The care, breeding and diseases of snow leopards in Qinghai, China

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According to statistics in the annual journal of world zoos, before 1967 there were 46 snow leopards (not including China) in 33 zoos around the world, among them 15 were born in captivity. There were 35 snow leopards in Chinese zoos in 1983. Although seven zoos (Beijing, Shanghai, Dalian, Yinchuan, Yiantai, Urumqi, Xining) were attempting to breed snow leopards, reproduction problems had not been solved. In May 1983, Xining Zoo began to breed snow leopards by creating circumstances similar to natural ones. By the combined efforts of our zoo staff, with strong support from various government branches, the No. 1 female snow leopard at Xining Zoo gave birth to a litter of 3 cubs on 13 July 1984, thus establishing the first record of snow leopard reproduction in captivity in China. On 5 June 1985 the No. 3 female snow leopard gave birth to a litter of 2 cubs. These two achievements under my direction led to my receiving the 3rd prize of the 1987 National Science and Technology Progressive Award. I need not repeat information from my two papers on snow leopard already published in Acta Theriological Sinica. The following is an account of our knowledge based on care and reproduction information from snow leopards at Xining Zoo.

CARE AND MANAGEMENT

Xining city has a continental climate in the temperate zone at 2275 m elevation. The average annual temperature is 5.5^{o}C, with the highest temperatures occurring in July when the average is 17.2^{o}C. The weather in summer is cool and comfortable. During a long winter the lowest temperature has reached 26.6^{o}C. Precipitation is 371.7 mm (19541970) and July to September is the rainy season, especially during nights. Annual sunshine duration is 26002800 hrs, more than 700 hrs greater that other cities of the same latitude. The annual radiation is 139177 kcal/cm^{2}. With strong ultraviolet radiation, the temperature during day and night is quite different (1220^{o}C). Such an alpine climate condition is quite similar to the field habitat of snow leopard.

From its start in 1956 when the Beijing Zoo began to keep snow leopards, Chinese Zoological gardens have continued this tradition for over 35 years. But there are still many problems confronting the rearing of snow leopards in China, and to date only one zoo (Xining Zoo) has successfully bred snow leopards, with 5 young in 1984 and only one in 1985.

On the basis of many years field investigation and zoo experience I think the following points should be emphasized with regard to creating a habitat similar to the natural one for snow leopards in captivity:

Increase Sunlight and Artificial Illumination -- As an alpine animal, snow leopards experience high levels of ultraviolet rays in the wild. As a timid animal in the zoo, it hides in its cage during daytime and comes out only at night. This 1ack of illumination has a negative effect on development of the sexual glands. Because many animals have estrus in spring as daylength increases, people have used added light in laboratory conditions to bring animals into estrus at any time of the year (Kurl 1964). A certain amount of light can increase stimulation of the hypothalamus and affect the pituitary, impelling an increase in sex hormone secretion, with subsequent estrus and mating behavior. Snow leopards in the field can get longer sunshine than in the cage. If the captive snow leopard does not come into estrus, one important reason may be a lack of sunlight. Therefore, artificial infrared and ultraviolet light for a certain time each day could be effective. To start, each day 3 minutes of infrared ray ultraviolet ray is given, with an increase of 1 minute every three days for 45 days (a 15 min. increase), then supplemental light is stopped for 5 days. After that, the cycle is begun again, repeatedly all year long to spur the snow leopard into estrus.

