile solution of 5% dextrose and 0.9% NaCl for the first few feedings. Tube feeding is quick and effective, and can be easily learned from Veterinarian Staff. Use a French stomach tube, size 5 to 10, depending on the size of the cub. Feed about 25% of the cubs total body weight. Continue to tube feed, using formula, for at least 3 days or until the cub becomes stronger. The longer that bottle feeding is delayed, the harder it may become to get the cub to suckle from a nipple.

If a cub is strong and healthy at the initial evaluation, it may be best to begin bottle feeding immediately. Again, use a sterile 5% dextrose and 0.9% NaCl solution for the first feedings in case of aspiration. Pet nursers are great for bottle feeding very small cubs and, as they grow, nipples for premature human infants are ideal. Care must be taken when making holes in the nipple in both cases. In the beginning, use one very small hole in the nipple to avoid too much milk flow and prevent aspiration. As the cub grows, the hole can be enlarged.

Formula preparation and feeding intervals.

Powdered Esbilac™ (Borden, Inc.) for puppies is used in red panda hand-rearing. For the first few days the formula should be very dilute, starting at about 7% Esbilac at birth and increasing concentration to 20% by the time the cub is ready to be weaned. This should be done by adjusting the % of Esbilac at regular intervals. To make 7% Esbilac by weight, for each 100 grams of formula, use 7 grams Esbilac and 93 grams water that has been boiled. To each 100 grams add 1 drop of lactase enzyme (Lactaid™), to aid in digestion of formula. The formula should be predigested with the enzyme for 24 hours in the refrigerator. This solution can be kept and used for up to 24 hours after predigestion. The formula can also be predigested using a faster method of a 90 minute bath in water that is between 90 and 95° F. It can be used immediately following the bath, but can only be kept for 12 hours. Keep this and all formula refrigerated. Remove and warm only the amount you will need at a particular feeding. The amount fed at each feeding is based on 25-30% of the cubs body weight initially, and then the percent is reduced as the cub matures.

Cubs should be weighed daily, but recalculating the amount of formula should take place every third day or so, unless the cub is weak and not gaining weight properly. In such case, the amount of formula should be recalculated more often. It is not unusual for a cub to lose 5-10 grams 2-4 days after first pulling them for hand-rearing, but do not decrease the amount of formula to be fed. A weight chart has been developed for use as a guideline on how the cubs should be gaining weight as they mature(See FIG. 1). Be careful not to over-feed cubs as they can become obese and may have difficulty cleaning themselves and moving around properly.

Cubs should be fed every three hours (8 times daily) for the first several weeks. As they grow and develop, they can be fed less frequently. The following is an example of how feed amounts and intervals may change throughout the hand-rearing process. This schedule is based on several cubs who were healthy and developed normally.

Day 1-4	Fed 7% Esbilac at 30% BW (body weight), 8x daily.
Day 5-8	10% Esbilac at 30% BW, 8x daily.
Day 9-14	12% Esbilac at 30% BW, 7-8x daily.
Day 15-20	15% Esbilac at 25% BW, 7x daily.
Day 21-27	18% Esbilac at 25% BW, 6-7x daily.(Feeding every 4 hours)

Day 28-36 20% Esbilac at 25% BW, 5-6x daily.(Discontinued night feedings at 31 days).
Day 37-58 20% Esbilac at 20% BW, 4-5x daily.(Feedings began at 7 am, then every 3 hours until 5 pm).
Day 59 20% Esbilac at 16% BW, 3x daily. (Began weaning, fed from dish).

. If cubs are weak or become ill, the amount fed by body weight may need to be increased again rather than decreased. **It is extremely important to stimulate each cub to urinate and defecate after each feeding session.** This should be done using a soft cloth or cotton moistened with warm water. Very gently stimulate the cub by rubbing the genital and anal regions. Care must be taken not to over-stimulate as the cubs are susceptible to irritations and sores could develop.

WEANING

Weaning of cubs can begin as early as 2 months of age. Again, this all depends on how they are developing and may need to be delayed for another month. The diet of choice for red pandas is the Marion Zoological leaf eater™ diet. When cubs are just about ready to be weaned, these biscuits can be crushed into a fine powder and added to the formula in the bottle. Add very little as this will get them used to the new taste. The hole in the nipple may need to be enlarged, but be careful of aspiration. The cubs can be encouraged to eat from a shallow dish by first placing a nipple in the dish and allowing them to suckle with their head down. Cubs need to be monitored closely when first taking formula from a dish as they have a tendency to put their whole face in and can easily aspirate. As the cubs become more accustomed to feeding from a dish, the amount of formula can be decreased and the amount of biscuit increased, and the nipple should be removed. Once they are eating mostly biscuit, the formula may be discontinued and water can be used to soften the biscuit until the cubs are used to eating it dry. By about 4 months of age the cubs should be eating dry food on their own. **Be sure that fresh water is always available to the cubs as soon as they are moving around very well on their own.**

VACCINATION AND OTHER CONSIDERATIONS

At 3 months of age the cubs should begin a killed canine distemper vaccination schedule. The vaccine for red pandas can be obtained from the Dept. of Animal Health, National Zoological Park, Washington, DC 20008, (202) 673-4793. The vaccine should be given in a series of three injections initially, at two week intervals, then every three months afterwards. This does not guarantee protection against canine distemper, and more research into red panda vaccines is needed.

