STUDY OF SNOW LEOPARD

(Uncia uncia)

AT PADMAJA NAIDU HIMALAYAN ZOOLOGICAL PARK , DARJEELING.

By Miss Shradhanjali Rai

सत्यमेव जयते

Project Report on

"Study of Snow leopard (*Uncia uncia*)
at
Padmaja Naidu Himalayan Zoological Park, Darjeeling"

By
Under Guidance of
Mr. A.K. Jha, IFS

Period - 22/03/2011 - 30/09/2013

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THE PROJECT IN BRIEF

1. Name of the Project: “Study of Snow leopard (*Uncia uncia*) at Padmaja Naidu Himalayan Zoological Park, Darjeeling”
2. Name of the Zoo/Organization: Padmaja Naidu Himalayan Zoological Park.
3. Project Letter: Sri.A.K.Jha IFS, Director, Padmaja Naidu Himalayan Zoological Park, Darjeeling.
4. Duration of the Project: From 22.03.2011-30.09.2013
5. Location of the Project: Padmaja Naidu Himalayan Zoological Park, Darjeeling.
6. Region/State: West Bengal.
7. Closest main city: Darjeeling.
8. Principal Investigator : Mr.A.K.Jha, IFS.
9. Research Associate : Miss Shradhanjali Rai.
10. Period to be spent on the Project from : For 48 hours /week for two and half years (Day/Momth/Year)
11. Total cost of the Project :Rs.8,40,000

12. Signature

Padmaja Naidu Himalayan Zoological Park, Darjeeling.

Signature:	Signature:	Signature
Date	Date	Date
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ACKNOWLEDGEMENT

The Project entitled " Study of Snow Leopard at Padmaja Naidu Himalayan Zoological Park, Darjeeling" under short term research grant by CZA was conducted by Miss Shradhanjali Rai, under the guidance of the undersigned from 22/11/2011 to 30/09/2013 which included further extension vide Memo No. 24-8/2007-CZA (Vol.I)(A)/3738 dated 08/10/2013. The work on captive population has been a new dimension and successful. The project report shall depend on contributions from many.

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Director,
Padmaja Naidu Himalayan Zoological Park,
Darjeeling, West Bengal.

1. INTRODUCTION

The Snow leopard (*Uncia uncia*, formerly Panthera uncia) inhabits the high, remote mountains of Central Asia, and has been listed in the Red Data Book as an endangered species throughout its range since 1972 (Goodwin and Holloway 1972). The Snow leopard meets criteria for endangered status under newly proposed criteria (IUCN 1994). The Snow leopard is primarily an inhabitant of the alpine and subalpine zone, from elevations of 900 m to 5,500 m or more, but usually between 3,000 and 4,500 m (except in the northern range limits where snow leopards occur between 900 and 2,500 m) (Heptner and Sludskii 1992; Schaller et al. 1994). In Pakistan, Russia and parts of India they are reported to migrate to lower elevations during winter, following prey (Roberts 1977; Dang 1967).The Snow leopard is one of the rarest and most interesting large carnivores on Earth. Inhabiting remote high mountains of Central Asia, including the Himalaya, these heavy-tailed cats are slate-gray in hue with a stunning mosaic of dark rosettes over their body. Muscular but with delicate features, these shy animals are endangered due to habitat loss, poaching and conflict with livestock herders. This beautiful and shy species is a striking symbol of the world's highest places and good indicator of the mountainous ecosystems (Shrestha 1997, Shrestha 2003, Jackson 1996). It is considered and ranked as a top-level species of the food chain in the Himalayan range. Because of its rarity and extremely harsh and often impassable terrain where it is found, little is known of its behavior in the wild state (Yaksha 1999).

If the Lion is the 'King of the Beasts' and the Tiger the 'King of the Jungle', the Snow leopard is surely 'Queen of the high mountains of Asia'. Queen? Somehow that title seems more appropriate than 'King' when applied to the Snow Leopard. The Lion and the Tiger evoke power and ferocity. But the Snow Leopard's image is gentler. Its ethereal beauty has attracted the admiration of people from all over the world and around their interest in its homeland and varied cultures who live there (Jackson 1995).

The Snow leopard is about the same size as or slightly smaller than a common leopard. This stocky cat has a well-developed chest and powerful lungs to help them get enough oxygen from the thin mountain air. They are excellent and agile leapers; there have been reliable reports of snow leopards jumping six meters. The ears are short and rounded and set wide apart and the back of the ears have pale centres rimmed with black. In winter the cats ears become almost invisible, hidden by its long dense fur. Its coat offers a superb camouflage for its mountain environment of bare rocks and snow, being whitish-grey (tinged with yellow) in colour, and patterned with dark grey rosettes and spots.

1.1.TAXONOMY OF SPECIES:

- **Common name: Snow leopard**
- **Scientific name*: Uncia uncia***

Taxonomically the Snow leopard *(Panthera uncia)* is considered a member of Felidae subfamily Pantherinae (Blomqvist 1978,Nowak and Paradiso 1983).However on the basis of morphology and behaviour ,some authors place it alone in a separate genus *Unica unica* (Pocock 1917, Peter 1980,Rieger 1978b,Hemmer 1967,1972, Anonymous 1987c). The snow leopard's vocal fold is less developed than in the other pantherines, lacking a thick pad of fibro -elastic tissue, so that it cannot make the low and intense «roars» of which the other big cats are capable (Hemmer 1972, Peters 1980, Haste1989).

Classification of Snow leopard (Toriello 2002)

Kingdom - Animalia
Phylum - Chordata
Subphylum - Vertebrata
Class - Mammalia
Order - Carnivora
Family - Felidae
Sub Family - Pantherine
Genus - Uncia
Species - *Uncia uncia*

1.2 NAMING AND ETYMOLOGY:

Both the Latinised genus name ,Uncia and the occasional English name “Ounce” are derived from the old French Once, originally used for the European lynx “Once” itself is believed to have arisen by back formation from an earlier word “Lonce”-the “L” of “Lonce” was constructed as an abbreviated “le”(“the”)leaving “Once” to be perceived as the animals name. This like the English version “Ounce” became used for other lynx-sized cats, and eventually for Snow leopard.

The Snow leopard is also known in its native lands as Shan(Ladakhi),waawrin prraang (Pashto),Bars or barys(Kazakh), ilbris(Kyryz) and Barfani chit “Snow Cheetah” ,*Ounce* (English), *Bharal-mar, Barfani chita* (Hindi, Urdu: India, Pakistan), *Hiun chituwa* (Nepal), *Irbis, irvis*(Russia, Central Asian republics,Mongolia);Snow Leopard (English); Panthere des Neiges. Leopard des Neiges, Once (French); Schneelopard, Irbis (German); Leopardo Nival, Pantera Las Nieves (Spanish);Xue Bao (Chinese); Palang-i-berfy (Dari Afganisthan); Bharal he, Barfani Chita (Hindi, Urdu, Pakistan); Shan (Ladakhi, India); Chen (Bhutan), Sarken (Tibetan)

1.3. SUB-SPECIES*:* *Uncia uncia uncia*- Asia, Mongolia, Russia. *Uncia uncia uncioides*- China, Himalayas.

1.4. CONSERVATION STATUS:

Snow leopards are classified as Endangered in the International Union for Conservation of Nature and Natural Resources (IUCN) Red List of Threatened Species since 1988. Snow leopards have been included in Appendix I of the Convention on International Trade in Endangered Species of Fauna and Flora (CITES) since 1975, and hence all international commercial trade in the species, its parts and derivatives is prohibited.

Endangered IUCN (International Union for Conservation of Nature and Natural Resources)
Appendix I CITES (Convention on International Trade of Endangered Species of Wild Flora and Fauna)

1.5. PROTECTED SPECIES ROLE IN ECOSYSTEM:

THE SNOW LEOPARD AS AN INDICATOR SPECIES.

The Snow leopard serves as an indicator species for Asia's high mountain ecosystems, as it resides at the top of the food chain, requires large home ranges, moves over vast areas and flourishes under pristine conditions. It is also a “flagship” species around which people rally support for far–reaching conservation initiatives. The snow leopard’s endangerment has made it a symbol for international cooperation. Conservation efforts in the high mountains of central Asia are hindered by political instability and large border areas off–limits to scientific study. In addition, this region is perhaps the most inhospitable in the world for scientific studies. By protecting snow leopards, one also protects habitat for a host of other plant and animal species. Where the Snow leopard occurs in good number, the environment is considered to be more productive and healthy. Because parks and reserves are generally the primary repository for Asia’s remaining mountain biological diversity, governments need to protect them. With steep slopes and shallow soils, high–altitude ecosystems are among the most fragile of the Earth’s habitats. Yet, these areas support critical watershed for low–lying valleys and plains, where the nation’s human, agricultural, and industrial activities are concentrated.

The Snow leopard can be a focal species for landscape conservation planning in the montane areas of the Himalayas, as elephants, rhinos, and tigers have done for other landscapes elsewhere in South and Southeast Asia and in the lowlands of the Himalayas as well.

1.6. DISTRIBUTION AND HABITAT USE OF SNOW LEOPARD IN INDIA:

In India, studies had been conducted in some of the protected areas of Jammu and Kashmir and Himachal Pradesh, but in rest of the states such as Sikkim and Arunachal Pradesh, the unprotected areas of snow leopard distribution range have been still unexplored. In Uttarakhand, wildlife surveys were conducted by Green (1985), Sathyakumar (1993 and 2003a) and Rawat (2005). But specific surveys on Snow leopard were lacking. Researchers documented Snow leopard information while conducting other studies in various regions of Uttarakhand (Green

1985, Sathyakumar 1993 and 2003a, Rawat 2002). Though Uttarakhand has very little area under Trans-Himalayan Biogeography zone i.e. ideal habitat for Snow leopard, there are many areas which fall in the transitional zone of Trans-Himalayas and Greater Himalayas. Similarly, the Trans-Himalayan zone of Himachal Pradesh, Lahaul-Spiti and Pangi Valley were studied for Snow leopard and wildlife values by Bhatnagar (1996, 1997 and 2002) and Saberwal (1996) but some of the areas of Himachal Pradesh have very poor information about Snow leopard.

Study conducted by WWF-India in 2010 with the objective to study the occurrence and distribution of Snow leopard in Uttarakhand and Himachal Pradesh confirms the presence of Snow leopard in Uttarakhand, but could not find signs of Snow leopards from Surveyed area in Himachal Pradesh. It is proposed that Gangotri National Park, Askot Wildlife Sanctuary and Nanda Devi Biosphere Reserve are seen as potential habitats for Snow leopard under Project Snow leopard. There are other areas viz., Valley of Flower National Park, Tundah Wildlife Sanctuary, Great Himalayan National Park and Lippa Arsang Wildlife Sanctuary which should also be taken into consideration for Snow leopard Conservation (WWF 2010)

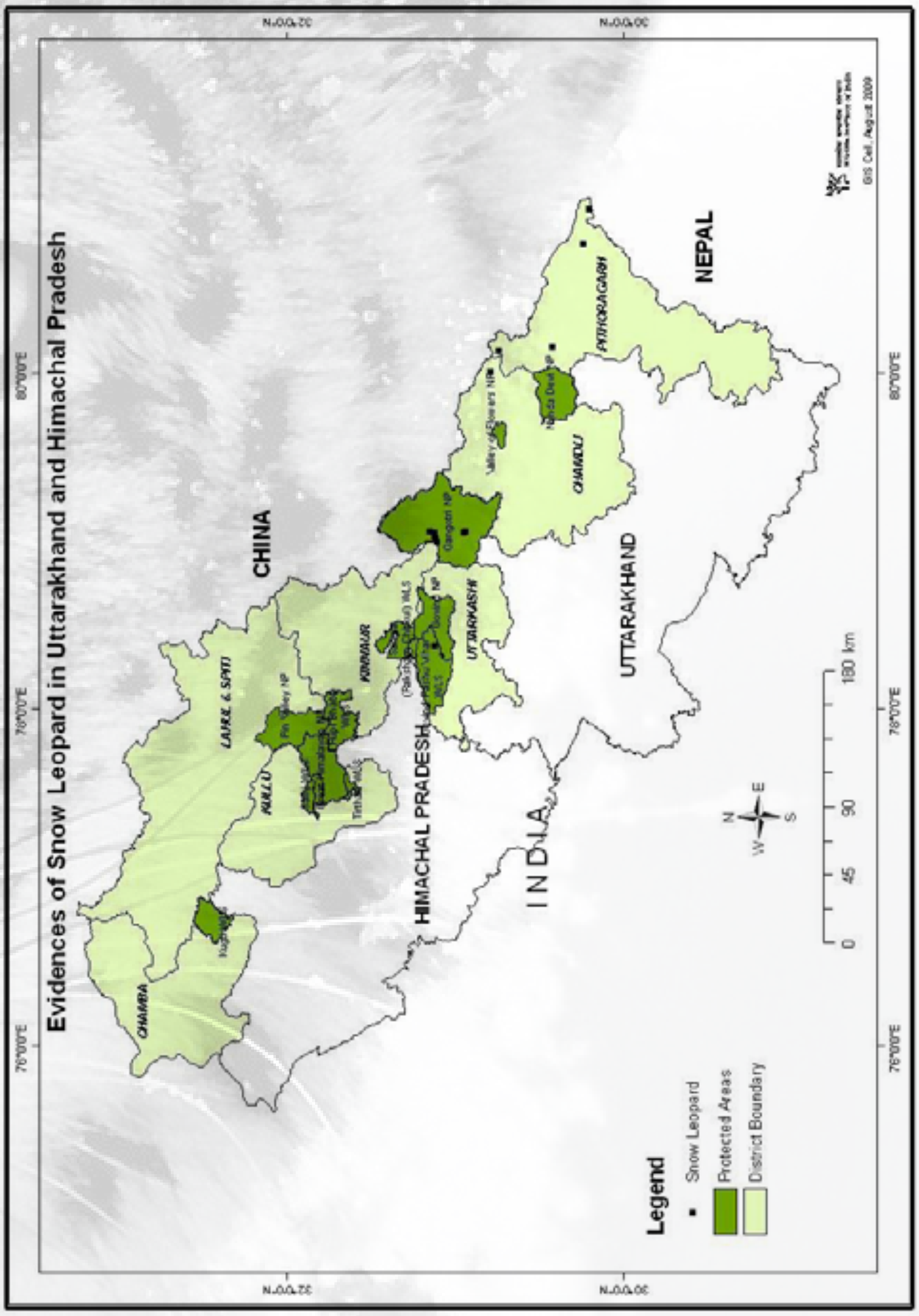


Fig. 1: Location of Snow leopard indirect evidence in surveyed areas of Uttarakhand and Himachal Pradesh (Picture courtesy: Wildlife Institute of India, Dehradun)

1.7. PRINCIPAL THREATS:

Historically, habitat remoteness served to insulate the species from human but Snow leopards are no longer present in many areas that they formerly occupied. The species continues to suffer due to fragmentation across more disturbed mountain range habitat and its low population density (Fox 1994, Jackson 2000).

According to the survey of more than 60 Snow leopard specialists, undertaken by the Snow leopard survival strategy, direct killings of Snow leopards and loss of their natural prey base are considered the most significant threats to the long-term survival of the species (McCarthy and Chapron 2003). It is difficult to identify baseline causes and effects in many cases due to the different types of threats are closely inter-woven and complexly related.

- **Habitat Loss and Fragmentation**

Habitat fragmentation, degradation and loss affect Snow leopards but owing to the remoteness and inaccessibility of the preferred habitat, such influences Snow leopards have been relatively limited until recently. Habitat alternations occur because of human encroachment into the species ' range'- for resource extraction, new grazing grounds living space excessive tourists flow or road building. Human conflicts may also contribute to habitat degradation or loss (Theile 2003, WWF 2001).

- **Lack of Awareness**

Local people depend upon animal husbandry and its extension throughout the highland pasture for their livelihood. They will be happy if there is no loss of their livestock by the wild predator and population increment of cattle naturally will enhanced their standard of livelihood. Thus, they might see no advantage to coexisting with Snow leopards, which are a major source of their livestock remover and no means of their use too. Understandably, they are reluctant to support snow leopard conservation unless depredation losses are reduced or concern authorities for any livestock killed by predators compensate them (WWF 2001).

- **Habitat Degradation and Fragmentation While Reduction of Natural Prey due to Illegal or Unregulated Hunting**

Mountain ungulates are hunted, either illegally or without regulation, for meat and trophies by local residents. Additionally, wild game meat can be highly prized for its medicinal value or used as traditional food for honored guests or special holidays. In some cases illegal hunting may constitute a commercial activity. There is rarely any provision for legal hunting by local people which disenfranchises them and makes compliance with laws minimal. **The illegal harvest likely far exceeds the legal harvest in many areas, with resultant declines in Snow leopard food resources.**

- **Reduction of Natural Prey due to Legal Hunting**

In many Snow leopard range-states trophy hunting for wild sheep and goats is a lucrative business, bringing in substantial income to government, hunting organizations and both private and state hunting reserves. These can play an important role in community based conservation, if they are sustainable and provide economic incentives to local communities to protect wildlife and habitat. However, in some cases these hunts are not well managed and harvest levels result in medium-term social instability and/or long-term genetic problems. A conflict of interest can exist when the management agency receives a large portion of its income from foreign trophy hunting. Wild ungulate stocks are in decline in many areas, reducing carrying capacity for snow leopards and other carnivores. Declines in other snow leopard prey species such as marmots are attributable to an unsustainable harvest for fur markets, and pika are targets of widespread vermin poisoning programmes

- **Killing of Snow leopards in Retribution for Livestock Depredation Loss**

Snow leopards use domestic livestock as a food resource in nearly all areas where they overlap with resultant retribution killing by herders. In many areas, encroachment of herders into Snow leopard habitat is increasing. Given the reliance on livestock for food, clothing, and trade goods, retribution killing by poor grazier families may seem understandable. Yet predation on domestic livestock is a complex situation. Greatest losses occur where native prey species (ibex, blue sheep, argali, and marmot) have been reduced, but are also more serious where herders employ poor guarding practices.

- **Poaching Snow leopards for Trade in Hides or Bones**

Snow leopards have long been hunted for their pelts, and demand remains high. A pelt can bring a few hundred dollars for a herder or upwards of one thousand dollars on the International black market. In some parts of Central Asia, poaching is rampant within and near Protected Areas as unemployed or unpaid rangers seeks to overcome extreme financial hardship by poaching the animals they once protected. Kyrgyzstan may have lost more than 30% of its snow leopard population to poaching in the past eight years. There is demand for snow leopard bones for use as substitutes for tiger bone from the traditional Asian medicine trade. Traders will pay up several thousand dollars for a complete fresh snow leopard skeleton. Ironically, the demand for snow leopard bones may be increasing, as it serves as a replacement for tiger bone which has been the subject of extensive antipoaching campaigns. Organized crime is playing an increasingly important role in illegal trade in many areas.

- **Traditional Hunting of Snow leopards**

Snow leopard hides are traditional adornments for homes and clothing in many parts of their range. They can be a status symbol and a highly valued gift. Snow leopard hunters and trappers have long been held in high stead among village peers. Reversal of these cultural values is both a difficult and sensitive process. A considerable portion of illegally traded hides actually remain in the country in the hands of officials or other powerful individuals.

Livestock depredation tends to be greater in areas where wild sheep and goat populations have been depleted (Miller and Jackson 1994, Schaller et al. 1994), although prey availability is not the only factor influencing depredation (Oli 1994, Jackson et al. in prep.). There is demand for snow leopard bones for use as substitutes for tiger bone from the Chinese medicine trade (Liao and Tan 1988). Traders will pay up to U.S. $190 for a snow leopard skeleton in Tibet. In northern Nepal, people have been seen to trade snow leopard bones for sheep along the border with Tibet (Jackson 1992). Garments of snow leopard fur were once highly prized in the fashion world, with high quality coats valued at up to U.S. $50,000 (H. Freeman, pers. comm.). Heptner and Sludskii (1972) and Fox (1989) review central Asian and Russian exports of snow leopard skins during the 20th century; world trade was of the order of 1,000 pelts per year in the 1920s. Although no longer in international trade fur coats have been seen for sale in shops in Kathmandu (Barnes 1989), and “novelty” furs have been seen for sale throughout China, including Taiwan (Jackson 1992, Fox 1994).

Climate change has now emerged as another potential threat to Snow leopards (McCarthy and Chapron, 2003).The Intergovernmental Panel on Climate Change (IPCC) projects that the average annual temperature in South Asia and Tibet will increase by 3-4 °C by 2080-2099 based on comparison with historical averages from 1980-1999, while annual precipitation is expected to increase throughout this region as well (Christensen et al., 2007). Previous studies have shown a distinct correlation between tree line and climate (Korner, 1998; Korner and Paulsen, 2004). Therefore, the warmer and wetter conditions consistent with climate change predictions in this region may result in forests ascending into alpine areas, the snow leopards’ preferred habitat.

2. DIAGNOSTIC FEATURES: The Snow leopard is the only member of the genus *Uncia*. Its classification in a separate genus from other big cats is justified by its unique hyoid apparatus (a series of skeletal elements which support the base of the tongue) (Haste 1989). The distinction between “Big Cats” and “Small Cats” is not based on size, as the term suggests, but on the type of hyoid. In big cats this has cartilaginous portions, whereas in small cats, the hyoid is completely ossified or bony. The hyoid and a series of thick fibrous pads on the vocal cords of big cats enable them to roar, but they are unable to purr continuously. The hyoid of the Snow leopard is only partly ossified and the vocal folds only slightly thickened, so that Snow leopards are unable to roar, or to purr, continuously (Theile 2003). Snow leopard skull can be easily distinguished from that of a common leopard. In profile the Snow leopard skull has a marked step in front of the eyes, a short muzzle, and a high domed forehead caused by an enlargement of the nasal cavities. The large nasal cavities are thought to allow the Snow leopard to breathe more easily at high altitudes, where temperatures are low and oxygen is in short supply (Sunquist. and Sunquist 2002).

2.1. SEXUAL DIMORPHISM: There is sometimes little difference in the sizes of adult male and adult female Snow leopards making it difficult to distinguish between the two sexes.

2.2. COAT: The coat of Snow leopard is white to cream-yellow in background colour, mottled with grey to black spots and rosettes. Spots on the head and neck are solid, whereas larger rings or rosettes, most enclosing smaller spots, occur on the body and tail. Snow leopards can be recognized individually by their facial spot patterns (Blomqvist and Nystorm 1980).Compact elongated spots and two lateral rows of elongated rings extend along the center of the back from neck to tail base. In juveniles, these elongated rings are frequently consolidated into solid black stripes which break up into large and thick.

Fig. 2: Coat colour and pattern in new born cub.

2.3. MORPHOLOGY: The Snow leopard exhibit superb camouflage for its mountain environment of bare rocks, mosses and snow, being whitish-gray (tinged with yellow) in color and patterned with dark gray rosettes and spots. Further adaptations for high altitude life includes an enlarged nasal cavity, shortened limbs (adult shoulder height is about 60 70cm); well developed chest muscles (for climbing); long hair with dense, wooly under fur (belly fur grows as long as 12 cm) and a tail up to one meter long, 75-90% of head m body length (IUCN/SSC Cat Specialist Group 1996, Jackson 1996, WWF 2001, Shrestha 2003). These adaptive features not only assist balancing in steep terrain movement but the thick tail can be wrapped around the body to protect the animal from the cold (Theile 2003).

2.4. SIZE: Males are larger than female, with average weights between 45-55 kg as opposed to 35-40 kg for females (Jackson 1992, Fox 1994, Jackson 1996, Yaksha 1998, Shah 1998, WWF 2001, Theile 2003). The pugmarks of adults are 9-11 cm, in length and 7-9 cm in width, but variation in cubs (Jackson 1996, WWF 2001, Shrestha 2003).

2.5 IDENTIFICATION OF INDIVIDUAL SNOW LEOPARD

Male Snow leopards are larger than females but apart from that they are visually difficult to tell apart. The fact that Snow Leopard are usually solitary and are not kept together in large numbers means that the physical differences are usually enough for keepers to identify individuals and records of their individual markings are usually kept. It is standard procedure though for a permanent method of identification to be used and in the case of the Snow leopard the methods of identification usually employed is electronic transponders. The electronic transponders are small microchips which are placed under the Snow leopard skin as a permanent identification marker. Zookeepers can then use a scanner to read the unique twelve digit number that identifies the Snow leopard. They are easier to use since with a scanner they can be read quickly and easily without immobilizing the animal. Though it is painful and they can migrate throughout the body the patient does not need to be sedated and the wound is not large, visible or as prone to infection.

Beside transponders individual Snow leopards can be identified by their physical characteristics. For that purpose photographs of individual Snow leopard housed at PNHZPark was taken and variation in the pelage pattern was taken into consideration.

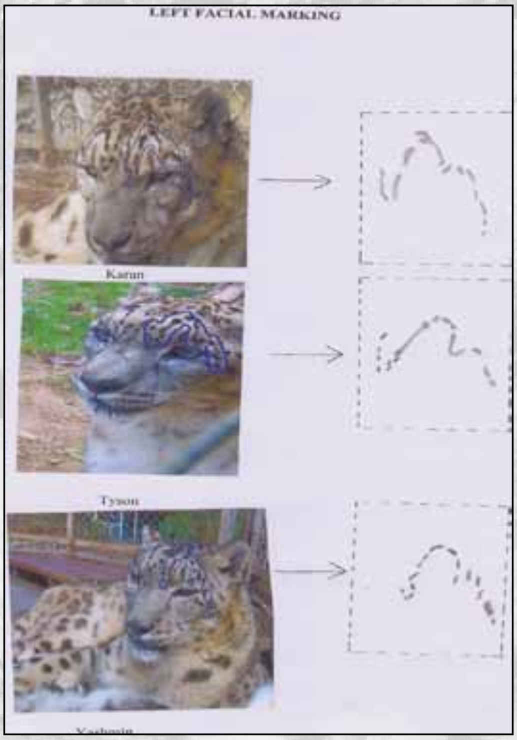
Snow leopard pelage patterns vary between individuals with respect to the size, shape, orientation and coloration of individual spots and rosettes. Each snow leopard's coat patterns are unique like our fingerprints. Pelage patterns are asymmetrical, often varying significantly between the sides, lower limbs and tail.

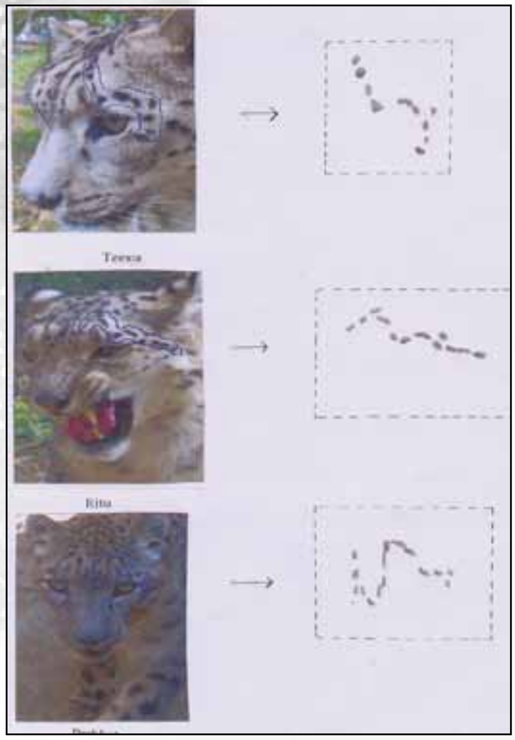
Blomqvist and Nystrom (1980) used the leopard's highly distinctive spotting pattern on the forehead to distinguish individual snow leopards in captivity.

Areas used for identification included uniquely shaped or arranged rosettes, spots or groupings thereof, located on the lower limbs forequarters, dorsal tail marking, front, and right and left facial markings. Identification of one different feature was considered sufficient to determine that two photographs depicted different animals.

Areas such as the lower limbs proved the most useful in identification due to the short fur and clearly defined spot shapes; however, even Slight rotation in body orientation can influence the ease with which patterns can be identified.

Fig. 3: Individual identification of Snow leopard by their Pelage pattern


LEFT FACIAL MARKING
Karan
Tyson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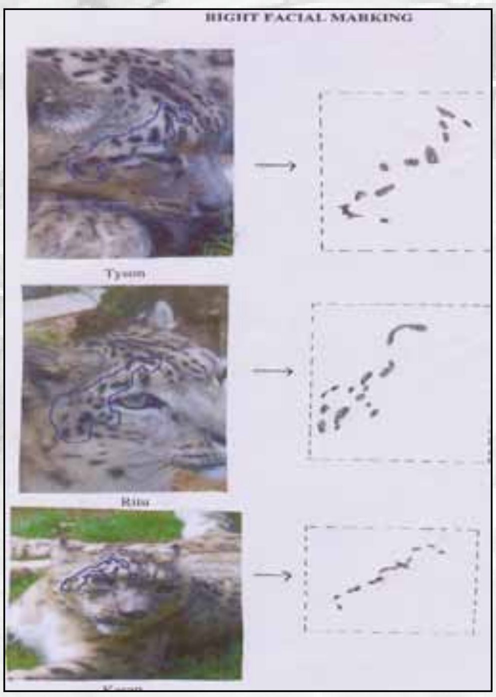
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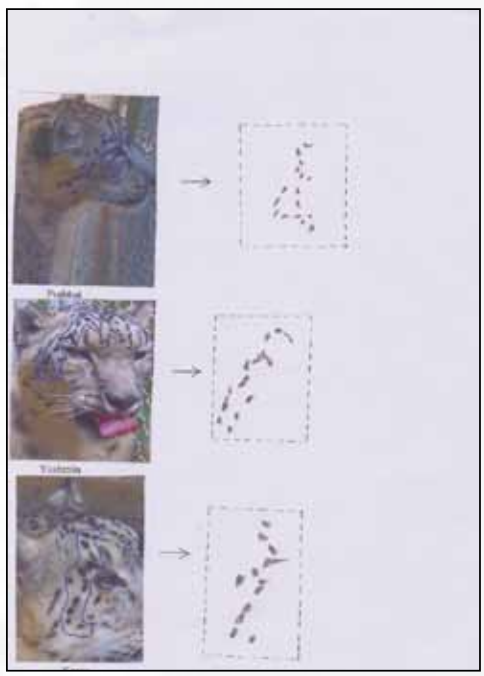


FRONT LEG MARKING

3. COMMUNICATION:

3.1. VOCAL: Snow leopards communicate using a variety of close- range, medium range and long distance vocalization. Their vocal repertoire is similar to that of other felids, except that they do not purr. Sounds made are similar to those made by other large cats, they spit, and hiss, growl and cough-roar, meow, moan, and yowl and they also make a nonaggressive puffing sound called “prusten” (chuff) through their nostrils. This is a friendly greeting which both males and females use. Both sexes have a “main” call, which has been described as a “piercing yowl. The call is used by females in oestrus and probably helps animals find each other. However, unlike other large cats, snow leopards cannot roar.

3.2. OLFACTORY: The sources of chemical scents or odours are secreted from various glands (e.g., anal sacs, sub caudal glands, cheek glands, and foot glands) as well as saliva, urine and faeces. Compared with dogs, cats have a poor sense of smell, but olfaction obviously plays an integral role in their social lives. Snow leopards mark territories in a variety of ways; they scrape their back legs in loose soil leaving small depressions with a mound of soil next to it. They mark rocks, bushes and boulders with pungent spray from a scent gland near the tail. Cheek rubbing helps spread the scent. Faeces is also used to mark territory and allows the animals to stay out of each other’s way, or notify a male of a female in oestrus and assist in helping males locate females.

3.3. TACTILE: Tactile communication consists of greeting ceremony, social licking and lying in close contact. The kind of close, affectionate contact seen between mothers and young cats include head rubbing, licking and nuzzling.

3.4. VISUAL: Visual communications consist of offensive and defensive facial expressions and postures (Estes 1991). These can include relaxed expressions where ears are alert and facing forward to aggressive expressions where ears are pulled back, mouth open and face is in a grimace. *Flehmen* can be described as the wrinkling up of the nose with the mouth open and eyes closed. It is used after smelling urine to detect oestrus females, and sometimes carrion. Captive snow leopard males are often seen Flehmen.

4. LONGEVITY OF SNOW LEOPARD IN CAPTIVITY (*Uncia uncia*)

As per the record of International Studbook of Snow leopard volume 9, globally 205 institutions are housing Snow leopard with a total population of 445 individuals in a 206:239 ratio.

Analysis done on the number of individuals housing in different captive facilities of Snow leopard shows that a total of 212 individuals were housing in 100 European institutions, 164 individuals were housing in 84 American institutions,46 individuals were housing in 16 Asian institutions ,15 individuals were housing 4 Australian institutions and 2 individuals were housing in 1 African institution.

The analysis further showed that there are very few individuals that have survived after crossing the age of 17 years. Snow leopards in captivity are known to live up to 21 years (Blomqvist and Sten 1982, Wharton and Freeman 1988) but are unlikely to reach half this age in the wild (Blomqvist and Sten 1982, Theile 2003).Below given analysis of Snow leopard longevity in different regions shows that the animals have survived till the age of 21.The longevity can be credited to proper husbandry, regular health monitoring including research on the biology of the species to cater to their needs.

According to the International Pedigree book of Snow leopard 2003, males are considered post-reproductive at the age of >17-18 and females are considered post-reproductive at the age of 15-16 years, so from the aspect of **conservation breeding for endangered species like the Snow leopard longevity of the individuals has no contribution to increase the number of the captive stock including the gene pool. Longevity also means that the individuals would be occupying space thus giving no further scope for exchange as space restrain is always a problem in captivity and building conservation breeding facilities is not feasible in all circumstances. Therefore, it is recommended that a separate facility can be created to keep such individuals and keep the breeding facilities free for new individuals for breeding and helping the species towards conservation.**

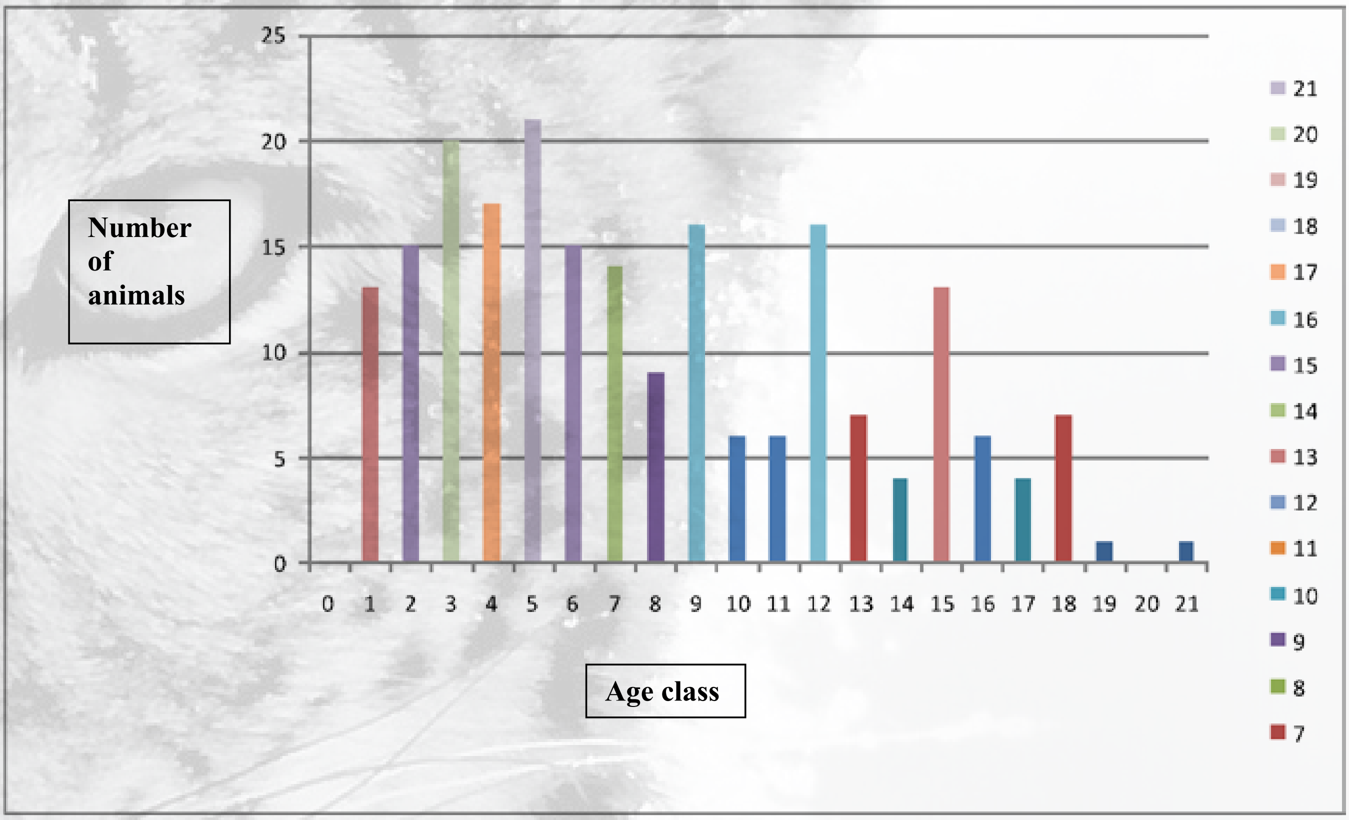

Fig. 4a: Age distribution of the captive Snow leopard population in European institution as on 1.1.2008.

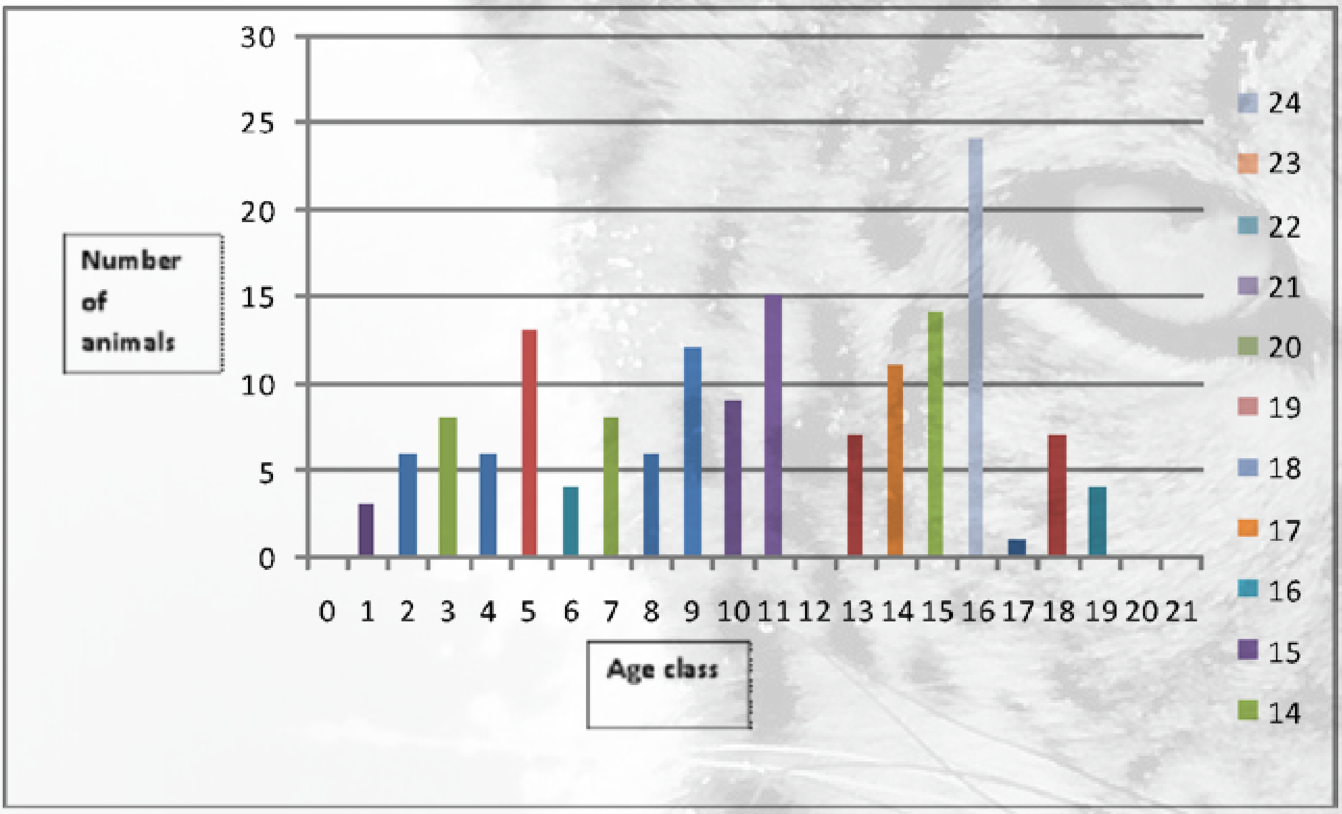

Fig. 4b: Age distribution of the captive Snow leopard population in American institution as on 1.1.2008.