Cage Characteristics -- In the field snow leopards have large spaces for movement. To enlarge the captive snow leopard's activity area we built a small playground outside the cage, connecting the cage and playground with a door. With a cage size of 3 x 2.7 x 3.2 m, facing south and sheltered from the wind, the playground added an area of 3.3 x 3.8 x 2.85 m which was protected around the top with reinforcing bar. Besides cleaning the cage and playground, we used 15 minutes each day to sterilize the area with ultraviolet light. The snow leopard is uncomfortable in heat and once the temperature reaches 25^{o}C it breathes very fast. Under such conditions, the shelter door is always open to expand the play area. Snow

leopards are very active in the wild, often moving nearly the entire night. Zoos are concerned with ways to increase daily exercise in the limited space of captivity in connection with consumption of excess energy and control of bodyweight. For this reason we keep the door separating inner and outer cages open all day, and we set up raised platforms in both cages. A perch outside the cage was also set up for the snow leopard's jumping and grinding. The size of the perch is 250 x 50 x 5 cm, and is 2 m above the ground. Observations indicated that the snow leopard was very active at night, jumping and climbing vertically on the perch. But during daytime, it lay on the perch most of the time. During the middle of summer, the snow leopard lay on its back on the cement ground, especially in breezy places.

Healthy Weight -- The snow leopard's natural prey, blue sheep, has a fat content of about 13.7%, whereas in the captive snow leopard's food, beef and mutton, the fat content is 20.7% and 34.6%, respectively. This caused wild snow leopards to become fat in the zoo after 4 months. Too much fat could affect a female snow leopard's ovary function and sexual cyclicity. Therefore, we increased its stereoscopic activity (perch) to control its appetite for food. For the adult snow leopard, daily diet is 2 kg beef or mutton, 1/2 lb milk, 2 raw eggs and 5 drops of concentrated codliver oil, with a fast of one day per week. Wild snow leopards can take living prey, including the important nutrients contained in heart, liver, lung and blood. But captive snow leopard receive mostly frozen beef and mutton. Beginning in October 1983 we drove living sheep and goats to the snow leopard's cage and let it kill these animals, and three times a week it was provided with living chicken, rabbit and fresh liver, blood of domestic animals. We have seen plant fibers in the excrement of wild snow leopards, mostly grass stems and the bark of Tibetan sabina (juniper). The captive snow leopard likes to take grass and branches and leaves of willow and poplar after it is full, necessary because of its sticky and thick excrement. The newly captive snow leopard should be given an anthelmintic, and the proper time would be spring and autumn.

Since snow leopards in captivity have limited selection and variation in food, it should be supplemented with different kinds of minerals and vitamins. Some grasses and willow twigs should also be made available. Snow leopards molt once in the summer, with date of onset depending on the nourishment of the animal, the better nourishment the earlier the molting. The molt starts from its forelimbs and chest, to be followed with the base of tail, head, outer parts of hind limbs, outer and under parts of abdomen and lastly the back. It is generally completed before the end of July, but may be later with undernourished animals.

REPRODUCTION

Courting -- On the basis of 17 years of observation at Xining Zoo, sexual maturation of snow leopard females is at about 3 years and males at about 3.5-4 years. Both male and female reproductive behavior started in spring, the earliest seen was on January 25 1979, the latest on July 3, 1984. Estrus lasts 57 days and occurs 4 times a year. The female appears excited, meowing and crying during nighttime and early morning, clawing the bars and rubbing the neighboring male, rolling on the ground, and showing a poor appetite. During the climax of estrus, she completely refuses to take any food, constantly raising her tail, exhibiting frequent urination and slightly swollen genitals, and constantly vocalized a "tututu" sound. Stimulated by the female's sex hormones (urine) and the seduction of vocalization, the male snow leopard next door went to the female at the partition bar, raised its tail and urinated on the bar. Its appetite did not change as much as the female. At this time, we keep the male and female in one cage.

Failure to Achieve Pregnancy -- In 1984 and 1985 all 5 females at the Xining Zoo were in heat and mated regularly, but each year only one became pregnant. This rate of 80% nonpregnancy increased in 1986, 1987 and 1988 to 100%, which was very abnormal indeed. Studies indicate that wild snow leopards are not guaranteed food every day; once they do catch a prey, however, they eat to the full. According to our records of 12 adults (7 males, 5 females), newly-caught females weighed <26 kg and males <32 kg. Nourishment of females was usually worse than males, as indicated by their coarse fur and hungry appearance. Whenever given food, snow leopards would immediately consume it all regardless of whether people were watching or not. During the first 60-180 days of captive life body weight rose rapidly, with average weight gains of 5-8 kg for females and 7-11.5 kg for males. Wild snow leopards living in zoological gardens have abundant food and no need for capturing it, thus reducing their amount of exercise.