Diarrhea can be a problem, especially in younger cubs. A prescribed dose of kaopectate has been helpful. Adding plain rice baby cereal to the formula will also help firm up stools, but can put excess weight on cubs. If diarrhea becomes severe, reduce the % of Esbilac in the formula. Rehydration may be necessary using the 5% dextrose and 0.9% NaCl solution orally or other rehydrating solutions (Pedialyte™).

Constipation is also a concern, especially when cubs are very young. This can be detected if cubs are straining, and have not defecated in a reasonable amount of time (they should defecate several times daily). A warm water enema, using a lubricated small size French tube, can be given as needed. An enema can also help if stools are hard and defecation appears painful for the cub.

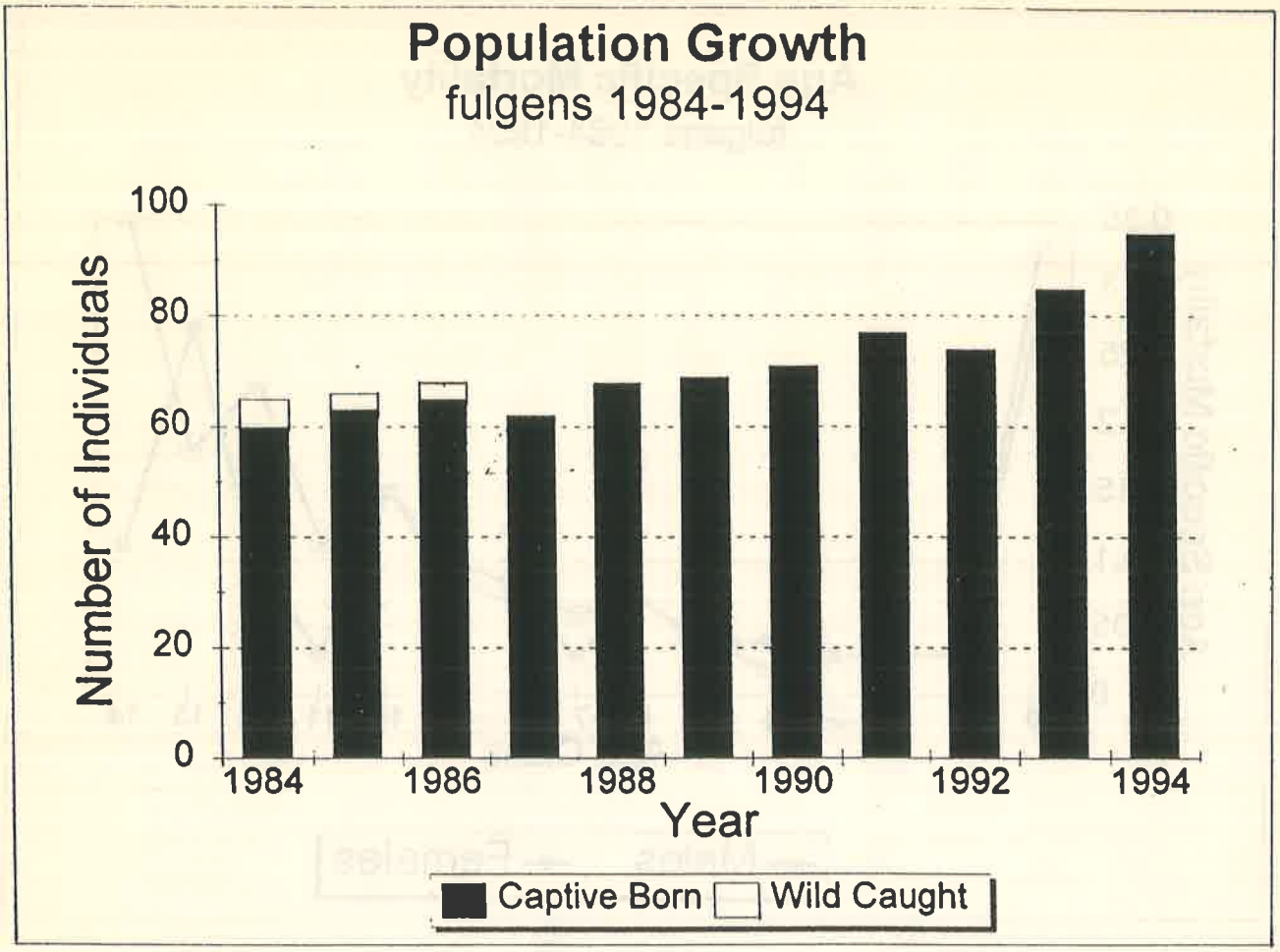
Skin irritations from scent-marking too often, excessive stimulation or injury from others may occur. A&D Ointment™ is helpful as a cure in minor cases and can be used as a preventative. It has been noted that several minor irritations of the skin have developed into open sores that are extremely difficult to heal. This can lead to fungal and bacterial infections, to which red panda cubs are susceptible. Adding extra zinc to their diet at an early age may help prevent such wounds and infections. Products that have been used to a small extent are Dia-Glow™, a powdered supplement that can be added to formula, and Z-BEC™ vitamin tablets. Research into the use of zinc supplement in red panda diets is only beginning, so how much effect it will have is unknown.