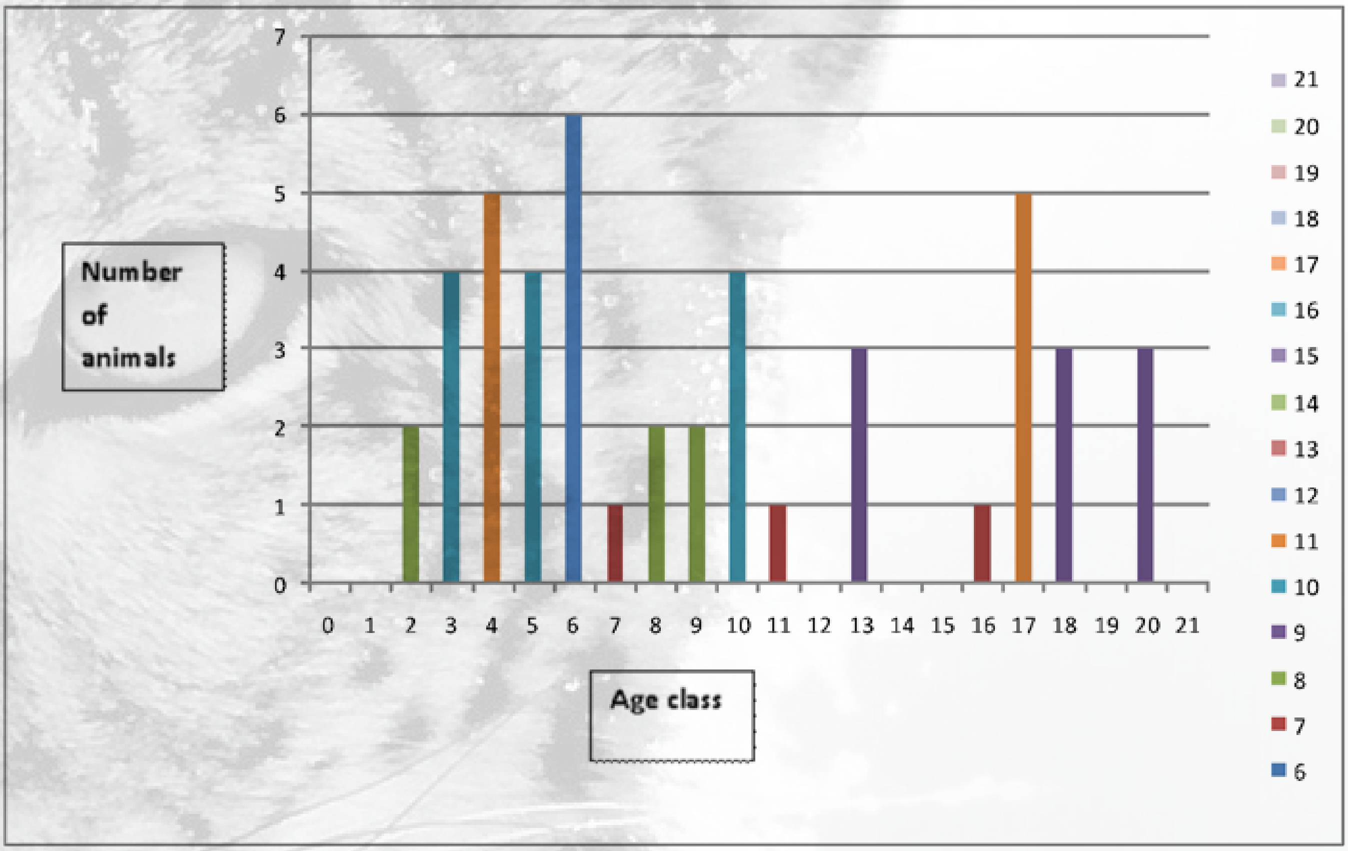

Fig. 4c: Age distribution of the captive Snow leopard population in Asian institution except China as on 1.1.2008.

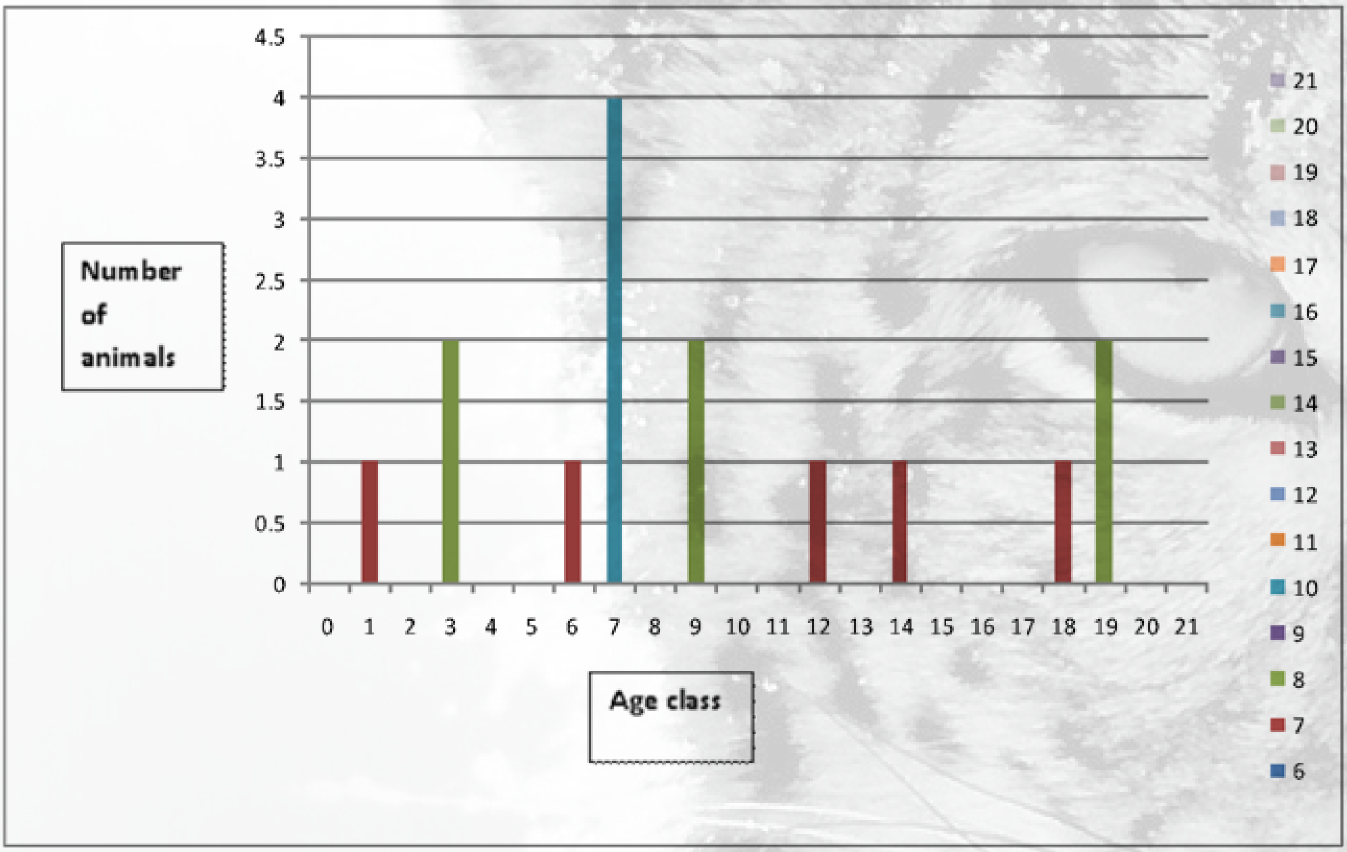

Fig. 4d: Age distribution of the captive Snow leopard population in Australian institution as on 1.1.2008.

5. ECOLOGY

5.1. HABITAT: Snow leopards live in rugged mountainous terrain and are associated through most of their range with arid and semi-arid shrub land, grassland or steppe (Fox 1989; Jackson 1992). They are generally found in elevations between 3000 to 4500m, although they occasionally go above 5500m in the Himalayas, and can be found between 600 to 1500m at the northern limit of their range (Theile. 2003). Usually associated with steep rocky slopes with arid and semi-arid shrub land, grassland, or steppe vegetation. They have been observed in coniferous forests, but generally avoid dense forest. They are found at altitudes of 3,000 to 4,500 m., with a high of 5,500 m. and low elevations of 600 to 1,500 m. being observed. Generally, this species prefers areas of cliffs, gullies, rocky outcroppings, and ridges.

5.2. VEGETATION: Snow leopards inhabit the high mountainous regions of central Asia. Vegetation in areas where snow leopards occur ranges from timberline alpine ecotones in the heavily forested southern slopes of the Himalaya, the mountains of western Sichuan (China), and parts of the Soviet Union ranges, through open forests and woodland habitats in many mountain systems on the outer arc of snow leopard distribution, and alpine zones in most all mountain systems, to scrubland and desert mountain habitats in the central portion of snow leopard range as one approaches the Gobi desert region (Novikov 1956, Schaller 1977, Jackson 1979a, Koshkarev 1984, Mallon 1984b). A large portion of their range is predominantly treeless due to either alpine or desert conditions. Snow leopards occur at elevations of about *600- 4000* m in the northern part of their range to 1800-5800 m in the southern portions (Ognev 1935, Stroganov 1962, Dang 1967).

5.3. TERRAIN: The terrain used by Snow leopards is typically extremely rugged (Schaller 1977, Koshkarev 1984, Mallon 1984b, Fox et al. 1988, Jackson and Ahlborn 1988). In Ladakh, India, snow leopard travel routes occurred on terrain averaging 24° in slope angle and 35 m from steep cliffs or other sharp breaks in terrain; 50% of all travel route locations were within 5 m of such cliffs (Fox et al. 1988). Snow leopards in western Nepal showed preference for cliffs, areas with slopes in excess of 40°, and areas within 25 m of edges such as cliffs. Preferred bedding sites were situated on or near ridges, cliffs and other sites with good views. Snow leopards preferred to move, bed, and mark along linear topographic features such as major ridgelines, bluff edges, gullies, and the base or crest of broken cliffs (Jackson and Ahlborn 1988).

5.4. MARKING SITES/BEHAVIOUR: Marking behavior includes scraping, claw raking, spraying (squirting) urine, and cheek/head rubbing (Wemmer and Scow 1977, Rieger 1978b, Blomqvist and Sten 1982, Freeman 1983, Ahlborn and Jackson 1988). Snow leopards scrape their hind feet over horizontal surfaces (usually of loose material), sometimes urinating on the pile of material formed behind the scrape (Rieger 1978b). Trees are sometimes marked by snow leopards raking their claws vertically along the trunks (Ahlborn and Jackson 1988). They spray-mark by moving their tails vertically upright and squirting urine backwards and up against near-vertical surfaces or bushes. Captive males spray-marked more frequently than females, but both sexes scraped equally often (Rieger 1978b). Snow leopards rub their cheeks/heads against odor-ous surfaces such as spray marks, meat, or plants (Rieger 1978b).In wild snow leopards, both sexes (age >1.5 yr) commonly make scrapes and spray marks, scraping being more frequent.

Fig. 5a: Sniffing the marked area.

Fig. 5b: Flehmen action

(A)
(B)
(C)
(A) **(B)**

Fig. 5c: Combinations of associated marks A. Urine with Scrape (Very Fresh scrape) B.Stool with Scrape (Very Fresh Stool) (Visuals: PNHZPark)

Fig. 5d: Very Fresh Scrape (1 day)

5.5. HUNTING BEHAVIOUR: Snow leopards are opportunistic predators capable of killing prey three times their own weight (Schaller 1977, Jackson and Ahlborn 1988, Fox 1989). Like other felids, the Snow leopard approaches their prey as closely as possible before launching the final attack. They make full use of the rugged terrain to hide their approach, and then rely on surprise and their own athletic abilities to catch prey. Snow leopards use this agility when pursuing prey across slopes or down mountainsides. They seem more inclined to chase prey than most of the other big cats; several observers have noted chases of 200 to 300 meters. Hunting is done mainly in the early morning or late afternoon. The Snow leopard kills its prey with a bite to the throat or nape. Its feeding behaviour varies: the prey may or may not be eviscerated, and the cat may begin to eat almost anywhere on the carcass. It may move its kill to a more secure place and may protect the carcass from scavengers. Not much is known about the influence of weather on the snow leopards hunting, but there is some conjecture that the cat is more successful hunter in the rain and snow. The deterioration of visibility in foul weather allows the predator to approach more closely. Naturalists and trappers have often made mention that the snow leopards often hunt after a heavy snowfall. No one has quantified these observations, but fresh snow would help the cat move silently and so might make it easier to stalk prey on the steep, rocky slopes (Sunquist and Sunquist 2002).

Snow leopards eat everything they find in the mountain regions. That’s why they are called opportunistic feeders. Oftentimes they prey other animals and preserve them in tunnels in the snow. They are also known to jump as far as fourteen meters. Usually snow leopards eat slowly and take 2-3 days to finish a sheep or goat. Snow leopards kill large animals twice monthly. In summer months they also use to eat small animals. Small preys of Snow leopard include marmots, pikas, hares, small rodents and snow cocks.

Snow leopards also consume plants and other things in some areas. Particularly during mating they eat notable amount of plants. They preserve their food that they need to have that time of the year.

5.6. WILD PREY SPECIES: The primary prey of the Snow leopard is wild sheep and goats whose typical habitat is the rugged terrain of mountainous regions. The most common of these species throughout Sow leopard range are the blue sheep *(Pseudois nayaur),* Asiatic ibex *(Capra ibex sibirica),* markhor *(Capra Jalconeri),* and several forms of argali sheep *(Ovis ammon).* Wild sheep and goat species with more restricted distributions within snow leopard range include the urial *(Ovis orientalis),* Himalayan tahr *(Hemitragus jemlahicus),* serow *(Capricornis sumatraensis),* and goral *(Nemorhaedus goral).* Other ungulates which have been reported to constitute snow leopard prey include the musk deer *(Moschus chrysogaster),* wild boar *(Sus scroJa),* Tibetan antelope *(Pantholops hodgsoni),* Tibetan gazelle *(Procapra picticaudata),* goitered gazelle *(Gazella subgutturosa),* wild ass *(Equus hemionus),* and wild yak *(Bas grunninus).* Snow leopards are also reported to have hunted or killed langur *(Presbytis entellus)* (Green 1982) and bear *(Ursus* sp.) (Schaposchnikov 1956). Smaller mammals preyed on by snow leopard include marmots *(Marmota* spp.), hares *(Lepus* spp.), pikas *(Ochotona* spp.), and voles and mice. Snow leopards also prey on birds, including the snowcock *(Tetrogallus* spp.) and chukor *(Alectoris chukar).* Relatively long periods between kills of large prey suggest that small mammals and birds may be important in meeting overall energy requirements (Jackson and Ahlborn 1988). Domestic animals such as sheep, goats, donkeys, horses, and cattle also constitute snow leopard prey, and may be important components of their diet in some areas (Schaller 1977).

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6. HISTORY OF PROJECT SNOW LEOPARD (*Uncia uncia*)-AN EX-SITU EFFORT IN INDIA

The programme of ex-situ conservation for Snow leopards in India had started prior to the In-situ conservation. In this regard, Padmaja Naidu Himalayan Zoological Park Society, dedicated to the Conservation of Himalayan Wild Life, took a serious note of the present position of Himalayan Wild Life, particular on the rare species and examined possibilities of embarking upon a captive Breeding Programme pertaining to Snow Leopard. With the above object in view the society in their Annual General meeting held on the 23rd October 1982 under chairmanship of Shri S.V. Krishnan, I.A.S., Chief secretary to the Government of West Bengal and President, Padmaja Naidu Himalayan Zoological Park Society, unanimously adopted resolution reading as following:

"(viii) Re: Captive Breeding Programme involving Snow leopard

Sri Hari Dang proposed starting of Snow Leopard captive breeding programme in the PNHZ Park, Darjeeling. Sri Hari Dang voluntarily offered to contact International Snow leopard Trust for seeking their know-how for implementation of the project."

In pursuance of the above decision efforts were initiated by Sri Hari Dang for securing the services of Swiss experts for rendering required technical of and guidance for establishment of a Breeding centre for Snow leopards . Dr.Ingo Rieger also extended his valuable assistance in the matter of drawing up the plan and design of required Snow leopard facilities. Accordingly estimates have been drawn up with suggested specification etc. and duly incorporated in this report. Thereafter a project report in outline has been formulated. Experts Dr .Ingo Rieger and D .Walzthoeny inspected the site in July 1983 and gave their approval .The site selected for off display conservation Breeding center of Snow leopards is the North-Western corner of the Jawahar Parbat (Birch Hill) at a latitude of 27 º and longitude 88 º E .Altitude is 6900 ft. a little above the Lebong cart Road within the compound wall of the Zoological Park, opposite St. Joseph's' college, Darjeeling.

This was the first instance of an Asian Zoo participating in the Snow leopard Master plan conceptualized by Mrs. Helen Freeman, President of International Snow leopard Trust and species coordinator of the species Survival Plan for Snow leopards.

The Project Proposal prepared by Dr. R.K. Lahiri in 1983 had the following objectives:

1. To establish and maintain a breeding centre for Snow leopard at a suitable location in the Padmaja Naidu Himalayan Zoological Park, Darjeeling.
2. To acclimatize, rear, breed and multiply the endangered species and then making effort to establish subsidiary breeding centres in suitable locations in Himalayas.
3. Preservation of the rare and endangered species in the Padmaja Naidu Himalayan Zoological Park, Darjeeling.
4. To provide opportunity to scientist and naturalists for study of Snow leopard under captivity/semi-captivity.
5. To promote rationale utilization of facilities for scientific, educational, recreational and other process provided that the same are in no way in conflict with the main conservation objectives.
6. To arrange special and guided visits of interested tourist to the centre.
7. To provide for the additional employment opportunity to the local people of the hill areas and to help boosting up of the economy of the areas through the prestigious venture directly and indirectly.
8. To arouse public consciousness about this endangered rare species and to cater popular and scientific information relating to this species and amongst people from far and near.

6.1. SELECTION OF SITE

Pending arrival of the invited foreign experts a site selection committee in its first deliberation examined five possible sites including a site within the Park area. The Lebong site was rejected because of its lower altitude much warmer condition and other congenial factors taking into consideration the meteorological condition ,altitude ,accessibility etc.

The experts Dr. Ingo Rieger and Dr. Walzthoeny inspected the site on 22/23-07-1983 and examined in detail the terrain etc. and made final selection of the site no.1. He thus agreed to the selection made earlier. The detailed report appears in the proceedings of the second site Selection Committee meeting held on 23rd July 1983

The exact location of the finally selected site is in the north –Western corner of the Park(Jawahar Parbat- Birch Hill) latitude 27° Longitude 88 ° E ,altitude 6900 ft approx (2130.07 mt.). The site is little above the Lebong Cart Road within the compound wall of the park opposite St.Joseph's college, school Department.

6.2. SCHEME

A phase-wise scheme covering three years at the present for the establishment of a Breeding centre for Snow leopard has been worked out on the basis of data and information collected (vide Rieger), (i) Management technique of captive ounces ,Uncia uncia ,& (ii)Enclosure for ounces and advice rendered by the foreign experts on management of Snow leopard during their joint discussion on 22nd and 23rd July 1983.While working out the scheme, careful consideration was bestowed all aspects pertaining to the selection of site ;its existing features ,nature of terrain, availability of nearest approach roads etc. In working out the scheme and locating different units the major trees standing at and within the selected site have been preserved as far as possible.

For the purpose of establishment of breeding centre all the required essential facilities for proper management of such rare species have been taken into consideration and incorporated in the phase-wise scheme, suitably , in proper sequence and are given below as “items of work” under each phase.

The purpose of establishment of a breeding centre all the required essential facilities for proper management of such rare species have been taken into consideration and incorporated in the phase-wise scheme, suitably, in proper sequence and are given below as “items of work” under each phase.

FIRST PHASE (1983-84)

ITEMS OF WORKS:

1. Construction of accommodation for Snow leopards with required facilities as per specification drawn and as per technical requirements with its internal fittings and fixtures (excepting electrical installations) e.g. Dog-hut, sliding door, operated manually by pulley, wire ropes and handles etc. all complete.

2. Fencing and covering area approximately 462m² under enclosure no.1 with one small enclosure for off-springs, including provision of entry and exit gate for zoo-keepers to look after the area, with Galvanized Iron chain link wire net fitted and fixed to R.S.I. posts on cement rubble masonry dwarf wall place suitably apart and adequately traced.

3. Construction of caves within the enclosure with rubble masonry work for resting of Snow leopard during rain and sun as per their requirement.

SECOND PHASE (1984-85)

ITEMS OF WORKS:

1. Construction of metalled approach connecting the West Birch Hill Road to Park gate no. 3.

2. Development of internal roads and pathways from Park gate no. 3 to Snow leopard Housing complex by stone pavements and V-shaped roadside catch drain.

3. Construction of second enclosure with G.I. interlink wire-net fitted to R.S.I. posts fixed to C.R.M. dwarf and wall with provision of entry and exits for Snow leopards and entry gate for Zoo-keepers.

4. Construction of C.R.M. caves within the enclosure as retiring place for Snow leopards.

5. Construction of Pathways around enclosure no.1 and 2 by stone pavement with provision for V-shaped side drain and ramps wherever necessary.

6. Construction of cement/dry rubble masonry breast/retaining walls on Hill/or khudsides of the roads and pavements as where necessary.

7. Construction of culverts and causeways as and when necessary.

8. Construction of Mild steel Railing by the side of internal pathways around and in front of enclosure no.1 and 2.

9. Construction of one-watch tower.

THIRD PHASE (1985-86)

ITEMS OF WORKS:

1. Construction of third enclosure with specification same as that of 1st and 2nd enclosures with modification of size if required to suit the local need based on experience.

2. Development of roads and pathways by construction of 2.5 m wide pathways, with stone pavement with provision of hillside V-Shaped catch drain with dry stones, connecting the Snow leopard Housing complex to the existing Nature's Trail (with some improvement to Nature's trail) towards newly constructed Birds Aviary.

3. Construction of 1.5 m wide pathways around the outer periphery of 3rd enclosure with V-shaped when necessary.

4. Construction of M.S. Railing along the pathway around the outer periphery of 3rd enclosure and pathway along the Nature's trail.

5. Construction of retaining wall and protective walls on hill or khudsides of pathways along the nature's Trail and enclosure.

6. Construction of culverts and causeways of minor nature as and when necessary.

7. Construction of 2 nos. watch tower.

8. Construction of 3 nos. visitors' resting place (Hawa Ghar) for shelter from rain.
9. Construction of 5 nos. of benches for visitors' resting place.
10. Construction of 1 no. twin staff quarters for accommodation of zoo-keepers/zoo-guard.
11. Barrier with plantation of bushes in between adjacent fencing of enclosure and in front for keeping the visitors at safe distance from Snow leopard inmates

6.3. PROCUREMENT OF SPECIMEN-NUCLEUS STOCK

NUCLEUS STOCK:

Procurement of the specimen for the Breeding centre –the nucleus stock of the centre –will constitute two breeding pairs of unrelated Snow leopards tobe procured from overseas Snow leopard breeding centres. Thus it will not be necessary to capture any animals from wild within our territory. At present there is no captive Snow leopard in our country so far known .It is proposed that at the initial stage of the specimens will be procured from Helsinki Zoo, Finland and Zurich Zoo, Switzerland on permanent breeding loan basis. The breeding pairs will be carefully selected by the aforesaid authorities after consulting the "International Pedigree Book of Snow Leopard, *Panthera uncia*", with a view to ensure that the specimen are genuinely unrelated breeding pairs.

A pair of unrelated Snow leopard was flown to Darjeeling Zoo from Zurich Zoo via London and New Delhi on 21st March 1986.These beautiful specimens were 'Kashi' the female and "Vishna" the male. The female was born on 26th August 1983 in the Zurich Zoo. The male was born on 23rd June 1978 in Helsinki Zoo.

Another pair "Hank" ♂ and "Persia" ♀ came to Darjeeling Zoo from U.S.Zoo on 16th January 1989.The "Hank" ♂ was born at Litterock on 6th June 1985 and "Persia" ♀ at San Antonio on April 23rd 1980. The pair gave birth to two female cubs on May 20th, 1989. This was the first successful breeding of Snow leopard in Darjeeling.

"Quizil" (Male, Date of birth 23rd May, 1990, Zurich)," Quila (Female, date of birth 23rd May, 1990, Zurich) and "Quetta" (Female, Date of birth 23rd May, 1990, Zurich) were later added to the collection of the Zoological Park on January 28, 1992 to include new blood and continue planned breeding programme at Darjeeling Zoo.

Another Male “Tyson” date of birth 8th August 1995 from Hunbstrnd arrived at Darjeeling Zoo on 27th January 2000 for the same purpose.

Two wild rescued females “Neeta” and “Meeta” from Leh-Ladakh region of Jammu and Kashmir were also air lifted to Darjeeling by Charted Plane of Ministry of Defence on May 17, 2000, again to continue with the breeding project. “Meeta” unfortunately died within few days of its arrival.

On 16th October 2012, a new female Snow Leopard named as “Kim” was brought to PNHZ Park, Darjeeling all the way from Nurnberg, Germany to support the decling population of captive Snow leopard.

In the last 26 years there are in total 50 births of Snow leopard in captivity in the Padmaja Naidu Himalayan Zoological Park, Darjeeling. The Snow leopard Breeding Project at Padmaja Naidu Himalayan Zoological Park, Darjeeling is one of the most successful and only breeding programme of the species in South-East Asia.

All the record keeping programme of animals is not only done in Darjeeling Zoo, but is also recorded with the International Stud Book keeper of the Species at Helsinki.

Steady research and studies are also being undertaken so that this very special and sensitive project can become a model for other such Conservation Breeding Project in suitable locations.

Padmaja Naidu Himalayan Zoological Park, Darjeeling in 2003 had 18 Snow leopards (9:9), one of the largest captive populations, in a single zoo in the World and a record of the zoos as on May, 2006.

Next step taken was to have at least 4-5 stable captive populations of Snow leopards at different high altitude zoo in the country, before releasing/stocking in the wild can be contemplated. In 2004, a pair each of Snow leopards was sent from Darjeeling Zoo to Himalayan Zoological Park, Gangtok, Himalayan Nature Park,Kufri & Pandit Ballav Pant, Nainital high altitude zoos to start subsidiary Snow leopard breeding centers in these Himalayan Zoos.

Within a span of twenty six years PNHZ Park, Darjeeling has successfully managed and bred the species in captivity yet problems have arouse regarding cub mortality, absence of genetic variability among the existing population and various veterinary problems that might be originating from genetic history, scientific management of the present population. Thus the project would be focused into all these aspects and to prepare a Conservation breeding Management Plan of the species in Indian conditions. Further the projects aims at making a comparative study of the behaviour of the present captive Snow leopard and then co-relate it to the wild population and then implement the factors possible in captivity for the animal's well being and for their breeding success.

The methodology for the aimed study is as follows:

- Behavioural study of the Snow leopard in Captivity at PNHZ Park, Darjeeling and other zoos in India housing Snow leopard.
- Study on the Husbandry Techniques: cage, enclosure design and sizes and hygiene etc.
- Environmental Enrichment.
- Diet: Types, quantity and preferred diet.
- Breeding biology and post breeding behaviour.
- Communication and literature review.
- Health and Veterinary implications.

6.4. MANAGEMENT OF CAPTIVE STOCK OF SNOW LEOPARD AT PNHZPARK FROM 1986 AND ONWARDS.

Arrival of Snow leopard at PNHZPark for the Conservation Breeding Progamme and management of the captive stock during the initiation of the project and thereafter.

CASE STUDY I -1986
NAME OF ANIMAL: VISHNA
SEX: MALE
DATE OF BIRTH: 23.06.1978 AT HELSINKI
AGE ON ARRIVAL i.e. on 21.03.1986 7yrs 8months 28 days
DATE AND TIME OF ARRIVAL: 21ST DAY OF MARCH, 1986 AT 0600HRS AT PALAM AIRPORT, NEW DELHI.

NAME OF ANIMAL: KASHI

SEX: FEMALE

DATE OF BIRTH:

AGE ON ARRIVAL i.e. on 21.03.1986 7yrs 8months 28 days

DATE AND TIME OF ARRIVAL: 21^{ST} DAY OF MARCH, 1986 AT 0600HRS AT PALAM AIRPORT, NEW DELHI.

Vishna along with Kashi dispatched in a different crate from Zurich to New Delhi via London on 19.03.1986 through Britsh Airways flight which landed at Palam Airport, New Delhi at 0600hrs.

At Palam Airport Dr.R.K. Lahiri, the Director of the park was present to receive the animals along with Mr.Patra, the Addl. Dist. Magistrate, Mr.Dhar.Dy.Magistrate, Dr.B.N.Ghosh, Ex A.D.V.O. of the Park, Dr.C.K.Mondol, Veterinary Officer, Delhi National Zoological Park, two field staff-Shri N.K.Bhujel and Shri K.Moktan and two Police officers as armed escorts.

While clearing custom formalities, it took about an hour and then again the animals were flown to Bagdogra by Indian Air force AVRO plane.

Both Kashi and Vishna were found exhausted when observed at Palam Airport. Both of them were thirsty and looked dull and tired. They were offered with water to which they responded very quickly by licking the water provided in a small disc. Kashi and Vishna accepted not less than 8 to 10 cups of water respectively.

During the journey by AVRO plane from Palam Airport to Bagdogra, both the animals were observed tobe feeling disturbed due to constant sound of engine. Kashi was much more disturbed than Vishna as it was noticed panting and breathing at a quick pace. However, Vishna was found relaxing throughout the journey.

After three hours of journey the plane landed at Bagdogra at 1120hrs. The temperature outside the plane was very high so the crate containing Kashi and Vishna was kept inside the plane where temperature was not so high.

The Leopards were offered with a few small pieces of goat meat and water. They were feeling hungry and thirsty, so they accepted whatever was provided to them. After about an hour and a half the journey again started to its final destination i.e. at Darjeeling at about 1300 hrs.

Both the animals had to suffer a lot from the heat of days as the vehicle carrying these animals were ampicillin towards the foothill of Darjeeling. The temperature somewhat lowered and they were relieved of the heat when reached Kurseong. Took rest at Kurseong for about an hour and ultimately reached Darjeeling at nearly 1700hrs.

The moment the animals reached Snow Leopard complex, the crates containing the Leopards were taken to the Complex for release .The animals were released one after another in presence of Mr.Ghosh, Commissioner, Jal Division, Mr.G.Bala Gopal, Dist.Magistrate and Mr. Patra, A.D.M. and other guest who were present at the time.

Since the animals were already feeling tiresome and exhausted due to long journey, they went inside the cage very slowly and retired inside the cages. Necessary arrangements were made and keepers, Night guards along with Police guards were also provided for the night duty before leaving the complex at 1900hrs.Keepers were further instructed to look after the animals properly and to keep note on night activities and feeding of the animals and to report in the morning. Keepers were further instructed to look after the animals properly and to keep note on night activities and feeding of the animals and to report in the morning. Following recordings were done by Dr R K Lahiri Director, Mr Vinod Rishi Director and Mr Kiran Moktan, Animal Supervisor

The records from 1986 and onwards were manually maintained in a register which has records on the behaviour, feed and medical histories. Below given chart depicts the kinds of record maintained for the Snow leopard at Conservation Breeding facility

Name of animal: Vishna

Date	Daily Activities	Feed given	Feed accepted	Treatment
22.03.1986	In early hours of morning animal was found moving restlessly inside its cage and occasionally it was panting. It was observed staring outside from the gaps of the sliding door. To avoid disturbances it	1 kg. goat meat 250gms. Goat liver and about 400 gms. Of fowl meat	250 gms of goat liver and 200gms of fowl meat	Given essence of chicken with Ampicillin cap.To

	was left alone and nobody was allowed to enter inside. During daytime the animal was found sleeping peacefully .Perhaps it was not yet fully recovered from the exhaustion of the journey. Stool was not found inside the cage			control its flu or cold.
23.03.1986	In early hours of morning animal was growling at kashi.It was observed licking its paws and cleaning its face as a sign of normal and good health. Stool found inside the cage which was duly examined by D.B.N.Ghosh who examined and found it to be normal. Its movement though very slow and suspicious did not indicate any sign of dullness and sickness. While making observation between 900 hrs and 1000 hrs it was found relaxing in sitting pasture with its head down on its paws. It was reported that at around 1530 hrs it had vomited. So immediately Dr.B.N.Ghosh attended the animal and as per his version it was not of any serious nature. It might have been caused due to minor stomach upset/	Beef: ½ kg, Goat meat:1 kg ,fowl 800 gms along with liver.	3-4 pieces of liver.	Essence of chicken mixed with ampicillin and foristal tab. It was also provide with complain mixed with ampicillin in another disc. No specific treatment was necessary as the animal was not found ailing or suffering from sickness. Except a sign of cold was

				evident from their running nose. A hot air blower was provided near the cage to avoid cold.
24.03.1986	Observed restless at night between 2300hrs to 2430 hrs. It was seen growling and moving restlessly around its cage. It also urinated at night. It was taking rest throughout the day.Occassionaly the animal was seen licking water. During morning when the cages were being cleaned, it was staring at the keeper with suspicious movement. Its move from one compartment to the other was very slow .There was however no visible symptoms of any sickness or dullness in its health.			
25.03.1986	Licking water at 0500hrs. 840 hrs feed given, few pieces of goat liver, weighing approx.200 gms. In the morning, observed cold with running nose, hot air blower provided. Observed sleeping during the day time, no sign of illness.	Small quantity of pork meat given along with complains mixed with egg.	Not accepted	Ampicillin cap. Given in complain and egg mixture. Dr. Ghosh suggested not giving hot air blower for a considerable length of

				time.
26.03.1986	Occasionally hot air blowers used to keep them warm during night time at different intervals of time. Found licking water at 2345 hrs, 0300 hrs, 0630 hrs and 0700 hrs. At 1200 hrs animal was quietly sleeping at the corner of the cage. Afternoon seen relaxing in a sitting posture.Occassionaly move slowly and peep outside from the small gaps of sliding door.Inqusitively listening to the frequent sound of vehicles. No sign of aggressiveness. Loved human company. Found licking its front leg, cleaning its face and body. Observed to the animal to be feeling comfortable in the environment.	1720 hrs provide small piece of goat liver (500 gms) and goat meat.	Liver accepted, meat rejected.	Ampicillin cap. Given in complain and egg mixture.
27.03.1986	0900hrs relaxing quietly.1440hrs observed licking body, paws and tail. Animal not so dull or exhausted.	Goat liver, fowl and dressed chicken offered. Two live fowl provided	500gms of goat liver accepted at 1800 hrs and a solid dressed fowl. Further found licking complain ,water at 0200	Ampicillin cap. Given in complain and egg mixture.

			hrs,0400 hrs,0730 hrs and 0800 hrs respectively. Two live fowl accepted.	
28.03.1986	Feed accepted of the previous evening. Stool dark and hard. Movement observed inside the cage at night. Relaxing and sleeping during day time.	Dressed chicken, water.	Accepted	Ampicillin cap. Given in complain and egg mixture.
29.03.1986	In the morning the animal was found relaxing. During day time the animal was sleeping and occasionally found staring outside from the gaps of the sliding door. Looking inactive, shy and solitary. Found licking a mug of water mixed with complain, Ampicillin cap and egg.	Live chicken, few pieces of goat meat and liver.	300gms of goat liver and a piece of goat meat at around 2300 hrs.	Ampicillin cap. Given in complain and water.
30.03.1986	First day of release in an open enclosure. Looking very shy and nervous and took several minutes to come out in the open enclosure. The animal stayed in an open enclosure for a very short period of time. Relaxing quietly and peacefully inside the compartment. No stool found inside the cage.	At 1640hrs offered a solid dressed chicken, Dressed pigeon, water, essence of chicken two bottles and complain. Goat meat and liver, glucose water at around 2200 hrs and	Pigeon accepted 1 kg goat meat and ½ kg liver at around 1600 hrs.	-

		22415 hrs.		
31.03.1986	Relaxing inside the night shelter, did not prefer to move outside. At 1030hrs, found sleeping inside the night shelter. Licked water at 2200hrs and complain at 2245 hrs.	At 1650 hrs offered dressed chicken and dressed pigeon along with 300gm of goat live and goat meat about 600gms.	Accepted half dressed chicken. Observed licking essence of chicken at 1935 hrs.	
1.04.1986	Observed restless at around 1910 hrs to 1915 hrs.Stool found inside its den at 1900 hrs, observed restless at 2245 hrs.The exhaust fan was used to keep it cool and it was seen relaxing afterward. Relaxing quietly at around 1030 hrs. Observed licking complain at 1840 hrs and essence of chicken at 2045 hrs. Stool found inside den at around 2110 hrs.	Offered half dressed chicken in the morning. Solid dressed chicken in evening. Boneless goat meat about 750 gms and liver ½ kg.	Did not accept in the morning. Accepted small piece of chicken at around 1730hrs. Accepted solid dressed chicken	_
2.04.1986	In the morning the animal was found relaxing. Stool found inside cage at 0750 hrs. At 1430hrs the animal was observed relaxing inside the den. At 1800 hrs came out of the den and entered inside the night shelter. Licked water at 2110 hrs and 0100 and complain at 2030 hrs.	One dressed pigeon, goat liver and heart about 700gms. Goat meat about 250gms.Two dressed chicken.	At 1915 hrs seen licking essence of chicken. Accpeted all.	
3.04.1986	Quietly relaxing inside the night shelter in a good health. Stool sent to the Dy.Director for test.	Two dressed chicken. Complan mixed		

	Found licking water at around 1900 hrs. Stool found around d1700 hrs, smelling very bad.	with two eggs and essence of chicken three bottles.		
04.04.1986	In the morning the animal was found relaxing. Occasionally staring outside the night shelter when anybody passing through the cage. Looking solitary.	Complan mixed with one egg. Three dressed chicken, goat and sheep meat (1 kg), Essence of chicken five bottles, glucose water	Accepted all.	Ampicillin mixed with essence of chicken.
05.04.1986	Stool found inside the cage. Relaxing at 1200 hrs. No sign of worms in the stool test.	Dressed chicken, goat meat.	Did not accepted chicken, accepted ¾goat meat, three chicken and about 100gms of goat liver. Chicken essence (ten bottles * 10 ml.) mixed with Ampicillin cap and two eggs.	
06.04.1986	At 1100 hrs animal was lying quietly in	At 1750hrs dressed	All accepted	

	the corner of the den.At1600 hrs the animal came out of the den and with utmost precaution it moved towards its cage from the same route from where it had come out in the morning and slowly entered inside its compartment. Licking its front paws. General appearance was healthy. Observed licking water at 1940 hrs and 2210 hrs.Passed stool at 1945 hrs.Heard making a loud cry at 2300 hrs.	chicken was offered. One chicken, one pigeon and abut one kg. goat meat. Chicken essence (six bottles * 10ml.)		
7.04.1986	Weather was cold so the animal was kept inside the night shelter only. Relaxing inside the cage. Observed licking complan mixed with egg at 1615 hrs.After feeding the animal was seen moving restlessly inside the cage.	Two dressed chicken, beef liver about 700gms. And mutton about 300gms.Dressed chicken offered at 2100hrs and 150 gms of liver.	Accepted all.	Essence of chicken (6 bottles * 10 ml) mixed with two Ampicillin cap. and complan mixed with two eggs at 1100hrs.
8.04.1986	In the morning animal appeared lazy and quiet. Found relaxing inside the night shelter. Animal was not very active however the eyes looked bright and there was no sign of dullness or no visible sign of sickness. Before feeding the animal was restlessly pacing inside the night shelter.	Four Dressed chicken with liver.	Accepted all.	Essence of chicken (6 bottles * 10 ml) mixed with two Ampicillin cap. and complan mixed with two eggs.