The variety and quality of food, including beef (20.7% fat) or mutton (34.6% fat), leads to their easily growing fat, which is the main cause for barrenness, non-pregnancy and abnormal estrus. Therefore, snow leopard keepers must pay more attention to feeding standards and keep the animal's body weight under control.

Mating -- During 5-7 April 1984, the No. 1 female snow leopard began estrus, so we placed it with the No. 5 male in one cage. The female came near the male and went around it, rubbing it with her heat and body. They both vocalized. Then the female lay prostrate with tail raised and front legs lifted up, the male mounted the female from her side and behind, biting her neck during mating and giving a peculiar vocalization. The mating lasted about 315 seconds. The female was very excited, rolling about on the ground. After a short rest they continued to mate. They mated more often if there was no human disturbance. Observations of the No. 3 female and No. 6 male on March 2631, 1984 show that they mated an average of 5.2 (38) times per hour. The shortest time and the longest times between matings was 1.13 min and 43 min, respectively. The most frequent mating occurred on the second day of estrus, then decreased. Generally, mating occurred between 1700 hr and 0700 hr.

Pregnancy -- Within one month of becoming pregnant the female snow leopard is separated from the male. At this time the female has a large appetite (about 30%). Observations of two female snow leopards, during 50 to 60 days of their pregnancies, showed that they did not like taking beef or live chicken as they did before. After 65 days their appetite became normal and their bellies began to protrude by 70 days. When the nipples became apparent they jumped slowly to the perch, were lazy in movement and showed fear of people. After 76 days the belly was big, it hung down by 79 days and she moved more slowly, showing greybrown nipples. At 85 days she began to lick her breast and the fur around it. The mammary areola appeared, the nipples were pink, and the cleft became long. A bit droopy, her genitals twitched frequently. From 91 to 96 days the droopy genitals were obvious and she lay on the playground in the sun all day long without jumping up to the perch or showing fear of people. At 97 days her appetite decreased, she was in low spirits with semiopen eyes, a transparent liquid began to appear from her vagina, and she constantly licked her breast genitals. At 98 days a pink liquid flowed from her vagina, she was restless, refusing to take any food, and during that night she gave birth. The pregnancy period was 99 days.

Birthing -- A delivery box is necessary for the successful breeding of snow leopards. The darkness inside the box provides a sense of security for the pregnant female. It is used both for delivery and nursing. To avoid interference and allow the birthing to proceed quickly and successfully we set up a box inside the cage (Figure 1), 1.3 m long, 1 m high and 35 x 40 cm at the opening. The box was made of high quality wood, 2.5 cm in thickness. There were two lines and de-watering holes at the bottom of the box. Because the female gave birth in the box it was difficult to observe the process in detail; we could only listen carefully and take notes. Based on the first sounds of young, the first was born at 2300 on July 13, 1984. At the same time we heard the mother eating the afterbirth, biting off the umbilical cord and licking her baby dry. After 40 minutes she gave birth to the second young. Then, at 1435 on July 14, she gave birth to the third young. The whole birth encompassed 3 hours.

FIGURE 1. Female and young in the birthing box.