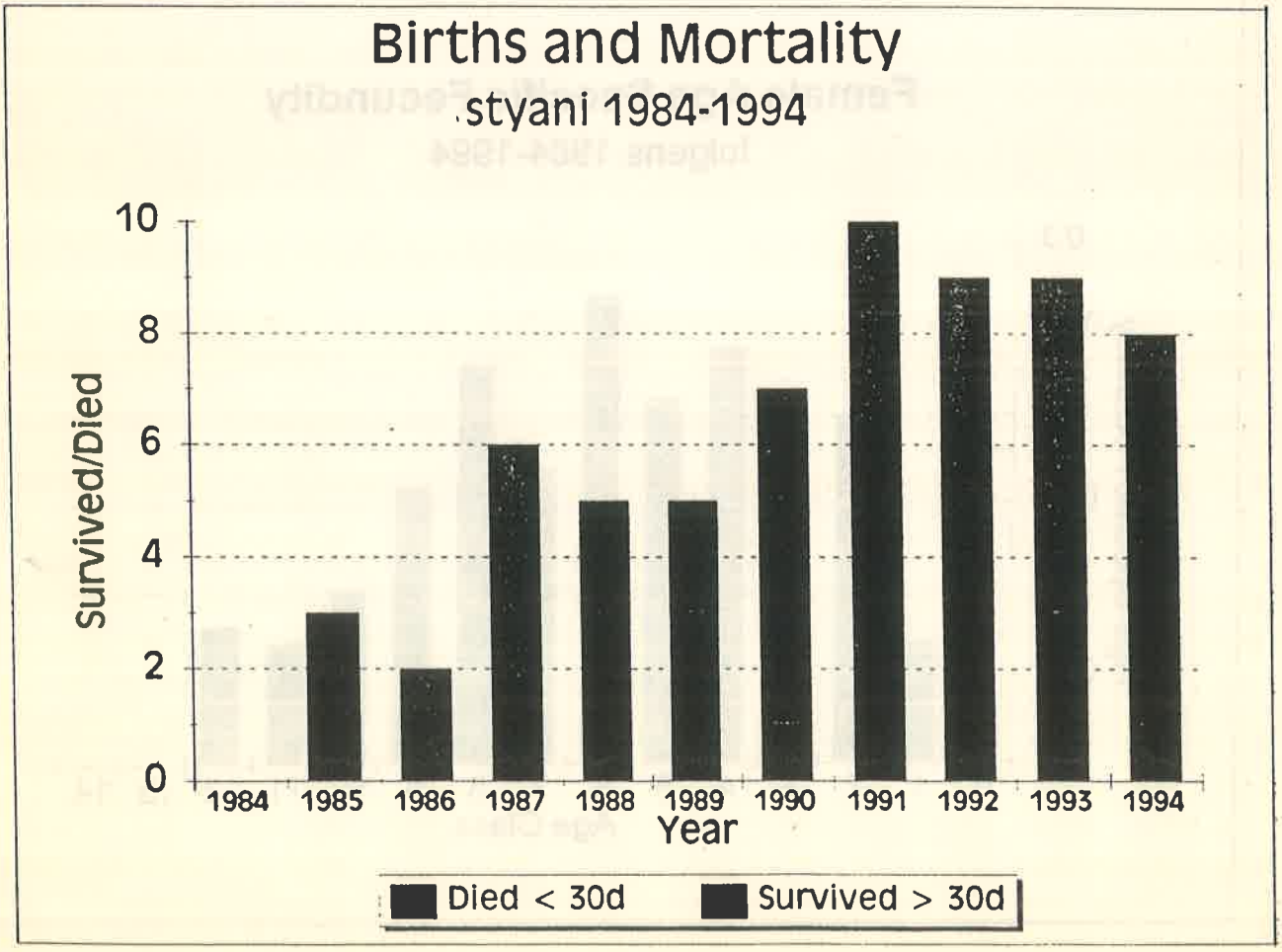
In warm summer temperatures, red panda cubs are especially prone to overheating, as stated before. Allowing them access to a temperature controlled area (air conditioning), using fans, or using sprinklers is recommended. It must also be noted that allowing animals to go from one temperature extreme to another can be dangerous. If they are allowed access from a non-temperature controlled area into one that is controlled, be sure that the difference in temp. between them is not too great.

Any zoo or facility that has to handle a lactating red panda is asked to obtain a sample of milk for analysis, as more research is needed to develop a new milk substitute. If a sample is obtained, please contact_____