9.04.1986	In the morning the animal was resting quietly at the corner of night shelter.	Three dressed chicken,600gms of mutton liver ,essence of chicken (six bottles *10ml) Complan mixed with two eggs	Accepted all.	_
10.04.1986	In the morning at 0830 hrs animal was sleeping. When disturbed the animal found growling.	Four dressed chicken. Essence of chicken (six bottles *10ml). Complan mixed with two eggs	Accepted all.	_
11.04.1986	In the morning the animal was found relaxing at the corner of the cage. In the afternoon Vishna growl at Kashi. Moving very slowly and quietly.	Three dressed chicken, about 200gms mutton liver and mutton about 300gms at 1700 hrs, 1730 hrs and 1820hrs respectively. Complan mixed with two eggs, essence of chicken (six bottles *10ml) at 2040 hrs.	Accepted all.	_
12.04.1986	In the morning the animal was sleeping. During afternoon the animal was taking rest. Passed stool at 0915hrs.	Five dressed chicken, complan mixed with three eggs. Essence of	Accepted all.	

		chicken (six bottles *10ml).		
13.04.1986	In the morning the animal was taking rest. Animal was relaxing most of the time. General appearance was healthy and normal and the eyes were looking bright, however the animal looked lazy and dull. Respiration high at night for about an hour. Passed stool at 2000hrs.	Five dressed chicken. Essence of chicken (six bottles *10ml).	Accepted all.	Two multivitamin tab. Given with mixture of complan and eggs.
14.04.1986	Relaxing inside the night shelter. Observed growling at Kashi. Licked water at 1830hrs.Found restless between 1840-1900hrs.Found restless between 1840-1900 hrs	Six dressed chicken. Essence of chicken (six bottles *10ml).	Accepted all.	Two multivitamin tab. Given with mixture of complan and eggs
15.04.1986	Relaxing inside the night shelter. Taking rest throughout the day. Growled loudly at 2000hrsLicked water at 2200hrs. Passed stool at 2210 hrs.	Essence of chicken (six bottles *10ml).	Accepted all.	Two multivitamin tab. Complan mixed with yellow of two eggs and two multivitamin tab.
16.04.1986	Animal was looking healthy, eyes looking bright although totally lazy and slow.	Four dressed chicken	Accepted all.	Two multivitamin tab. Complan mixed with yellow of two eggs and two

				multivitamin tab.
17.04.1986	During day time animal was looking lazy and inactive. Pacing restlessly to and fro inside its compartment. Made a loud cry at 2015hrs.	Fasting day.	_	Two multivitamin tab. Animal was offered complan mixed with four eggs and water
18.04.1986	Animal was looking a bit active and for a few minutes made slow but free movement and was found pacing from one corner of the enclosure to the other. He appeared a little bit confident and gave a good response by grunting when called upon. To avoid the heat of the day the animal was sleeping in a corner of the enclosure .He appeared tobe in a good health. He made a loud cry at around 1945 hrs.	Four dressed chicken.		Two multivitamin tab. Animal was offered complan mixed with four eggs and water
19.04.1986	During day time animal was observed relaxing at the corner of night shelter. He is active at night. He prefers to take chicken rather than mutton.	Four dressed chicken, liver 750 gms.		Two multivitamin tab. Animal was offered complan mixed with four eggs and water
20.04.1986	Resting at the corner of the enclosure. He was making most precautious and slow movement around the den. No sign of	Five dressed chicken.		Essence of chicken (four bottles

	aggressiveness towards Kashi. Appearance was normal and eyes were looking bright.			*10ml).
21.04.1986	In absence of human disturbance the animal was looking confident. After feeding the animal was moving restlessly inside the cage.	Mutton 600gms. Five dressed chicken.	200gms of mutton. Accepted all.	Essence of chicken (four bottles *10ml). Two multivitamin tab. Animal was offered complan mixed with two eggs and water
22.04.1986	Relaxing at the corner of the enclosure. At 1300hrs animal was taking rest inside the cage. Animal was looking more confident,	Five dressed chicken. Mutton 500gms. Essence of chicken (four bottles *10ml).Mixture of Beef and mutton liver about 1 kg.	Accepted all.	Two multivitamin tab. Animal was offered complan mixed with two eggs and water

Table 1: Records on the behaviour, feed and medical histories of Snow leopard house name "Vishna"

FEEDING RECORD OF SNOW LEOPARD AT PNHZPARK (1986-2013)

SL.NO.	YEAR	FEED AND MEDICATION GIVEN	QUANTITY
1.	1986	Dressed chicken	3kg.
		Sheep meat	1 kg
		Beef	¾ kg
		Liv-52	1 tab
		Multi vitamin	1tab
		Complan mixed with kalzan	1 tab
2.	1987	Dressed chicken	1 no.
		Sheep meat	1.280 kg
		Beef	1 kg
		Liv-52	1 tab
		Multi vitamin	1tab
		Complan mixed with kalzan	1 tab
3.	1988	Chicken	2 no.
		Mutton	2.500 kg
		Liv-52	1 tab
		Multi vitamin	1tab
		Kalzana	1tab
		Vit E	1cap
		Phosphorin	5ml
		Hypocal	5ml.
		Complan	20gm
		Essence of chicken	1 amp.
		Mutton	3.5 kg
4.	1989	Beef	1 kg

		Multi vitamin	2 tab
		Kalzana	1 tab
		Essence of chicken	1 amp.
		Recovit	10m.
		Mutton	3 kg
5.	1990	Beef	1 kg
		Complan	20 gms
		Essence of chicken	1 amp.
		Kalzana	1 tab
		Multi vitamin	3 tab
		Vitamin	1 tab
		Mutton	3 to 3.5 kg
		Off feed day	
		Complan	30 gms.
6.	1991	Beef	500gms.
		Complan	20 gms.
		Multi vitamin	1 tab.
		Kalzana	1 tab.
		Liv- 52	1 tab
		Mutton	3.5 kg
		Off feed day	
		Complan	30 gms.
7.	1992	Beef	½ kg
		Multi vitamin	1 tab
		Ossopan	1 tab
		Mutton	4 kg
		Off feed day	
		Complan	30 gms.
8.	1993	Multi vitamin	1 tab.
		Ossopan	1 tab

		Cod liver oil	1 cap.
		Austrin	1 amp
		Evion	1 cap.
		Mutton	3.5 kg
		Off feed day	
		Complan	30 gms.
9.	1994	Multi vitamin	1 tab.
		Ossopan	1 tab
		Aquasol	1 tab.
		Mutton	4 kg
		Off feed day	
		Complan	30 gms.
10.	1995	Multi vitamin	1 tab.
		Ossopan	1 tab
		Aquasol	1 tab.
		Mutton	4.5 kg
		Off feed day	
		Complan	35gms.
		Egg	1 piece.
11.	1996	Multi vitamin	1 tab.
		Ossopan	1 tab
		Aquasol	1 tab.
		Kalzan	1 tab.
		Mutton	3 kg- 4.5 kg
		Off feed day	
		Complan	35gms.
		Egg	1 piece.
12.	1997	Multi vitamin	1 tab.
		Ossopan	1 tab.

		Aquasol	1 cap
		Cod liver oil	1 cap.
		Mutton	3 kg to 5 kg
		Off- feed day	
		Egg	1 piece
		Complan	35 gms.
13.	1998	Multi vitamin	1 tab.
		Ossopan	1 tab.
		Aquasol	1 cap
		Cod liver oil	1 cap.
		Mutton	3-4.5 kg.
14.	1999	Multi vitamin	1 tab.
		Ossopan	1 tab.
		Cod liver oil	1 cap.
		Aquasol	1 cap
		Cal. Lactate	½tbs.
		Mutton (Wednesday,Friday,Saturday, sunday)	3.5 kg
15.	2001	Mutton (Monday, Wednesday and Friday)	3.5 kg
		Beef (Saturday)	3.5 kg
		Pork (Sunday)	3 kg
		Milk (Amul) every day	500ml
		Chicken (Tuesday)	3.5 kg
		Egg (every day)	1 pc.
16.	2002	Chicken(Tuesday)	4 kg
		Mutton(Tuesday,Wednesday,Friday, Saturday)	3.5 kg
		Beef(Monday)	3.5 kg.
		Milk(Amul)	500ml

		Egg (every day)	1 Piece
17.	2003	Chicken(Tuesday)	4 kg
		Mutton(Tuesday,Wednesday,Friday, Saturday)	3.5 kg
		Beef(Monday)	3.5 kg.
		Milk(Amul)	500ml
		Egg	1 Piece
18.	2003	Chicken(Tuesday)	4 kg
		Mutton(Tuesday,Wednesday,Friday, Saturday)	3.5 kg
		Beef(Monday)	3.5 kg.
		Milk(Amul)	500ml
		Egg	1 Piece
20.	2005	Beef (Monday)	3.5 kg
		Mutton(Tuesday,Wednesday,Friday, Sunday)	3.5 kg
		Chicken (Saturday)	3.5 kg
21.	2007	Chicken (Saturday)	4 kg
		Beef (Monday)	3.5 kg
		Mutton (Tuesday ,Wednesday, Friday Sunday)	3.5 kg.
		Chicken (Saturday)	3.5 kg
22.	2008	Mutton(Tuesday, Wednesday,Friday,Sunday)	3.5 kg
		Chicken (Saturday)	3.5 kg
		Beef	3.5 kg
23.	2009	Beef (Monday, Tuesday, Wednesday)	2.5 kg
		Chicken (Saturday and Tuesday)	2 kg
		Mutton with Skin and Head (Friday)	2.5 kg

24.	2010	Mutton (Friday,)	2.5 kg
		Beef(Saturday,Sunday,Monday, Wednesday)	2.5 kg
		Chicken (Tuesday)	2.5 kg
25.	2011	Mutton (Tuesday)	2- 2.5 kg
		Beef (Wednesday,Sunday,Monday)	2- 2.5 kg
		Egg (everyday)	1 piece
		Chicken (Friday)	2- 2.5 kg
26.	2012	Mutton(Saturday, Monday and Wednesday)	2-2.5 kg
		Beef (Sunday and Tuesday)	2-2.5 kg
		Egg (everyday)	1 piece

Table 2: Feeding record of Snow leopard at PNHZPark (1986-2013)

6.5. MANAGING FIRST SUCCESSFULL CAPTIVE BREEDING OF SNOW LEOPARDS AT PNHZPARK.

In 1980 the American Association of Zoological Park and Aquariums (AAZAP) had introduced the concept of Species Survival Pan (SSP), with the objectives of strengthening and coordinating captive breeding programs in the zoos for ensuring the continued survival of endangered species. Studbook records, genetic information and life histories of individual animals determine the pairing of the breeding individuals so as to avoid the dangers of inbreeding. In 1981 the International Snow leopard Trust (SLT) was founded. It had a strong charter of objectives aimed at international cooperation among the zoos that pledge themselves to the conservation of the Snow leopard in accordance with the requirements under SSP. The fast decline of the Snow leopard population in its natural habitat in the Indian Himalayan deeply concerned the Padmaja Naidu Himalayan Zoological Park, Society, Darjeeling. In1983, the society resolved to launch a program in their zoo at Darjeeling for the conservation of the highly endangered species in captivity. But the past record of keeping the Snow leopard in Indian zoos was not very encouraging. For almost a hundred years the zoos in India had tried but failed to keep Snow leopard in captivity. At the initiative of Mr. Hari Dang, Rector, and St.Joseph's School, Darjeeling and an esteemed member of the PNHZP society approached ISLT for necessary help.

The Trust came forward and helped the society launch its Snow Leopard Conservation Breeding Program at Darjeeling. International experts on the subject helped the zoo with selection of the site, the design of the Snow leopard Breeding Centre (SLBC) and procurement of the first pair of Snow leopards on breeding loan from Zurich.

Padmaja Naidu Himalayan Zoological Park (PNHZP), Darjeeling received two Snow leopards on 21st March 1986. Vishna a male and Kashi, a female from Zurich Zoo.

The historical records showed that till then there had been only one instance of Snow leopard breeding in captivity in Asia. It had taken a zoo in China thirty years of efforts to breed Snow leopards in captivity in 1984. There was no other record of successful breeding of Snow leopard in captivity in Asia. The arrival of Vishna and Kashi at Darjeeling was therefore an important event in the conservation history of Snow Leopard in India.

6.5.1. BREEDING HISTORY OF VISHNA AND KASHI

VISHNA: Vishna was born at Helsinki Zoo on 23.06.1978.He is identified as "Helsinki 38" (Hel 38) in the International studbook of Snow leopard. He was shifted from Helsinki Zoo to Zurich Zoo on 01.06.1979. He was then transferred to Basel Zoo for a short period and then brought back to Zurich on 30.01.1980, from where he came to PNHZP, Darjeeling on 21.03.1986.Vishna was seven years eight months and twenty eight days old when arrived at Darjeeling.

Before he came to Darjeeling, Vishna was mated with Dobra (Zu 4) and had a proven track record as a breeding Snow leopard. At Darjeeling, he accepted Kashi as his mate.

KASHI

Kashi was born at Zurich Zoo on 26.08.1984. On her arrival at Darjeeling on 21.03.1986, Kashi was three years ten months and twenty five days old. She had no proven past record as a successful mother. She mated for the first time with Vishna at Darjeeling on 1st, 2nd and 3rd January 1987. She mated with Vishna again on 27th January to 6th February 1987, and 22nd February to 1st March 1987 respectively.

Kashi had an extended parturation period in May 1987. She had a litter of two cubs. Her first cub was still born on 29.05.1987. On 01.06.1987 a second cub was born with assistance from the zoo personnel. It was still born: male, 492 gms in weight, total body length was 42.5 cm out of which tail measured 16.5 cm. Kashi came into oestrus again on 07.07.1987 but this union was unproductive .Her next mating with Vishna took place on January 11th and 12th, 1988, and again between 1st to 6th February, 1988. Her second litter was born on 24.04.1988, premature and not successfully formed. One was still born and the other she abandoned. Attempts to save the cub failed after intensive effort for forty seven hours. Kashi mated with Vishna again in May 1988, July 1988 and September 1988, but these mating were unproductive.

At this stage the PNHZP Society approached the ISLT again with the case history of the first pair, after a brief on the spot review of the Snow leopard breeding program at Darjeeling the team from ISLT approved the procurement of another pair for the program Hank and Persia arrived from the Little Rock Zoo and Toledo zoo, respectively, on 20.01.1989.

6.5.2. THE SECOND PAIR HANK AND PERSIA

HANK:

Hank was born at Little Rock Zoo, U.S.A. on 06.06.1985 and given a stud book number LR2. Hank was related to Vishna: Hank's grandmother, Marylin (LPZ 6), and Vishna's father, Charlie (LPZ9), where the off springs of Walter (LPZ 2) and Ida II(LPZ 3). Hank was a bachelor when he arrived at Darjeeling. He did not have a breeding history.

PERSIA

Persia was born at San Antonio on 23.04.1980 and given a studbook no. (SA 20). Persia's first litter was born at Toledo Zoo on 24.05.1984. The litter consisted of two male cubs, Koshka (Toledo 3) and Tavarish (Toledo 4). Persia was an experienced mother.

INITIAL OBSERVATSION:

Persia and Hank had travelled by the same International airlines from U.S.A. to Delhi, and then by an Indian Air force carrier from Delhi to Bagdogra near Siliguri.The journey between Bagdogra and Darjeeling Zoo was made by road. They had covered the distance between their zoos of origin to destination under conditions they were not accustomed to. To help the new comers ease the stress of their long journey to Darjeeling we choose the cool and peaceful night time to release and quarantine them in Snow leopard breeding center. The two were given light feed and final check up before the zoo personnel left them for the night. One of the keepers was deputed to record observations over-night in chart format used over the past one year for studying the behaviour of Kashi and Vishna.

The keeper were trained in the use of chart format for recording reliable information on the behaviour of Snow leopards, twenty four hours a day, seven days a week. Earlier, they had collected data on Kashi and Vishna over a period of one year. A look at the data sheet on the behaviour of the new comers over the following day and the day after indicated that Persia and Hank had reacted differently towards their new environment. While Persia ate her feed given, Hank did not touch it at all till midnight; Persia had been moving around at will and watching other Snow leopard and the new keepers without exhibiting signs of stress, wheras hank spent his day time hiding in his wooden box, and came out of his den to take his feed only in the dead of night when the breeding center had become quiet and the human crowd was not in sight. Hank's behaviour also indicated that he was stressed even with the presence of Persia in the neighbouring accommodation, for he rushed back to his den every time he found Persia watching him.

Hank and Persia were to accept each other as mates and get used to their new environs. The climate and new enclosures, faces, sounds and voices of their new keeper's and their attendants, and even the kind of feed they were provided were different from what they were used to in their respective previous stations. Our Study on Kashi and Vishna have told us that the Snow leopard were very sensitive to such changes. Therefore, it was presumed that the sudden change in their life caused by their shifting to Darjeeling was the cause of Hank's behaviour.

At the time of their arrival at Darjeeling Persia was eight years old, older than Hank, who was three years and six months of age and they were complete strangers to each other. They had not seen each other before. They took their flight to India. It was indicated by an International Authority on captive Snow leopards that there was no cause to worry if it took three to four months for their new comers to adjust to each other and the new environment at Darjeeling. When the pair arrived, the breeding season for Snow leopards in the wild was fast approaching its end. Because of their life-histories and age differences, the timing of the breeding season and the difficulty the zoo at Darjeeling had faced with the breeding of their only other pair of Snow leopards, it was a matter of concern for PNHZP to ensure that the two new comers accepted each other as mates as soon as possible. The yearlong observations on the behaviour of Kashi and Vishna helped in managing the adjustment of Hank and Persia to the sudden change in their environment handlers.

6.5.3. MANAGING THE ADJUSTMENT TO THE ENVIRONMENT AT DARJEELING

The Snow leopard is adopted to live in rugged mountainous terrain that can exhibit great variation in the environmental gradients .In its representative habitat in upper Suru valley in Ladakh Himalaya the altitude of the valley varies between 12000-14500 ft. above the mean sea level (msl). The average hight of the surrounding peaks is 18500 ft. the highest being nun at 23440 ft. and kun at 23,250 ft mean sea level. above .On an average the diurnal temperatures can vary from -22°Celsius at 0630 hrs to -6 °Celsius. at 1030 hrs. +27 °Celsius at 1230 hrs under bright sun. At Jangla in the eastern Zanskar, another sample of natural habitat of Snow leopards in the Himalayas, the average diurnal temperature variation may vary between +10 °and 5 °Celsius. Precipitation is mostly in the form of Snowfall. In the Altai mountain range the altitude is moderate but the climate is comparable to the other parts of natural range of distribution of Snow leopard in the world.

Darjeeling does not fall in the natural range of Snow leopard. At about 7000 ft. above mean sea level it lies in moist temperate climatic region of the eastern Himalaya. Here Snow fall is a rarity, rainy season extends from mid June to end of September. The natural habitat of Snow leopard is drier and receives more of snow fall than rain. The Snow leopard's range in its natural habitat in the Himalaya covers rocky terrain with sparsely distributed vegetative cover, but the zoo had an extensive and dense tree cover.

Out of the factors one could anticipate as contributing to the stress on Hank the efficacy of management intervention was expected to be limited where the factors beyond human control were involved, such as climate, weather etc. thus focus of activity, therefore, revolved mainly round the manageable opportunities for making the two Snow leopards helped in achieving the objective of management intervention.

Climate management was beyond the capacity of Zoo authorities. Weather conditions could be handled to some extent. Rains were not like by all the Snow leopards, who preferred to sit back in their rooms. During the first week at Darjeeling it did not rain, and the days were mostly sunny, the nights were quite cold and dry. It did not take extra effort to have hank and Persia adjust to the winter season at Darjeeling.

In case Darjeeling received rain preparations had been made to spread a translucent polythene sheet half way over the roof of the outdoor enclosures, which would keep the rain out. Kashi and Vishna had adjusted to such an arrangement. Later on during the year Perasi and hank also accepted such an arrangement. In 1990 when it snowed at Darjeeling all the Snow Leopards were allowed access to the Snow covered outdoor enclosure and were observed to play and romp in the snow.

Vegetation could be manipulated to a limited extent, without introducing exotics or plants alien to the forest ecosystem at Darjeeling. Very few trees grew in the outdoor enclosures. These were looped lightly for allowing sun on to the ground of the enclosures and dry it up. The ground surface in the outdoor enclosures was patchy with tufts of grass. These tufts were not removed and were allowed to grow in the enclosure, for Kashi and Vishna had been observed eating grass blades from time to time. The literature had also indicated that Snow leopard do take grass once in a while. The taller plants in the enclosure were regularly trimmed at the top so as to keep them below the roof level of the enclosure. It did not take long for hank and Persia to adjust to the natural environment of Darjeeling.

6.5.4. MANAGING ACCEPTANCE OF NEW KEEPERS

The supervisor of the Snow leopard Breeding Centre and the attendants at Darjeeling tried to introduce themselves by calling out hank and Persia by name and offering them small pieces of meat dipped in milk and complan. Persia cautiously came out and accepted the gift and returned to her box, but Hank stayed in his box. A few attempts later Persia accepted the proximity of her new keepers and attendants, and did not rush back to hide in her den box. She was found to like complan in a cup of milk in the morning. With this as a lure she quickly accepted her new keepers.

Hank had shown liking for his cup of complan and milk, but he refused to accept the drink from any person at the zoo so long as the cup was held up by one. One had to place the cup on the ground and leave the spot. It was suspected that the problem might have arisen because Hank was used to fair–skinned, tall and fair and could speaking keepers. The only one who he might accept was Kiran, who was tall and fair and could speak English fluently. Kiran was asked to approach Hank with a cup of complan and call him by his name and speak to him in English. He was successful with this new approach in drawing hank out of his den. Hank warily approached the cub held in Karan's hand. Kiran coaxed him on with his soft talk. Hank started lapping the tasty concoction. After a few moments of speaking to him in low, soft voice Kiran gently touched on his head. Hank did not flinch: and it was a beginning of a new relationship. In a few days hank became comfortable with other keepers and attendants of the centre, too.

6.5.5. MANAGING ACCEPTANCE OF OTHER SNOW LEOPARD AT SLBC.

The snow leopard housed at the Snow leopard breeding center at Darjeeling consisted of eight rooms in two rows of four rooms each separated by a common service corridor running between the rows under a common roof .The rooms were numbered A to D. In each row, starting with A, nearest to the entrance to the house D being the farthest from it. Near the entrance to the Snow Leopard house in each row an inspection chamber (IC) was constructed of chain mesh and iron stripes to facilitate holding and quick examination of a Snow leopard .It was accessed by a sliding gate in the room to which it was attached. Two outdoor enclosures, numbered 1 and 2, served one row of four rooms each. Each room had three openings: one provided access to the outdoor enclosure, another opened in to the common corridor and the third one opened into the adjacent room, or inspection chamber, as the case may be in the row. These openings were served by sliding gates that could be operated by the keepers from outside .In this manner, the rooms in each row were inter- linked by sliding iron bar gates and any occupant could be moved from one room to the other or to the inspection chamber.

A pair of adjacent rooms in each row A & B and C & D respectively was allotted to a Snow leopard at the Snow leopard breeding center . Rooms B and D were furnished with a den–box each to provide an inner sanctum sanctorum to the Snow leopards and a chance to isolate them from stress generating environment or unwanted human disturbance. Rooms A and C were used to serve food and water.

On the day of arrival of hank and Persia, the SLBC had only two inhabitants: Vishna and Kashi. Kashi occupied rooms A and B, and Vishna was in rooms C and D of the row attached to outdoor enclosure 2. Hank was accommodated in rooms A and B, and Persia in rooms C and D of the row accessing outdoor enclosure 1. Hank came to occupy the rooms facing Kashi's accommodations. This was done to facilitate maximum visual interaction between the Snow leopards of both sexes. It helped in understanding their mutual comfort levels respect to one another. Kashi and Vishna, who occupied the set of four rooms in the facing row, spent most of their time looking at the new comers. Persia had simply returned their stares a few times, but Hank had not ventured out of his den. Overall, the snow leopards evidenced non aggressive interest in one another and easily accepted their presence in the SLBC.

MANAGING ACCEPTANCE OF PERSIA BY HANK AS MATE

Hank was extremely reluctant to come anywhere near Persia. He was even shy of her staring at him. It seemed that hank was nervous of Persia's presence. The moment he saw Persia in the adjacent room he would steal back into his box. Hank was supposed to pair with Persia. His fear of Persia could result in his non acceptance of her as a mate. Breeding programmes do not succeed if the breeding individuals do not take a softer line. This was rather upsetting and it seemed he needed special attention for introducing him to Persia.

After quarantine days, a field observation diary was being maintained from 28.01.1989 in which observations made on the behaviour of Persia and Hank in the monitoring chart format were collated and entered. The main observation on the behaviour of Snow leopards are extracted are extracted from the observations collated in the FOD.

THE APPROACH

The approach was based on clues generated by the year long observations on Kashi and Vishna recorded in the Snow leopard behaviour monitoring register. The process of introduction was planned to proceed in a subtle manner by facilitating brief visual contact between Hank and

Persia, initially for a few minutes. The exposure time was to be gradually increased, and the two Snow leopards were to be brought together in the outdoor enclosure when Hank reservations were observed to be diminishing.

The room in which hank and Persia were lodged allowed them independent access to a common outdoor space. It was planned that till such time as they started accepting each other's presence in their SLBC accommodation, they should be separately released in the outdoor enclosure, one after the other. Besides allowing them to exercise their limbs and acclimatize to their new environment it was aimed at getting Hank accustomed to Persia's use of the area in the outdoor enclosure.

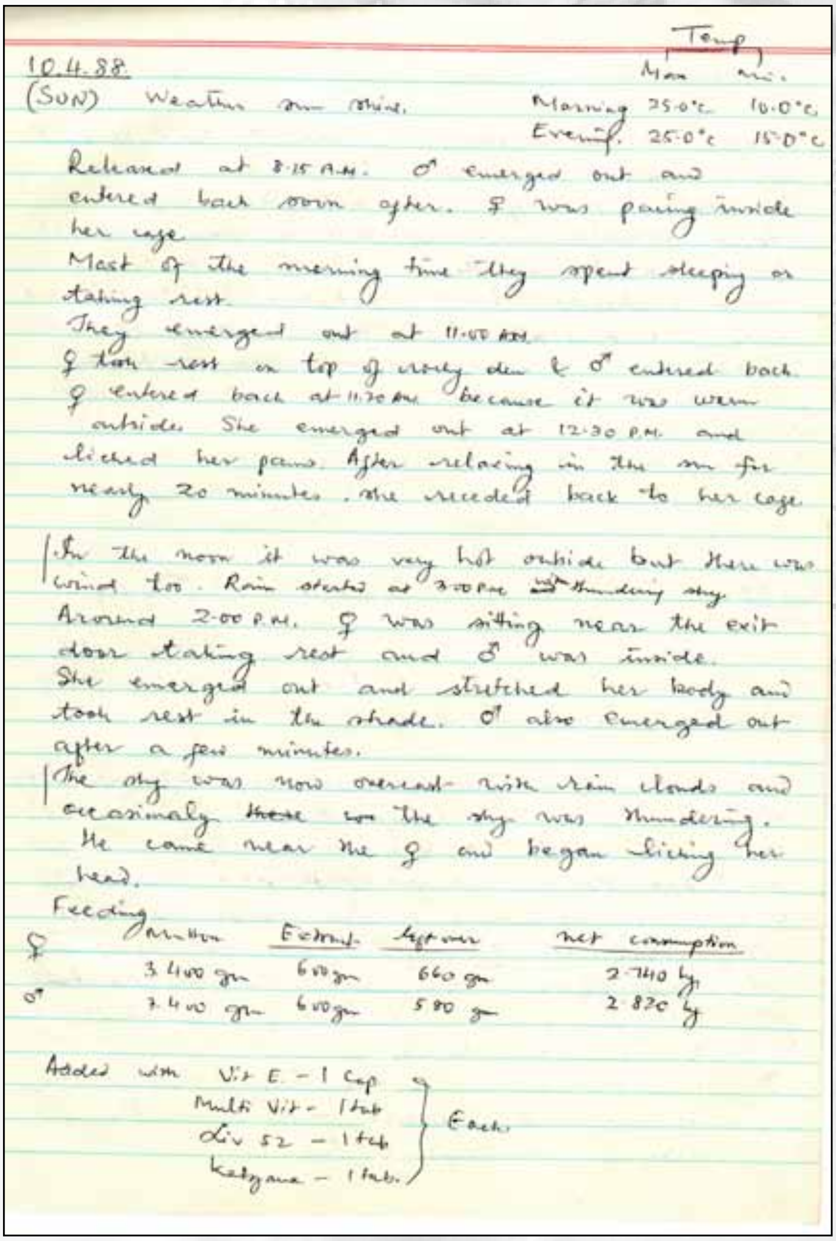
The next step was to allow each of them to get used to their body scents. It was planned to be achieved through the behaviour of sniffing at the spots and the smears made by the individual animal using their body parts and physiological processes including the making of scrapes on the ground or raking objects with their claws, urination and passing of stool. The time to start with this step would be indicated when at least one of them was in heat. On the basis of the observation of their responses to the marked spots further steps would be taken for bringing Hank and Persia together to mate. Timing of these actions was of great importance. The timing of release of Hank and Persia together for mating was to be guided by the exhibition of indicators of high intensity desire by Hank and Persia to mate. One of such indicators is the exhibition of a silent grimace called "Flehmen".

MONTIORING METHODOLOGY

The observation was made round the clock in the format in which activities were arranged in the top row and time in the first column. Time was entered in the first column in chronological order as and when any of the activities defined in the top row occurred. The observer recorded a tick-mark under the column for the activity and against its time of occurrence. Extra entries, if required, were made in the Remarks column on the activity chart, or on a separate sheet. The salient features of the pre-mating breeding behaviour exhibited by the two Snow leopards are summarized below and the sample of observation sheet maintained earlier at the park in 1986 and onwards and how the methods of data collection gets modified from time to time. Even though the behavioural observation was being done continuously the time of data recording was random, so it was not possible to analyze the datas from the observed behaviours. Therefore during the project tenure an ethogram was constructed to observe the behaviour of the snow leopard using "Focal and Continuous" sampling method (Altman, 1974)

Fig. 7 formats of the behaviour observation sheets maintained at PNHZPark, Darjeeling (1986 to 2011)

Fig. 7a Sample of behaviour observation sheet in 1988



10.4.88
(SUN) Weather sun shine.

	Temp Max	Min.
Morning	25.0°c	10.0°c
Evening.	25.0°c	15.0°c

Released at 8.15 A.M. ♂ emerged out and entered back soon after. ♀ was pacing inside her cage
Most of the morning time they spent sleeping or taking rest
They emerged out at 11.00 AM.
♀ took rest on top of wooly den & ♂ entered back
♀ entered back at 11.30 AM because it was warm outside. She emerged out at 12.30 P.M. and licked her paws. After relaxing in the sun for nearly 20 minutes, she receded back to her cage

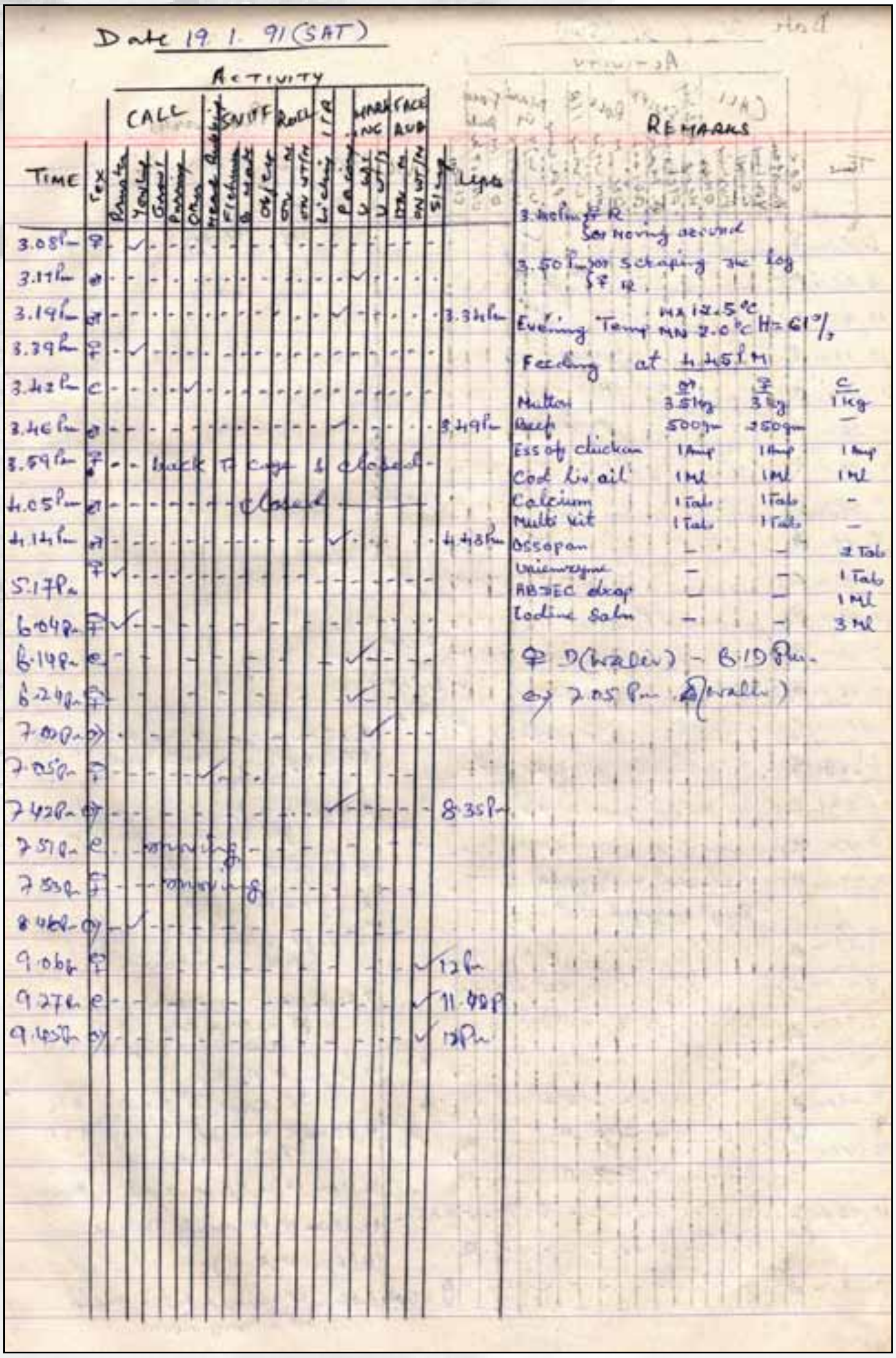
In the noon it was very hot outside but there was wind too. Rain started at 3.00 PM with thundering sky.
Around 2.00 P.M. ♀ was sitting near the exit door taking rest and ♂ was inside.
She emerged out and stretched her body and took rest in the shade. ♂ also emerged out after a few minutes.
The sky was now overcast with rain clouds and occasionaly ~~there~~ was the sky was thundering.
He came near the ♀ and began licking her head.

Feeding

	Mutton	Extract.	Leftover	net consumption
♀	3.400 gm	600 gm	660 gm	2.740 kg
♂	7.400 gm	600 gm	580 g	2.820 kg

Added with Vit E. – 1 Cap
Multi Vit – 1 tab
Liv 52 – 1 tab
Kalzana – 1 tab.
} Each

Fig. 7b: sample of behaviour observation sheet in 1991



Date 19.1.91 (SAT)

ACTIVITY: CALL | SNIFF | ROLL | MARKING | FACE RUB — REMARKS

TIME	Sex	Remarks
3.08pm	♀	
3.11pm	♂	
3.19pm	♂	
3.39pm	♀	
3.42pm	C	
3.46pm	♂	
3.59pm	♀	back to cage & closed
4.05pm	♂	closed
4.14pm	♂	
5.17pm	♀	
6.04pm	♀	
6.14pm	C	
6.24pm	♀	
7.00pm	♂	
7.05pm	♀	
7.42pm	♂	
7.57pm	C	moving
7.58pm	♀	moving
8.46pm	♂	
9.06pm	♀	
9.27pm	C	
9.45pm	♂	

Remarks:

3.40pm ♀ R, Son moving around

3.50pm son scraping the log ♀ R

Evening Temp MX 12.5°C MN 2.0°C H = 61%

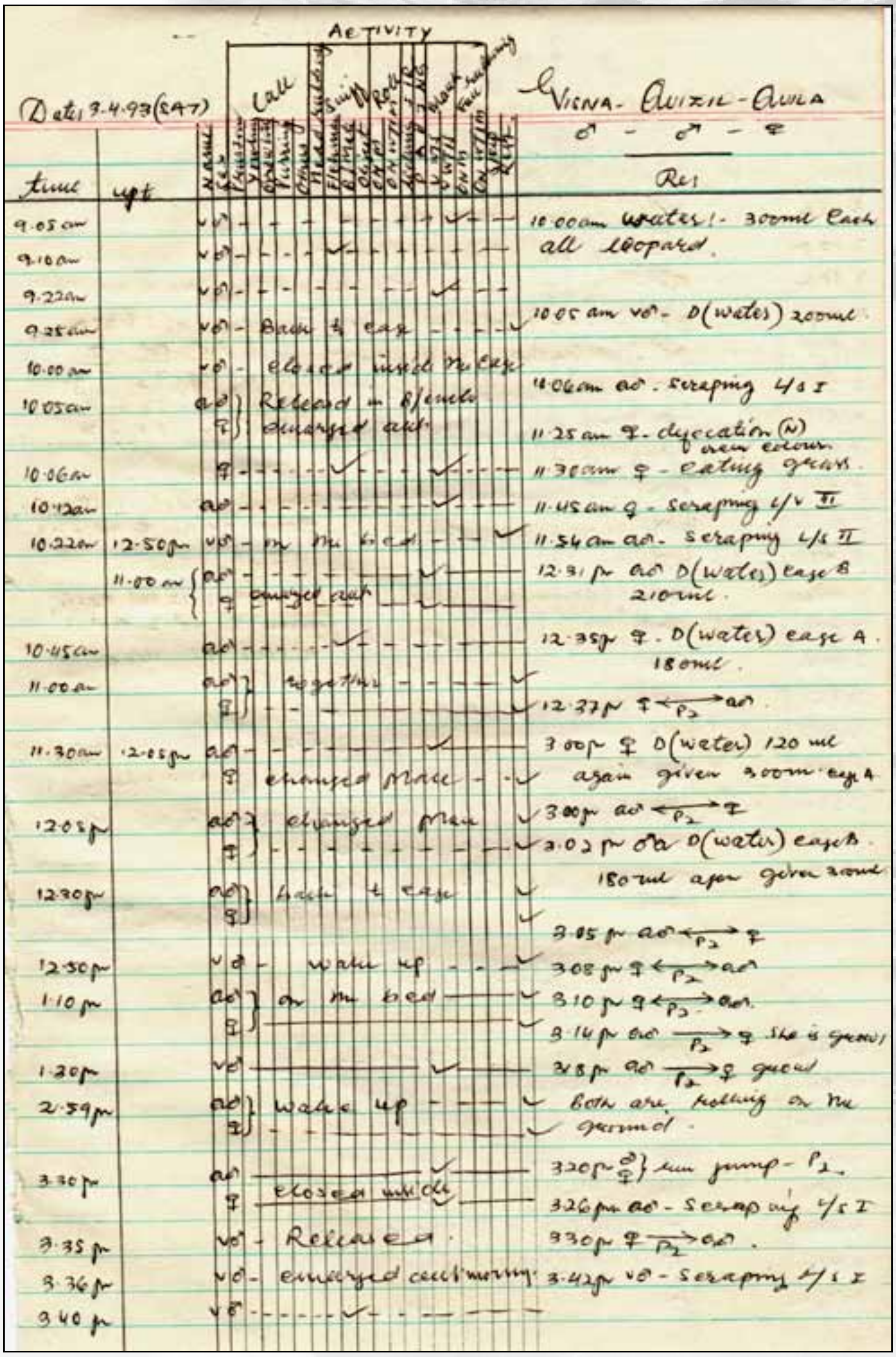
Feeding at 4.45 PM

	♂	♀	C
Mutton	3.5 kg	3 kg	1 kg
Beef	500 gm	250 gm	—
Ess of chicken	1 Amp	1 Amp	1 Amp
Cod liv oil	1 ml	1 ml	1 ml
Calcium	1 Tab	1 Tab	—
Multi vit	1 Tab	1 Tab	—
Ossopan	—	—	2 Tab
Unienzyme	—	—	1 Tab
ABDEC drop	—	—	1 ml
Iodine Salt	—	—	3 ml

♀ D (water) – 6.10 pm

♂ 7.05 pm (water)

Fig. 7c: sample of behaviour observation sheet in 1993


Date 3.4.93 (247)

ACTIVITY

Visna - Quizil - Qula
♂ - ♂ - ♀

Res

10.00am water :- 300ml each all leopard.

10.05 am V♂ - D(water) 200ml.

11.06am Q♂ - Scraping 4/s I

11.25 am ♀ - defecation (N) over colour

11.30am ♀ - eating grass.

11.45 am ♀ - scraping 4/s II

11.54 am Q♂ - scraping 4/s II

12.31 pm Q♂ D(water) cage B 210ml.

12.35pm ♀ . D(water) cage A . 180ml .

12.37pm ♀ $\xleftrightarrow{P_2}$ Q♂ .

3.00pm ♀ D(water) 120 ml again given 300ml cage A

3.00pm Q♂ $\xleftrightarrow{P_2}$ ♀

3.02 pm ♂Q D(water) cage B . 180ml again given 300ml

3.05 pm Q♂ $\xleftrightarrow{P_2}$ ♀

3.08 pm ♀ $\xleftrightarrow{P_2}$ Q♂

3.10 pm ♀ $\xleftrightarrow{P_2}$ Q♂.

3.14 pm Q♂ $\xrightarrow{P_2}$ ♀ She is growl

3.18 pm Q♂ $\xrightarrow{P_2}$ ♀ growl

Both are rolling on the ground .

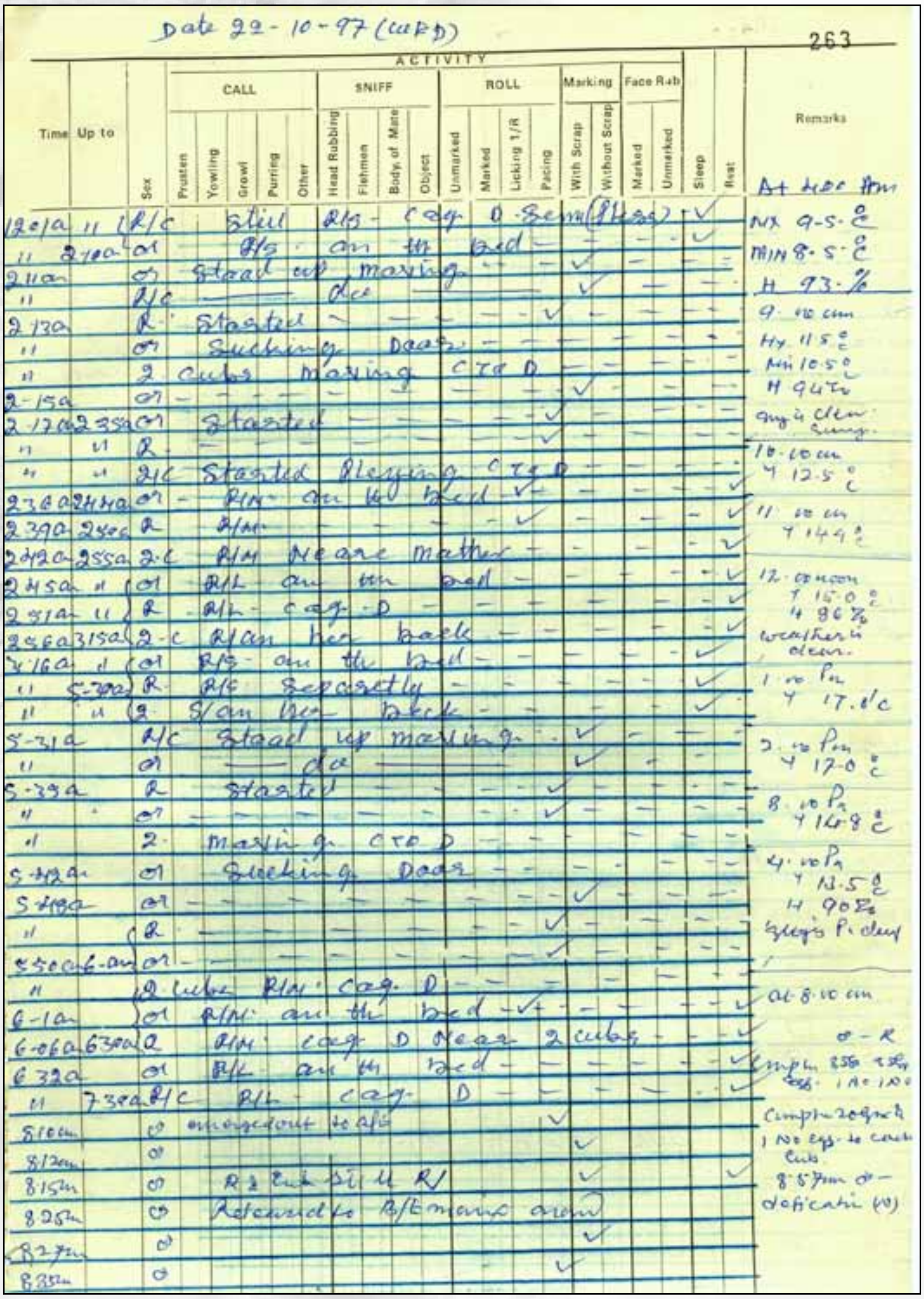
3.20pm ♂ ♀ } run jump - P_2.