Breeding -- For the first 3 days after birthing the mother snow leopard stayed in the box all the times to take care of her babies. On the fourth day she went out for water and took food on the fifth day. After 15 days, except to take food, the mother never left her babies, even excreting and urinating in the box. From the 16th day she went out to excrete and left her babies for a prolonged the time in the box. After 20 days, except nursing, the mother rested outside the cage and lay on the perch, going back to the box in the evening. After one month the mother did not go back to the box at night, lying on the perch just with her head close to the box window and fixing her babies. At the sound of a voice or someone opening the box she jumped into the cage to protect her babies. After 73 days the mother's breast became smaller, with fur growing around it. She rested during daytime and stayed with her babies at night. After 90 days she was separated from her babies, which were reared in the next cage where mother and babies could see each other. The mother always lay on the perch staring at her babies and took less food during the first few days after separation.

THE GROWTH AND DEVELOPMENT OF YOUNG SNOW LEOPARDS

The new-born snow leopard has tightly closed eyes and has fur color quite similar to that of the adult. Its nursing frequency and duration decreased with time. At 20 days post-birth the mother breast-fed 8.8 (715) times during day and night, each taking 13-15 min. At 40 days the babies were nursed 4-6 times, 15-25 minutes each time. No. 1, No. 2 and No. 3 baby snow leopards began to take meat at 50, 56 and 66 days, respectively, and they were weaned at 63, 67 and 73 days, respectively. At about 40 days the babies kept close to each other in long periods of sleep, their limbs and bodies physically twitched in deep sleep. After 43 days the babies began to come out from the box and moved around in the cage, and after 46 days they went out on the playground to move about in the sun, going back to the box at night. We sliced a sheep leg with many cuts, so that when the No. 1 baby started to take meat at 50 days it bit the meat with its molar, pushing down the sheep leg strongly with its front limbs and tearing off the meet to eat.

Observations made on 8 cubs (including two zoo-born) confirmed that the replacement of teeth occurs when they are 10-11 months old, beginning with lower canines and then upper canines. New teeth all erupted within 20 days. Photographs show that one cub had a new canine tooth erupted before the old one dropped off.

To characterize organ growth and physical changes in the young snow leopards during the first three months after birth, we made careful observations as follows:

Visual Development -- The babies' opened their eyes at 8-9 days, however, their cornea were opaque so they bumped against things when they crawled. At 23 days their cornea separated with conjunctiva and they could see moving objects within 1 m. At 40 days they could see things within 5 m, and at 90 days they had the same sight ability as the adult.

Hearing Development -- There was a sense of hearing before they opened their eyes. When they heard the door open they climbed into the box immediately. After 20 days they could distinguish the walk of their mother and the keeper. When the keeper came near they lay in the box without moving, but when their mother came near they moved at once.

Smell Development -- It was inconvenient to examine the babies' sense of smell before 50 days. After they started to take meat we went into the cage many times and found them sleeping in the box without any reaction. When the keeper put meat quietly in the box the babies soon awoke and came to eat. So, we could say that their smell sensitivity was very high at about 2 months.

Movement Ability -- When the new-born snow leopards crawled, their bellies kept close to the floor of the box. At 10 days they crawled faster using the strength of all four limbs. At 15 days, when they crawled their back legs were in the shape of "C". At 30 days the No. 1 baby, still with a big belly, did not keep close to the box as it crawled. At 50 days the No. 1 and No. 2 babies could climb out on the shelf boards of the box at a 10 cm height, and their front legs could grasp food. At 75 days they could jump up to a height of 25 cm. After 90 days they could climb up a 40 cm high flight of steps in the playground.

From three months of age we weighed and measured the babies once a month for a three-months period (Table 1). Before this time they stayed with their mother and it was difficult to test their appetite. After three months, the babies were separated from their mother and food intake increased from about 700 g at 90 days, and about 900 g at 150 days, to 1,650 g at 180 days.

TABLE 1. Body measurements (cm) and weight (g) related to age for captive-reared snow leopard cubs.