FIG.1

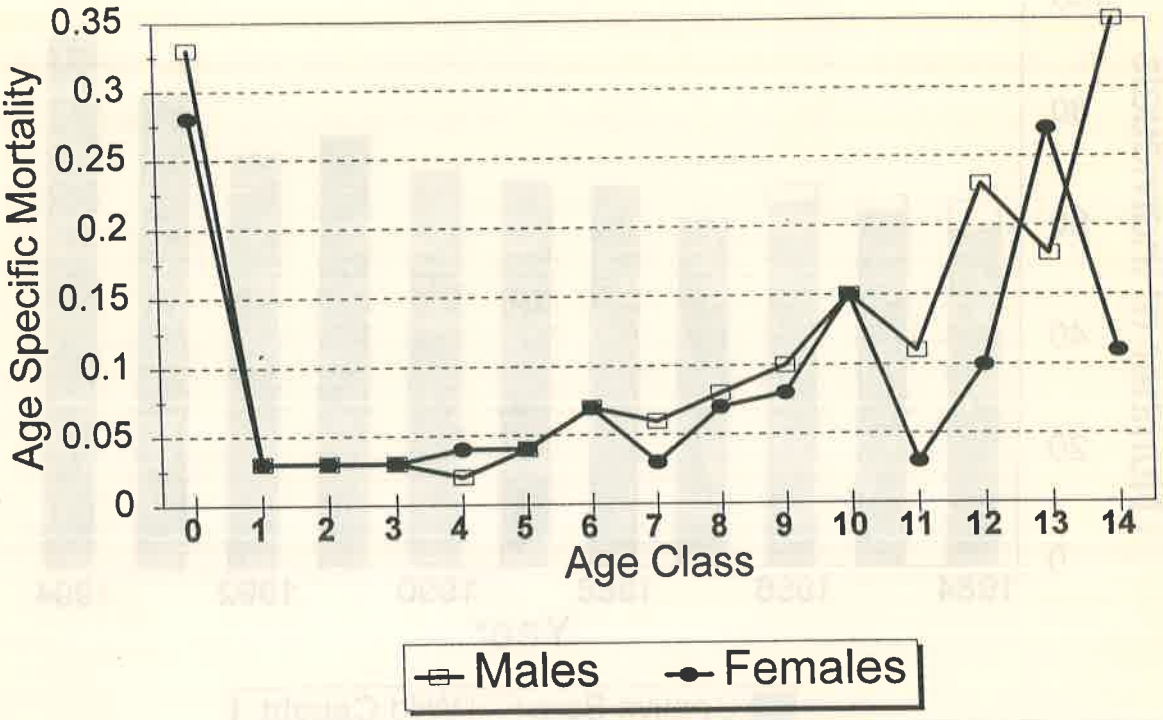
Birth	100 - 110 g	10 weeks	1.0 - 1.7kg
2 weeks	100 - 210g	12 weeks	1.5 - 2.2kg
4 weeks	260 - 450g	16 weeks	2.0 - 3.0kg
6 weeks	460 - 820g	20 weeks	2.5 - 3.8kg
8 weeks	700 - 1000g	24 weeks	3.2 - 5.2kg


Population Growth
fulgens 1984-1994
Number of Individuals
100
80
60
40
20
0
1984
1986
1988
1990
1992
1994
Year
Captive Born
Wild Caught


Births and Mortality
.styani 1984-1994
Survived/Died
10
8
6
4
2
0
1984
1985
1986
1987
1988
1989
1990
1991
1992
1993
1994
Year
Died < 30d
Survived > 30d