3.26pm Q♂ - Scraping 4/s I

3.30pm ♀ $\xrightarrow{P_2}$ Q♂ .

3.42pm V♂ - Scraping 4/s I

Fig. 7d: sample of behaviour observation sheet in 1997



6.5.6. MANAGING ACCEPTABILITY OF THE MATES

VISUAL ACCEPTANCE

The process of breaking ice between Hank and Persia started on 26.01.1989 with the serving of their favorite morning cup of milk and Complan. The iron-barred sliding gates interconnecting the rooms allowed visual access to the adjacent rooms. But so far Hank had been reacting to Persia's presence in his field of view by dashing back into his den-box and staying in for long periods of time.

Hank's feeding place was room 'A' near the entrance to the night shelters and his den was in room 'B'. Persia's feeding place was in room 'C' and her den in room 'D'. By design, on the morning of 26.01.1989., hank was called out first for his morning drink. He cautiously emerged from his den; Persia was nowhere in sight. While in room 'A' Hank lapped up the mixture held out in his cup by Kiran, one of the keepers called Persia to the front door in room C for her cup of milk and Complan. Persia came and lapped up her drink, all the while keeping an interested eye on Hank her stare disturbed Hank. He was in a quandary; to flee, or not to flee. He fidgeted, but Kiran encouraged him to stay on with his reassuring words and softness caresses. Eventually, Kiran and milk won Hank stayed on and finished his cup of Complan and milk, while Persia kept looking at him. For a few days Hank relied on Kiran as a shield against Persia's attentions. Thereafter, he grew a little bold and did not bolt away at the sight of Persia. He became more accustomed to Persia's attentions are 30.01.1989, and stopped avoiding her proximity.

6.5.7. ROLE OF SCENT MARKING IN BREEDING BEHAVIOUR OF FELIDS

Scent is known to play an important role in the lives of terrestrial large mammals, as the olfactory senses helps in distinguishing a friend from foe, assess the readiness of an individual of opposite sex for mating social bonding and other relationships vital for the survival of the species. Olfactory acceptance of the mates is essential before individuals accept each other as mates, whether in the wild or in captivity. The mechanism of olfactory acceptance involves sniffing of the body, air borne smell and spots and objects marked with its pheromones by the target individual. Among its many values is the one concerned with inducing sexual activity in an inactive partner. The role of sniffing of scent marked spots and objects may need some elaboration. In wild big cats tiger and leopards are known to mark out their stakes with pheromones in their urine. Most people believe it to be a major for establishing their territories during the field observations on tigers and leopards the author had observed that the role of scent marking (pheromone marking) was not confined only to terrestrial behaviour of the animals. The authors personal observation on the wild tigers and leopards were: a. That the marking behaviour was not noticed all the year round; b The scent marking behaviour was exhibited mostly when the big cats were in breeding condition and were on the lookout for a mate; and c The marking frequency was not uniform, it fluctuated during their breeding season. These observations indicated that there was much more to the role of scent marking than just establishment of territory.

The act of sniffing a marked spot by another individual induced the later the start spots with its own scents, if not already doing so. For the benefit of individuals of the same sex scent marking served the purpose of advertising the occupancy of the area by the availability of a mate for breeding also resulted in inducing breeding response in the less active individual of opposite sex and for promoting sexual activity.

Sniffing at a scent marked spot may be followed by the exhibition of “Flehmen”. Flehmen helps determine the breeding status of the marker animal. It is an indicator of the intensity or an urge to mate. The animal exhibiting Flehmen shows a peculiar facial expression in which its eyes are narrowed down, its nose wrinkled up, its upper lips pulled up and the tongue is allowed to hang loosely out of the mouth while the breath is forcefully drawn in to carry the scent to Jacobson’s Organ

The behaviour was also observed in captivity. The yearlong study of the behaviour of Kashi and Vishna confirmed the hitherto unrecorded role of scent marking in the breeding behaviour of big cats. At the zoo, it was found that Kashi started scent marking only when she was in heat. Initially both the male and female big cats did not start marking spots with their pheromones on the same day: there was a time differential in their marking activity. If one started scent markings the spots before the other did, the later would, after sniffing at the spot start marking the spots with its own pheromones signatures sometime later, which could even be a few days. The process then took a cyclic rhythm in which both the animals with marked spots in the same area with their urine borne pheromones. After a few days of marking the activity waned, in a somewhat similar but not necessarily the same differential time scale. The difference in starting and ending times for scent marking periods of the two animals reduced with every cycle till it became close enough for them to start mating. A similar pattern of breeding behaviour was also observed in Siberian tigers and common leopards in the zoo. The scent marking behaviour indicated that it could play an important role in bringing two individuals of the opposite sex together. This characteristic of scent marking behaviour was picked up as useful clue for thawing the ice between hank and Persia.

6.5.8. MANAGING PRE-MATING BEHAVIOR OF HANK AND PERSIA

Persia came into estrus on 28.01.1989 when she started marking her enclosure with her pheromones through her urine. During the following days she gradually started exhibiting all signs of her seeking a mating partner. These included, casting steady stress from time to time at male Snow Leopards, Hank and Vishna. Vishna was mating with Kashi and the project needed Hank as Persia's partner. In her own rooms as well as in outdoor enclosure Persia was observed sniffing at different spots from Day 1 (28.01.1989) and started marking spots with her urine-borne pheromones from Day (30.01.1989). she started making scrapes by ranking the wooden floor of her rooms C and D, and on ground in the outdoor enclosure, and scent marking them from Day (31.01.1989).

As soon as Hank showed signs of overcoming his fear of Persia, he was restrained from rushing back to his room after sniffing the spots marked by Persia. It was done by the simple expedient of sliding close the gate to the outdoor enclosure once he was out of his night shelter. Hank soon discovered an artificial cave in it. He had now the choice of moving around in the enclosure or spending his time hiding in the cave; but the cave did not allow him complete isolation from the outside world.

Persia had been leaving her scent scattered about on different spots in the enclosure. Hank started sniffing at the spots marked by Persia. There was a perceptible change in his response to Persia's presence in the night shelter. He had stopped making a run for at the approach of Persia.

6.5.9. FACILITATING CONTACT BETWEEN MATING PATNERS

Hank's behaviour on the observation chart indicated his lees than expected activity. There were some contradictions noticed in his behavior. On day 5 (02.02.1989) Both Hank and Persia intermittently looked at each other. At 1813 hrs Persia and Hank stood close to each other on either side of the sliding gate between their respective rooms. On Day 6 (03.02.1989) Hank and Persia stood close to each other for some moments, but Hank did not stay near her and moved away. Hank had exhibited some degree of tolerance to Persia's attentions but he did not appear to be ready to be put together in the same room or enclosure with Persia. On Day 8 (05.02.1989) Hank appeared to be attentive toward Persia, watched Kashi, heard the scrapping sounds made by Persia, sat near the interconnecting sliding gate between Rooms B and C. on Day 9 (06.02.1989) Hank scent marked some spots in his room, but went back into his den-box and watched Persia's activities through its entrance,. When he emerged from the den-box he did not run away when Persia came and sat down near him at 2249 hrs. on Day 10 (07.02.1989) Hank sniffed, looked around and sprayed the entrance of his den-box with his urine, but was reluctant to come out in the outdoor enclosure. Hank's behavior indicated that he was getting ready to breed, but was avoiding moving about when the chance to get closer to Persia arrived or was given by the keepers.

A close examination of the chart revealed that he had not passed stool over the past five days since 3.2.1989. It was suspected to be the unknown reason why he exhibited contradictory behavior; he exhibited his interest in Persia, but spent most of the time sitting in his den-box, as if avoiding her. Any attempt to force him out of his den elicited growls of protest. Hank used to take his morning cup of Complan and milk if offered by Kiran. But he did not take feed at the scheduled time in the afternoon. He would take his feed at 2356 hrs when everything around was quiet and calm. Hank's feeding behaviour coupled with his spending most of his time in his den box contributed to his suffering from constipation for five days between 3rd – 7th February 1989. He was treated for constipation on 07.02.1989. On day 11 (08.02.1989), after clearing his bowels, he became active and exhibited the signs of readiness to mate with Persia. He gave prusten calls, did not avoid Persia's presence, marked spots with his scent, gave head shake and in general he was more active than on previous days.

On day 12th (09.02.1989) Persia and hank were released simultaneously in the outdoor enclosure at 1015 hrs. Persia was released first, and after she had a round of the enclosure, sniffing the spots Hank had marked, the sliding gate of Hank's room was opened to let hank enter the outdoor enclosure. Hank stood half in and half out to the door of his room, watching Persia about on her own business of sniffing at the marked spots. After a few long moments, Persia looked up at hank that seems to be at the brink of shying away. A bucket full of water and a long thin stick with a piece of cloth tied to one end was kept ready for separating the two in case their first meeting turned into a hostile confrontation, but Persia whispered her reassuring "prusten"; making him relax his taut muscles. She slowly walked away at an oblique angle from Hank, who hesitantly stepped out into the enclosure. The door of Hank's room was closed behind him.

Hank looked over his shoulder and found his retreat cut off. He sat down on his hunches and stared at us in an accusing manner. Persia came to his rescue; she quickly came up to him and stood near him. Hank also stood up ready to run away from her, but Persia was quicker; she blocked his way with her body and then touched him, nose to nose. It was a bit amusing: hank, his hairs pressed down flat against his head and eyes wide, was a portrait of abject fear; and Persia with her reassuring prusten, body sniffing and gentle rubbing of her chicks and face on Hank's head and face, was a picture of love, the picture was dramatic. Hank relaxed and we too relaxed and out anxiety vanished in thin air. Hank stood there for a few more moments and allowed Persia to touch him, On 09.02.1989 and 10.02.1989 the two snow leopards played with each other running and playing tagged around the outdoor enclosure. Hank sniffed at Persia's body and seemed to have accepted her company without reservations. They mated from day 13th (10.02.1989) to day 16th (13.02.1989) after Persia came in estrus. Hank and Persia had mated within 20 days of their arrival at Darjeeling. The two had adjusted well to each other's company. On 20.05.1989 Hank and Persia contributed the first ever record of successful breeding of Snow leopard in captivity in South east Asia but it was not without its own hurdles and hiccups.

6.5.10. CONCLUSION

The clues from the data on monitoring the behaviour of Kashi and Vishna during 1988 had provided an invaluable contribution to the Conservation Breeding of Snow leopard at Darjeeling. We did not separate the two even after their mating was over. Persia mated with Hank from 10.02.1989-13.02.1989 and delivered a litter of two female cubs on 20.05.1989.

The study had confirmed the value of scent marking in the breeding behaviour of big cats. The successful management of pre-mating behaviour of Hank using this knowledge as a tool suggests new possibilities in the management of breeding of rare and endangered species of big cats in captivity. Regular monitoring of the behaviour of rare and endangered species of wild life in captivity provided important inputs to the understanding of the imperatives of their conservation. Zoos, particularly the Conservation Breeding Centres provide priceless opportunities to study certain aspects of etiology of wild animals that otherwise are not accessible in free ranging conditions.

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7. CAPTIVE HUSBANDRY FOR KEEPING SNOW LEOPARD.

When designing housing areas for Snow leopards some important factors to consider are their shy, elusive, reclusive nature and the reputation of aggression between individuals of same sex.Wild Snow Leopard typically live a solitary existence, occupying home range of 12-39 km²(Jackson and Ahlborn, 1988) and travelled an average straight line of 0.8 km².The longest distance moved in one day is 7 km² (Jackson and Alhborn,1988).In captivity ,however they are often housed with , or in close proximity to, other Snow leopard (as well as other species), and spatial and financial constraints restrict enclosure size, resulting insignificantly smaller territories. Thus in designing the housing, it is important to consider the animal's natural habitat and the behavioural needs.

7.1. EXHIBIT DESIGN: Careful consideration should be given to exhibit design. The terrain used by Snow leopards is typically extremely rugged (Schaller 1977, Koshkarev 1984, Mallon 1984b, Fox et al. 1988, Jackson and Ahlborn 1988) .They show a high preference for cliff, areas with slopes in excess of 40 □ and areas with 25m of edges with cliff. Preferred bedding sites are situated on or near ridges, cliffs and other sites with good views. Snow leopards prefer to move, bed, and mark along linear topographic features such as major ridgelines, bluff edges, gullies, and the base or crest of broken cliffs (Jackson and Ahlborn 1988).Thus Animals should be displayed, whenever possible, in exhibits replicating their wild habitat and in numbers sufficient to meet their social and behavioral needs.

7.2. EXHIBIT SIZE: The behavioral needs of the animals are an important factor in the development of exhibit size recommendations.

Table 3: Minimum prescribed size for feeding/ retiring cubicle for important mammalian species of captive animals (as per CZA guidelines)

sl.no.	Name of the Species	Size of the feeding cubicle/ night shelter for each animal (meters)		
1.	Common leopard, Clouded leopard & Snow leopard	Length	Breadth	Height
		2.00	1.80	2.5

Table 4: Minimum prescribed sizes for outdoor open enclosures for important mammalian species in captivity (as per CZA guidelines)

sl.no.	Animals/ Species	Minimum size of outdoor enclosure (per pair) (Square meters)
1.	Panther, Clouded leopard and Snow leopard	500

Table 5: AZA Recommended enclosure sizes for Snow leopards (Rigger 1978)

Exhibit type	Size range	Recommended size
Outdoor	25-190m^2	Maximum
Indoor	6-50m^2	"
Off-exhibit dens	2-6m^2	"

For evaluation of Carnivore enclosure and upkeep different Indian Zoos (Himalayan Zoological Park, Sikkim, National Zoological Park, Delhi, Nehru Zoological Park, Hyderabad, Nandankanan Biological Park, Bhubaneswar and Alipore Zoological Gardens, Kolkata) were visited where the records collected were on enclosure, night shelter areas specifications, enclosure furnishing and sanitation including behavioural observation of the species kept, to have a comparative study with that of Snow leopard in the wild and to standardize the holding area and enclosure size for the Snow leopard at PNHZPark to meet their psychological and behavioural needs.

Table 6: Table depicts the Size of Enclosure and holding area of different Indian Zoos housing Snow leopard.

		NAME OF ZOO	
SL.NO.	**NO. OF ENCLOSURE**	**PNHZPARK DARJEELING**	**HIMALAYAN ZOOLOGICAL PARK GANGTOK.**
1.	Enclosure area(in sq.mt.)	Enclosure no.1(C.B.C)-207.98	1800 sq m
		Enclosure no.2 (C.B.C)-230.00 sq.mt.	
		Enclosure no.3 (C.B.C)-230.00 sq.mt.	
		Enclosure no.4 (Beat-4)-107.11 sq.mt.	
2.	Enclosure dimension	Enclosure no.1 (C.B.C)-L: 8.90mt. B: 2.15mt. H: 2.89mt.	5.2 m (height) + 1.2 m (overhang
		Enclosure no.2 (C.B.C)-L: 8.90 mt., B: 2.15mt. H: 2.89mt.	
		Enclosure no.3 (C.B.C) - L: 8.90mt. B: 2.15mt. H: 2.89mt.	
		Enclosure no.4 (Beat-4) - L: 6.65mt. B: 2.11mt. H: 2.61mt.	
3.	Enclosure substrate	Earth and cemented flooring.	Earthen with much vegetation
4.	Type of enclosure barrier	chain link mesh	Chain link mesh.

5.	substrate of retiring cells	Cemented flooring. All the retiring cells for the snow leopards have cemented flooring where wooden platforms are provided to the animals in each retiring cells for warmth. The wooden planks are removable.	Cemented flooring.
6.	Availability of squeeze cage	Availability of squeeze cage for treatment of animals attached with enclosures	No
7.		The roofs of the retiring cells have been provided with skylight as a result of which the retiring cells receive sunlight in entire day.	_
8.		Boiled drinking water is provided in the steel water bowls the entire day inside the retiring cells.	Boiled drinking water is provided in the silver water bowls throughout out inside the retiring cells.
9.	Vegetation type in the enclosure	Mixed type.	
10.	kraal dimension		12.2 m x 12.2 m x 2.7 m

Table 7: Table depicts the name of tree species planted inside the Snow leopard enclosure at PNHZPark.

ENCLOSURE: 1(C.B.C)

SL.NO.	TREE SPECIES	APPROX HEIGHT OF TREE IN THE ENCLOSURE	
	Mahonia acanthifolisa (Chutro)	15-20 ft	
	Arundinaria sp. (Bamboo)	10 ft	
	Ficus nemoralis (Dudilo)	30-50 ft	
	Michelia cathcartii (Tite champ)	60-80 ft	
	Machilus edulis (Lapche kawla)	80-100 ft	
	Eurya acuminate (Jhingani)	30-40 ft	

ENCLOSURE: 2(C.B.C)

SL.NO.	TREE SPECIES	APPROX HEIGHT OF TREE IN THE ENCLOSURE
	Cryptomeria japonica (Dhupi)	20-40 ft
	Arundinaria sp. (Bamboo)	10 ft
	Ficus nemoralis (Dudilo)	30-50 ft
	Acer osmastoni (Kapasi)	100-120 ft.
	Castanopsis hystrix (Katus)	100-120 ft
	Quercus fenestrate (Arkawla)	30-40 ft
	Michelia cathcartii (Tite champ)	60-80 ft

ENCLOSURE: 3(C.B.C)

SL.NO.	TREE SPECIES	APPROX HEIGHT OF TREE IN THE ENCLOSURE
	Michelia cathcartii (Tite champ)	60-80 ft

	Eurya acuminate (Jhingani)	30-40 ft
	***Cinnamomum impessinervium* (Sissi)**	**40-50 ft**
	***Michilus gammieana* (Chiple kwla)**	**60 ft**
	***Acer laevigatum* (Putli)**	**60-80 ft**
	Machilus edulis (Lapche kawla)	80-100 ft
	Quercus fenestrate (Arkawla)	30-40 ft
	***Engelhardita spicata*(Mauwa)**	**60-100 ft**

Fig. 7: Snow leopard enclosure I at CBC

<u>Snow Leopard Enclosure I at CBC</u>

This is a good off display enclosure in the Conservation breeding of Snow leopard. There are basically two enclosures with night shelters in the same building. The enclosure is made up of strong chain link. There are eight number of night cells (four on each side) with kraal (one on each side) with a long passage in-between. The level of night cell has been raised to reduce dampness. Kota stone flooring has been done in addition to providing wooden bed in each of the house. The slope in the enclosures is gentle. Each enclosure is provided with a den. Furnishing has been provided using logs; ropes etc

The floor of one of the enclosure has been made concrete.

CBC Snow Leopard Enclosure 2

This is a newly constructed enclosure at the Conservation breeding Centre. The enclosure is provided with two night shelters of 1.90m X 2.00m each with a corridor of 3.87 m long. . Each night cell is provided with skylight for adequate sunlight and ventilation for proper aeration. The night cells are also provided with wooden platforms.

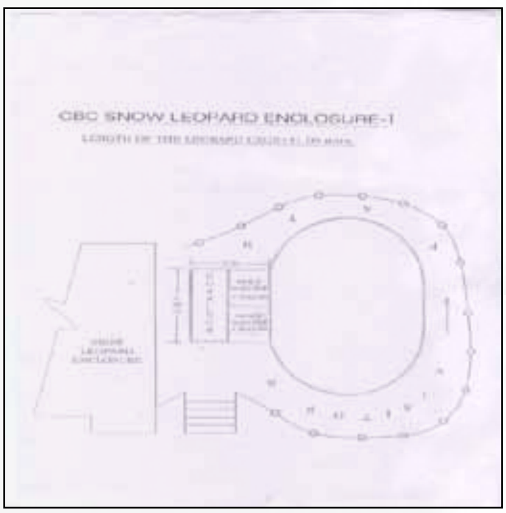

Fig. 8: Snow Leopard enclosure II at CBC

CBC Snow Leopard Enclosure III

This is a newly constructed enclosure at the Conservation breeding Centre. The enclosure is provided with two night shelters of 1.90m X 2.00m each with a corridor of 3.87 m long. . Each night cell is provided with skylight for adequate sunlight and ventilation for proper aeration. The night cells are also provided with wooden platforms.

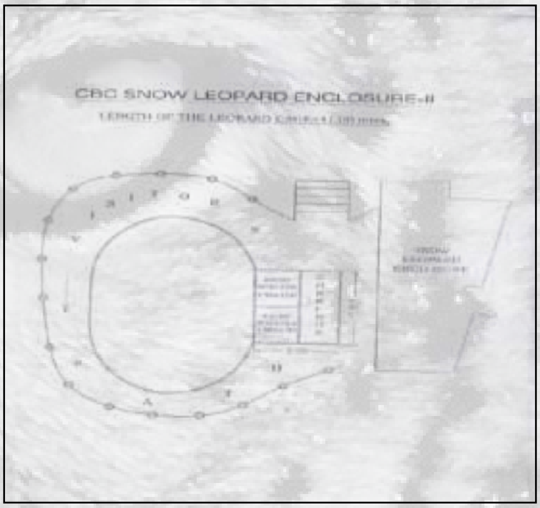

Fig. 9: Snow Leopard enclosure II at CBC

Fig. 10: Keeper's Gallery at Conservation Breeding Center

Fig. 11a: kraal area of Snow leopard at HZP, Gangtok

Fig. 11b: Open enclosure for Snow leopard at HZP, Gangtok.

Fig. 11c: Retiring cell of Snow leopard at HZP, Gangtok.

NEW OFF DISPLAY BREEDING CENTER AT TOPKEY DARA

A new off display breeding and release facility has been established in an area of 5 hectares at Topkey Dara near 3rd mile under Darjeeling Forest division with the purpose of investigating and study on behaviour, breeding cycle, food adaptation of Snow leopard when kept in near natural condition. Such purpose shall be ancillary to larger goals set up by Central Zoo Authority while allowing conservation breeding programme of Snow leopard. The site fits the bill as it is on a sunny aspect, experiences snow fall being at an altitude of 6800-6900 feet.

The off display breeding center hold two open enclosures with an area of 45×30 mt. attached with six numbers of night shelters and two kraal areas. Each night cell is provided with skylight for adequate sunlight and ventilation for proper aeration. The night csheltersare also provided with wooden platforms. The slope in the enclosures is gentle. The enclosure is made up of strong chain link. Each enclosure is provided with dens. Furnishing has been provided using logs; ropes etc.

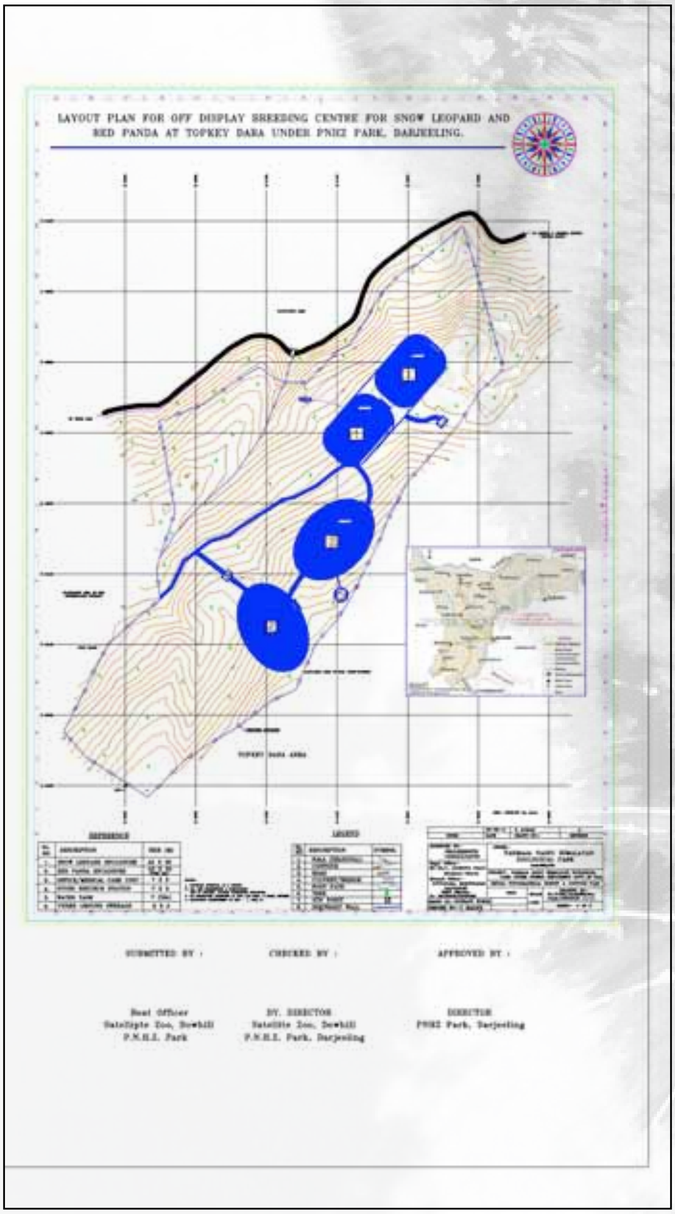

Fig. 12: Layout plan for off-display conservation breeding center for Snow Leopard at Topkeydara

Table 8: Size of Enclosure and holding area of different International Zoos housing Snow leopard.

Sl.no.	Name of Institution	Size of Enclosure	Size of Holding area
1.	Chattanooga Zoo, USA.	4*4(den size)	_
2.	Cat Haven Zoo,	~30ft*25ft height 10-18 ft.	_
3.	Toronga Zoo, Australlia.	300sq.mt.	50 sq. mt
4.	Rosamond Gifford Zoo, New York	25 ft*20 ft*30 ft	
5.	Porter park Zoo, Lansing Michigan	30 ft wide * 50 ft deep* 17 ft high.	Approx 12 ft. deep*25 ft.long. Rockwork: 4.5 ft.high.
6.	Wuppertal Zoo.	440 mt²	52 mt².
7.	Kaunas Zoo,Lithuiana	8*880mt.	_

After the evaluation of the zoos having Snow leopard and other carnivore species including review works conducted followed with communications with different zoos abroad housing snow leopards following are the recommendations drawn for the exhibit design

- Keeping in view the topography and the area of the Zoo, the enclosure size for felids as per prescribed by CZA cannot be strictly followed up. Hence regardless of the enclosure size, the enclosure should be well furnished and the animal should be given enough choices so as to carry out species specific behaviour.
- The exhibit should be designed to reflect as much as the natural habitat as possible. Since the habitat is a stark vista of rock, snow, and little vegetation an exhibit heavy in rock work with shallow cave retreats and ledges would be reflective of the natural environment in the winter. In the summer they descend below the tree line. Added trees can reflect that fact.
- Devoting a percentage of the exhibit to vertical space is also important. Snow leopards often live and hunt in very steep rock habitat and thus like high places in their enclosure.

It is necessary that the exhibit be fully enclosed as their climbing ability and agility would allow them to escape from any form of open top exhibit.

- In captivity it is strongly encouraged that there are both indoor and outdoor enclosures. Additional exhibit components may include caves, logs for scratching, and some type of natural substrate (mulch, turf, sod, etc.) for digging and making scrapes.
- For snow leopards, having an overhang under which they can scent mark is very important. In the wild, upper surfaces are often covered with snow and using the underside of a ledge helps to preserve the scent message a much longer.
- Additional square footage, whether indoor or outdoor is highly desirable for introductions and breeding pairs. Small or poorly furnished enclosures can lead to problems such as agitation, boredom, self-mutilation, weight problems, and lethargy.
- Attached squeeze cage in the night shelters are a necessity especially during the treatment of the animals either during physical or chemical restraint.

Fig. 13: Attached squeeze cage at PNHZ Park.

7.3.OFF-EXHIBIT DENS:

It is recommended that off-exhibit dens be provided to snow leopards to allow them privacy and shelter from the elements (Wharton & Mainka 1997). In facilities with breeding programs, maternity dens (containing nest boxes) should also be provided. Holding areas for snow leopards should all contain some type of furniture to allow the cat to lie above the floor as this is preferred by them in most situations.

Fig. 14a: Off-exhibit den at CBC

7.3. ENCLOSURE FURNISHING

- Snow leopards are amazing climbers and should be kept in enclosed exhibits, which should be well drained; offer natural substrate such as soil with a grass cover or a layer of marly limestone, gravel or similar substrate.
- Visual barriers should be provided, rocks, logs for scratching will provide for wear maintenance on nails, i.e., to help reduce ingrown claws and suitable plants will also create a naturalistic environment for these animals. The use of suitable natural furnishings greatly reduces the incidence of Osteoarthritis and pad ulceration.
- Platforms or raised rock points will provide suitable outlook viewing points. These should be partially shaded and protected to provide shelter from inclement weather.

- Whenever possible, large felids should not be housed for long periods of time on concrete. Perimeter fencing is absolutely necessary as a back- up in case an animal escapes its enclosure.

Fig. 14b: Fencing of Snow leopard enclosure

7.5. GATES AND HOLDING AREAS: Each habitat should have separate “room” in which animal(s) can be kept while the main cage is being cleaned or otherwise serviced or to segregate an animal from others in the enclosure. The openings should be equipped with double doors for security reasons (the inner door is fenced, the outer door is closed)

7.6. TOPOGRAPHY:

- Exhibits may be terraced, sloped, and contain high or low spots. An exhibit with no change in elevation should be heavily planted or provided with other climbing structures to enable the snow leopards to utilize all areas of the enclosure to hide or find shelter.

- Rocky / slate outcrops and ledges provide contrast and viewing vantage points that are also suitable features for snow leopards which they will actively utilize and rest on the elevated areas.

Fig. 15: Rockey substrate at Conservation Breeding Center

8. TEMPERATURE:

- Although large felids may originate from all manner of climates, most are tolerant of wide temperature extremes, at least during daylight hours.
- Animals kept outside should always have access to shade, especially during warmer months of the year. When acclimated, most species without young require only minimal unheated shelter at night.
- When kept indoor year around, animals should be protected from temperatures above 26.5 degrees Celsius.
- Snow leopards do not need additional sources of heat or cold if exhibits are designed to include access to a shelter from inclement conditions in the winter and access to shade or pools in the summer (Wharton & Mainka 1997).

High Altitude Zoos like PNHZPark, Pt. Govind Ballabh Pant Zoo, Kufri zoo and Himalayan Zoological Park, Gangtok are the preferred captive facilities for Snow leopards. Although these high altitude zoos can keep the snow leopard yet the environmental factors are not met by these zoos as Snow Leopard requires cold and dry climate. For e.g. Darjeeling Zoo does not have this condition. Darjeeling zoo situated at 7000 ft. where the temperature normally ranges between 3-22 degree celcius.The Snow Leopard is an animal of higher altitude where the temperature is sub zero and plenty of sunshine. It has been observed that the animals during summer do not venture out in the enclosure often and it is often seen to utilize shady areas. Therefore the animals should be provided with adequate dry and airy night shelters including enclosures furnished with shades and rocky substrates. During extreme winter the temperature in Darjeeling reaches below minus 1 degree Celsius during which moderate temperature of about 13degree Celsius maintained inside night shelter by providing the animals with blowers, heaters, curtains.

Hence it is recommended that Zoos like Nehru Zoological Park, Hyderabad, Nandankanan Biological Park, and Alipore Zoo, Kolkata should not house this species due to extreme temperature variation during summers and winters.

(A)

(B)

(C)

Fig. 16(A-C) Plantation of trees and bushes in the Conservation Breeding Centre of Snow leopard at PNHZ park

8.1. LIGHT & VENTILATION: For Snow leopards no special light requirements are needed as long as the animals are provided with access to the normal cycles of the outdoor environment. Flowing fresh air through the dens will help to increase appetite and metabolism of newborn cubs. It is important that ventilation is monitored closely as respiratory tract infections have been known to occur in cubs with little access to fresh air.

At PNHZPark, Darjeeling renovation of old night shelter has been done. The roof of all night shelters are provided with sky-lights so that fresh air and natural sunlight can get inside the room preventing dampness and growth of micro-organisms.

Fig. 17: Skylight and ventilation of retiring cell.

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9. HEALTH ISSUES-IN EX-SITU POPULATION

Literature review shows the ailments of Snow leopards in different captive facilities like Mycotic pneumonia due to *Aspergillus terreus* in a neonatal cub (Peden and Richard,1985), Lymphoid interstitial pneumonia different forms of pneumonia are observed at Kansas City Zoological Garden and Chongqing zoo, china respectively,

Some of the major diseases of Snow leopards reported in different global captive condition are ovarian dysgerminoma (William B. Karesh & Robert Russell, 1988) Pancreatic carcinoma (Murata K. Yanai T. Aquatsuma T. Uni S., 2003) Demodicosis in juvenile snow leopards (Fletcher K.C, 1980) feline panleukopenia virus, canine distemper virus (Andrew S.Fix et al,. 1989), veno-occlusive disease (Munson L. and Worley M.B, 1991), coxofemoral dysplasia (Karkkainen. M. and C. Wahlberg,1984), multifocal osteomyelitis caused by Klebsiella oxytoca in a juvenile animal (Wack and Kramer, 1995)Cerebral or extramedullary spinal fungal abcesses in two sub adult littermates from a North-American zoo, *Scopulariopsis sp*, a common saprophytic fungi, was isolated from a spinal abcess (Calle, P.P., S.B. Colter, R.A. Taylor and A.M. Wright. 1989.). A further myelitis case caused by a phaehyphomycete (*Cladiophalophora bantiana*) has been observed in a cub in a Swiss zoo and a cerebral chromomycosis was diagnosed in juvenile individual in another North-American zoo. Invasive Infections with both fungi have been reported in immunocompromised people (Janovsky et al., 2006)as well as cases of multiple ocular colobomas, which are congenital malformations in which a portion of the structure of the eye is lacking (Barnett K.C and Lewis J.C. 2002), oral and cutaneous number of papillomavirus infection sometimes associated with malignant transformation (squamous cell carcinoma), have been documented in snow leopard (Ott Joslin et al., 2000)

Multiple Ocular Coloboma (MOC) (2008, PNHZ Park record), Septicemia (2009, PNHZPark record), Brittle bone in cubs are some of the diseases prevalent at PNHZPark with minor ailments like Parasitic load, loose stool.

Limping of the hind and fore limbs including accidental external injury like tearing of skin etc.Old age related problems include Urinary tract infection and inappetince.

In the Indian scenario particularly in the study area during the project tenure it became evident the for the past few decades Environmental factors seems to have played a crucial role in occurrence of different types of disease in the new born cubs at PNHZPark. Although Snow leopard inhabit in a very high altitude where the temperature is sub- zero , they receive plenty of sunshine, acting as a source of UV ray which is responsible for the synthesis of Vit D_3 essential for bone metabolism of Calcium & Phosphorus in new born cubs. Although PNHZPark is located at an altitude 7000ft. the air is very cold and moisture laden. Most of the time it remains humid and there is a very little availability of direct sunlight. Therefore, environmental factors seem to be one of the major causes for the accumulation of different types of diseases especially in new born cubs.

BIRTH RECORD OF SNOW LEOPARD RECORDED AT PNHZPark.

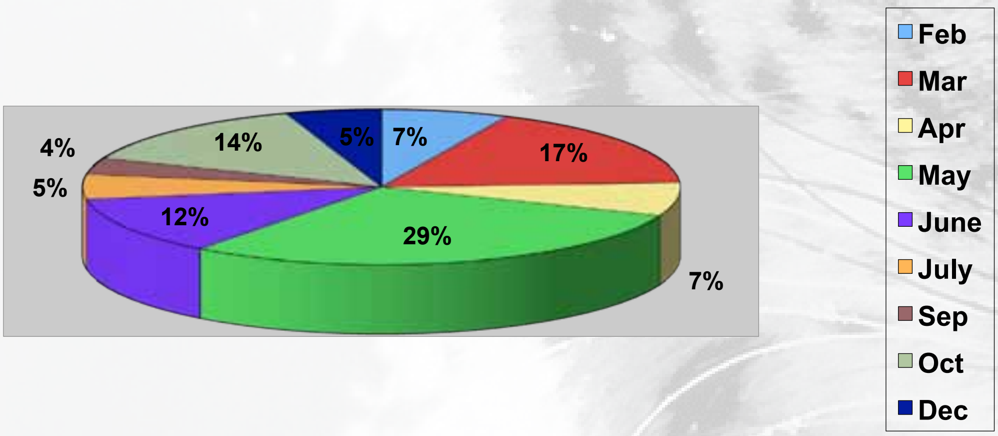

Fig. 18 : Month of birth for snow leaopard cubs born between 1987 to 2012

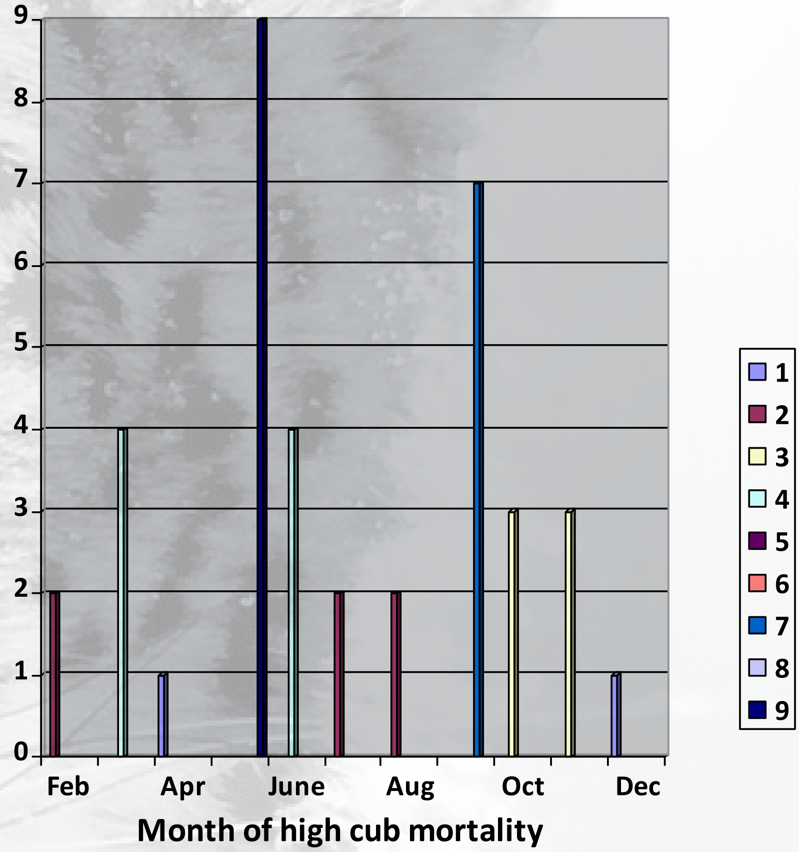

Fig. 19: Mortality rate of cub in different months recorded at PNHZPark (1987-

The above pie diagram and graphical representation shows the season of cub natality and mortality. Recorded births occurred mostly between the month of March to July and October to December, peak in the month of May. Of the births which took place in PNHZPark between 1987-2012,7% of birth occur in February,5% of birth occur in December, 5%in July, 7% in February , 12% in June ,17 % in March, 7% in October,4% in September and 29 % in May.

Since Snow leopard mate usually during winter time. So, considering their gestation period of 90-105 days, most of the births take place in monsoon season.