Age (days)	Body weight	Body length	Tail length	Chest girth
90	64	90	41	40
120	73	108	45	48
150	109	120	55	51
180	170	133	59	58

DISEASES OF THE SNOW LEOPARD

As a typical alpine animal, the snow leopard lives all year round in high mountains with cold temperatures, clear thin air and intense solar radiation with strong ultraviolet components, all promoting limited bacterial growth. When transferred to cities where the summer is long, human population is high, air is dense and polluted, and bacteria easily multiply, it is not difficult for snow leopard to become ill. The following ailments are common to snow leopard in Chinese zoos:

Injuries to Feet and Toes -- Few adult and subadult snow leopards collected by our zoo were completely intact. Most had injuries to their limbs. Some had broken bones, others had severe bacterial infections. Most recovered, however, after they were treated with surgery and/or antibiotics for about a week. In 11 operations performed our recovery rate was 100%.

Parasitism -- Roundworms are common in both adults and newly captured cubs or cubs living with Tibetan families for some days. Examination of 14 adults showed 85.7% infected with roundworms and a few with tapeworms. In the winter of 1978 we obtained a 4 month-old snow leopard cub from a Tibetan herdsman living at Yushu. On the way to Xining the animal died of pneumonia; during its autopsy we discovered the small intestine to be completely stuffed with roundworms, which is also a possible cause of death for snow leopard cubs. Ectoparasites are rare with snow leopards.

Respiratory Diseases -- Acute pneumonia caused by colonbacilius and pneumonian diplococcus is a frequent disease in snow leopard. Although a cold-resistent animal of high mountains, long-distance transportation without heating can weaken its resistance to disease. Subadults in captivity also easily fell ill with respiratory diseases during the changing seasons of winter and spring. Symptoms of sick animals include listlessness, poor appetite, thirst, thick liquid secretion in the nostrils, puss in excrement and phlegm three days after capture, protrusion of eyelids and rapid, difficult breathing. Timely treatment with intravenous infusion and injection of large doses of antibiotics may cure the sick animal in a short time, otherwise it will probably die of suffocation within 5 days. There were also exceptional cases of chronic disease which may last more than 3 weeks.

Virulent Enteritis -- This is a strongly infectious disease of great menace to snow leopards under one year old that have not received immunity inoculations. There are two levels of this disease, acute and extra acute. No characteristic symptoms could be detected for the extra acute type. The sick animal, having finished eating its meal the previous evening, might vomit and then die in the morning. The vomit includes undigested meat and stomach mucus, but there is no diarrhea. No obvious changes were observed in any internal organs upon autopsy. Symptoms for the acute type include violent vomiting of undigested meat with white foam, greenish or pinkish mucus, diarrhea with blackish and then pinkish excrement, body temperature reaching 41-42^{o}C, listlessness with dehydration, skin losing elasticity, moaning and no resistance to handling. Treatment included infusion with fluid, repeated injection with antivirus medicine, clyster to wash out poisonous matter from intestines, and intramuscular injection of hemostatic to prevent massive intestinal hemorrhage. In 1974 we saved the life of two sick animals through continued emergency treatment over 18 days and nights.

Bacterial Enteritis -- This disease most often occurs in summer caused by filthy conditions on food, feeding apparatus or caging area. The main symptoms are diarrhea with blackish undigested matter, to be followed by watery diarrhea with mucus or blood. Should be treated with antiphlogistic medicine.

Skin Maggots -- An adult male snow leopard kept by the Xining Zoo in the summer of 1971 was so timid it always hid itself in a dark corner of its room. In order to clean the room our keeper had to drive it out with a hose so that its fur remained wet all day. Flies multiplied quickly in its fur and when we discovered its room full of flies and a bad smell we found the animal lying motionless, holding its head with two paws. When we later caught and examined the animal we found that 60% of the skin on its back had already fallen off, with countless maggots swarming under it. We tried to save its life but in vain.

Food Poisoning -- In January, 1980 our food purchaser bought a shipment of mutton for the spring festival. This polluted meat was fed to our animal without examination. As a result, all our carnivores including 7 snow leopards and 5 lynxes were poisoned. Three snow leopards and two lynxes died of botulism-toxin.

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