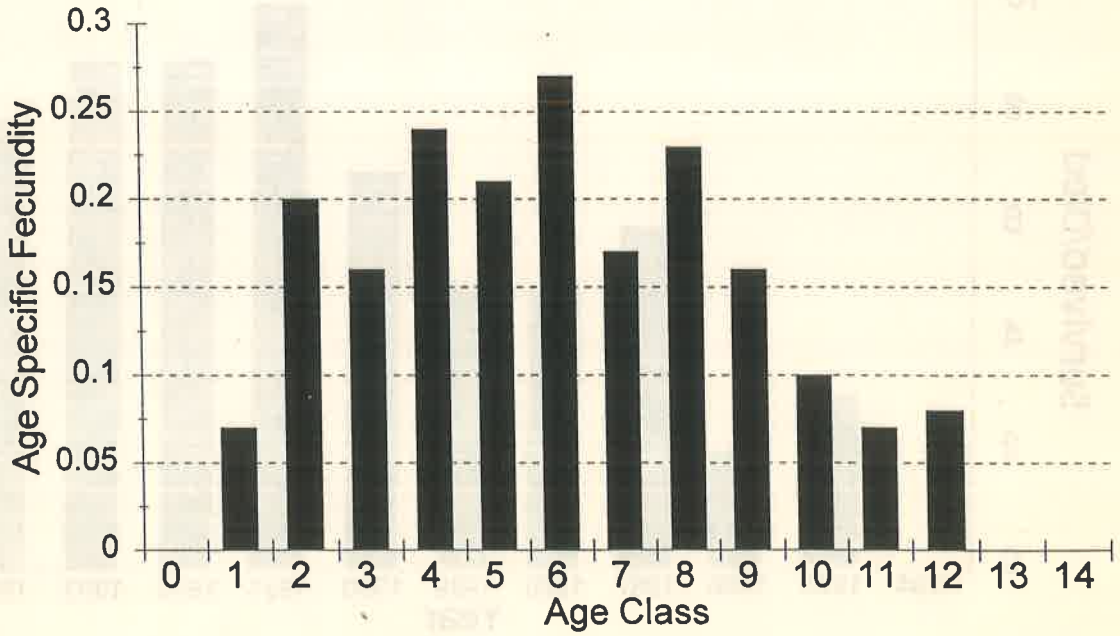
Age Specific Mortality

fulgens 1984-1994



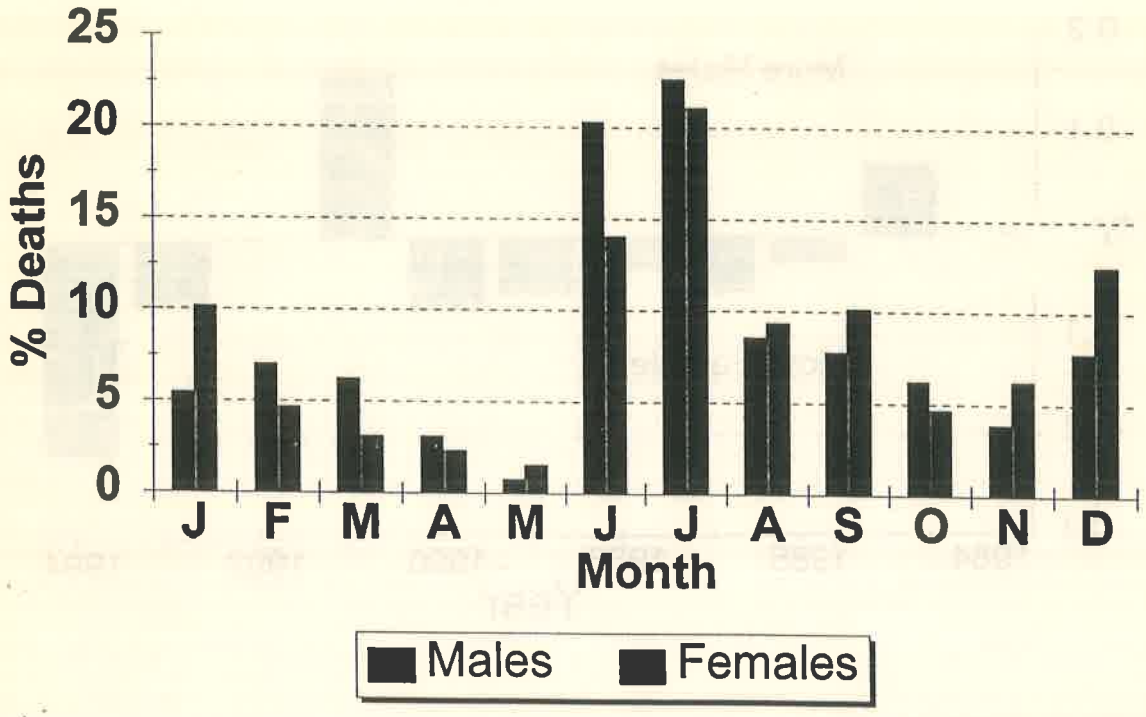
Female Age Specific Fecundity

fulgens 1984-1994

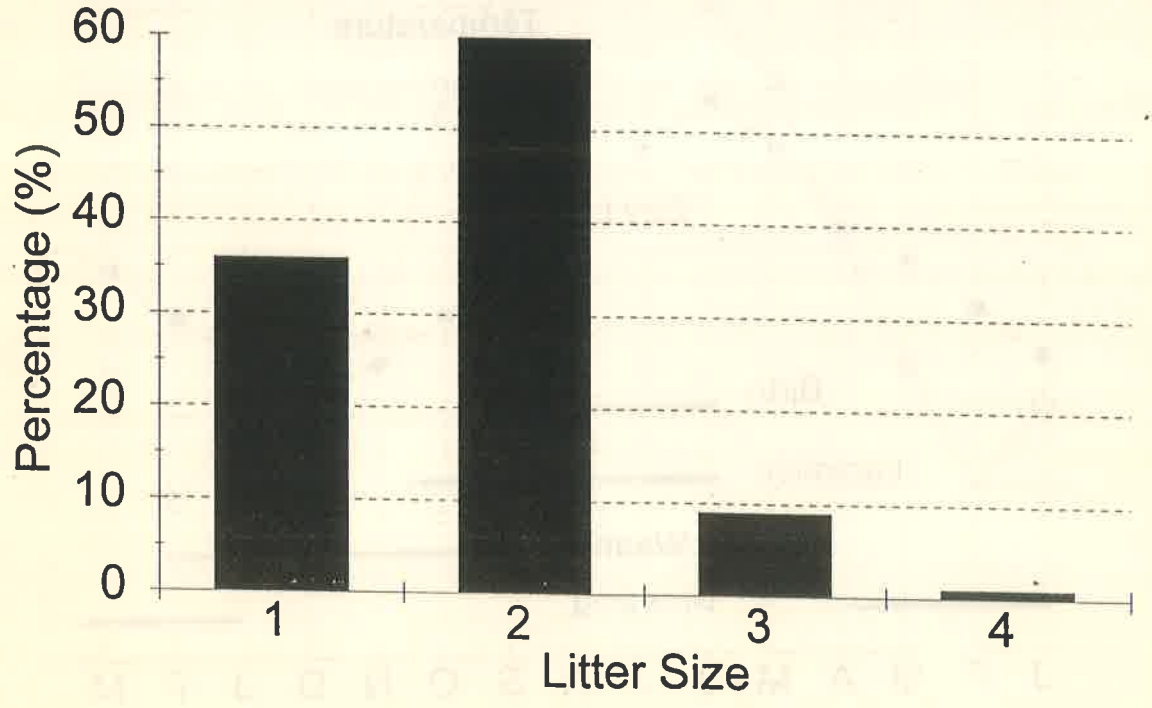