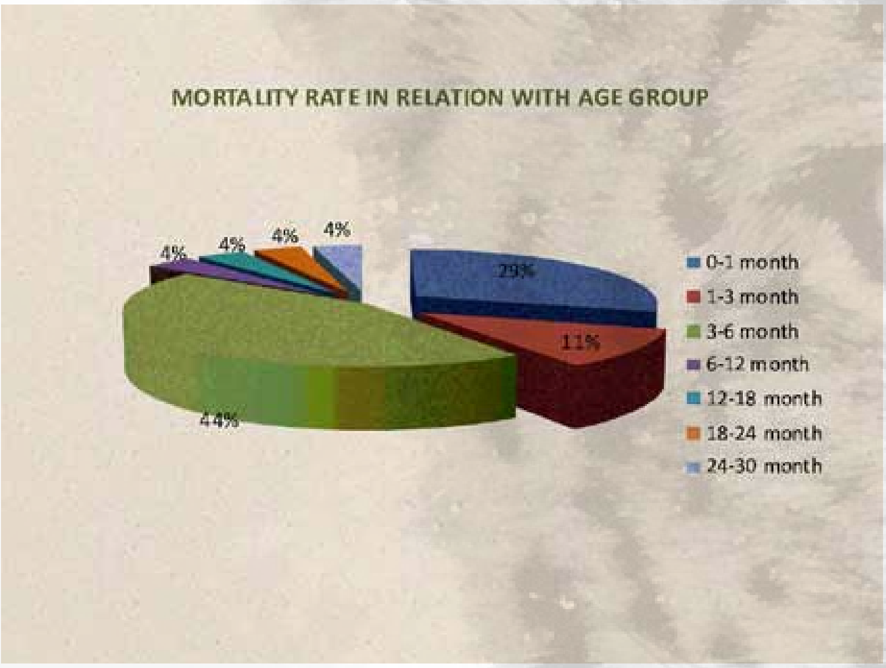

Fig. 20: Mortality rate in relation with age

The above pie diagram shows that high mortality has been seen in cubs aged between 1-6 months. Thus, 1-6 months is a very crucial period for the cub survivility.Within these months, cubs are very small, weak and are susceptible to various kinds of diseases. The survival rate of cubs depends on weather conditions as well. Although they inhabit in a very cold weather they are very sensitive to moisture and humid conditions. One of the reasons for such a high mortality in cubs is Pneumonia and Rickets (Brittle bone disease) which may be due to high humidity and lack of sunlight respectively.

9.1. FREQUENTLY OCCURRING DISEASES IN SNOW LEOPARD AT PNHZ Park.

9.1.1. RESPIRATORY TRACT DISEASES:

PNEUMONIA: Pneumonia is common mostly in new born cubs and sometimes in adults. The causative agent of Pneumonia is bacteria *streptococcus pneumonia*. It is characterized by fever with chills (rapidly rising) cough characterized by rusty sputum, chest pain – stabbing aggrevated by respiration & coughing, sniffing, runny nose.

In the park there is a long history of cub mortality due to pneumonia.

CASE REPORT

A cub born on 01.05.2007 (2 months old) suffered from respiratory infection. The body temperature was a 102.5ºF.Treatment consisted of Suspension Sporidex, Syrup PCM, and other Vitamin supplements orally. The cub was cured within a period of 5 supplements.

PLEURSIY:

PLEURISY: Pleurisy (also known as pleuritis) is an inflammation of the pleura, the lining surrounding the lungs. There are many possible causes of pleurisy but viral infections spreading from the lungs to pleural cavity are the most common .A pleural effusion is an abnormal collection of fluid in the pleural space resulting from excess fluid production or decreased absorption. It is the most common manifestation of pleural disease, with etiologies ranging from cardiopulmonary disorders to symptomatic inflammatory or malignant diseases requiring urgent evaluation and treatment.

SYMPTOMS OF PLEURISY INCLUDE:

- Pain in the chest that is aggravated by breathing,
- shortness of breath, and/or
- a "stabbing" sensation.

The most common symptom of pleurisy is pain that is generally aggravated by inspiration (breathing in). Although the lungs themselves do not contain any pain nerves, the pleura contains abundant nerve endings. When extra fluid accumulates in the space between the layers of pleura, the pain usually is a less severe form of pleurisy. With very large amounts of fluid accumulation, the expansion of the lungs can be limited, and shortness of breath can worsen.

TREATMENT OF PLEURISY:

External splinting of the chest wall and pain medication can reduce the pain of pleurisy. Treatment of the underlying disease, of course, ultimately relieves the pleurisy. For example, if a heart, lung, or kidney condition is present, it is treated. Removal of fluid from the chest cavity (thoracentesis) can relieve the pain and shortness of breath. Sometimes fluid removal can make the pleurisy temporarily worse since now the two inflamed pleural surfaces can rub directly on each other with each breath.

If the pleural fluid shows signs of infection, appropriate treatment involves antibiotics and drainage of the fluid. If there is pus inside the pleural space, a chest drainage tube should be inserted. This procedure involves placing a tube inside the chest under anesthesia. The tube is then connected to a sealed chamber that is connected to a suction device in order to create a negative pressure environment. In severe cases, in which there are large amounts of pus and scar tissue (adhesions), there is a need for "decortication." This procedure involves examining the pleural space under general anesthesia with a special scope (thoracoscope). Through this pipe like instrument, the scar tissue, pus, and debris can be removed. Sometimes, an open surgical procedure (thoracotomy) is required for more complicated cases.

In cases of pleural effusion that result from cancer, the fluid often reaccumulates. In this setting, a procedure called pleurodesis is used. This procedure entails instilling an irritant, such as bleomycin, tetracycline, or talc powder, inside the space between the pleural layers in order to create inflammation. This inflammation, in turn, will adhere or tack the two layers of pleura together as scarring develops. This procedure thereby obliterates the space between the pleura and prevents the reaccumulation of fluid.

CASE REPORT

A female cub born on 09.09.2011 after reaching 2 months i.e. on 22.11.2011 was found tobe dull, weak, and unresponsive with runny nose. Taken out immediately for physical examination.

The body temperature was 98.4ºF.Treatment consisted of 5ml Ambiplex and POW ORS orally. The cub was finding difficulty in breathing and feeling pain in a chest. The cub's condition continued to detoriate and ultimately died in the afternoon hour.

Pathology: Symptoms of Acute pleurisy. Accumulation of pleural fluid approximately 35ml of transparent, viscous, yellowish fluid slightly turbid in chest cavity .Lungs was congested with pleurisy. Liver congested, acid froth found in the stomach.

Fig. 21: Accumulation of pleural fluid

9.1.2. SKELETAL PROBLEMS:

As mentioned by the veterinarian Consultant of PNHZPark Dr. Sanjiwan Ray in 1999, rickets (brittle bones) is a chronic malady amongst the new born resulting in stress fracture, ultimately leading to lameness, crippleness and death. It is a rare, usually inherited disorder that causes bones to break easily due to the body's low production of collagen.

Main causes of Rickets are mentioned below:

Calcium (Ca): Phosphorus (P) imbalance in the diet.

Low exposure to UV-light.

Malabsorption of essential food constituents due to enteritis, worm infestation.

REMEDIAL MEASURES:

- Dietary supply of Vit-D3 tobe given to the animal in the form of Cod liver oil/alfacalcidol (one ALFA Leop cap.) or other form of Vit-d3., which will mature bone matrix.
- Protein metabolism, anabolic hormone e.g. Decarduabolin, Menabol etc. to be given to the growing stage of the bone.
- Sufficient amount of sunlight should reach the snow leopard enclosures.

Inspite of all necessary medicines and supplements before parturition, provided to the mother with Deworming drugs, still these kinds of symptoms develops in the cubs.

CASE REPORT:

During 2007 & 2009 the park lost 4 cubs (2- 4 months). After the symptoms developed X- ray done. X- ray showed rarification of bone structure, mottled radioluscent areas, thinning of cortices & epiphysis, multiple fractures.

Constraint: Bone plating and pinning is not possible.

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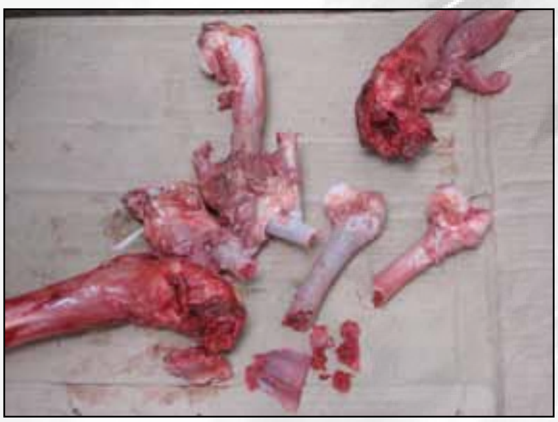


Fig 22: Rickets (Brittle bone)Snow leopard

9.1.3. HEAD INJURY:

- The type of Brain injury that was observed in the new born cub at PNHZPark in 2009 was a Traumatic Brain Injury (TBI)
- In TBI external force traumatically injures the brain.
- The prominent cause may be due to accidental hitting of head on some hard surface.
- The TBI mostly affects the new born(reference)

Fig. 23: Head injury in Snow leopard

9.1.4. MULTIPLE OCCULAR COLOBOMA

Multiple ocular coloboma in Snow leopard, is a specific clinical entity different from the coloboma complex and so far unknown outside the felid group (Walhbrg ,1978: Walhberg and Tarkkanen,1980 et al.)This entity consists of a coloboma of the upper eye lid and its complete form of a bilateral microphthalmia with uveal retinal and optic nerve coloboma, persistent primary hyper plastic vitreous and retinal dysplasia. The upper lid coloboma is the only constant feature in affected animals associated with or without any of the ocular signs.

Lid colobomas are generally regarded tobe of nonhereditary origin. They may result from a localized failure of adhesion of the lid folds externally caused during the late phase of embryonic development (Mann, 1957)

CASE REPORT:

Karish, male Snow leopard was born in Darjeeling Zoo from Mother Quila (Zurich Zoo) and Father Hank (U.S. Zoo) on 22nd March 1998.No major health problems till the age of 4 years.

From 12th April 2002, symptoms of paralysis was seen. Inj. Optineuron & other Calcium & Vitamin treatments were given. The problem subsided .

From 9.4.2004, again bi- lateral paralysis, eyesight and hearing problem developed. The animal seen lethargic and vomiting. Inj. Reglan, Inj. RL, Inj. Omnatex 1 gm was started along with nerve stimulants. Slowly blindness of both eyes was seen.

Human eye specialist was also consulted. Prescribed certain eye drops (Prednisolone) and Vit A, Celin tabs, Capsule Evion (400mg)

No progress in the condition of the animal & on 22.8.2004 the animal began to pass loose stool.

On 23.8.2004, the animal was brought to hospital in the in patient ward. Temp. recorded 104.5ºF, respiration 30/ min. Inj. RL , antibiotic magnamicin. Tab Nise were given . Temp. at 8:30 p.m. was 100.5ºF

On 13.9.2004. Haematuria with anorexia developed along with blindness and paralysis.

On 14.4.2005, it was shifted back to the cage. The animal started accepting water and some amount of feed.

Only Haematuria and blindness was prevalent.

All forms of allopathic medicine were used, for Haematuria. Tab. Neeri (Ayurvedic)1 tab/day & Vit A (aquasol) 1 capsule/day were started.

Haematuria was cured but nothing could be done for its eyesight.

On 8.11.2008, a team of doctors having a close look on the animal and going through the pedigree and health related history sheets tentatively diagnosed the case to be of “MULTIPLE OCULAR COLOBOMA” a congenital eye disease, a disease of Captive Snow leopards common in most of the western zoos.

9.1.5. PROSTRITIS IN SNOW LEOPARD: CASE STUDY

A male Snow leopard house name "Tyson" International studbook no. 1850 born at Hunbstrnd Sweden on 8th August 1995 was brought to PNHZ Park on 28.01.2000.The animal during his stay at the park sired six (4:2) individuals making significant contribution to the captive population. After reaching the age of eighteen, a small would was observed at the anal region. The animal was observed to be lying in one particular place and showing frequent urination. All effort was made to treat the animal by making necessary treatments and by providing better housing facilities like placing a dehumidifier inside the night shelter to keep the room dry and moisture free, insect flasher to get rid of the flies, burning turmeric powder as an insect repellent, foot baths with $KMnO_4$ and use wood shavings on the resting place as urine absorbent. Inspite of which the animal got deceased on 14.09.2013 after reaching the age of

Following are the day by day health condition of the animal observed and the medications provided:

Date	Health condition	Medications
13.06.13	Prostate problem	Tab.Finpecia - 1 tab/day x 10 days
16.06.13	Prostate problem observed small wound on anal region	Tab.Finpecia - 1 tab/day x 20 days Inj.Avil - 2 ml Dressing done
17.06.13	Observed maggot on wound	Inj.Fortivir - 3.5 ml /day x 10 days Inj.Melonex - 2 ml/day x 5 days Inj.Conciplex - 2 ml /day x 5 days Inj.Avil - 2 ml/ day x 11 days Dressing done
21.06.13	Observed maggot on wound	Dressing done
24.06.13	Observed maggot on wound	Tab.FloxIP TZ - 2 tab/day x 2 days Inj.Ivermectin - 1 ml Dressing done
6.07.13	Observed maggot on wound	Inj.Fortivir - 3.5 ml /day x days Inj.Conciplex - 3 ml /day x days
1.08.13	Prostate problem observed small wound on lumber area	Inj.Intacef Tazo - 562.50 g x 2 vials x 3 daysDressing done

1.08.13	Prostate problem observed small wound on lumber area	Dressing done
23.08.13	Prostate problem observed small wound on lumber area	Dressing done
8.09.13		Tab.Finpecia - 1 tab/day x 10 days Tab.Ciprodac - 1 tab/day x 5 days Syp.Neopaptin - 10 ml/day x 5 days Pow .ors - ½ pkt / day x 2 days
9.09.13	Anorexia	Inj.Conciplex - 2 ml /day x 5 days
11.09.13	Prostate problem observed small wound on Penis area	Inj.Fortivir - 5 ml /day x 2 days Inj.Melonex - 2.5 ml/day x 3 days Inj.Conciplex - 3 ml /day x 3 days Inj.Belamyl - 3 ml /day x 3 days Inj.Aceloc - 2 ml/ day x 4 days Dressing done
14.09.13		Inj.D- 5 - 500 ml i/v Syp.Cyton - 5 ml

9.1.6. TAIL DUCKLING IN SNOW LEOPARD-A CASE REPORT AT PNHZ PARK

A captive born male Snow leopard house name “Prabhat” born on 08.07.2002 with studbook no.2405 had no major ailments except for some parasitic infection (mild)(Ascaris sp/Toxocara sp.).Regular deworming and vaccination followed with mineral and vitamin supplements were provided to the animal.The animal was also tranquilized from time to time for blood collection.The earlier reports were normal.

On 08.07.2010, in the early morning hours the keepers of Conservation Breeding Center (CBC) reported to the Asst.Animal supervisor about the condition about of the animal.They had observed that there was a wound in both the ears followed by a scar in the tail. The animal was walking in the enclosure with its dropped tail. The animal was walking by dragging its tail in the enclosure parapet.Reported to the Veterinary section, after which the veterinary team went to see the animal.At 2:40 p.m. the animal was put inside the squeeze cage .X-ray of the tail region was done.The animal was thoroughly checked .5 ml. of blood collected for further test. Scrapping from the skin taken ectoparasites, after which the animal was given the following medications:

1. Inj.Ivermectin (2ml S/c-1st dose)
2. Inj. Tribivet (3 ml Im/ly)
3. Topicare spray in the tail region
4. Betadine ointment & lotion in the ear
5. Neosporin powder

After the treatment, the infected portion showed no sign of improvement, on 04.07.2010 the animal was once again tried to put inside the squeeze cage but the animal failed to cooperate. The animal was left to rest that day.

On 05.07.2010, the keeper of CBC reported to the veterinary section that the fur from the tail region had shade off completely from where the infection was observed. The Director was informed who instructed to take necessary actions. The animal was put into the squeeze cage again. It was observed that the dropped tail had become naked after the hair fall in the particular infected region. Not much sensation in the tail region which was still lying drooped.Following medicines were given to the anima:

1. Inj. Intacef (1gm Im/ly)
2. Inj. Avil (0.6 ml Im/ly)
3. Topicur spray used after washing the infected part of the tail with betadine lotion

After the treatment the animal was left out in the crawl area to rest.

On 06.07.2010 dressing of the infected part and antibiotics given:

1. Inj. Intacef (1gm Im/ly)
2. Inj. Avil (0.6 ml Im/ly)

3. Topicur spray used after washing the infected part of the tail with betadine lotion\

On 07.07.2010 dressing of the infected part and antibiotics including vitamin supplements given:

1. Inj. Intacef (1gm Im/ly)
2. Inj. Avil (0.6 ml Im/ly)
3. Topicur spray used after washing the infected part of the tail with betadine lotion
4. Inj.Tribivet (2 ml Im/ly)
5. Nutricoat (5ml orally)

On 08.07.2010, dressing of the infected part and antibiotics including vitamin supplements given:

1. Inj. Intacef (1gm Im/ly)
2. Inj. Avil (0.6 ml Im/ly)
3. Topicur spray used after washing the infected part of the tail with betadine lotion
4. Inj.Tribivet (2 ml Im/ly)
5. Nutricoat (5ml orally)
6. Inj. Ivermectin (2 ml S/c -2nd dose)

X-ray was also done of the tail region. The report was normal.

On 09.07.2010, dressing of the infected part and antibiotics including vitamin supplements given:

1. Inj. Intacef (1gm Im/ly)
2. Inj. Avil (0.6 ml Im/ly)
3. Topicur spray used after washing the infected part of the tail with betadine lotion

4. Tetanus toxoide (TT 0.5 ml Im/ly)

On 07.10.2010, dressing of the infected part and antibiotics including vitamin supplements given:

1. Inj. Intacef (1gm Im/ly)
2. Inj. Avil (0.6 ml Im/ly)
3. Topicur spray used after washing the infected part of the tail with betadine lotion

From 11.07.2010 to 13.07.2010, dressing of the infected part and antibiotics including vitamin supplements given:

1. Inj. Intacef (1gm Im/ly)
2. Inj. Avil (0.6 ml Im/ly)
3. Topicur spray used after washing the infected part of the tail with betadine lotion

On 14.07.2010, the Veterinary Officer observed that the infection had failed to subside.Only dressing of the infected part was done. No other medicines given. The infected part was washed with betadine lotion, tincture iodine,Hydrogen peroxide (H_2O_2) and Kiskin lotion applied.The infected part was left unbandaged.

On 15.07.2010, the same treatment given to the infected part

Even after all these, the infected part failed to get cured hence the matter was discussed with the Director of the park, who suggested that if the infection fails to heal the tail should be ducked. Was further instructed to inform Dr. M.Maity to assist in the operation and for further suggestions post-operation.

On 16.07.2010, Dr. Maity arrived at the park around 10:30 a.m. After going through the case history Dr. Maity along with the V.O. of the Park and others began with the operaration.The animal was put inside the squeeze cage. Both th doctors checked the entire tail regiomn for sensation.It was checked to see which portion had totally become useless or that portion which had to be ducked. The animal was then tranquilized using Ketamine (3/5 ml Im/ly) and Xylazine (0.7 ml Im/ly) at12:05 p.m. Head down at 12:19 p.m. The animal was laid down in the cage. Then the useless portion of the part that had no sensation was ducked followed by treatment which is as follows:

1. Inj. Intacef (1gm Im/ly)
2. Inj. Avil (1 ml Im/ly)
3. Inj. Melonex (1 ml Im.ly)
4. Inj. Ringer lactate (500ml the animal accepted only 200 ml Iv/ly)
5. Betadine ointment & lotion, Neosporin powder (For dressing)

The cut portion was properly bandaged,At 1:40 p.m. Reverzine 1 ml was given Im;ly. The animal was up at 1:46 p.m. After theoperation was done bothe the doctors had a discussion with the Director regarding the cause of the infection of the tail. The animal didi not get up from the place till 3:30 p.m. The Veterinary compounder went to check the again.

At 4:00 p.m. the animal stood up and accepted its feed.

On 17.07.2010 to 19.07.2010, antibiotics and vitamin supplements given to the animal:

1. Inj. Intacef (1gm Im/ly)
2. Inj. Avil (0.6 ml Im/ly)
3. Inj. Melonex (1 ml Im.ly)

On 19.07.2010, along with antibiotics dressing of the wound was also done.On opening the wound it was found out that few open, restitching was not done as suggested by the doctor.

On 20.07.2010 antibiotics given:

1. Inj. Intacef (1gm Im/ly)
2. Inj. Avil (0.6 ml Im/ly)
3. Inj. Melonex (1 ml Im.ly)

On 21.07.2010 to 25.07.2010 antibiotics given followed by dressing,

1. Inj. Intacef (1gm Im/ly)
2. Inj. Avil (0.6 ml Im/ly)
3. Inj. Melonex (1 ml Im.ly)
4. Betadine ointment & lotion, Neosporin powder (For dressing)

On 25.07.2010 it was also observed that half portion of the stitches had opened and pus seen over the wound.

On 26.07.2010 it was once again observed that again one –third of the stitches had opened, pus observed.Medicines given:

1. Inj. Intacef (1gm Im/ly)
2. Inj. Avil (0.6 ml Im/ly)
3. Inj. Melonex (1 ml Im.ly)
4. Betadine ointment & lotion, Neosporin powder (For dressing)

On 27.07.2010 to 28.07.2010 antibiotics provided with dressing,

1. Inj. Intacef (1gm Im/ly)
2. Inj. Avil (0.6 ml Im/ly)
3. Inj. Melonex (1 ml Im.ly)

4. Betadine ointment & lotion, Neosporin powder (For dressing)

On 28.07.2010 after all thse treatment post-operation the veterinary officer realized that the wound was not healing up.Consulted Dr, Maity and then after which the antibiotics were changed:

1. Inj.Fortivir (2.6 ml Im/ly)
2. Inj.Avil (1ml Im/ly)

On 29.07.2010 to 30.07.2010 dressing done with betadine ointment and lotion ,Neosporin powder.

On 31.07.2010, Inj.Fortivir (2.6 ml Im/ly) after an interval of two days followed by dressing .I,provement seen in the wound.

On 01.08.2010 dressing don2, on 02.08.2010 the animal was simly observed on.

On 03.08.2010, 06.08.2010 and 09.08.2010 dressing done . Inj.Fortivir (1 ml Im/ly and Inj.Avil (1ml Im/ly)

After 09.08.2010 the antibiotics were stopped and only dressing continued after every two days interval.

On 13.08.2010 suddenly the animal was observed to be weak and was unable to take its body weight on its left side. The animal was unable to stand on its feet. When the animal made an effort to walk the animal fell down. Immediately the animal was given following medicines after informing the authority.

1. Inj.Intacef tazo 1 gm (1 vial Im/ly)
2. Inj. Tribivet (3 ml Im/ly)
3. Tab. Neurobin Forte (2 tab orally × 7 days)
4. Electrol powder (5 pkt × 5 days)

After 11:00 a.m. the animal was put inside the squeeze cage and 5 ml of blood taken for further tests. Dressing done.In the afternoon the test result showed low blood sugar.Treatment given:

RL (Ringer Lactate 5 ml Iv/ly)

Glucose in drinking water (100 gms)

On 14.08.2010 the animal showed improvement.The animal was able to stand a bit on its own.The animal was put inside the squeeze cage and was given D5(500ml Iv/ly),Inj. Tribivet (1.5 ml Iv/ly).Glucose (100gms) and honey (10 ml) give.

On 15.08.2010 to 17.08.2010 the animal was put inside the squeeze cage and given D5 (500ml Iv/ly),Inj. Tribivet (1.5 ml Iv/ly).Glucose (100gms) and honey (10 ml).On 15.08.210 dressing of the tail wound was also done.

From 18.08.2010, the animal was observed .Honey and glucose given.

On 19.08.210 second blood sample taken (2 ml).Dressing done.Test result showed the blood sugar level had increased a bit.Honey and glucose continued.

On 21.08.2010 dressing of the tail wound done.Oral medicies continued.

On 25.08.2010 dressing of tail wound done.Oral medicines continued.Honey and glucose continued.

On 27.08.2010 medicied prescribed:

Neurobin Forte tab (2 tab/day × 7 days)

Clcium tab (1 tab× 7 days)

On 29.08.2010 the veterinary officer had suggested an open wound dressing which was not possible due to bleeding of the wound when dressing was done.Medicine give.

Again on 03.09.2010 the animal developed a wound on the right belly , treatment given.Dressing is being continued for the wound in the tail region but the animal was fine and had shown no sign of weakness .Feeding was normal.

In all these instances beginning from tail infection, low blood pressure and wound in the belly the animal was behaviourally sound.Post-operation and during the low blood sugar level phase the animal had become a bit aggressib=ve and was often found pacing in the kraal making noise.At the moment the animal is fine and is behaving normally.

Table 9: Listed byelow are the most noticeable and periodically occurring diseases of Snow leopard at PNHZ Park

Sl.no.	Disease type	Most prevalent in
1.	Parasitic infection *Toxocara sp,Ascaris sp., Ancylostoma sp. and Spirometra sp.*	Adult and cubs
2.	MOC (Multiple Ocular Coloboma)	Male
3.	Fracture	Cubs
4.	Brain hemorrhage	Adult and cubs
5.	Anorexia	Adult
6.	Diarrohea (Bacilli infection)	Adult
7.	Eye inflammation	Adult
8.	Still Birth (*Pasturella Multocida)*	Cubs
9.	cardio respiratory failure	cubs
10.	Multi organ failure	Adults
11.	Ill nursing	cubs
12.	Enteritis	cubs

10. PREVENTIVE MEASURES TAKEN FOR SNOW LEOPARD AT PNHZPARK.

10.1. Sanitation:

- Hard-surface primary enclosures and food containers (if used) should be cleaned daily with detergent and disinfectant.
- Perches and shelves where animals climb and sit should also be included in this regime. Dirt substrates in outdoor planted exhibits should be raked and spot-cleaned daily.
- Footbaths containing quaternary chemicals should be used prior to entering all felid enclosures or areas containing enclosures. Each should be filled with a disinfectant and its use strictly adhered to by all personnel by burning blow lamp or welding machine. To be done every month.
- There should be a well managed drainage system.
- Fumigation by Sodium hypochlorite 3-4%, Formaldehyde, Attak, Kohrsolin every month.
- Common disinfectant like Potash, Bleaching powder and common salt regularly.

During Field survey the disinfectants used for the felines were Kohrsolin and Bleaching powder in most of the captive facilities. A workshop organized during 2009 for Snow leopards in Darjeeling suggest the following disinfectants:

Table 10: Disinfectant used for Felid

Trade name	Chemical composition	% of dilution	Mode of application	Effectiveness	Advantage & disadvantage	Remark
Attak	Bezalkonium cloride,gluteraldyde, formaldehyde	2-5	With water as fumigation	Bacteria, virus, parasite ova, fungus, tubercle	Toxic but can be safely used	Animal should be removed for 2 hours.
Kohrsolin	Glutaraldehyde	3	spray	Bacteria, virus,	Toxic but can be	Animal should be

	, dihydroxy dioxylexane, polymethyuria			parasite ova, fungal, tubercle	safely used	removed for 2 hours
Common salt	--	As such	powder	Worms, bacteria, virus, parasite egg,	Non toxic	Precaution not needed
Beaching powder	---	As such or mix with water	As such or mix with water	Worms, bacteria, virus, parasite egg,	Non toxic	Remove the animal for 1 hour
Lime powder	---	As such	powder	Worms, bacteria, virus, parasite egg,	Non toxic	No precaution needed
Potash	-----	2-3	With water	Bacteria & virus	Not toxic	No precaution
Turmeric powder	----	As such	powder	Bacteria	Non toxic	No precaution.
Copper sulphate	---		Powder or with water	Bacteria, virus, fungus	Non toxic	No precaution
Formalin	---	2-10	With water as fumigatio n	Bacteria, virus, fungus & Parasite egg	toxic	Remove animal for 2 hours.

Fig. 24a: Cleaning of wooden platform with antiseptic solution

Fig. 24b: Burning of Turmeric powde

as an insecticide

Fig. 24c: Cleaning of retiring cell.

Fig. 24d: Insect Flasher installed inside the night holding pens.

Fig. 24e: Foot bath with KMnO4

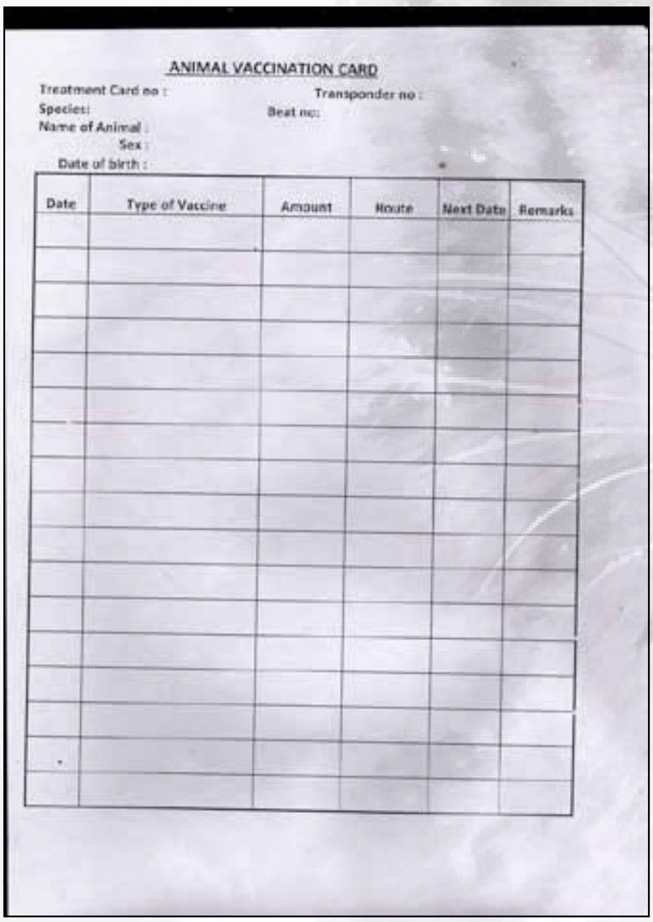
10.2. VACCINATION:

As per AZA, vaccinations for feline respiratory viruses and feline distemper are recommended for snow leopards (Wharton & Mainka 1997).

At the Park vaccination of Snow Leopards are done in regular intervals for diseases such as Feline panleukopenia, Feline rhinotracheitis, feline calicivirus, rabies, canine distemper, and canine parvovirus.

Vaccines used are Inj. Fel-o-vax PCT, Inj.T.T.

Duration: Once in a year



ANIMAL VACCINATION CARD

Treatment Card no :
Transponder no :
Species:
Beat no:
Name of Animal :
Sex :
Date of birth :

Date	Type of Vaccine	Amount	Route	Next Date	Remarks

Fig. 25: Sample of Animal Vaccination

VACCINATION RECORD OF SNOW LEOPARD

Name of Animal : KARAN
Sex : MALE
Date of birth : 23.10.95

Date	kind of illness & symptoms	Treatment	Remarks
16.09.01	Vaccination	Ing Novivac (Tricat 1 dose)	15.10.01
15.10.01	Vaccination	Ing Novivac (Tricat 1 dose)	16.10.02
16.10.02	Vaccination	Ing Fel-o-pct 1ml i/mly 1 dose	16.10.03
9.10.04	Vaccination	Ing Fel-o-pct 1ml i/mly 1 dose	9.10.05
9.10.05	Vaccination	Ing Fel-o-pct 1ml i/mly 1 dose	9.10.06
14.11.06	Vaccination	Ing Fel-o-pct 1ml i/mly 1 dose	14.11.07
19.11.07	Vaccination	Ing Fel-o-pct 1ml i/mly 1 dose	19.11.08
21.01.09	Vaccination	Ing Fel-o-pct 1ml i/mly 1 dose	21.01.10
3.06.11	Vaccination	Ing Fel-o-pct 1ml i/mly 1 dose	

10.3. PARASITIC EXAMINATION:

As per AZA,Species survival Programme common parasites for snow leopards include ascarids, coccidia, fleas, ear mites, strongyles, lungworm, demodex and sarcoptid mites, giardia, and hookworm (Wharton & Mainka 1997). Demodicosis have also been reported in snow leopards. Fenbendazole, mebendazole, pyrantel pamoate, and ivermectin have all been used successfully with snow leopards Organophosphate anthelmintics must not be used with any felids (Wharton & Mainka 1997).

Snow leopards are carnivorous animals so at the park they are fed with flesh of beef, mutton and chicken. Beef is a high source of parasitic infection in Snow leopards. Parasitic overload has reported to cause a high mortility in both new born cubs (case report of Pasturella infection in 1992 and 2001 at PNHZPark) and adults. So in order to avoid this, weekly stool test is done at the Park itself. In case of report positive to worm infection necessary treatments are given. Post treatment fecal examination is done, which is necessary in assessing efficacy of the initial treatment. Follow-up treatments in every 21 days cycle is required to remove larval stages not susceptible during the initial treatment .Commonly identified species in the park are from the orders Ascarididae and Strongyloidae (i.e., *Toxocara, Toxascaris, and Ancylostoma.).*

Drugs used at PNHZPark:

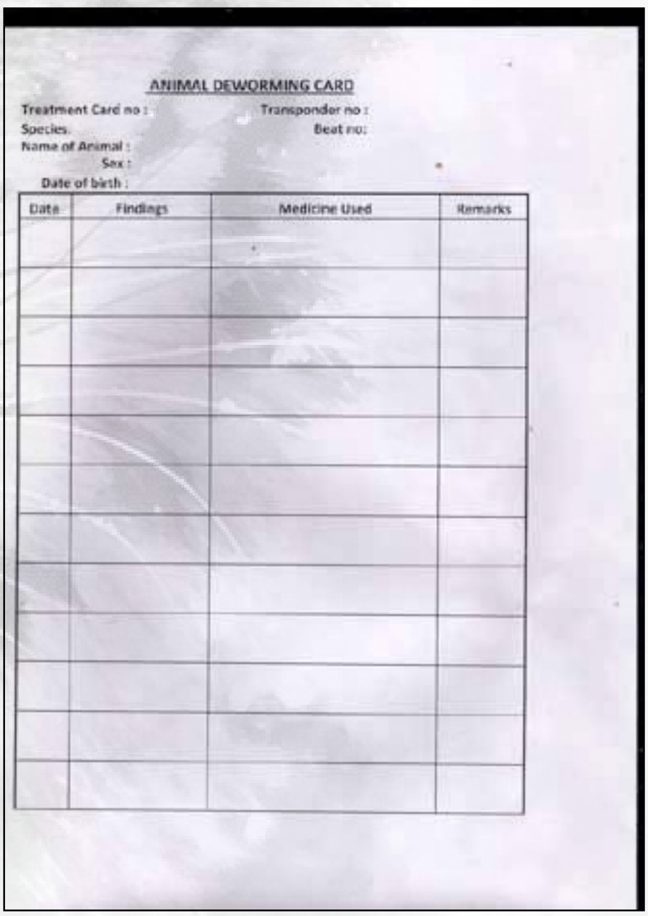
I. Tab panacur (150 mg.)
II. Tab. Pyrateforte
III. Bol. Fants (1.5 mg)
IV. Bol. Oxzol
V. Tab Plozin
VI. Tab Zolebend
VII. Tab Ivectin

Regular parasitology screening-medication controls but does not completely eradicate

TOXOCARIASIS IN SNOW LEOPARD 1993(B.Maity,, G.Chakraborty & K.K.Pradhan, 1994):CASE STUDY

Materials and methods: In the month of January 1993, fine number of Snow Leopard (3:2) housed at PNHZPark showed acute illness. They were given treatment with the anti bacterial drug Sulmet[2] @ 20ml/30 kg body weight orally for 3 days and then anthelminthic drug Nemocid[3] @ 1½ tab orally and Sulmet for 5 days .Liv-52 and Electral were given as supportive therapy. Stools and expelled parasites were collected for laboratory examination.

Results and discussion: Clinical symptoms observed were diarrhoea, general malaise, lethargy, dehydration, partial or complete anorexia, vomiting with or without expulsion of the Ascarids. Microscopic examination revealed eggs of *Toxocara sp.* The expelled parasites were identified



ANIMAL DEWORMING CARD

Treatment Card no : Transponder no :
Species. Beat no:
Name of Animal :
Sex :
Date of birth :

Date	Findings	Medicine Used	Remarks

Fig 26: Sample of animal deworming card used at PNHZPark.

Fig. 27 :*Toxoca sp* (ova)

DEWORMING RECORD OF SNOW LEOPARD

Padmaja Naidu Himalayan Zoological Park, Darjeeling.

Treatment Card no. : 95 | Transponder no : 981-0981-02057256

Species: SNOW LEOPARD | Beat no. : 4

Name of Animal : KARAN

Sex : MALE

Date of birth : 23.10.1995

Date	kind of illness & symptoms	Treatment	Remarks
1.8.01	Deworming	Syru. Piperizing ciutrate 10ml/day x3days	Feceal test Toxocara sp (++)
13.08.01	Deworming	Tab . Panacur-(150 mg)-4 at once	Altheminthic
14.08.01	Deworming	Tab. Panacur (150 mg)- 2 tab/day x2days Tab liv 52 - 2 tab/dayx15 days Cap. Astymin- 1 cap/day x20 days	
3.09.01	Deworming	Tab panacur (150 mg)-4 2tab/day x 2 days Pow. Electrol 1pkt	
11.09.01	Deworming	Cap Ginphen 1 cap/day x 10 days Tab liv 52 1tab/day x15 days	
9.11.01	Deworming	Tab.Fenmendazole(150 mg)-4 tab/day x 2 days Tab liv 52 - 2 tab/dayx15 days Cap. Astymin- 1 cap/day x20 days	
15.12.01	Deworming	Tab. Panacur (150 mg)- 2 tab/day x2days Tab liv 52 - 2 tab/dayx15 days Cap. Astymin- 1 cap/day x20 days	
5.01.02	Deworming	Tab panacur (150 mg)-4 2tab/day x 2 days	
7.02.02	Deworming	Tab.Fenmendazole(150 mg)-4 tab/day x 2 days Tab liv 52 - 2 tab/dayx15 days Cap. Astymin- 1 cap/day x20 days	
31.07.02		Cap. Vitacef 1cap/day x 20 days	
27.08.02	Deworming	Tab.Albomer- 400mg-½ tab/day x 2 days Tab liv 52 - 2 tab/dayx15 days Cap. Astymin- 1 cap/day x20 days	

16.11.02	Deworming	Tab.Praqzism plus- 2½ tab/day x2 days Tab liv 52 - 2 tab/dayx15 days Cap. Astymin- 1 cap/day x 20 days	
6.12.02	Deworming	Tab panacur (1.5 mg)- ½ tab/day x 2 days	
5.03.03	Deworming	Bol.Wormer(600mg)-½ bol /day x 2 days Tab liv 52 - 2 tab/dayx15 days Cap. Astymin- 1 cap/day x20 days	
19.12.03	Deworming	Tab.Plozin-4 tab at a time Tab.liv 52 2 tab/day x 15 days cap Astymin 1cap/day x20days	
9.01.04	Deworming	Tab Albidol 1tab/day x3 days Tab.liv 52 2 tab/day x 15 days cap Astymin 1cap/day x20days cap. vitafit fort-1 cap/day x 15 days	
7.04.04	Deworming	Bol.Panacur(1.5mg)- ½ bol/dayX 5 days Tab.liv 52 2 tab/day x 15 days cap Astymin 1cap/day x20days	
3.05.04	Deworming	Tab.Pyrate plus - 4 tab at a time Tab.liv 52 2 tab/day x 15 days cap Astymin 1cap/day x20days	
1.07.04	Deworming	Tab.Zeebee(400mg)- 1tab/day X 5 days Tab.liv 52 2 tab/day x 15 days cap Astymin 1cap/day x20 days	
23.07.04		Pow. Garlic 10gm/day x 10days	
25.07.04	Deworming	Tab.Zentil - 1 tab/dayX 5 days Tab.liv 52 2 tab/day x 15 days cap Astymin 1cap/day x20 days	
25.10.04	Deworming	Bol.Endectin-1 bol at once Tab.liv 52 2 tab/day x 15 days cap Astymin 1cap/day x20 days	
15.11.04	Deworming	Tab.Fenmendazole (1.5 mg) ½ bol/day x 5 days Tab.liv 52 2 tab/day x 15 days cap Astymin 1cap/day x20 days	
04.01.05		Tab Cynobac 2 tab/day x 3 days BD Syp.Bacigyl 5ml/dayx 5 days BD Tab Lomofen 1 tab/day x 2 days Inj Omnatex (500mg) 1.5ml/day x 5 days Inj Conciplex 2ml/day x 5 days	vomiting
15.02.05	Deworming	Tab.Plozin - 4 tab at a time Tab.liv 52 2 tab/day x 15 days cap Astymin 1cap/day x20 days	

5.03.05	Deworming	Bol.Endectin - 1 bol at once Tab.liv 52 2 tab/day x 15 days cap Astymin 1cap/day x20 days	
23.05.05	Deworming	Tab.Fenmendazole(1.5 mg) ½ bol/day x 5 days Tab.liv 52 2 tab/day x 15 days cap Astymin 1cap/day x20 days	
13.06.05	Deworming	Tab.Zentil - 1 tab/day X 5days Tab.liv 52 2 tab/day x 15 days cap Astymin 1cap/day x20 days	
13.09.05	Deworming	Tab panacur (150 mg)-1tab/day x 4days Tab liv 52 2tab/dayx15days Tab Astymin 1tab/day x20days	
12.12.05	Deworming	Bol.Panacur(1.5mg)- ½ bol/day X 5 days Tab.liv 52 2 tab/day x 15 days cap Astymin 1cap/day x20 days	
13.03.06	Deworming	Bol.Wormer(600mg) 1 bol /day x 3 days Tab.liv 52 2 tab/day x 15 days cap Astymin 1cap/day x20 days	
15.12.06	Deworming	Tab.Zeebee -2 tab/day x 3 days Tab.liv 52 2 tab/day x 15 days cap Astymin 1cap/day x20 days	
12.03.07	Deworming	Tab.Wormer-1tab /day x 3 days Tab.liv 52 2 tab/day x 15 days cap Astymin 1cap/day x20 days	
12.06.07	Deworming	Tab.Easypet(meltab)-1 tab /day x 4 days Tab.liv 52 2 tab/day x 15 days cap Astymin 1cap/day x20 days	
15.09.07	Deworming	Bol.Fantas(1.5mg)- ½ bol/day X 4 days Tab.liv 52 2 tab/day x 15 days cap Astymin 1cap/day x20 days	
4.12.07	Deworming	Tab Pyrate plus - 1 tab/day x 4 days Tab.liv 52 2 tab/day x 15 days cap Astymin 1cap/day x20 days	
2.03.08	Deworming	Tab.Easypet (meltab)-1 tab /day x 4 days Tab.liv 52 2 tab/day x 15 days cap Astymin 1cap/day x20 days	
2.06.08	Deworming	Bol.Fantas (1.5mg)- ½ bol/dayX 2 days Tab.liv 52 2 tab/day x 15 days cap Astymin 1cap/day x20 days	After stool test (Deworming given)
2.09.08	Deworming	Bol.Fantas (1.5mg)- ½ bol/dayX 2 days Tab.liv 52 2 tab/day x 15 days cap Astymin 1cap/day x20 days	
2.12.08	Deworming	Tab.Panacur (150mg) - 2 tab/day x 3 days Tab.liv 52 2 tab/day x 15 days cap	

		Astymin 1cap/day x20 days	
2.03.09	Deworming	Bol.Fantas (1.5mg)- ½ bol/dayX 2 days Tab.liv 52 2 tab/day x 15 days cap Astymin 1cap/day x20 days	
5.06.09	Deworming	Tab.Prazism plus - 2 tab/day x 2 days Tab.liv 52 2 tab/day x 15 days cap Astymin 1cap/day x20 days	
5.11.09	Deworming	Bol.Fantas (1.5mg)- ½ bol/dayX 2 days Tab.liv 52 2 tab/day x 15 days cap Astymin 1cap/day x20 days	
5.02.10	Deworming	Tab.Prazism plus - 2 tab/day x 2 days Tab.liv 52 2 tab/day x 15 days cap Astymin 1cap/day x20 days	
5.05.10	Deworming	Bol.Fantas (1.5mg)- ½ bol/dayX 2 days Tab.liv 52 2 tab/day x 15 days cap Astymin 1cap/day x20 days	
6.08.10	Deworming	Tab.Pyrate fort - 1 tab/day x 4 days Tab.liv 52 2 tab/day x 15 days cap Astymin 1cap/day x20 days	
8.12.10	Deworming	Bol.Fantas (1.5mg)- ½ bol/dayX 2 days Tab.liv 52 2 tab/day x 15 days cap Astymin 1cap/day x20 days	
6.02.11	Deworming	Bol.Fantas (1.5mg)- ½ bol/dayX 2 days Tab.liv 52 2 tab/day x 15 days cap Astymin 1cap/day x20 days	
2.04.11	Deworming	Bol.Fantas (1.5mg)- ½ bol/dayX 2 days Tab.liv 52 2 tab/day x 15 days cap Astymin 1cap/day x20 days	
6.05.11	Deworming	Bol . Ivermectin-82 mg-½ bol at once Tab. liv 52 2tab/day x 7 days cap Astymin 1cap/day x 7 days	
29.05.11	Deworming	Bol . Ivermectin-82 mg-¼ bol at once	
22.07.11	Deworming	Tab.Zolbend-400 mg-1 tab/day x 3 days Tab. liv 52 2tab/day x 7 days cap Astymin 1cap/day x 7 days	
10.08.11	Vomiting	Syp.Gelosil-10 ml /day x 10 days Tab.Reglin-2 tab/day x 3 days ORS-1 pkt/day x 5 days	
11.08.11	Vomiting	Syp.Griptol-N-10 ml /day x 6 days	
19.08.11	Deworming	Bol.Oxzol-(2200 mg)- ½ bol/day X 2 days	
14.10.11	Deworming	Bol.Oxzol-(2200 mg)- ½ bol/day X 2 days	

22.10.11	Deworming	Bol Fantas (1.5mg)- ½ bol/dayX 2 days Tab. liv 52 2tab/day x 7 days cap Astymin 1cap/day x 7 days	
12.11.11	Deworming	Bol Fantas (1.5mg)- ½ bol/dayX 2 days	
16.12.11	Deworming	Tab.Zolbend-400 mg-1 tab/day x 3 days Tab. liv 52 2tab/day x 7 days cap Astymin 1cap/day x 7 days	
6.01.12	Deworming	Tab.Zolbend-400 mg-1 tab/day x 3 days	

Padmaja Naidu Himalayan Zoological Park , Darjeeling

Treatment Card no : 101

Transponder no. : 981098102056547

Species: SNOW LEOPARD

Beat no: 6 (CBC)

Name of Animal : RETU

Sex : FEMALE
Date of birth : 11.03.2004

Date	kind of illness & symptoms	Treatment	Remarks
26.07.04	Deworming	Tab.Albidol (150mg) - ½ tab/day x 4 days Tab.liv 52 - 2 tab/day x 15 days Cap.Astymin - 1 cap/day x 15 days	
20.08.04	Deworming	Tab.Plozin - 4 tab at a time Tab.liv 52 - 2 tab/day x 15 days Cap.Astymin - 1 cap/day x 15 days	
9.10.04	Deworming	Tab.Panacur (150mg) - 2 tab/day x 3 days Tab.liv 52 - 2 tab/day x 15 days Cap.Astymin - 1 cap/day x 15 days	
18.01.05	Deworming	Tab.Plozin - 4 tab at a time Tab.liv 52 - 2 tab/day x 15 days Cap.Astymin - 1 cap/day x 15 days	
15.02.05	Deworming	Bol.Endectin - ½ bol once Tab.liv 52 - 2 tab/day x 15 days Cap.Astymin - 1 cap/day x 15 days	

16.03.05	Deworming	Tab.Plozin - 2 tab at a time Tab.liv 52 - 2 tab/day x 15 days Cap.Astymin - 1 cap/day x 15 days	10.03.06
5.06.05	Deworming	Tab.Panacur (150mg) - 3 tab/day x 3 days Tab.liv 52 - 2 tab/day x 15 days Cap.Astymin - 1 cap/day x 15 days	
5.08.05	Deworming	Tab.Plozin - 2 tab at a time Tab.liv 52 - 2 tab/day x 15 days Cap.Astymin - 1 cap/day x 15 days	
30.08.05	Deworming	Tab.Panacur (150 mg) - 3 tab/day x 3 days Tab.liv 52 - 2 tab/day x 15 days Cap.Astymin - 1 cap/day x 15 days	
2.01.06	Deworming	Tab .Wormer - 1 tab /day x 3 days Tab.liv 52 - 2 tab/day x 15 days Cap.Astymin - 1 cap/day x 15 days	
18.06.06	Deworming	Tab.Wormer - 1 tab /day x 3 days Tab.liv 52 - 2 tab/day x 15 days Cap.Astymin - 1 cap/day x 15 days	
25.08.06	Deworming	Tab.Pyrate fort - 1 tab/day x 4 days Tab.liv 52 - 2 tab/day x 15 days Cap.Astymin - 1 cap/day x 15 days	
25.11.06	Deworming	Tab.Panacur (150mg) - 3 tab/day x 3 days Tab.liv 52 - 2 tab/day x 15 days Cap.Astymin - 1 cap/day x 15 days	
2.02.07	Deworming	Tab.Wormer - 1 tab /day x 3 days Tab.liv 52 - 2 tab/day x 15 days Cap.Astymin - 1 cap/day x 15 days	
5.05.07	Deworming	Bol.Fantas (1.5mg)- ½ bol/day X 4 days Tab.liv 52 - 2 tab/day x 15 days Cap.Astymin - 1 cap/day x 15 days	
1.08.07	Deworming	Tab.Wormer - 1 tab /day x 3 days Tab.liv 52 - 2 tab/day x 15 days Cap.Astymin - 1 cap/day x 15 days	
17.10.07	Deworming	Bol.Fantas (1.5 mg)- ½ bol/day X 4 days Tab.liv 52 - 2 tab/day x 15 days Cap.Astymin - 1 cap/day x 15 days	

15.01.08	Deworming	Tab.Panacur (150mg) - 1 tab/day x 4 days Tab.liv 52 - 2 tab/day x 15 days Cap.Astymin - 1 cap/day x 15 days	
2.03.08	Deworming	Tab.Easypet (meltab) - 1 tab /day x 4 days Tab.liv 52 - 2 tab/day x 15 days Cap.Astymin - 1 cap/day x 15 days	After stool test (Deworming given)
2.06.08	Deworming	Bol.Fantas (1.5 mg)- ½ bol/day X 2 days Tab.liv 52 - 2 tab/day x 15 days Cap.Astymin - 1 cap/day x 15 days	
11.07.08	Deworming	Bol.Fantas (1.5 mg)- ½ bol/day X 2days Tab.liv 52 - 2 tab/day x 15 days Cap.Astymin - 1 cap/day x 15 days	
16.10.08	Deworming	Bol.Fantas (1.5 mg)- ½ bol/day X 2 days Tab.liv 52 - 2 tab/day x 15 days Cap.Astymin - 1 cap/day x 15 days	Worm found in stool
20.01.09	Deworming	Bol.Fantas (1.5mg) - ½ bol/dayX 2 days Tab.liv 52 - 2 tab/day x 15 days Cap.Astymin - 1 cap/day x 15 days	Worm found in stool
20.03.09	Deworming	Bol.Panacur (1.5 g) - ½ bol at once Tab.liv 52 - 2 tab/day x 15 days Cap.Astymin - 1 cap/day x 15 days	
5.06.09	Deworming	Tab.Prazism plus - 2 tab/day x 2 days Tab.liv 52 - 2 tab/day x 15 days Cap.Astymin - 1 cap/day x 15 days	
4.08.09	Deworming	Bol.Endectin - ½ bol x 2 days Tab.liv 52 - 2 tab/day x 15 days Cap.Astymin - 1 cap/day x 15 days	
5.02.10	Deworming	Tab.Prazism plus-2 tab/day x 2 days Tab.liv 52 - 2 tab/day x 15 days Cap.Astymin - 1 cap/day x 15 days	
4.05.10	Deworming	Bol.Fantas (1.5mg) - ½ bol/day X 2 days Tab.liv 52 - 2 tab/day x 15 days Cap.Astymin - 1 cap/day x 15 days	

6.08.10	Deworming	Tab.Pyrate fort - 2 tab/day x 2 days Tab.liv 52 - 2 tab/day x 15 days Cap.Astymin - 1 cap/day x 15 days	
7.09.10	Deworming	Tab.Pyrate fort - 2 tab/day x 2 days Tab.liv 52 - 2 tab/day x 15 days Cap.Astymin - 1 cap/day x 15 days	
6.02.11	Deworming	Bol.Fantas (1.5 mg)- ½ bol/day X 2 days Tab.liv 52 - 2 tab/day x 15 days Cap.Astymin - 1 cap/day x 15 days	
6.05.11	Deworming	Bol. Ivarmactin - ¼ bol at once Tab.liv 52 - 2 tab/day x 7 days Cap.Astymin -1 cap/day x 7 days	
29.05.11	Deworming	Bol.Ivermectin - 80 mg - ¼ bol at once	Gram Steem done Result (+ve Cocci)Retu
22.07.11	Deworming	Bol.Fantas(1.5 mg) - ½ bol/day X 2 days	
19.08.11	Deworming	Bol.Oxzol (2200 mg) - ½ bol/day X 2 days	
22.10.11	Deworming	Bol Fantas (1.5mg)- ½ bol/day X 2 days Tab.liv 52 - 2 tab/day x 7 days Cap.Astymin - 1 cap/day x 7 days	
12.11.11	Deworming	Bol.Fantas (1.5mg) - ½ bol/day X 2 days	
22.10.11	Deworming	Bol Fantas (1.5mg)- ½ bol/dayX 2days Tab. liv 52 2tab/day x 7 days cap Astymin 1cap/day x 7 days	
12.11.11	Deworming	Bol Fantas (1.5mg)- ½ bol/dayX 2 days	

13.01.12	Deworming	Tab.Zolbend(400 mg)-1 tab/day x 3 days	Worm Found in vomit

11. POST MORTEM EXAMINATION:

Necropsy (post-mortem examination) is an excellent diagnostic tool that should be performed on all zoo collection animals. When it becomes necessary to euthanize any animal the method of euthanasia should cause the least amount of artifactual changes in the tissues and leaves the animal as intact as possible. The course of a disease can be better understood if necropsy is preformed when animals die unexpectedly. In addition, the knowledge gained from a necropsy can be applied to future circumstances involving similar conditions or disease processes (Pratt1998).

Histopathological examination of tissues is mandatory and should be done in a timely manner to make those findings relevant to the health care of the collection. Concurrent cultures may be indicated for bacteria, fungi, and viruses. Appropriate tissues not formalin fixed may be frozen for viral, toxicology, and genetic studies. Besides determining the cause of death, a complete post-mortem examination allows review of anatomical structure, assessment of nutritional status and parasitic burden of the animal.

11.1. OBJECTIVE

- To investigate and determine the cause of animal deaths, so as to identify and therefore minimize biosecurity risks.

- To minimize or eliminate the spread of disease or contamination via animal carcasses.

- To identify problems and to find out the solution to safeguard the health of the rest of the animals.

Post mortem is particularly important for animals which die in quarantine in preparation for introduction to a collection translocation or reintroduction programme.

Post mortem may be performed in the field or laboratory by a clinician or a pathologist dependent on the circumstances.

Where the gross post mortem is performed by an individual other than the pathologist who will perform the further examinations on samples provided communication between the two parties is essential to ensure that optimal samples are taken (tissue type, volume/weight storage, transport, temperature etc.).

Inadequate or incorrect sample taking may reduce the likelihood of reaching an accurate diagnosis. Forensic post mortem for legal investigation should be performed by an experienced wildlife pathologist, since the credentials of the pathologist will be assessed as part of the case.

Similar protocols should be used for the post- mortem examination of domestic, free- ranging or captive wild animals. If possible findings should be dictated during the examination or as an alternative noted down at the time of examination.

When performing a necropsy or post mortem examination it is important to:

- First consider the history of the animal (where available). Not the clinical signs, treatment, diagnostic tests, possible differential diagnosis, number of animal's involved etc. communication between the pathologist and the case clinician, where available is recommended.
- Consider recent and historical disease problems in the collection (captive animal), region (free ranging), in-contact domestic animal and human population.
- Examine the site where carcass was found if possible (e.g. of agonal movements, convulsions disturbing the local area, piles of faeces and urine around the hindquarters suggestive of prolonged recumbency).
- Have a systematic approach, whether head to tail, system to system (digestive, respiratory etc), or any other.
- Recognize the normal anatomy, normal appearance of organs/tissues and anatomical variations between species.
- Have knowledge of seasonal variations between individual of the same species dependent on whether they are captive or free ranging (e.g. obese body condition may be seen in captive animals than those under wild conditions): Ectoparasite and endo- parasite

burdens may be expected to be greater in free-ranging wild animals than those under captive management.

- Have knowledge of potential art factual findings e.g. hypostatic congestion (pooling of blood in organs under the effects of gravity which can be mistaken for potential congestion), barbiturate crystals from euthanasia solution which can be mistaken from gout, pseudo prolapse of the anus or vagina as a result of increased pressure within the abdomen caused by gas production after death.
- Accurately describe lesions/ abnormalities.
- Record both positive and negative findings.
- Keep accurate records, including a unique identifying number for each carcass and for samples from that carcass.
- Keep detailed notes on all findings and procedures for forensic post moterm, written in non- technical language wherever possible.
- Avoid the use of non- standard abbreviations in permanent records.
- Take photographs (include case identification, details) for animal identification and illustration of gross pathology.
- Preserve samples (tissue, parasites etc) for further research and reference.
- A full spectrum of samples should be taken where possible at the initial examination if possible and stored properly.
- Further investigations at first, may be directed at the samples thought most likely to be important in revealing the cause of death. However if further samples are needed subsequently the full spectrum are available in store.
- Where time and financial constraints limit samples taking a short list of standard tissues should be sampled, in addition to those with apparent gross pathology.
- In some circumstances it may be advised to keep the entire carcass for a period following the postmortem examination refrigerated in the short term to provide samples in the future if required.
- Consult the appropriate regional authority if a notifiable disease (FMD) is suspected before progressing with the post mortem examination.

- Carcass location and body size may dictate whether transport to the laboratory facility for examination is possible or whether the post mortem must be performed in the field.
- Autolysis of the organs occurs with variable speed, the adrenal medullae, gastro-intestinal mucosa, pancreas, liver, kidney and CNS develop autoloytic changes particularly quickly, post mortem should be performed as quickly as possible after death has occurred and has been confirmed however this may not always be possible and carcass cooling to slow the rate of autolysis should be practiced.
- The carcass should be placed within a sealed plastic bag clearly labeled with excess air removed and be refrigerated if its body size allows.
- Carcasses preferably should be refrigerated while awaiting examination.
- With large mammals cooling of central organs will not occur sufficiently quickly to prevent autolysis. Priority should be given to performing post moterm as soon as possible, opening the abdomen may help lower the core temperature as quickly as possible. 72 Where post moterm examination must be delayed until 72- 96 hrs after death. The carcass should be refrigerated only, however if the examination must be delayed over 96 hrs postmoterm, it is recommended to freeze the carcass immediately.
- When transporting a carcass or pathological sample to a laboratory for analysis attention should be paid to temperature control in transit. Insulated containers should be chosen, ice packing of frozen samples may be used and times when post gets delayed may be. (E.g. weekends, public holidays, strikes).
- In an event of a die-off (mass mortality event) it is important to examine fresh carcasses of a number of individuals, representatives of the range of species affected and the ages of individuals affected and to remember that more than one disease process may be acting at any one time and that the major causes of death may change during a prolonged die-off.
- The result of the post moterm should be used in conjunction with the history of the mammal or mammals and assessment of the environment to help determine their significance and recommended future action.
- Suspect cases of sudden death should have peripheral blood smears taken to exclude anthrax infection as a differential before the carcass is opened. Bloody discharges should

direct the examiners attention to the need to exclude anthrax infection before continuing with the examination. Depending on region, specialist, and veterinary staff may be legally required to carry out the anthrax testing process.

- Samples should be taken by nicking the dependent ear or from the coronary band.
- In wild equids (Equidae – Horses (family)- horses, wild pigs (Suidae – Pigs (Family) and carnivores (Carnivora- Carnivores (order), anthrax bacilli may not be present within the blood therefore examination of a smear made from the cut surface of a lymph node (usually submandibullar is recommended in addition.
- Tissue and blood smears should first be air dried and then fixed in methanol.
- Staining should be performed for two minutes with polychrome methylene blue or Giesma stain.
- Samples should be examined under oil immersion microscopy for evidence of anthrax bacilli.
- If anthrax infection is confirmed, careful attention must be paid to quick and effective carcass disposal.
- Regional authorities responsible for disease control should be notified and action taken as appropriate.
- If anthrax infection is excluded, the post moterm examination should proceed.

- In areas where rabies infection is enzootic, all mammals found dead, and particularly those with a clinical history of abnormal behaviour or neurological signs should be carefully examined and considered as potentially infected until proven otherwise.

11.2. EQUIPMENTS

Laboratory post moterm facilities should be housed in a separate room to the clinical facilities and should be cleaned with adequate water supply and draining floor in consultation with the veterinary section of the park.

Weighing Scales And Measuring Devices (tapes, clippers) should be available with a level of accuracy and range appropriate for the mammals under investigation.

Suitable Dissection Instruments should be available in the laboratory or the field: 1) a curved knife for skinning, a straight pointed knife for dissecting, a pair each of 25 cm rat-toothed forceps, 15 cm pointed forceps, 15 cm dissecting scissors, a sterile scalpel and blades, an enterotome, a bone saw, a large pair of bone forceps or bone-cutting shears, an axe, a sharpening stone and steel, a balance to weigh, some nylon rope, and a small gas or alcohol burner for sterilizing instruments.

2) “Knife, lamp, matches, sterile syringes and needles, sterile swabs with transport media”

- Dissection equipments should be clearly marked and kept solely for the purpose.
- Equipments should be cleaned and sterilized following use.
- Size of equipments should be tailored to the carcass size; ophthalmology instruments, hand lens and dissecting microscopes may be useful for small mammals where available.
- All non- disposable cutting instruments should be kept sharp.

Suitable Sample Collection Equipment and disposable should be available in the laboratory or the field.

- An equipment list for specimen collection in the field includes sterile disposable 5 ml syringes and sterile needles (20 gauge); culture tubes with sterile swabs, microscope slides in box; sterile universal bottles; sterile blood tubes; plastic bags with closure taps (Ziploc types), heavy duty plastic sealing tape; 300ml wide mouthed glass and plastic jars, a measuring tape or ruler rubber or plastic string and a waterproof marker pen or pencil.
- Microscope, clean slides and cover slips.
- Sterile swabs and transport media.
- Gas source for heating metal blade to sear surface of an organ before sampling for microbiology.

- Suitable Fixation Medium should be available in the laboratory or the field including 10% neutral buffered formalin, 70% alcohol for parasites, 100% acetone for cytology (danger flammable), normal saline.
- Stain kits for cytological, bacteriological and fungal examinations (Gram, Ziehl- Nielsen, Diff Quick, Hemacolor, lactophenol)

11.3. GENERAL EXTERNAL EXAMINATION

- Record the sex and estimate age. Classification as a neonate/infant/juvenile/adult/geriatric may be useful.
- Record any identifying numbers e.g. tattoo, tags, microchip number etc, retain any physical markers for future reference e.g. radio transmitters, tag.
- Record any characteristic features e.g. characteristic scars or colour markers, coat colour e.g. (e.g. albino, leucistic, melanistic).
- Examine the inside of the container/wrappings that the carcass have been presented in noting contaminants (e.g. mud, oil) and possible external parasites such as fleas, lice or mites which may have left the host. Presence of maggots within the wrappings may indicate significant carcass decomposition but should alert the examiner to search the lesions of fly strike.
- Weigh the carcass. Dry weight should be taken where possible to minimise error where the carcass is presented wet, this should be noted for future reference to allow recognition of potential bias.
- Biometric measurements: a range of biometrics should be taken using graduated calipers.. the accuracy and units of measurement should be clearly noted. For e.g. body length, chest girth, head length, head girth, neck length, neck girth, ear length, ear girth, length of fore and hind limbs etc. if specific anatomical measurements to be noted, we have to carry on specifically.
- Body condition – use a combination of subjective and objective measurement of body conditions where possible

1. Subjective scores can be developed, perhaps by creating indices based on muscle bulk, amount of subcutaneous and visceral fat deposits.

2. Objective scores can be developed, perhaps by creating indices of parametric measurement to body mass.

- Radiography may be indicated to detect e.g. fractures radio dense foreign bodies, air gun or shot pellets, metabolic bone disease.
- Examine the external surface of the carcass; note whether the carcass is fresh or decomposed; whether it has been refrigerated or frozen; also whether it is intact or scavenged; and if scavenged to what degree.
- Estimate time of death where unknown
- Autolysis will be accelerated where the temperature of the animal is increased at the time of death e.g. heat stroke, lightening strike.
- Differentiate gas production in the gastro- intestinal tract post moterm with premortem “bloat”
- Bile staining of tissue adjacent to the gall bladder can be seen in carcasses as post moterm change.

Head and Neck

- Examine the eyes, ears, nostrils (external nares) and mouth for evidence of haemorrhage, discharge, external parasites, maggots, abnormal growths, foreign bodies, other lesions etc.
- Fatalities following acute plant poisoning may still have remnants of the plant material within their mouth.

- Examine the eyes carefully for evidence of opacity or long standing injury which may have compromised vision.
- Examine the condition of the lips, oral mucosa, soft/hard palate and tongue for lesions such as ulcers, growths or developmental abnormalities. (e.g. cleft palate).
- Cut through the oral commissures to allow adequate examination right to the back of the oral cavity.
- For more thorough examination, continue the incision to allow disarticulation of the lower jaw, this will allow full inspection of the nasopharyngeal area, tonsils, and retro pharyngeal and parotid nodes, as required.
- The teeth should be examined for evidence of tooth loss, abnormal or excessive wear (attrition), gingivitis, periodontal disease, tartar accumulation etc.
- Full dental formula should be recorded.
- Remove the skin from the skull and the temporal muscle as necessary.
- Examine the subcutaneous tissues and skull table for evidence of trauma, bruising etc.
- Section of the base of the auricular (ear) cartilage and examine the contents for evidence of discharge, inflammation parasite etc.
- Sectioning of the skull for examination of the sinuses, turbinates or tymphanic bullae may be performed if required given specialist facilities.

Skin, Fur (Integument) Body – External Examination

- Note the general appearance of the carcass, pelage (fur, spines) e.g. condition: wet. Muddy, oiled, clean, bloody, moult
- If in moult, note the extent and take into account the season
- Missing patches of fur should be correlated with wound, parasites, history of pruritus (itching), entanglement etc.
- Condition of the fur may indicate whether that animal was in good condition or a state of debility prior to death.

- Note any would present and characterize them in terms of age, size, location, degree of sepsis.
- Check for the presence of external parasites (Ectoparasites) – fleas, lics, ticks, maggots etc.
- Particular attention should be paid to checking the predilection sites for external parasites e.g. .armpits (axillae), groin, perineum, hoof clefts, eyes, ears etc.
- Systematically part the hair over multiple areas of the body to examine the skin, looking for the lesions including bite wounds, macules, pustules, comedones, furuncles etc.
- Examine all body orifices, including the anus, vulva, prepuce, cloaca as appropriate for evidence of haemorrage, discharge, parasites, maggots, abnormal growth.
- The carcass must be turned over allowing a full examination to be performed over both sides of the body.
- Examine the perineum and hindquarters for evidence of faecal scouring suggestive of diarrhea.
- At the end of the post mortem, the skin should be removed from the entire carcass to allow complete examination of the subcutaneous layer.

MUSCULO-SKELETAL SYSTEM – EXTERNAL EXAMINATION:

- Examine the limb for evidence of fracture dislocation, swelling, deformity, lacerations, wound (including snare wounds) etc.
- Use the other limb as a comparison for reference to help identify pathology.
- Palpate the muscle bulk over all limbs using this as another indicator of body condition.
- Muscle wasting (atrophy) affecting a single limb, or muscle group within a single limb may indicate recent disuse, possibly due to a long standing injury affecting the limb.
- Provided the carcass is not in rigor mortis manipulate each limb and joint through its range of movement, comparing each side with one another to the top (proximal) of the limb.
- Abnormal increased or restrained range of movement at a joint should direct further internal joint examination.
- Radiographic examination may be indicated if an abnormality is detected on palpitation.

11.4. NECROPSY DETAILS OF SNOW LEOPARD CARRIED OUT AT PNHZPARK 2011.

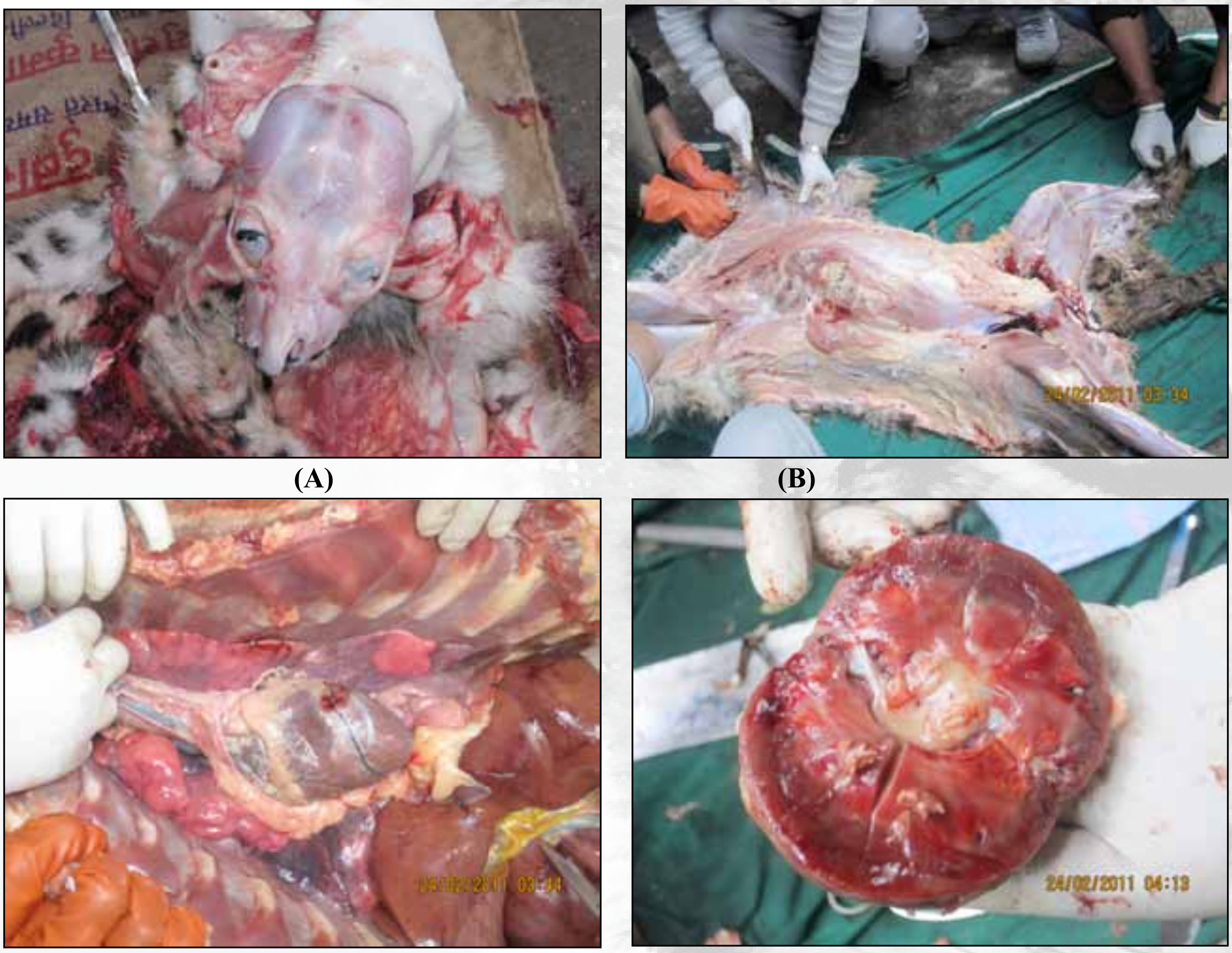
External examination was carried out that includes:

- Record of Sex and Age
- Identification number record: microchip number.
  Examination of endoparasite and Ectoparasite
- Dry weight of the carcass.
- Biometric measurements. For e.g. Body length, chest girth, head length, head girth, neck length, neck girth, ear length, length of forelimb and hind limb etc.
- Radiography: may be indicated to detect e.g. Fractures radio dense foreign bodies, air gun or shoot pellets and metabolic bone disease.
- Tissues (liver, Lung, heart, Kidney, intestine, spleen, blood) are preserved for laboratory analysis and for potential future examinations.

CASE REPORT:

Female Snow Leopard cub of Ritu (Dam) and Parbhat (Sire) which was born on 09.09.2011 died after reaching 75 days i.e. on 22.11.2011. Post mortem was done on the same day. Necropsy follows symptoms of acute pleurisy subsequently followed by cardiorespiratory failure. Accumulation of pleural fluid approximately 35ml, transparent, viscous, yellowish fluid slightly turbid in chest cavity .Lungs was congested with pleurisy. Liver congested, acid froth found in the stomach.

Fig. 28:X-Ray of snow leopard cub



(A) **(B)** **(C)** **(D)**

Fig. 29(A-D): Post mortem of animal carried out at PNHZPark

Fig 30: Burning of carcass after Post mortem.

APPENDIX-XIV

PADMAJA NAIDU HIMALAYAN ZOOLOGICAL PARK
DARJEELING

Veterinary Necropsy Protocol
Post-Mortem Report

No. PNHZP/30/2011 Date: 22.11.11

Kind of animals (with remarks of identification if any)	Scientific Name	Sex	Personal Name	Age	Size	Weight
Snow leopard cub of Ritu(F)		F		75 days D.O.B 09.09.11		4.15 kg.

Time, date and place of death: 2.05 p.m., 22.11.11

Time and date of post-mortem examination: 3.15 p.m. 22.11.11

Short history of illness, if any: Today at about 10.50 a.m it was reported that the cub of the snow leopard Ritu showing the symptom of weakness, unwilling to move, high respiratory rate which was of abdominal type.

1. General description: Body length 15", Shoulder height 10", length of tail 13", Chest girth 12", Neck girth 8", Neck length 3", Head girth 9", Head length 5", length of ear 2", length of fore limb 9", Length of hind limb 9½", Fore paw length 3"/3-2½", hind paw 2⅓"X2"

3. Organ-wise description of lesions-

(1) Head and neck .... (a) Skull and brain (b) Cervical vertebrae — Checked no abnormality found

(2) Thorax .... (a) Lungs — Congested with pleurisy, pleuritis (b) Heart — Pericarditis, accumulation of fluid 35ml (c) Ribs — exudate slightly tinted in the chest cavity, symptom of acute pleurisy

(3) Abdomen .... (a) Liver — Congested (b) Stomach — no abnormality found, curd/milk found (c) Intestines — in the stomach, intestine normal (d) Kidney (e) Spleen — no abnormality found

(4) Pelvic girdle .... (a) Uterus and Ovaries (b) Bladder (c) Genital passage — no abnormality found

(5) Limbs .... (a) Puro Limbs (b) Hind Limbs — no abnormality found

(6) Any other special features:
Biological tests done (if any)
(i) Blood
ii) Urine
iii) Discharges
iv) Biopsy

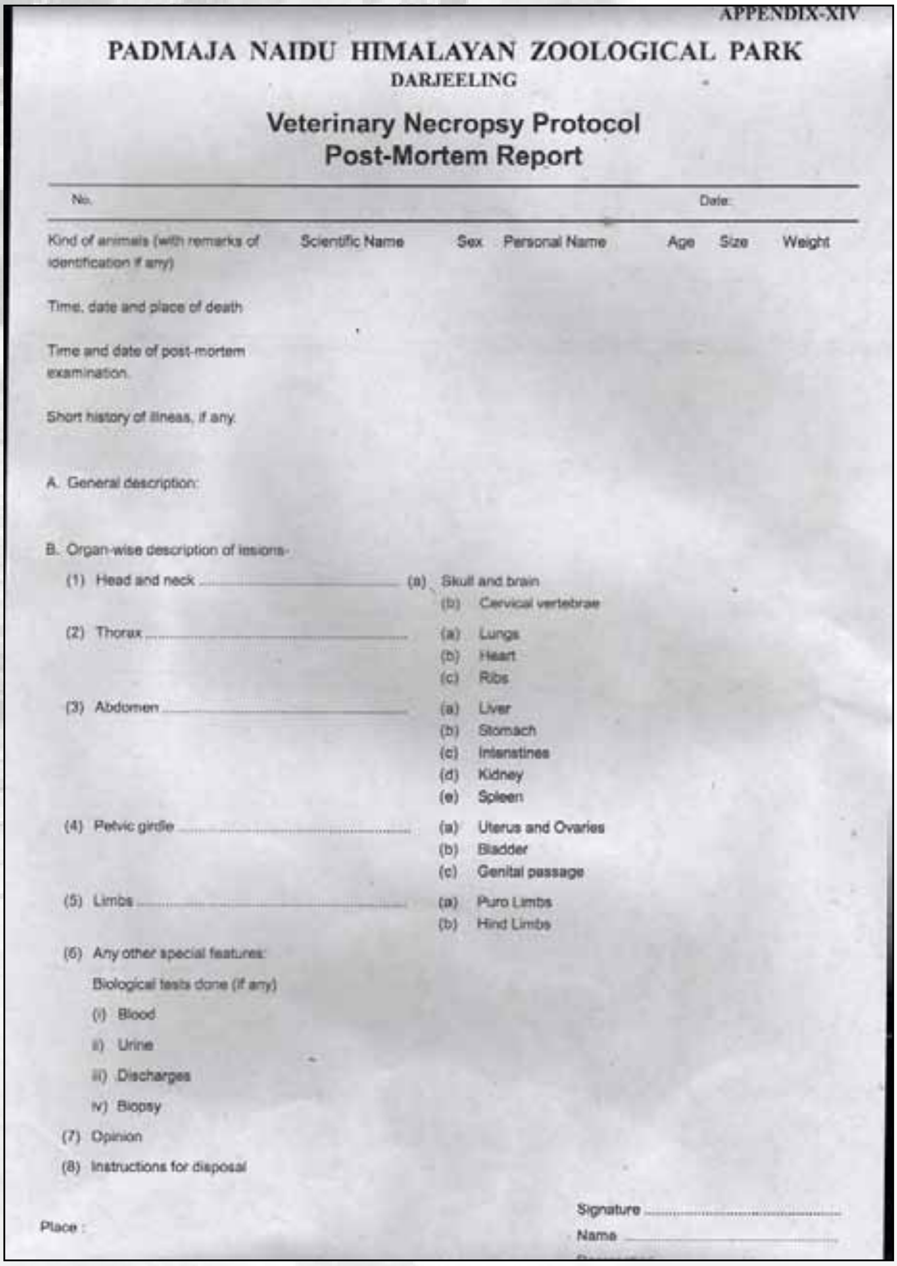
Sample of Lung, pleural fluid, Liver, kidney, spleen, heart, blood collected and send to Laboratory for Biological tests.

(7) Opinion: Death may be due to pleurisy and subsequent cardiorespiratory failure.

(8) Instructions for disposal: Skin collected for preservation other body parts for burning.

Signature ....

Fig. 31: Necropsy report of Snow leopard cub PNHZPark 2011.



APPENDIX-XIV

PADMAJA NAIDU HIMALAYAN ZOOLOGICAL PARK

DARJEELING

Veterinary Necropsy Protocol

Post-Mortem Report

No. Date:

Kind of animals (with remarks of identification if any)	Scientific Name	Sex	Personal Name	Age	Size	Weight

Time, date and place of death

Time and date of post-mortem examination.

Short history of illness, if any.

A. General description:

B. Organ-wise description of lesions-

(1) Head and neck .... (a) Skull and brain (b) Cervical vertebrae

(2) Thorax .... (a) Lungs (b) Heart (c) Ribs

(3) Abdomen .... (a) Liver (b) Stomach (c) Interstines (d) Kidney (e) Spleen

(4) Pelvic girdle .... (a) Uterus and Ovaries (b) Bladder (c) Genital passage

(5) Limbs .... (a) Puro Limbs (b) Hind Limbs

(6) Any other special features:

Biological tests done (if any)

(i) Blood

ii) Urine

iii) Discharges

iv) Biopsy

(7) Opinion

(8) Instructions for disposal

Place :

Signature ....

Name ....

Fig. 32: Format of Post Mortem Report card of PNHZPark

The above mentioned preventive measures were being carried out at the Park for the last couple of years. After doing an intensive study for two years and going through each and every details/records of Snow Leopard at the Park finding reveals that there are some minor detailing which needs to be seriously took into consideration for the successful breeding of Snow Leopard in captivity.

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12. Capture and Restraint Method:

Wild animals are far more susceptible to stress and injury than domestic species, particularly during capture, handling, restraint and transportation. Even apparently innocuous procedures such as blood collections and clinical examinations can be as distressing to wild animals as to significantly jeopardize its health and welfare.

12.1. Objective: The main objective of every capture and restrain procedure is to minimize the stress on animal side and to maximize the safety of the handler.

Some of the important factors to be considered during Restraint

- Thorough knowledge about the species to be handled, including its behaviour, reaction to stress, ability to defend, and the appropriate physical and chemical restraint procedures;
- The equipment and facilities needed – everything should be checked and made ready before the animal is captured;
- The restraint procedures to be adopted. Need to know whether physical restraint or chemical restraint is required for the particular animal.
- Best time to undertake the procedure (morning or late afternoon).
- To monitor the recovery conditions.

❖ **Restraint should be done during the following situations:**

- Shifting of animals from one housing facility to another.
- Treatment of disease or illness, regular vaccinations, etc. Unscheduled treatment, such as for injury.
- Animal escape.

12.2. TYPES OF RESTRAIN TECHNIQUES:

1. Physical Restrain
2. Chemical Restrain

12.2.1. Physical restrain: Humane and safe physical restraint is the use of manual or mechanical means to limit some or all of an animal's normal voluntary movement for the purposes of examination, collection of samples, drug administration, therapy, or manipulation. The method used should provide the least restraint required to allow the specific procedure(s) to be performed properly, should minimize fear, pain, stress and suffering for the animal, and should protect both the animal and personnel from harm. Every effort should be made to ensure adequate and ongoing training in animal handling and behavior by all parties involved, so that distress and physical restraint are minimized.

Physical restraint can usually be achieved in a squeeze cage, where minor procedures and a cursory examination can be conducted. Blood samples can be obtained from the lateral tail vein in Snow Leopards, and IM injections of medication, vaccines, or anesthetics are facilitated by squeeze cages (Ed. Kleiman et al, 1996).

In PNHZ Park the animals are physically restrained using squeeze cage usually during the time of shifting, for blood sample collection, routine checkup, vaccination, physical injury

Fig. 33: Physical restraint of Snow leopard at PNHZPark in squeeze cage.