Annual Distribution of Deaths

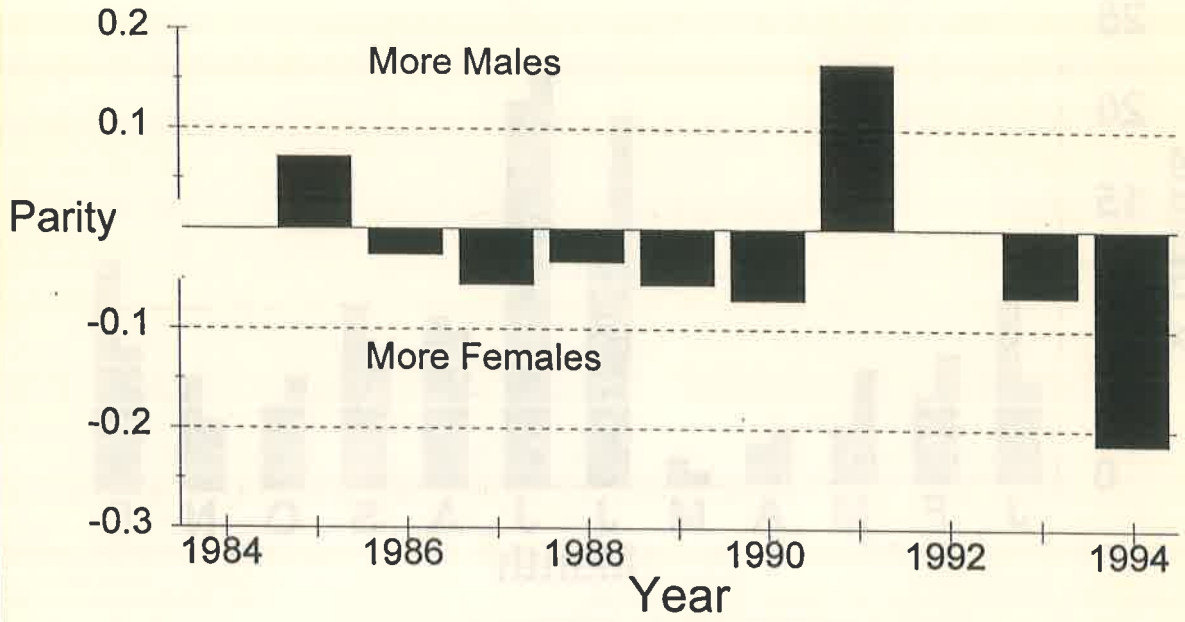
Both Subspecies by Sex



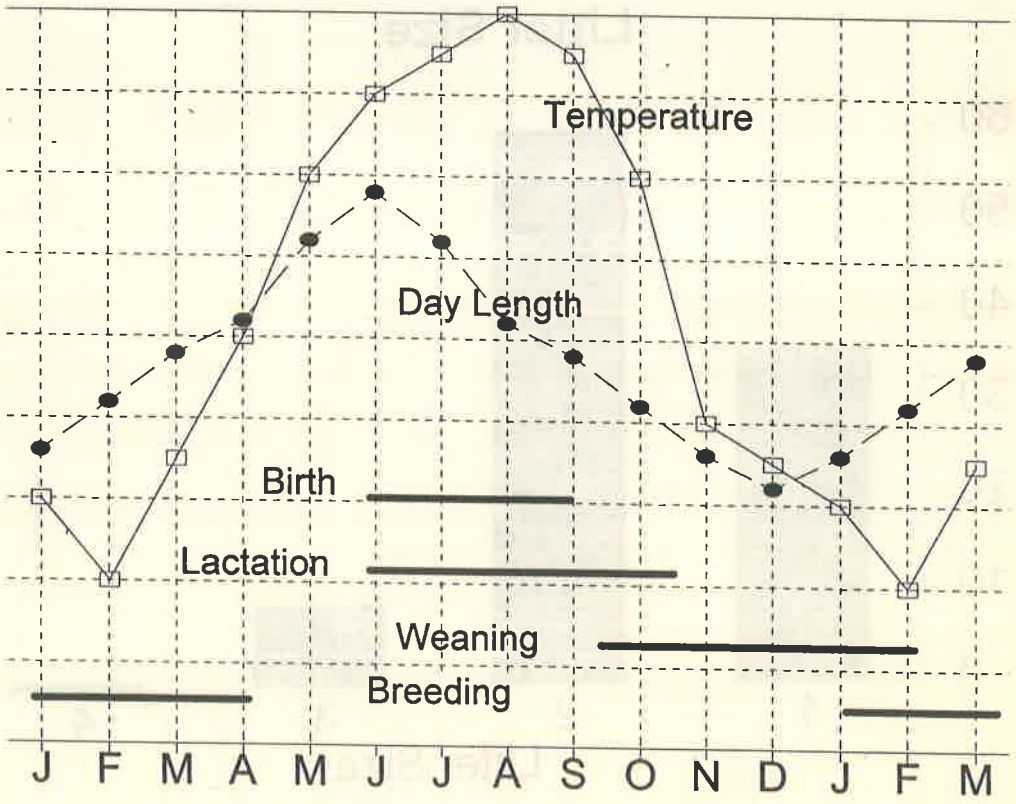
Litter Size



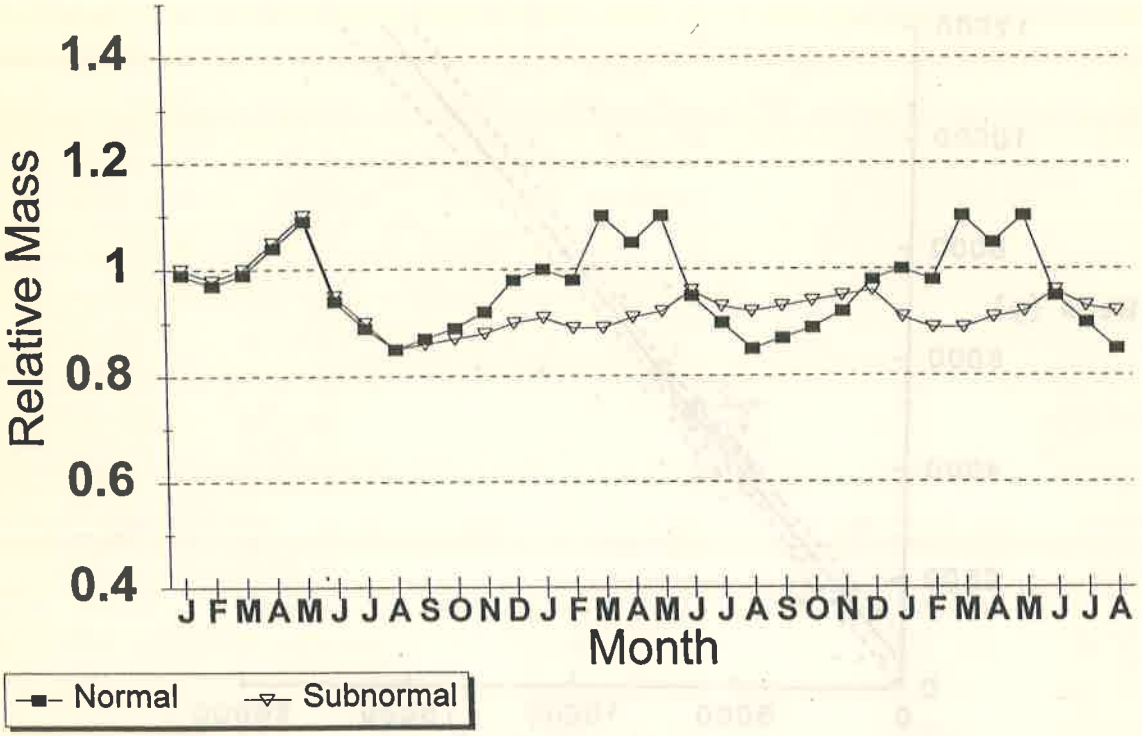
Annual Birth Sex Ratio