12.2.2. Chemical restrain: Chemical restraint can be extremely useful as an aid to diagnostic or minor surgical procedures or in the control of animals which have a potentially dangerous temperament. Selection of appropriate combinations and doses of drugs to provide ideal restraint for the spectrum of patients and procedures encountered in clinical practice requires experience of a wide range of agents and their effects in different circumstances. A suitable combination for a particular individual may be completely ineffective in another animal of similar breed and size, but different temperament, undergoing the same procedure. The administration of chemical restraint is therefore a much more difficult skill to acquire than that of general anaesthesia.

Chemical restraint is done mostly when the animals are severely injured and when they are not in a condition to be restrained physically. Since chemical restraint is quite difficult to apply to the animals. Therefore we have to be very cautious before undergoing the process of chemical restraint.

12.3. Following are few Pre- anesthesia considerations:

Animals should always be fasted at least 12 hours, and ideally 24 hours prior to anesthesia.
Water may be provided prior to anesthesia.

1. **Environmental considerations**

- Immobilizations should be planned to occur during the coolest part of the day if done in a region or time of year where the ambient temperatures are high and the procedure must be done outside in an uncontrolled environment. If high temperatures are expected, ample cool water should be on hand to help to prevent or manage hyperthermia.

- Whenever possible, species –specific anaesthetic protocols should be followed. Supplemental oxygen always should be provided, regardless of anaesthetic used (Fowler & Miller 2003). Most of the drugs used for carnivore immobilisation may be administered by any route. Ketamine with or without Xylazine has been used routinely to anaesthetise Snow Leopards (Jalanka, 1989a).

- Once the animal is immobilized make sure that the body is positioned correctly to insure that nothing interferes with respiration. Make sure the nose and mouth are clear, and the neck is straight. Keep the animal on a flat surface; this prevents occlusion of the trachea, pressure neuropathy, or circulation impairment.

- Vital signs need to be monitored; this includes respiration rate and heart rate. A portable pulse oximeter is invaluable for monitoring respiratory efficiency. Body temperature should be monitored, especially in hot or cold situations. If body temperature falls below 36.6 C or above 40 C, the environmental conditions need to be modified to correct it (Baeyens, 2007).

- Thermoregulation is a critical factor in many restraint procedures. Hyperthermia and more rarely, hypothermia are common sequelae. Heat is always generated with muscle activity. Restrained animals should be placed in the shade to avoid radiant heat and placed in the sun's heat if the weather is cool (Fowler 1995).
- Intramuscular injections are usually given in the thigh region of the left hind limb usually delivered by blow pipe,pistol.
- Infant felids may be handled in much the same manner as a domestic cat. Infant and juvenile cubs can be manually handled and restrained for examination by grasping them by the nape of the neck. This method is used by the mother to transport the cub; thus relaxation is an expected behavioural pattern.

2. **Condition of the animal:** Restraint or handling results in stress, and recently transported animals may be poor health risks; the longer the journey, the greater the risk. Don't handle the animal unnecessarily. Try to evaluate its health status before involving it in additional restraint.

3. **Behavioural aspects**: Know your animals; certain times of the year may be safer than others for handling some species. The cubs of many carnivores can be carried or lifted by grasping the loose skin at the back of the neck; this simulates the way in which the mother carries her young and the cubs will just curl up. This reaction will not be seen in adult animals. A female in estrus or with young close by, will react differently than when the young have grown and gone. A male near a conspecific in estrus may be aggressive.

The following anesthetic agents have been successfully used with snow leopards (Jalanka 1989a,; Wharton & Mainka 1997):

- Ketamine

- Ketamine and xylazine
- Ketamine and diazepam
- Medetomidine (with atipemezole as a reversal agent)
- Isoflurane (inhalation)
- Halothane (inhalation)

Pre-anesthetic treatments for snow leopards include acepromazine, diazepam, and atropine (Wharton & Mainka 1997). Yohimbine has been successfully utilized as an antagonist. The following table provides doses (ranges and means) of anesthetic agents provided to snow leopards:

Anesthetics used with snow leopards (from Rosenthal & Ott-Joslin 1988)

Anesthetic agent	**Dosage range (mg/kg)**	**Mean dosage (mg/kg)**
Ketamine	5-20	9.7-12.4
Xylazine	0.2-2	0.66-1.2
Tiletamine-zolazepam	-	2
Acepromazine	-	1-2.2
Atropine	-	0.04
Diazapam	2-10	5.5-7.5
Yohimbine	-	0.14

Problems during anesthetic procedures include seizures, vomiting and excess salivation. Most snow leopards fully recover from anesthetic 2-3 hours after immobilizations (Wharton & Mainka 1997).

Drugs are usually administered by dart for safety purposes although animals can be trained to receive drugs through the caging via hand injection. Once immobilized a keeper restrains the head by holding the back of the neck while the animal is safely carried to the exam facility if necessary.

Fig. 34: Chemical restraint of Male Snow leopard at PNHZ Park.

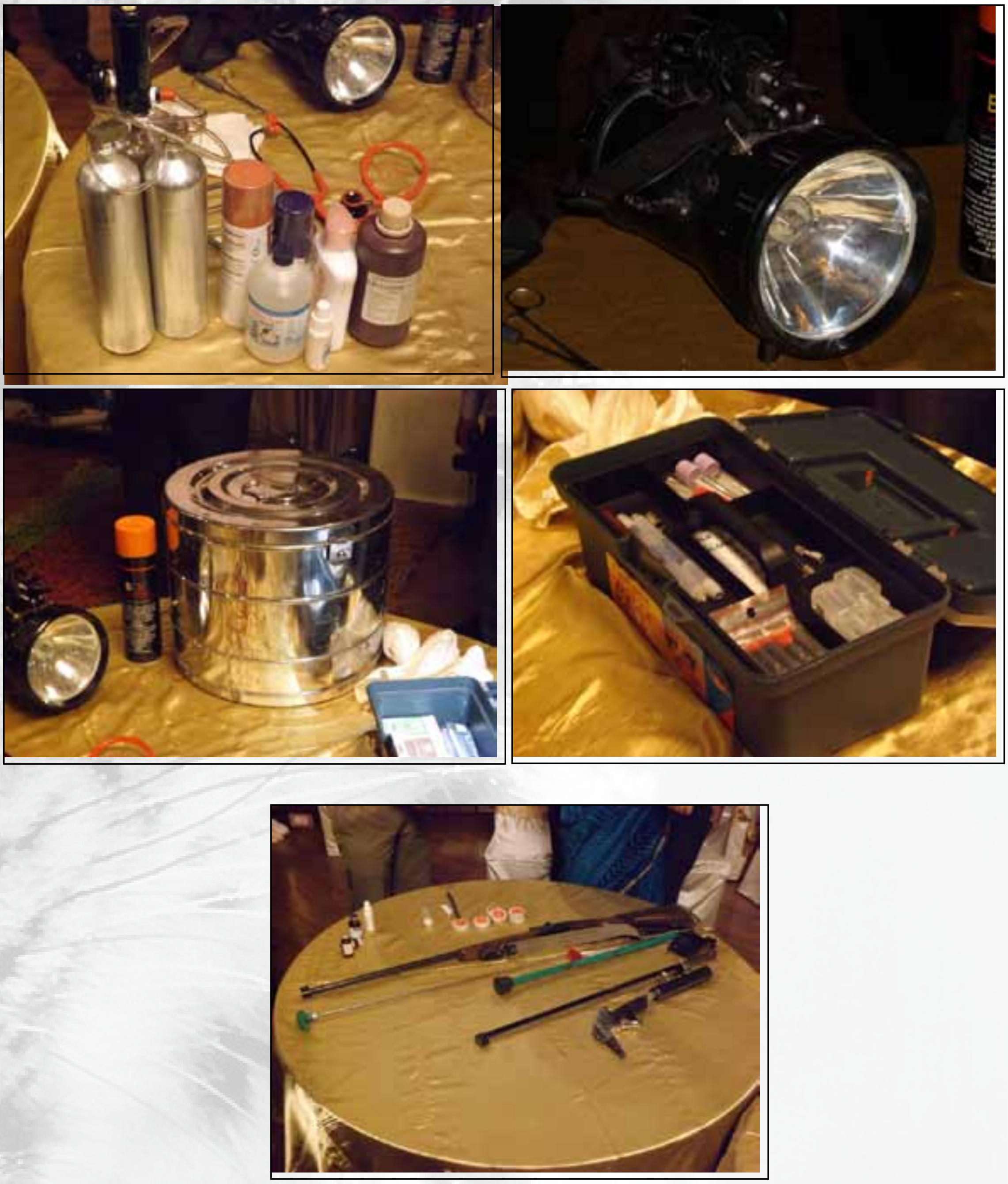

Fig 35: Tranquilization kits

Table 11: The table below depicts the Tranquilization conducted for Snow leopard (*Uncia uncia)* at Padmaja Naidu Himalayan Zoological Park, Darjeeling.

Sl.no	Name of animal	Sex	Date	Dose & Drugs used	Ailment
1.	Tyson	M	28.07.02	Inj.Ketamin-4ml inj.Xylazin- 0.8 Dressing done with betadine 100ml charmil oint 20g	Limping
2.	karan	M	16.10.02	Inj .Ketamin- 4ml, inj xylazin 0.8 ml	
3.	Tyson	M	10.11.02	Inj.Ketamin- 4 ml inj.Xylazin-0.8 ml	Limping
4.	karan	M	27.02.03	Inj Ketamin 4ml inj xylazin 0.8 ml Inj Antagozil 1ml inj Toxit 1ml inj Gentamycin 2ml dressing done with betadine 10ml Betadin oint 10g , H2O2 10 ml cotton 100gm , suturing done.	wound dressing
5.	karan	M	7.03.03	Inj Ketamin 2.5ml inj xylazin 0.5 ml Inj Antagozil 0.5ml Dressing done with betadine 10ml Betadin oint 10g , cotton 10gm Pow nevasulph 5gm Cap Symbiotic 1cap/day x 10 days Cap Becasule 1 tab/day x 10 days	wound dressing
6.	Tyson	M	26.04.03	Inj.Ketamin-4ml	Limping

				inj.Xylazin-0.8 ml inj-Antagozil 0.8 ml inj-Omnatex (1g) x 7days BD Iodine Tr.15ml iodine oint 5g H2O2 10 ml	&wound at paw
7.	Tyson	M	13.06.03	Inj.Ketamin-5ml inj.Xylazin-1 ml Inj.Antagozil-1ml inj.Dexavet-2 ml Dressing done with betadine 100ml Charmil oint 20g	Limping &wound at paw
8.	Tyson	M	25.07.03	Inj.Ketamin-3.5ml inj. Xylazin-0.7 ml Inj.Antagozil-0.8 ml	
9.	Prabhat	M	25.03.04	Inj.Ketamin - 2 ml inj.Xylazin - 0.4 ml inj.Gentamycin - 1.5 ml x 5 days BD	Wound in hind legs.
10.	Prabhat	M	28.09.04	Inj.Ketamin - 3 ml inj.Xylazin - 0.6 ml (wasted)	limping on left hind leg
11.	Prabhat	M	1.10.04	Inj.Ketamin- 3 ml inj.Xylazin - 0.6 ml (9:30am) (again) Inj.Ketamin - 0.5ml inj.Xylazin - 0.1 ml (9:55am) Inj. Antagozil - 1 ml (10:25am)	(Blood collected) limping on left hind leg
12.	karan	M	1.03.05	Inj.Ketamin- 4.8 ml inj. xylazin - 1 inj.Antagozil - 1ml	Nail Triming
13.	Budh	M	1.07.06	Inj.Ketamin-2.5 ml inj.Xylazin-0.5 ml	Injury due to infighting.

				Inj.Intacef (500mg) x 3 days (BD) Inj.Conciplex-2.5 ml x 3 days Inj.Melonex - 2 ml Inj. Antagozil - 2ml Dressing done with betadine Oint.Charmil Pow. Neosprin Oint.Ciplox 5 gm H2O2 .	
14.	Tyson	M	14.12.07	Inj.Ketamin-2ml inj.Xylazin- 0.4 ml Inj.Antagozil-0.8 ml	shifting
15.	Prabhat	M	28.01.10	Inj.Ketamin - 2 ml inj.Xylazin - 0.4 ml (10:55am) wasted (again) Inj.Ketamin - 2 ml inj.Xylazin - 0.4 ml (11.01 am) Inj.Antagozil - 1ml (10:25am) (again) Inj.Ketamin - 2 ml inj.Xylazin - 0.1 ml (11.10 am) Inj. Antagozil 1ml (11.48 am)	Shifting from beat 4 to C.B.C.
16.	Prabhat	M	16.07.10	Inj.Ketamin - 3.5 ml inj.Xylazin - 0.7 ml Inj.Intacef (1gm) Inj.Avil - 1 ml ;Inj.Melonex - 1ml inj. Cromostate - 4 vial Inj. Antagozil - 1 ml RL 500ml Dressing done with betadine Charmil Pow. Neosprin & surgical items	(Tail dockling has been done in presence of Dr. maity & Dr. R.Roy)
17.	Tyson	M	8.11.12	Inj.Ket-2.8 ml inj.Xylazin-0.6 ml Inj.Antagozil-1.5 ml	shifting
18.	Prabhat	M	10.06.13	Inj.Ketamin - 3 ml	Open Wound

				inj.Xylazin - 0.5 ml Inj. Antagozil - 0.5 ml	suturing
19.	Prabhat	M	17.06.13	Inj.Ketamin - 2.5 ml inj.Xylazin - 0.5 ml Inj. Antagozil - 1 ml	Open Wound suturing
20.	Prabhat	M	22.06.13	Inj.Ketamin - 2 ml inj.Xylazin - 0.4 ml Inj. Antagozil - 1 ml	Wound dressing.
21.	Tyson	M	17.06.2013	Inj.Ket-2 ml inj.Xylazin-0.5 ml Inj.Antagozil-1.5 ml	Wound dressing

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13. Reproductive Biology:

13.1. Breeding: Breeding is most seasonal in felids in the higher latitudes and this is of particular importance in the reproductive pattern of Snow Leopard. The mating season for ♀ snow leopards is generally the end of the winter (December through February) (Freeman et al. 1977)

The female Snow Leopard reaches sexual maturity in captivity at around 2-3 years while males take around 4 years. The age of specific fertility rate for captive snow leopards increases with age until six years for females and eight years for males. After these peaks, fertility decreases until the end of the life span. Although 5 % of both sexes start to reproduce before they have reached their third year of age, the main reproductive life span is from three to twelve years. Males have a longer potential reproductive life than females with 11 % successful breeders at the age of sixteen to seventeen years (Blomqvist 2002) Snow leopards are unusual among other large cats in having a well-defined birth peak. Wild breeding season is early January to mid- March, a time when vocalisations can most commonly be heard (Jackson and Ahlborn 1988). Captive reproductive season is nearly the same; most births occur in May-June (Freeman 1975, Blomqvist and Sten 1982). Unlike common leopards and many other cats, captive snow leopards rarely recycle and re –mate if a litter of cub's dies.

A similar form of analysis was done with the captive stock of the Snow leopards of Padmaja Naidu Himalayan Zoological Park.

At PNHZPark the age of first reproduction is known of in the cases of seven different females. It ranges from twenty four months of age to seventy eight months of age with an average of fifty two months (4.4 years).Longevity is also important to the management of feral and captive population, insofar , it relates to the length of reproductive life. The age of birth, death and time of last reproduction are known of in the cases of six females. The average last reproduction being at ninety eight months (8.2 years) of age. Last recorded reproduction in captivity was fifteen years (Nowell & Jackson1996). However, the International Pedigree of Snow Leopards 2003 report notes post reproductive females at 15-16 years and males at 17-18 years of age. Analysis and study of the records of Snow Leopard from the initiation till date (1987-2011) of Padmaja Naidu Himalayan Zoological Park, Darjeeling, the only two year old female which has given birth in captivity is the Female "Ramba" which gave birth to her first litter with two male cubs at the age of twenty four months sixteen days.

Unlike female Snow leopard, sexual maturity of male Snow Leopard is quite delayed. The male Snow leopard reaches their sexual maturity at around four years**.** As per the record of PNHZPark, the age of sexual maturity ranges from forty four months of age to hundred and ten months with an average of seventy three months (six years).

The table below depicts the breeding stock, reproductive age of female and male Snow Leopard at PNHZPark since 1986 till 2012.

TABLE 12: BREEDING STOCK OF SNOW LEOPARD AT PADMAJA NAIDU HIMALAYAN ZOOLOGICAL PARK.

SL.NO.	NAME	SEX	YEAR OF BIRTH	DATE OF ARRIVAL IN ZOO	WHERE OBTAINED	LONGEVITY IN ZOO (YEARS
1.	Hank	M	6.06.1985	16.01.1989	Littlerock-UNK	13Y 2M 21D
2.	Quizil	M	23.05.1990	28.01.1992	Zurich	10Y 6M 1D
3.	Karan	M	23.10.1995	23.10.1995	Zurich	15Y 10M 13D(still alive)
4.	Tyson	M	08.08.1995	1.07.2000	Zurich	16Y 1M(still alive)
5.	Vishna	M	23.06.1978	19.03.1986	Helsinki	15Y 24D

6.	Prabhat	M	08.07.2002	08.07.2002	PNHZP	
7.	Kashi	F	26.08.1984	19.03.1986	Zurich	11D6Y
8.	Quetta	F	23.05.1990	28.01.1992	Zurich	18Y 8M 7D
9.	Quilla	F	23.05.1990	28.01.1992	Zurich	13Y 3M 25D
10.	Ramba	F	15.10.1993	15.10.1993	PNHZP	12Y 7M 5D
11.	Urvashi	F	23.10.1995	23.10.1995	PNHZP	9Y 4M 7D
12.	Neeta	F	July 1997	17.05.2000	India –UNK	13Y 44M 11D
13.	Ritu	F	11.03.2004	11.03.2004	PNHZP	07Y 06 M 06D(still alive)

TABLE 13: BREEDING RECORD OF SNOW LEOPARD AT PNHZPARK

SL.NO.	NAME OF MATED ANIMALS	LITTER SIZE	SEX RATIO	Date of Birth	NO.SURVIVING TO MATURITY
1.	Vishna * kashi	1	U	29.05.1987	0
2.	Hank* Persia	2	0:2:1	20.05.1089	0
3.	Hank * Quetta	2	0:1:1	15.10.1993	0:1
4.	Hank * Quilla	3	2:1	02.05.1994	0
5.	Hank * Quetta	3	2:1	23.10.1995	1:1

6.	Quizil * Ramba	2	2:0	31.10.1996	0
7.	Hank * Quetta	2	0:2	15.12.1997	0
8.	Hank * Quilla	2	2:0	22.03.1998	1:0
9.	Karan *Ramba	1	1:0	29.06.1999	0
10.	Karan *Urvasi	1	1:0:0	31.03.1999	0
11.	Karan *Urvasi	1	1:0:0	19.10.1999	0
12.	Quizil * Urvasi	1	0:1	08.04.2000	0:1
13.	Tyson * Quilla	1	0:1	19.07.2000	0:1
14.	Tyson * Ramba	3	2:1	18.03.2001	0
15.	Karan * Neeta	1	1:0	08.05.2001	0
16.	Tyson * Urvasi	2	2:0	08.07.2002	2:0
17.	Tyson * Ramba	3	2:1	19.06.2002	2:0
18.	Tyson * Quilla	3	2:1:0	26.05.2003	0
19.	Karan * Neeta	2	0:2	29.03.2003	0:1

20.	Tyson * Urvasi	3	3:0:0	26.02.2004	0
21.	Karan * Neeta	2	0:1:1	11.03.2004	0:1
22.	Tyson *Ramba	4	2:2	25.05.2004	1:2
23.	Karan * Neeta	3	2:1	01.05.2007	0
24.	Karan * Neeta	3	3:0:0	18.04.2009	0
25.	Karan * Neeta	1	1:0:0	15.02.2010	0
26.	Prabhat * Ritu	2	0:2	09.09.2011	0
27.	Prabhat * Ritu	1	0:1	19.06.2012	0:1

Table 14: Reproductive age of female Snow leopard at PNHZ Park.

SL.NO.	NAME OF ANIMAL	SEX	DATE OF BIRTH	AGE WHEN FIRST USED IN BREEDING
1.	Kashi	♀	26.08.1984	04Y 08M 24D
2.	Quetta	♀	23.05.1990	03Y 04M 22D
3.	Quilla	♀	23.05.1993	03Y 07M 09D
4.	Ramba	♀	15.10.1993	02Y 00M 16D
5.	Urvashi	♀	23.10.1995	04Y 06M 16D
6.	Neeta	♀	July 1997	03Y 12M 07D
7.	Ritu	♀	11.03.2004	06Y 06M 28D

Table 15: Reproductive age of Male Snow leopard at PNHZ Park.

SL.NO.	NAME OF ANIMAL	SEX	DATE OF BIRTH	AGE WHEN FIRST USED IN BREEDING
1.	Hank	♂	23.05.1990	03Y 11M 14D
2.	Quizil	♂	23.10.1995	05Y 05M 08D
3.	Karan	♂	08.08.1995	03Y 08M 06D
4.	Tyson	♂	23.06.1978	5Y 7M 10D
5.	Vishna	♂	23.06.1978	08Y 11M 06D
6.	Prabhat	♂	08.07.2002	9Y 2M 1D

13.2. MATING BEHAVIOR OF SNOW LEOPARD

13.2.1. OESTRUS PERIOD

Very little information is available regarding the mating season of the wild Snow leopard. According to local information collected from the Himalayas, the Snow leopard courts in March to April while the Novikov (1956) reports that the oesrtus period takes place in the winter or early spring in USSR. From observation of Snow leopard in captivity, it has been reported that most of the mating take place in January – February. Kitchener et al (1975) reported that mating have been observed to take place between late winter and early spring. This has also been confirmed by Freeman (1978)

The time of the year of oesrtus is not always the same. This is probably the effect of captivity .Alteration of the seasonal sexual cycle in captivity has also been observed in other captive wild animals *(Capreolus capreolus, Cervus nippons)*(Marma, 1962a)

Of the collected information available at PNHZP, the most reliable data concerning twenty oesrtus periods has been chosen .of the periods.

13.2.2. Oestrus Detection: Captive observations indicate that oestrus usually lasts for five to eight days. A strong sign of oestrus is an increase in the time spent rolling, females in oestrus have a significant increase in rolling behaviour and captive males and females will produce more scuff marks from their hind legs. Head rubbing at specific spots like wooden logs, dens, tree trunk and grass field. The Flehmen behavior is also often seen .Very often the Female presents herself to the Male by walking in front of him with her tail raised in the air so that her anal region is clearly visible. Vocalizations from both males and females have also been recorded when females are in oestrus. It may be useful to monitor and record oestrus cycles in captivity as a management tool .Copulations take place over a period of three to six days. Some mounting without copulation may occur 1 or 2 days before oestrus. An introduction period of 1 hour in which copulation does not occur is usually a sign that full oestrus had not yet begun (Wharton and Mainka 1997).

Schaller observed that a Female in Bronx Zoo initiated mating by circling around the Male and rubbing herself against him before finally crouching down. Often the Female also initiates mating by prusten, thereafter moving to a specific spot in the enclosure where the act of mating takes place. This behavior has also been reported from Seattle (Freeman, 1978) and also from Helsinki Zoo (Blomqvist, 1982).

Fig. 36:Flehmen behaviour in Male Snow leopard (Photo: PNHZPark)

Copulation occurs over 3-6 days period .The male usually grips the fur on the female's neck when he mounts. After the last thrust and with the occurrence of full immissio penis, the male gives a loud piercing yowl. The vocalization during copulation is probably a derivative of the continuum mew/main call of the large felids though specific to this behavioural situation (Peters, 1978).

Sometimes aggressiveness is observed when the Male dismounts the Female. The Female might swear at the male, paw him and even chase him. After copulation, the female rolls on the ground (Behaviours observed at PNHZ Park).

(A) **(B)**

Fig. 37 (A &B): Copulation in ventral/ventral position (PNHZPark)

Fig. 38 (C & D): Interaction of Male and Female during mating period (PNHZPark)

13.2.3. Gestation period:_The gestation period has been reported to last 90-100 days (Kuznetsov, G.V. & Matyushkin, E.N.,1980), while Guggisberg has reported a duration of 98-103 (Guggisbergm C.A.W.,1975). Fowler (1986) described gestation period from 93-110 days . Owing to this short gestation period ,it is possible for a female to breed twice a year but this also depends greatly upon th timing of post partum oestrus and the survival of cubs with the female.It is often difficult to collate the different data due to the fact that the date of conception is invariably defined differently.

The record on the gestation period of Snow leopard at PNHZ Park from 2002 to 2012 shows that the gestation period has been recorded to last from 96-127days.However, the record shows no direct relation between the mating frequency, gestation period ,number of litters and the cub survivality rate. They all seem to be independent of each other. As recorded the number of mating ranges from ±9 to ±78 times. In many instances it has been recorded and observed that instead of successful and continuous mating the females have failed to conceive and sometimes showed a case of pseudo pregnancy. Hence, it is not reliable to consider maximum number of mating to be called as a successful mating.

Date/Year of mating	**No. of mating days**	**Mating pairs**	**No. of mating observed**	**Gestation period (days)**	**Litter size**	**Rate of cub survivality**
2002	-	Tyson ×Urvasi	74 times	101	2 (2:0)	2:0
2002	-	Tyson ×Ramba	40 times	98	3 (2:1)	0:1
2003	-	Tyson ×Quilla	55 times	104	3 (2:1)	0:0
5.11.2003-7.11.2003	3 days	Neeta ×Karan	66 times	127	2 (0:2)	0:1
19.11.2003-24.11.2003	6 days	Tyson× Urvasi	67 times	99	1 (0:0:1)	0
16.02.2004-17.02.2004	2 days	Tyson× Ramba	32 times	96	4 (2:2)	1:2
2004	-	Karan × Neeta	____	101	2 (0:1:1)	0:1
22.01.2007-23.01.2007	2 days	Karan × Neeta	9 times	99	3 (2:1)	0:0
8.01.2009-13.01.2009	6 days	Karan × Neeta	78 times	101	23 (0:3)	0:0
2011	4 days	Prabhat× Ritu	9 times	96	2 (0:2)	0:0
2012	6 days	Prabhat× Ritu	48 times	96	1 (0:1)	0:1

Table 16: Duration of Gestation Period for the Snow leopard (2003-2011) at PNHZ Park. The duration is counted from the last observed mating until the day of Birth

Relationship between the mating frequency and the time period is important factor for mating. Since in most cases recorded at PNHZ Park, mating frequency was maximum in early morning between 8:00 a.m. to 10 a.m. after which it slowly goes on declining towards the noon (Fig.40a-40g).Hence it is advisable to release the animal for the mating purpose during early morning. The reason behind this may be cool environment and minimum disturbances from the surroundings and the day progresses, outsides disturbances like construction, vehicular and human noises becomes maximum.

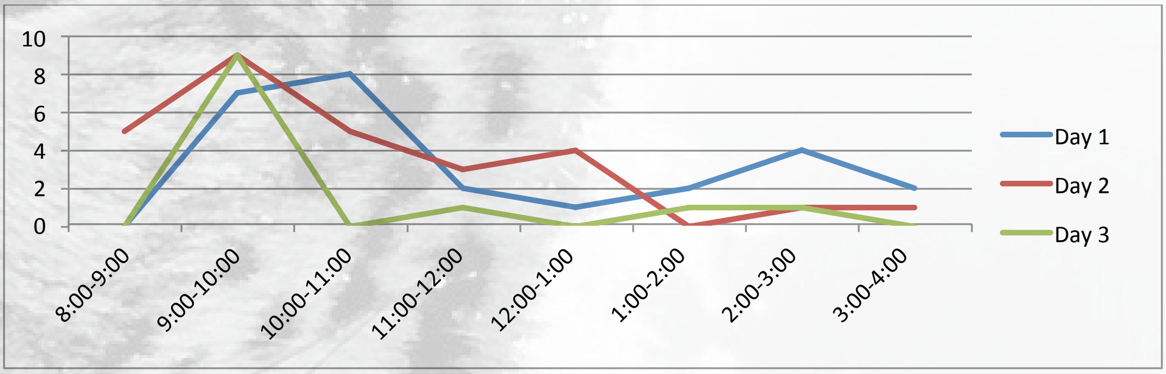


Fig. 39a: Mating frequency between Karan (♂) and Neeta (♀) (2003)

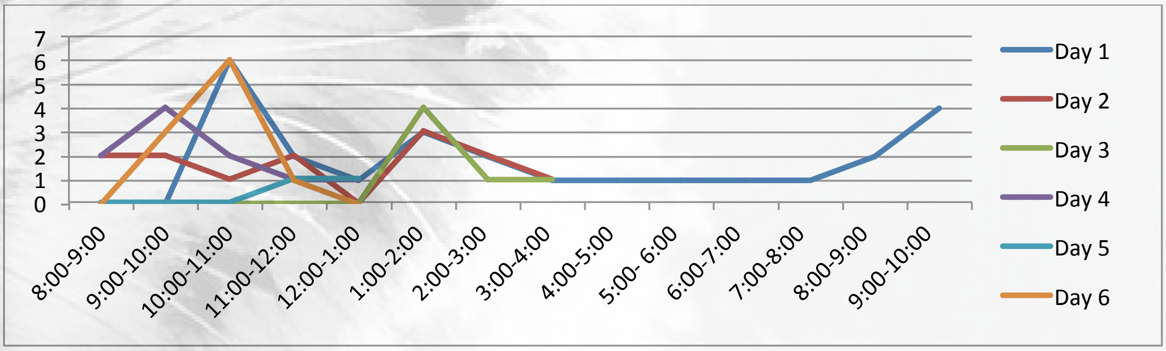


Fig. 39b: Mating frequency between Tyson (♂) and Urvasi (♀) (2003)

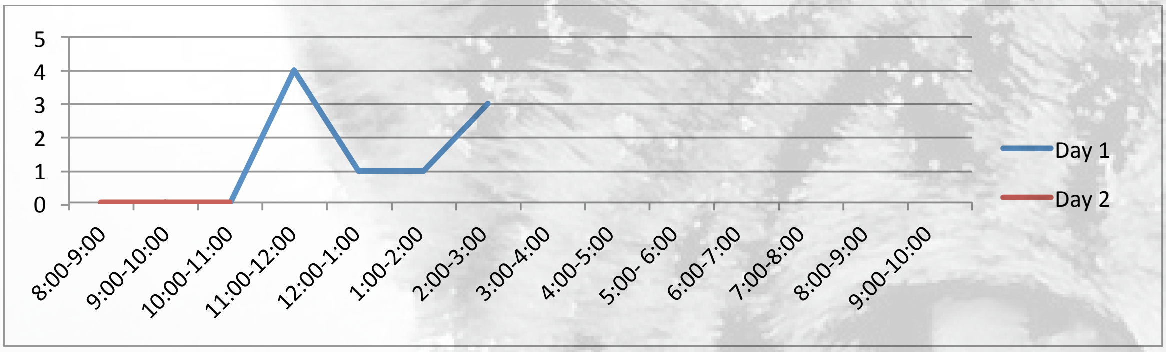


Fig. 39c: Mating frequency between Karan (♂) and Neeta (♀) (2007)

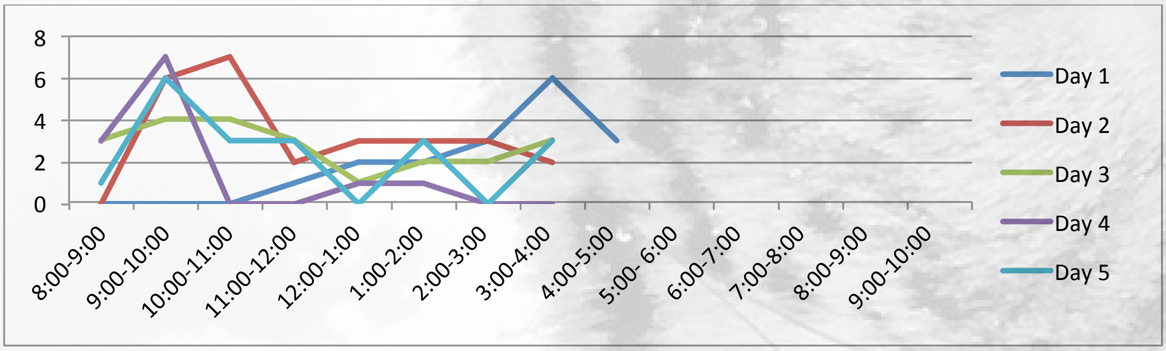


Fig. 39d: Mating frequency between Karan (♂) and Neeta (♀) (2007)

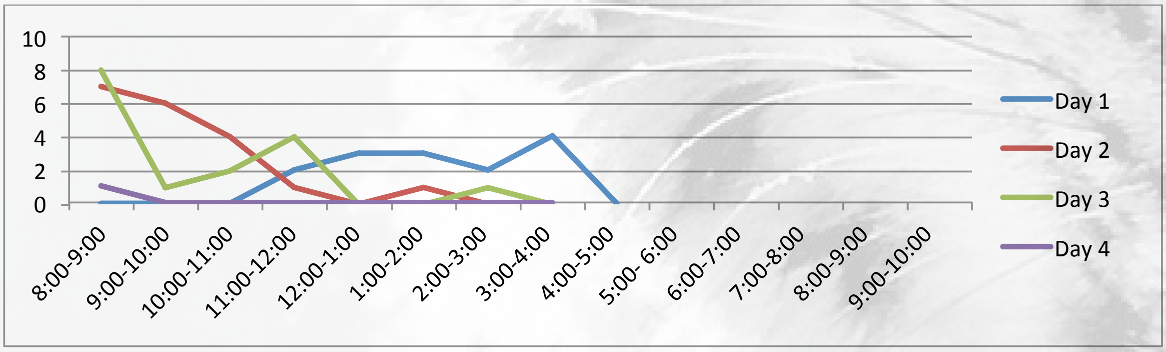


Fig. 39e: Mating frequency between Karan (♂) and Neeta (♀) (2009)

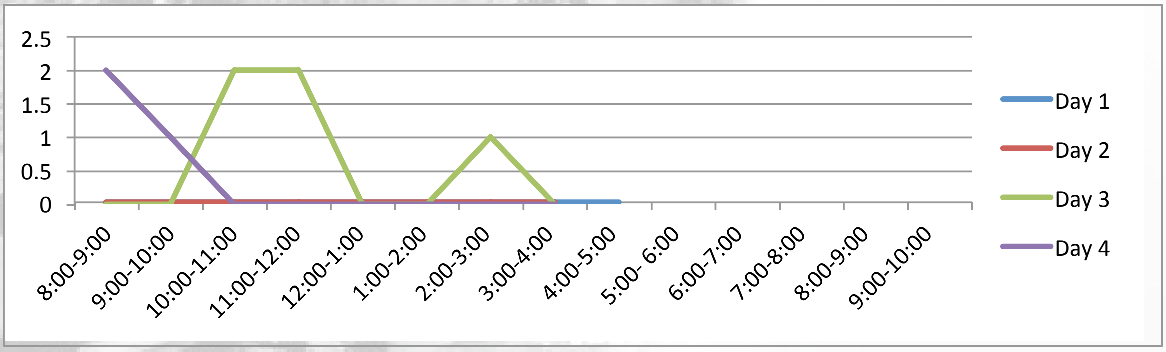


Fig. 39f: Mating frequency between Prabhat (♂) and Ritu (♀) (2011)

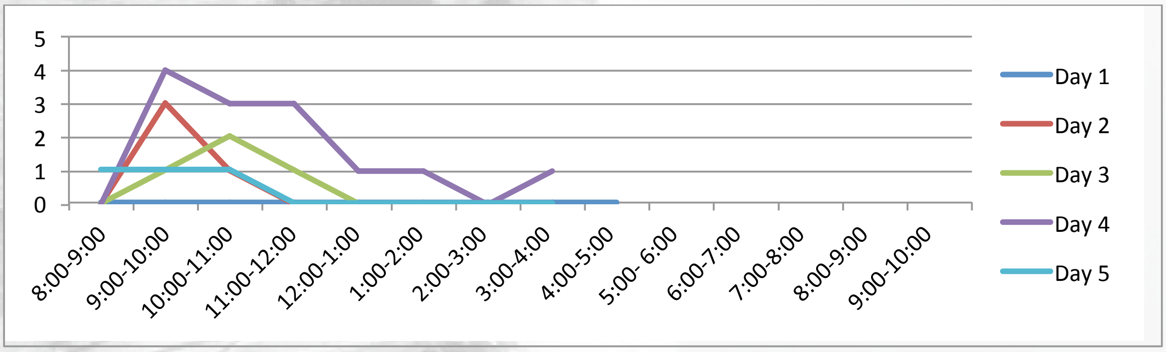


Fig. 39g: Mating frequency between Prabhat (♂) and Ritu (♀) (2012)

13.2.4. BIRTH AND LITTER SIZE

Based on the local information collected by Schaller (1977) in the Himalayas, Snow leopard cubs are born in June-July in this area. From the Kashmir area, Dang 1967) has reported that three cubs were found in a den in July, thus confirming Schaller's statement. Schaller has also reported of a cub which was probably born in August. Novikov 1956) reports that cubs are born in April in USSR.

Birth usually last two or three hours and in most cases takes place in the morning. The new born snow leopard weighs from 300 to 380g. They are weak at birth and their eyes are closed. Their first cries sound rather like those of a piglet. The eyes open in seventh and ninth day.

The litter size has been reported to be one to five cubs per litter, though most litters comprise one to three cubs. Snow leopard litter comprises two to five cubs (Marma et al 1968) and Heptner and Sludskij (1992) have also reported of a litter found in Tien-Shan in June comprising of 5 blind kittens. Based on the International stud book volume I, hundred and thirty eight litters available up untill 1978, it has been reported that the litter size in captivity were one cub 22%,two cubs 48%,three cubs 26% and four cubs 2% (Blomqvist L.1978)

The litter size recorded at PNHZ Park is one to five cubs per litter, though most litters comprise one to three Cubs (PNHZPark record 1987-2011).

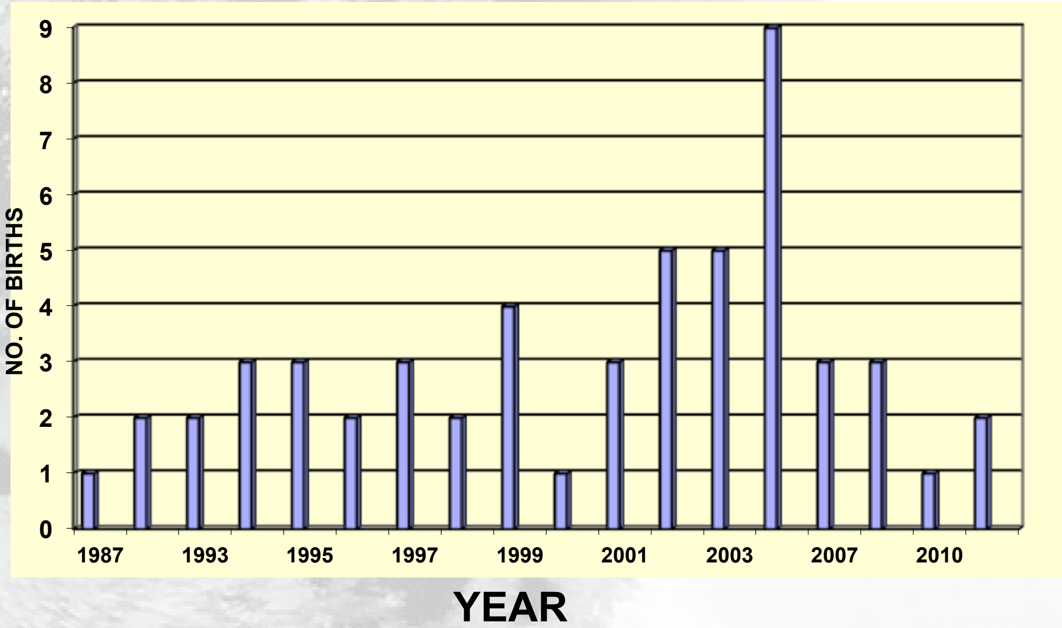


Fig. 40:No. of Births recorded at PNHZPark (1986-2012)

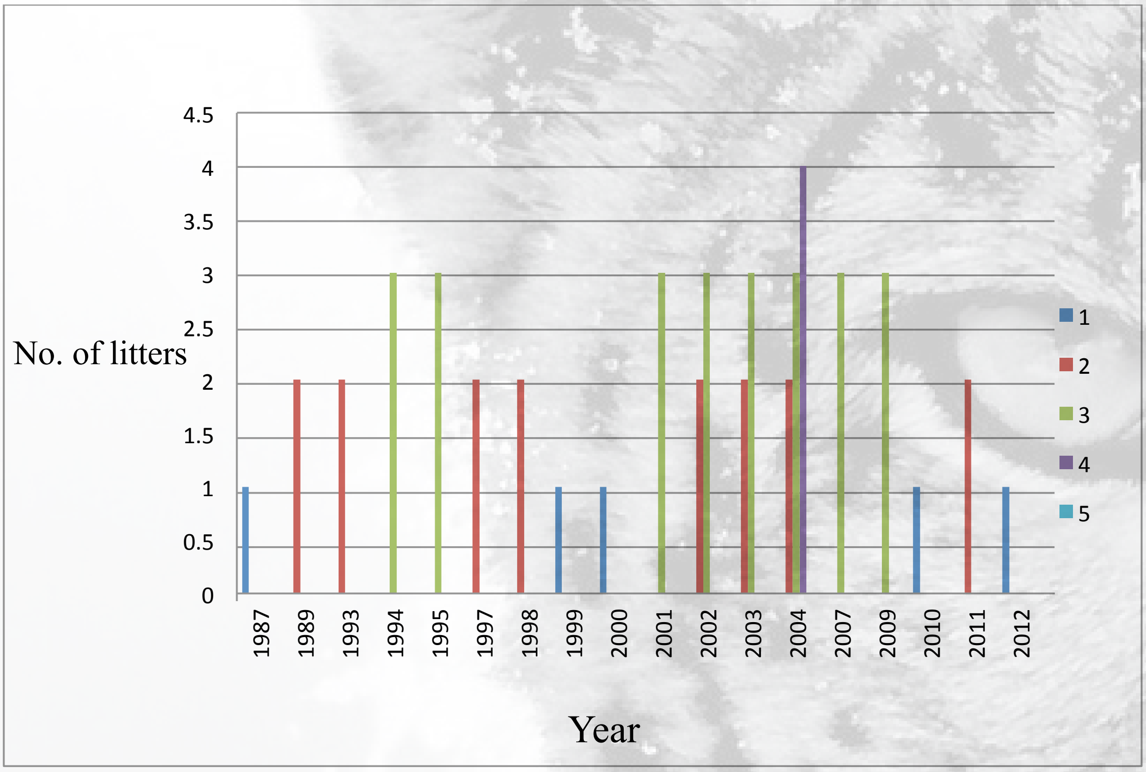


Fig. 41: Litter size recorded at PNHZPark (1987-2012)

14. BEHAVIOURS RECODED TO CONFIRM PREGNANCY IN SNOW LEOPARD AT PNHZPARK

After mating the males and the females are separated out and the females are kept in a separate enclosure. After forty five days if the mating becomes successful, we can observe slight changes in the behaviour of the females.