1984-1994

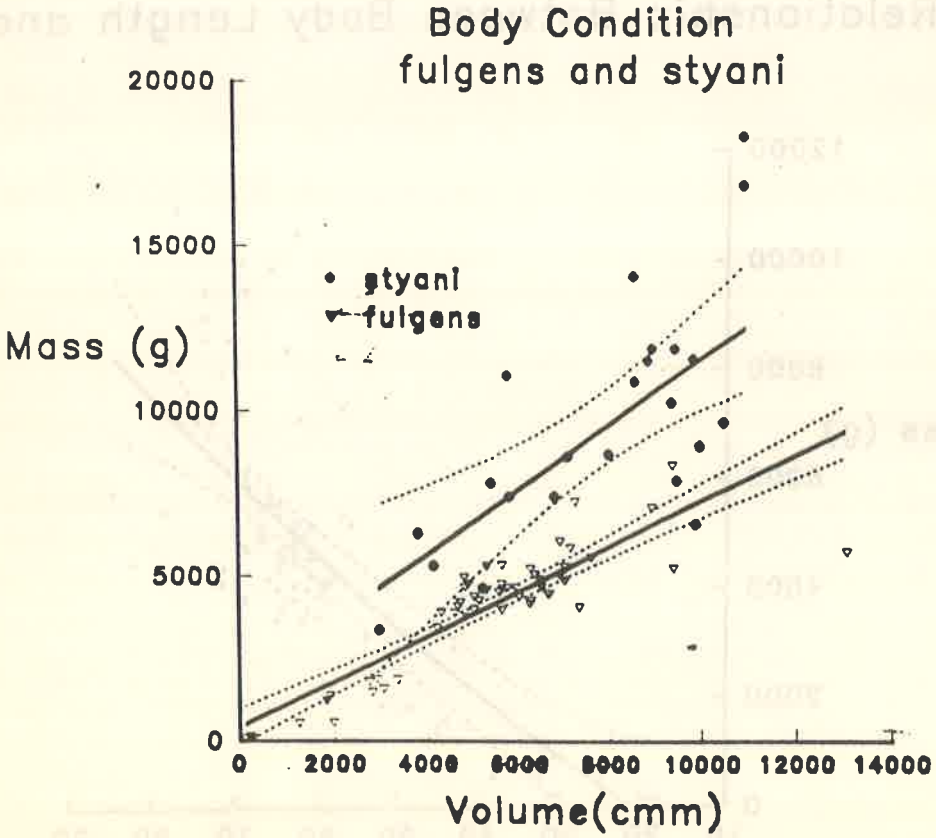


Annual Reproductive Cycle



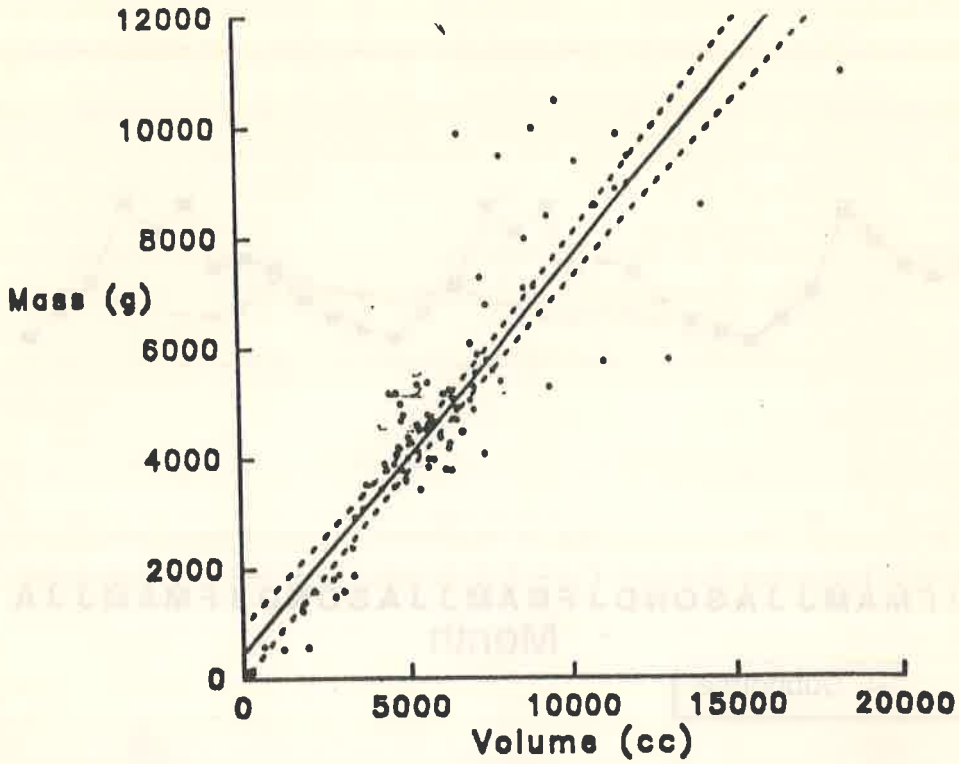
Annual Changes in Relative Mass



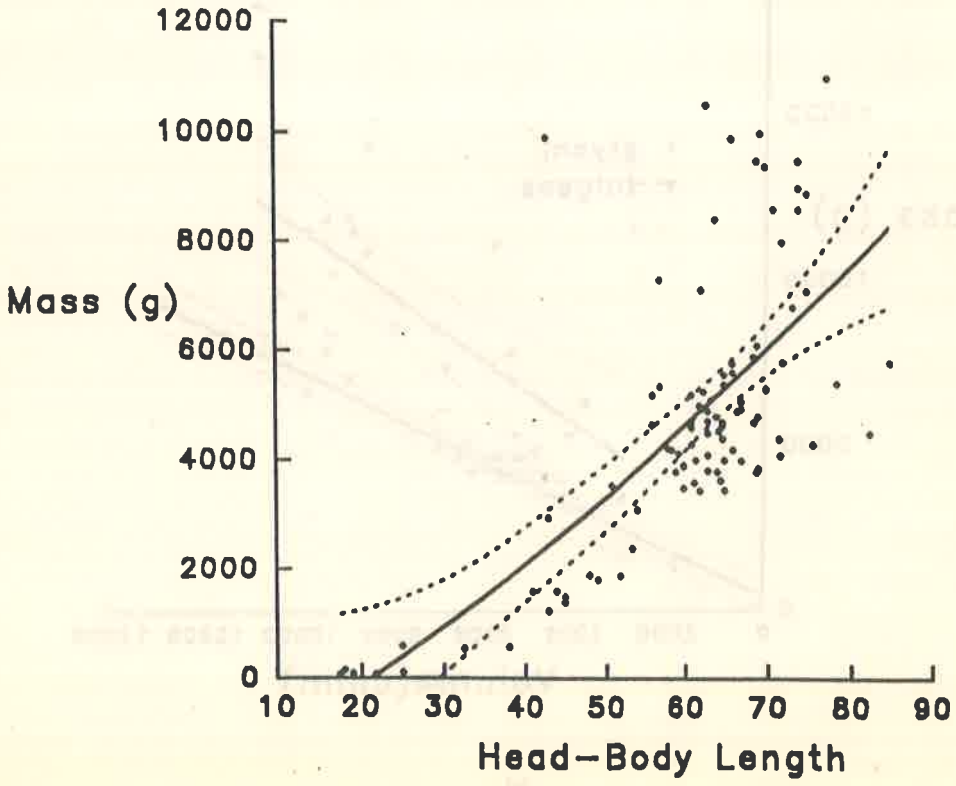


Red Panda Body Condition

Relationship Between Body Volume and Mass



Relationship Between Body Length and Mass



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23 - 26th APRIL 1995

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