Behaviours observed are as follows:

1. Increase in genital grooming.
2. Less active.
3. Resting in one particular place for a maximum time.
4. Change in the body shape, slight bulge in the hind quarters.
5. Two days prior to birth the female will start rejecting her feed.

TABLE 17: RECORD OF FEED REJECTION BY SNOW LEOPARD (PRE PARTURITION) (PNHZPark record 2011)

DATE	TIME	DIET	TOTAL QUANTITY GIVEN	TAKEN	REJECTED
1/09/2011	Evenin	Chicken + chicken soup + Raw egg	1.7 kg+500 gm (400ml) chicken soup	1.7 kg	500 gm (400ml) chicken soup
2/09/2011		Chicken + chicken soup +Raw egg	2.1 kg + 400gm (500ml)chicken soup	All	400gm (500ml)chicken soup

3/09/2011	g at around 4:30 p.m.	Chicken + chicken soup +Raw egg	2.6 kg + 500ml	All	200gm chicken+500ml soup
4/09/2011		Beef + Raw egg	2.6 kgkg	1.9 kg	700gm
5/09/2011		Chicken +Raw egg	2 kg	All	0.7 kg
5/09/2011		Mutton + Raw egg	2.6kg	300gm	2.3 kg
6/09/2011		Chicken +Raw egg	2.4 kg	All	____
7/09/2011		Mutton + Raw egg	2.2 kg	____	2.2 kg
08/09/2011		Chicken+ Raw egg	2 kg	____	2 kg
09/09/2010		Chicken+ Raw egg	2.4 kg	____	All

Fig. 42a: Change in body shape of a pregnant female.

Fig. 42b: Genital grooming by a pregnant female.

14.1. BREEDING AND MANAGEMENTAL INTERVENTIONS FOR SNOW LEOPARD AT PADMAJA NAIDU HIMALAYAN ZOOLOGICAL PARK, DARJEELING.

- On 6th June 2011, at Conservation Breeding Centre of Padmaja Naidu Himalayan Zoological Park, Darjeeling, mating was observed between Male "Prabhat 9" and Female "Ritu 7".
- No. of Mating observed=nine times.
- After fifty nine days of mating, Ritu was isolated in two interconnected Breeding room joined to an open enclosure.
- Three weeks before the assumed birth rate , the Breeding cage was provided with wooden platform ,cemented walls were white washed and Parqueting was done and the rods were shielded with wooden ply board so that every disturbance could be kept away from the animal.
- A CC TV was installed both inside the breeding room and at the open enclosure in order tobe able to supervise the events going on.
- Two days prior to parturition she stops taking food, she was found taking water.
- After a gestation period of ninety six days she appeared to have given birth to two little cubs.
- The cubs were looking very small and dark blackish in colour.
- Delivery date: 09.09.2011 .From the given data we can see that two days prior giving birth to a cub, Mother starts rejecting her entire feeding.

The following minutes of delivery span the period from the first signs of labour pain till the moment when the cubs encounter the nipples.

- Sire: Prabhat Dam: Ritu
- Date: 09.09.2011
- Time: cub 1 09:50 p.m.
- Cub 2 10:04:28

Time		Observed activities
Min	Sec	
1	00	Resting phase
1	50	Slight movement
2	20	Lies down , eyes closed
5	37	Eyes open , slight movement
6	46	1st labor pain
7	40	Eyes closed, lied down
7	52	2nd labor pain, eyes closed
9	02	Eyes open, inward recumbancy
10	08	Lying upright
10	10	Pacing
10	26	Tail grooming
10	46	Pacing in a circular fashion
11	12	Standing still
11	50	Lying down at corner
12	31	Licking tail and genital region
15	13	Feeling uneasy
15	50	Sitting at corner ,lies down.

24	17	Standing
26	35	Position change
27	35	Licking belly region
28	40	Position change , genital grooming
30	18	Sitting position, sniffing
32	00	genital grooming
33	32	crouching
34	26	Lying down, looking here and there
36	14	Position change, inward recumbancy
37	28	Position change, frequently licking tail.
39	36	Body posture looking very uneasy , position change
40	19	genital grooming
43	02	Lying still
43	30	genital grooming
44	36	Position change , genital grooming
45	00	Standing
45	39	Sitting position
47	08	Lying down, stretching her body
47	56	Position change, genital grooming
51	10	Licking foetus. Genital region very extensively, 1st birth, intensive licking and cleaning of the foetus, first movement of the foetus.
56	30	Female is turning, foetus still connected by umbilical cord, continuous licking.
58	21	Female turned around, foetus still connected by umbilical

		cord.
58	48	Umbilical cord cut off, mother continuously licking cub.
62	00	Cub hanging on mother's tail
64	30	Position change, intensive licking of genital region, 2nd Birth, intensive licking and cleaning of the foetus, first movement of the foetus.
65	50	Mother still licking 2nd cub.
66	32	Position change
66	34	Licking both cubs, licking her tail.
67	16	Position change
67	18	Licking cubs, 2nd cub still connected by umbilical cord.
67	30	Short resting phase
69	13	Mother licking 2nd cub
69	409	Mother licking 1st cub.
70	16	1st cub crawling on mother's haunch.
73	03	Mother licking both cubs
74	52	Mother lying still
76	37	Umbilical cord of 2nd cub bitten off, mother continuously licking her both cubs
84	06	One Cub seeking nipples
85	00	Cub suckling mother's milk

14.2. OBSERVATION ON THE NURSING BEHAVIOUR OF SNOW LEOPARD AT PNHZ Park.

Introduction: When the idea arose that milk from other species could be used for the nourishment of humans, ways had to be found to stimulate the nursing process to gain the milk. Illustrations dating from before 3,000 BC show that the Egyptians kept the calf near the cow while milking (Amoroso and Jewell, 1963). Sometimes the calf was allowed to suckle one teat while the others were milked by hand. To achieve a milk ejection, in some cultures the milker wore a calf skin, which the cow would lick (Amoroso and Jewell, 1963). However, the nursing process differs among species of mammals. To permit an optimal transfer of nutrients from the dam to the offspring, it is important to understand the details of the nursing process. This paper will present the type and frequency of nursing in Snow leopard.

So far as is known, Snow leopards have two pairs of nipples (J.Foster, 1975).

1. Inguinal and
2. Pectoral.

Recent anatomical studies on a number of euthanized lactating domestic cats whose litter size varied in size show that there is a preferential use of inguinal teats over the pectoral ones (J.Mc Vittie & G.Rodriguez (1975.)

Two types of behaviour were observed during Nursing:

1. **Jaw Sucking Nursing.**
2. **Ear Wiggling Nursing.**

1. Jaw Sucking Nursing: restlessness exhibited by cubs while on nipples .After they settled down, jaw movement as in sucking is seen .This period is often lengthy and interrupted by competitive interactions and is coded as Jaw-Sucking Nursing.
2. Ear Wiggling Nursing: Brief and invariably followed by sleep .Characterized by rhythmic back and forth motion of both ears; and was so called Ear Wiggling Nursing. Ear Wiggling Nursing never lasts more than fifty two sec and is brief as five sec.

When the cub terminated, Nursing Session without Ear-Wiggling nursing demonstrated restlessness in the form of general locomotion and repeated attempts to make nipple contact. In contrast, the cub slept after ear wiggling Nursing**.**

Method and material used: The entire observation was monitored through a CCTV that recorded the entire day's event for a period of six months. The CCTV recordings were analyzed and formulated accordingly.

The table below depicts the total time spent by a dam during the nursing of her new born cub.

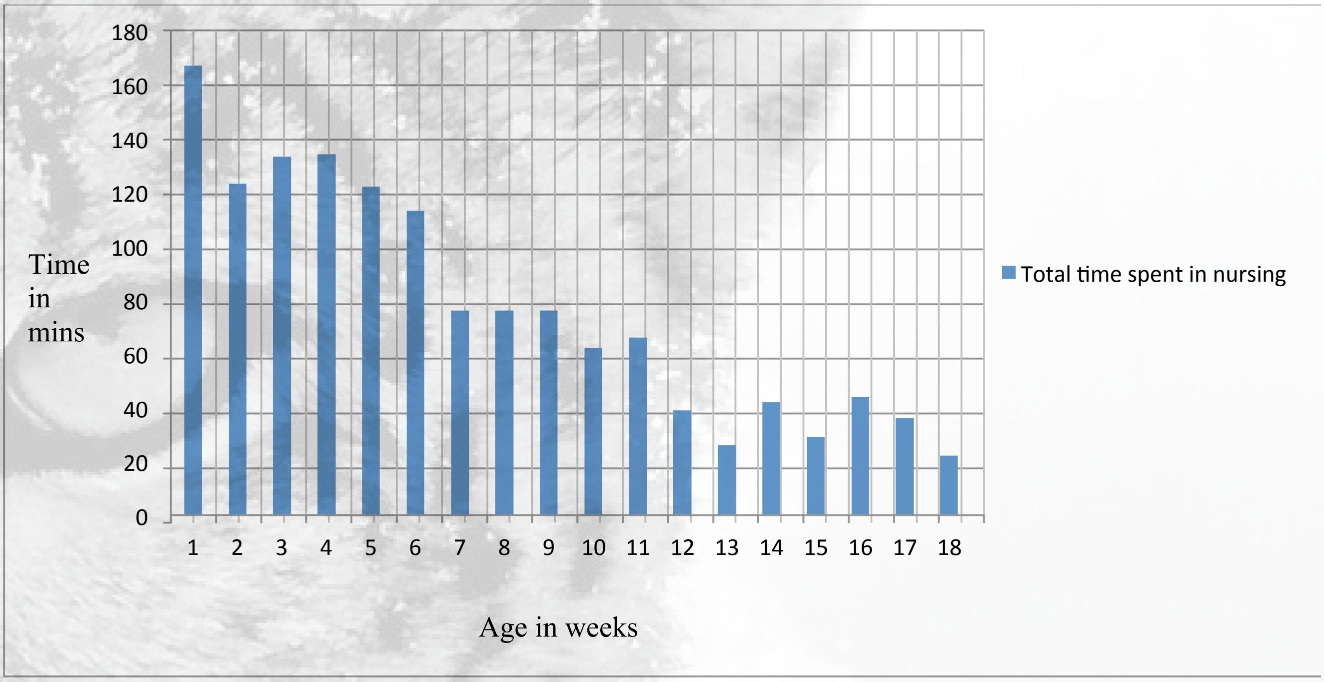


Fig. 43: Nursing pattern of Snow leopard to her new born cub

Implications: From the above given data we can clearly observed that by 7th week the frequency in nursing by Snow leopards slowly goes on diminishing, which is clearly indicated by the drop in duration by the cubs milk intake.

A situation observed during the nursing of Snow leopard at PNHZ Park shows a case of ill nursing. The mother was not paying proper attention to her new born cub. The cub was observed to be crawling towards her mother for feeding but mother was not showing any interest in caring her new born cub. Compared to the other cub born in the same litter, the neglected cub was showing abnormal crawling movement. From the day of birth the cub was left with the mother for next four days hoping that the mother will nurse the cub. Unfortunately she did not look after, ultimately compelling the zoo authority to take out the cub for hand rearing. This gives an indication that in felids, mother shows an innate instinct to differentiate a healthy from an unhealthy cub leading to ill nursing/rejection of cubs after birth.

ig. 44a: Mother nursing her 9 days old cub

Fig. 44b: Mother nursing her 13days old cub

Fig. 44c: Mother nursing her 20 days old cub

14.3. OBSERVATION ON THE POST PARTUM ACTIVITIES OF MOTHER AND CUB.

Introduction: Snow leopards are solitary in nature but not unsociable. They come in pairs only during mating season travel together for a few days and copulate. The cats will then part ways and become solitary once again, with the females taking full responsibility of raising any offspring (Snow Leopard Trust).Maternal behaviour of Snow leopard have been described by Freeman 1982, however description on post-partum behaviour of the Snow leopard remains limited hence the present study was undertaken with the following objectives:

1. To know the growth activity of cub in relation to mother's activity to the cub.
2. Comparison of Mother's activity to herself during the rearing of her new born cub.
3. How much attention she pays to the cub.
4. To know the behavioural ontogeny of the cub.

Materials and Method used: The entire observation was monitored through a CCTV that recorded the entire day's event for a period of ten weeks. The CCTV recordings were analyzed and formulated accordingly. The behavioural activity pattern has been given in the form of a pie-diagram.

Fig. 45(A-J) Post partum Activity pattern of Female Snow leopard

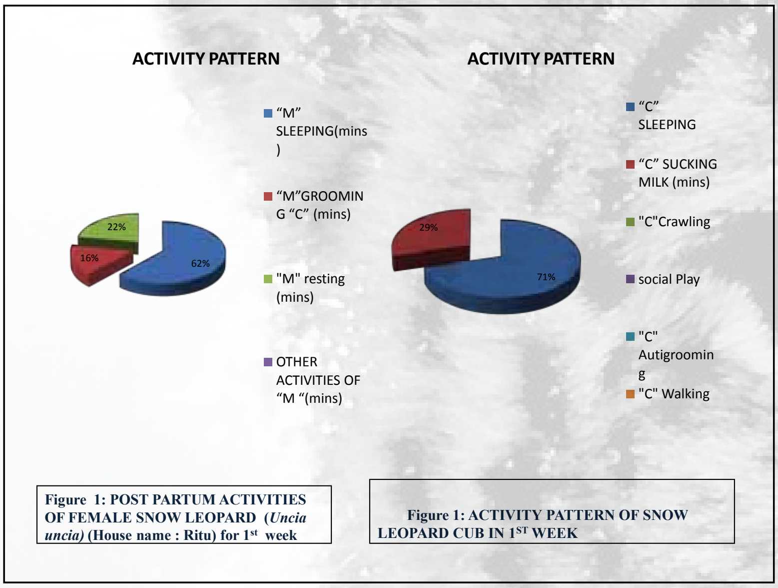


Figure 1: POST PARTUM ACTIVITIES OF FEMALE SNOW LEOPARD (*Uncia uncia*) (House name : Ritu) for 1st week

Figure 1: ACTIVITY PATTERN OF SNOW LEOPARD CUB IN 1ST WEEK

(A)

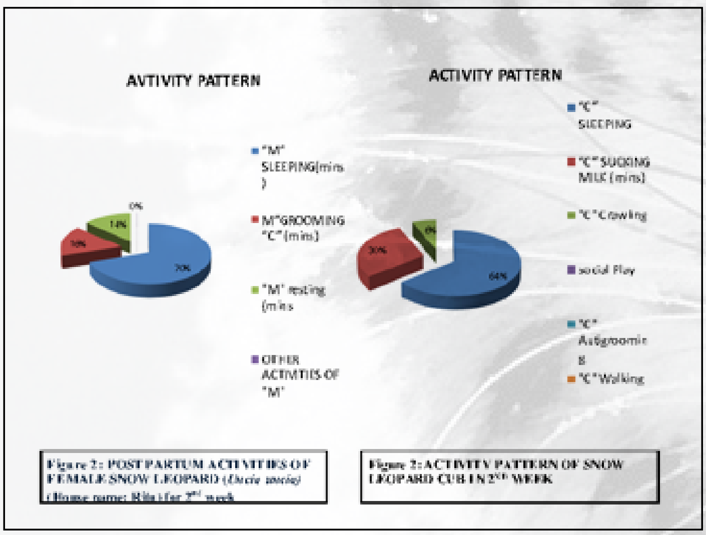


Figure 2: POST PARTUM ACTIVITIES OF FEMALE SNOW LEOPARD (*Uncia uncia*) (House name: Ritu) for 2nd week

Figure 2: ACTIVITY PATTERN OF SNOW LEOPARD CUB IN 2ND WEEK

(B)

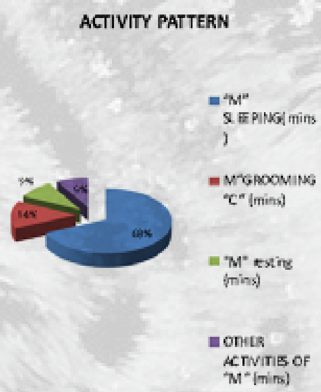


Figure 3: POST PARTUM ACTIVITIES OF FEMALE SNOW LEOPARD (*Uncia uncia*) (House name : Ritu) for 3RD week

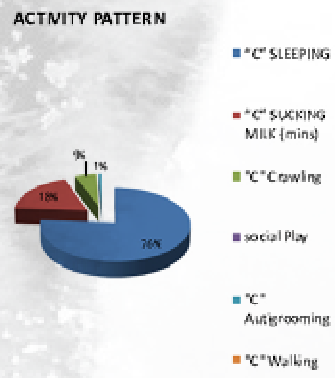


Figure 3: ACTIVITY PATTERN OF SNOW LEOPARD CUB IN 3RD WEEK.

(C)

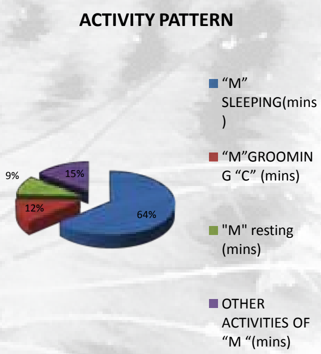


Figure 4: POST PARTUM ACTIVITIES OF FEMALE SNOW LEOPARD (*Uncia uncia*) (House name : Ritu) in 4TH week

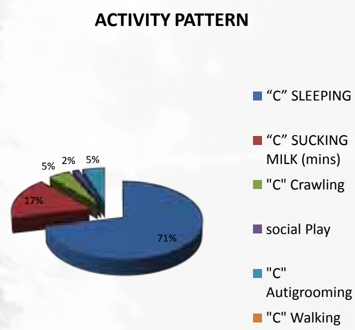


Figure 4: ACTIVITY PATTERN OF SNOW LEOPARD CUB IN 4TH WEEK

(D)

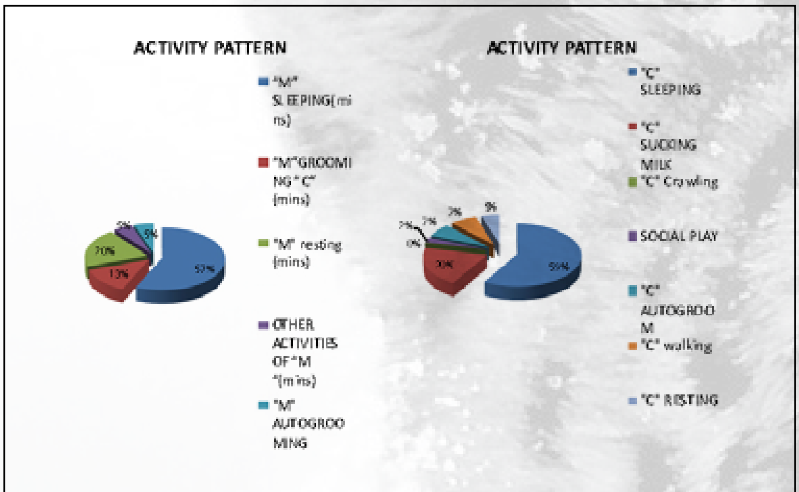


Figure5: POST PARTUM ACTIVITIES OF FEMALE SNOW LEOPARD(*Uncia uncia*) (House name : Rita) IN 5TH week

Figure5: ACTIVITY PATTERN OF SNOW LEOPARD CUB IN 5TH WEEK

(E)

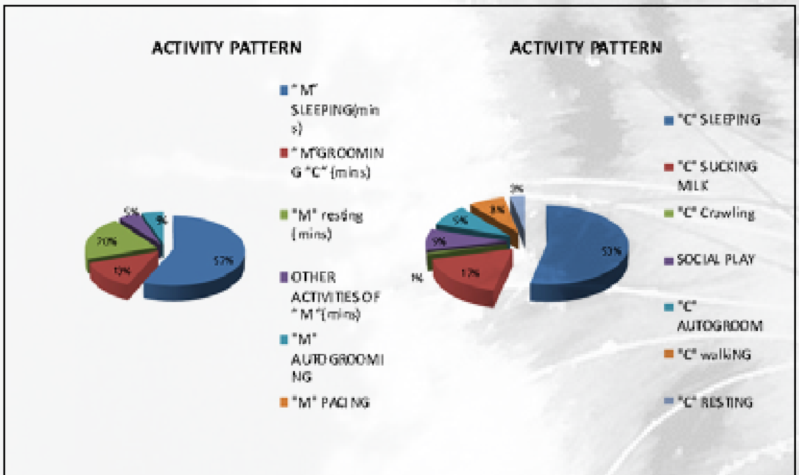


Figure6: POST PARTUM ACTIVITIES OF FEMALE SNOW LEOPARD(*Uncia uncia*) (House name : Rita) IN 6TH week

Figure 6: ACTIVITY PATTERN OF SNOW LEOPARD CUB IN 6TH WEEK

(F)

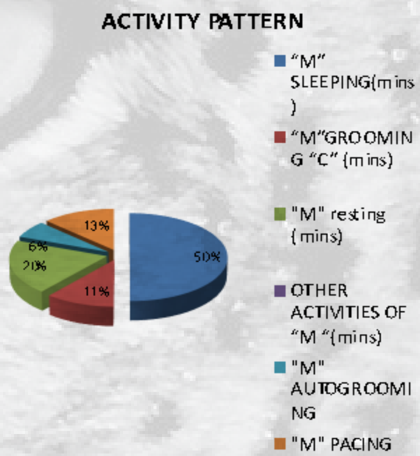


Figure7: POST PARTUM ACTIVITIES OF FEMALE SNOW LEOPARD(*Uncia uncia*) (House name : Ritu) IN 7TH week

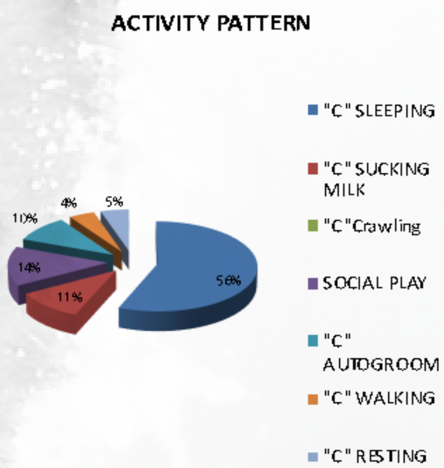
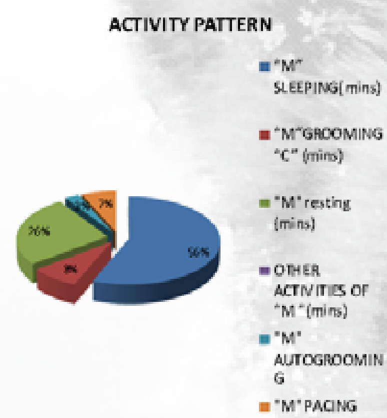


Figure 7: ACTIVITY PATTERN OF SNOW LEOPARD CUB IN 7TH WEEK

(G)



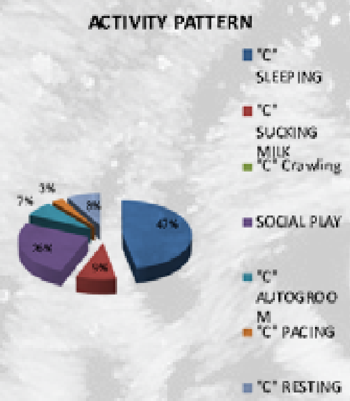
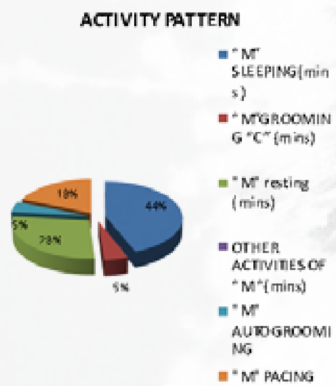


Figure8: POST PARTUM ACTIVITIES OF FEMALE SNOW LEOPARD(*Uncia uncia*) (House name : Rita) IN 8TH week

Figure 8: ACTIVITY PATTERN OF SNOW LEOPARD CUB IN 8TH WEEK

(H)



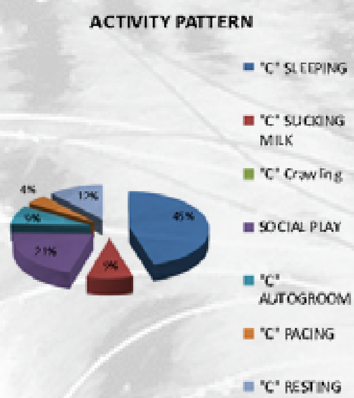


Figure9: POST PARTUM ACTIVITIES OF FEMALE SNOW LEOPARD(*Uncia uncia*) (House name : Rita) IN 9TH week

Figure 9: ACTIVITY PATTERN OF SNOW LEOPARD CUB IN 9TH WEEK

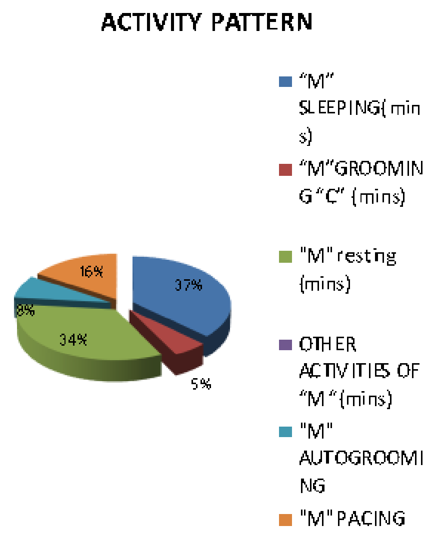


Figure 10: POST PARTUM ACTIVITIES OF FEMALE SNOW LEOPARD(*Uncia uncia*) (House name : Ritu) IN 10TH week

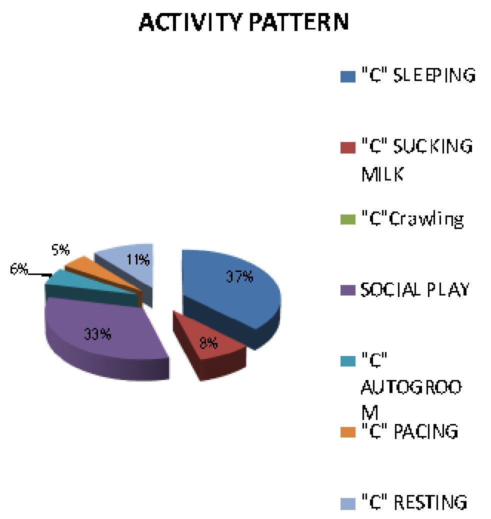


Figure 10: ACTIVITY PATTERN OF SNOW LEOPARD CUB IN 10TH WEEK

(J)

The above graphical representation shows that during the initial period only two behaviours were observed in cub i.e. sleeping and sucking. Similarly in mother house name "Ritu" only three behaviours were observed i.e. Sleeping, cub grooming and resting. In second week "crawling" was observed in the new born cub. Crawling referred to random movement on the floor or non-nursing area of the female (Freeman,H.& Teresa O'Connor,1982)From third week there was an occurrence of some more activities. The cub started auto grooming and mother "Ritu" was observed displaying other activities like claw racking, auto grooming, walking inside the breeding room. Likewise, between fourth and fifth week first play behaviors and upright walking were observed during the data-recording sessions: solitary play such as rolling and waving paws in the air, to social play with mother including cuffing and rolling, similar behaviours observed by Helen Freeman and Teresa O'Connor(1982).Although in observations on hand-reared cubs Koivisto et al (Koivisto, I, Wahlberg, C and Muuronen, P,1974) reported first walking at twenty three days, while Freeman and Hutchins (Freeman,H and Micheal H,1978) first observed this behavior as early as seventeen days.

Cub ontogeny:

In the wild habitat, Snow leopard cubs are normally born in a rock cave or crevice, which is almost like that, is available in the barren habitat. In a charming manner, there is evidence that the mother's molted fur forms the bedding for the den. Like all cats, Snow leopard cubs are born blind and open their eyes at the age of five to fifteen days (Freuch R.J.1968, Koivisto et al.1977, Freeman H.1982,Phillips ,L.G.1981) with an average of nine days .The milk teeth start erupting at three weeks of age (Freuch R.J.1968, Koivisto et al.1977) while a definite dentition is acquired after about one year. Lactation last for approximately five months and cubs begin to eat small quantities of meat when they are six to eight weeks old (Koivisto et al.1977, Freeman H.1982)

The weight of snow leopard cub at birth is about three hundred to three hundred eighty gms. They are weak at birth (Marma & Yunchis, 1968).However no such record could be made at PNHZPark considering the possibility of female rejecting the cub and so human interference was prohibited.

A cub born in 2012 was found sniffing the mother's feed on reaching thirty four days. After that she was found taking the mother's feed. Within a few days the cub was observed taking mother's feed in a very high amount. So it was decided to separate the mother and cub during feeding time and feed them individually. On feeding individually it was observed that the cub rejected the feed and she was screaming in very high pitch. So it was again decided to feed the Mother and cub together. To check that the cub doesn't get over fed enrichment items like wood wool, hanging logs, ledges and tree trunks were put inside the Breeding room and in the Kraal area.

On fifty two days body weight of cub was taken and she was two kgs seven hundred fifty gms. Further weights were taken at fifty nine, seventy seven, one hundred and twenty days showing an average difference of 1 kg per week. (Weights are mentioned on Table 18).After that the cub could not be weighed further as she could not be handled manually.

Study conducted at by Teresa O'Connor and Helen Freeman (1978) Woodland Park Zoo shows a comparative weight gain in three litters of captive snow leopard cubs. The weight gain in eight week is quite similar to the weight gained by the cub born at PNHZ Park in 2012.

Therefore keeping a detailed record on the weight gained can be an effective tool as to understand the general health and growth pattern in the new born cubs.

As mentioned earlier the cubs after reaching seventeen weeks gain much weight, hence it is not possible to weight the cub manually. Therefore, it is highly recommended that each breeding cell should have an attached squeeze cage facility where animal can put and further detailed record on weight gain can be made.

Table 18:Body weight of Snow leopard cub 2012.

SL. NO.	DATE OF BIRTH	DATE 0F INVESTIGATION	AGE (IN WEEKS)	BODY WEIGHT	SEX
1.	**19.6.2012**	03.08.2012	7weeks 3 days	2 kg 750 gms	F
2.		16.08.2012	8 weeks 3 days	3 kg 700 gms	
3.		04.09.2012	11 weeks	4kg 995 gms	
4.		19.10.2012	17 weeks 1 day	9kg 610 gms	
5.					

Fig. 46: Furnishing of kraal area with tree trunks, hanging logs and cemented ledge

Table 19: Various developmental events recorded in the cub born at PNHZ Park (2011 & 2012)

PHYSICAL AND BEHAVIOURAL FEATURES	2011 (in days)	2012 (in days)
Eyes open	9	11
Social Play	21	18
Upright walking	32	27
Upper canine visible	35	45
Emerge for their first glimpse of outside world	33	78
First instance of cub sniffing the bone.	32	34

The above given datas on the various developmental events in the cub born in two consecutive years at PNHZPark shows most of the physical and behavioural features advancing in similar manner. Hence it is also important to note whether these physical and behavioural features are visible in cubs while maturing at their adult stage.

To evaluate "normal" maternal behavior, we must also consider the probable causes of its counterpart: inadequate maternal care or abandonment. In the wild, this behavior would likely be explained by some defect in the young, where further parental investment would no longer be warranted. An inappropriate setting or disturbance may also trigger an abnormal maternal response (Ewer, R.F, 1973; Harper Lawrence V, 1981). In captivity, failure of the mother to provide maternal care necessitates hand-rearing of the young, or in the worst case, may result in infant mortality. In an analysis of snow leopard cub mortality, Freeman and Hutchins (Freeman, H and Michael H, 1978) found the major cause to be directly related to behavioral stress. The nature of the bond between the mother and the young is synchronous, each responding to the other's behavioral cues. As the young develop, their needs change, and maternal behavior toward them is altered (Ewer, 1973)

If the goal of zoos exhibiting snow leopards is to maximize breeding success in this species, then it is necessary to provide the optimal environment for the pregnant female. Several authors have indicated that privacy and freedom from disturbance influence the breeding success of snow leopards (Freeman, Helen and Michael Hutchins 1978, Freeman, Helen and Kathleen Braden 1977, Koivisto, Ilkka, Wahlberg, Carl 1974and Muuronen, Pertti, Harper, Lawrence V 1981), and of felids in general (Kleiman, D.1975 and Sadlier, R.M.F.S. 1975). A resolution from the First International Snow Leopard Conference in Helsinki in 1978 (Blomqvist, Leif 1978)) called for the provision of off-exhibit maternity dens for pregnant snow leopard females.

14.4. MODIFICATIONS AND NEW TECHNIQUES IMPLEMENTED INSIDE THE BREEDING ROOM IN 2012

Learning from the previous experience on breeding of Snow leopard and after doing an intensive review work on captive management of snow leopard, going through each and every detailed record on breeding as well as communicating with international zoos (Rosamond Gifford Zoo New York, Kaunas Zoo,Lithuiana , Granby Zoo , Wuppertal Zoo., Oklahoma City Zoo,U.S.A, St.Louis Zoo,U.S.A, Wildlife and Dinosaur Park, Chattanooga zoo, Cat haven Zoo, Utaha’s Hogle Zoo, Dublin Zoo, Ireland, Toronga Zoo,Australlia, Miller Park Zoo, Porter

Park,zoo,Lansing Michigan)housing snow leopard about their husbandry practices and discussing our problems with them, few of the modifications and new techniques were implemented inside the breeding room and in the kraal area. Parqueting of breeding room was done to make the room warm, dry and provide better traction for new born cubs.

Following are the modifications and new techniques implemented inside the breeding room

1. Installation of Dehumidifier to absorb the moisture coming from outside.
2. Installation of UV-light to sterilize the room & make it free of any micro- organisms.
3. Installation of CCTV inside the breeding room to monitor and record each and every event without disturbing the animal.
4. Bedding of room with dry leaves and dry wood shavings which aid in absorbing the urine and fecal matters keeping the room clean and dry.
5. Installation of thermometer and hygrometer to keep the record.
6. Rods of the Breeding room were shielded with ply board from in inner side in order to prevent any form of casualties in the cub which includes Brain haemorrhage.
7. Cubs are fed with femoral bone twice in a week to have a source of calcium which helps in bone formation and to keep healthy teeth and gums.

Fig. 47a: Parqueting of Breeding

Fig. 47b: CCTV cameras fitted at the top of Breeding Room

Fig. 47c: Dehumidifier installed inside Breeding Room of Snow Leopard *(Uncia uncia)*

Fig. 47d: UV light inside Breeding Room of Snow Leopard *(Uncia uncia)*

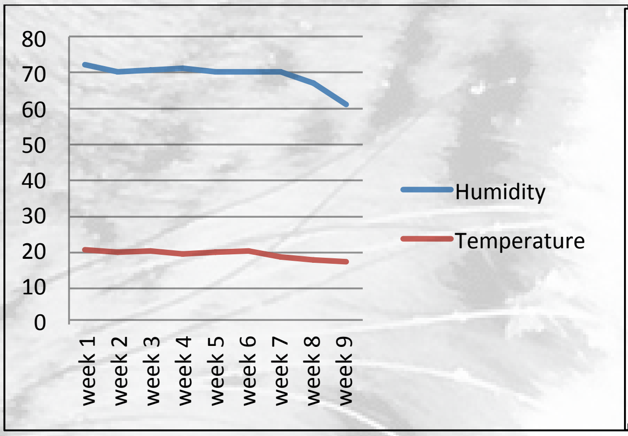
Fig. 47e: Thermometer and Hygrometer put inside the Breeding Room

Fig. 47f: Rods shielded with Ply board in the Breeding Room

14.5. RECORD ON TEMPERATURE, HUMIDITY AND VOLUME OF WATER COLLECTED FROM DEHUMIFIER AT PNHZPARK.

One of the observations made during the year 2009 for the cause of Snow leopard death was high percentage of moisture content in the breeding area. Hence an effort was made to overcome this problem by the installation of dehumidifier inside the breeding dens. The dehumidifier worked in a very good way and proved to solve one of the biggest problems of conservation breeding programme i.e. occurrence of pneumonia in new born cubs due to high humidity.

Throughout the breeding period i.e. from September to October record was made on the temperature, humidity and volume of water collected from dehumidifier.



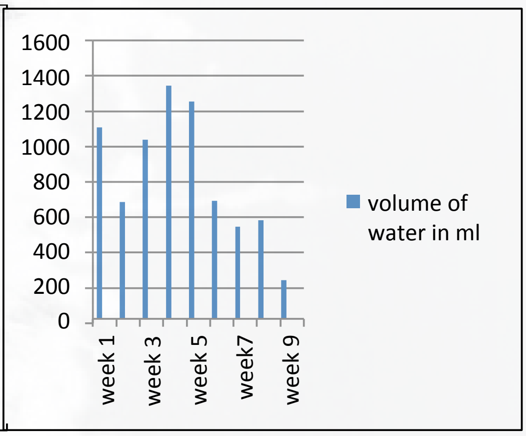


Fig. 48a: Morning hour record on Temperature and Humidity of Breeding area (Left) Volume of water collected from Dehumidifier (Right)

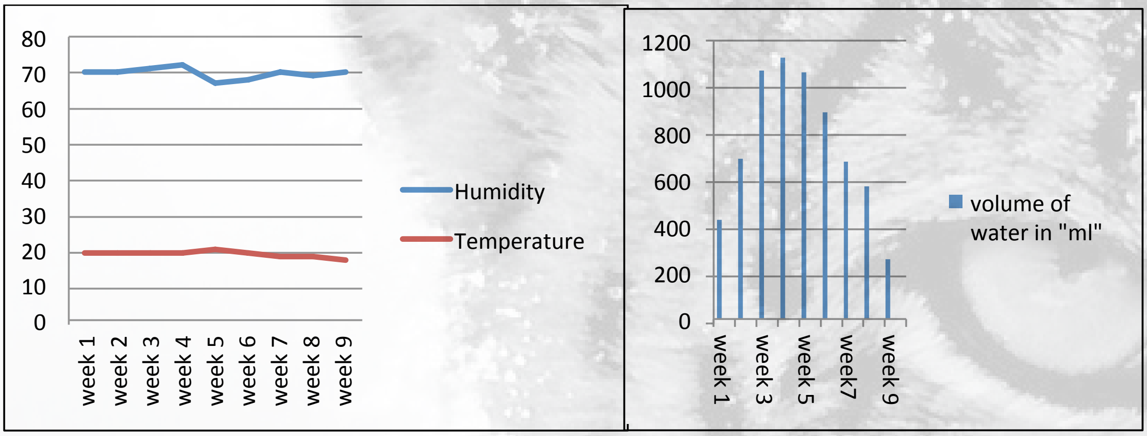


Fig. 48b: Evening hour record on Temperature and Humidity of Breeding area (Left) Volume of water collected from Dehumidifier (Right)

The above graphical representation shows the data on temperature and humidity recorded at the breeding area both in the morning and evening hour. The graph clearly shows that the percentage of humidity in the breeding area is considerably high ranging from 60-75%.The volume of water collected from dehumidifier ranges from 300-1400 ml, quite high both in morning and evening hour. Thus from the above findings it is highly recommended to maintain a record on temperature and humidity and to place a dehumidier inside the breeding room especially when the birth takes place during monsoon and late monsoon.

14.6. PRECAUTIONS TOBE TAKEN DURING THE REARING OF SNOW LEOPARD CUB

- Note down their sleeping time, feeding time and other activities like playing, auto grooming etc.
- Try to note down their day to day respiration rate.
- If the cub is resting/sleeping for a longer period then inform the higher authority and look into the matter because sleeping for a longer period is also not so good to any animal.
- While handling the animal, put mask and gloves and make sure not more than three people are engaged in handling the cub**.**

Rearing conditions: Cubs should be kept relatively cool (21-23°C) to prevent excessive hair loss (Wharton & Mainka 1997). Bedding materials should be provided for comfort and temperature regulation, and must be changed frequently as Snow leopard cubs produce copious amounts of urine (Frueh 1968; Brunstein 1978).The breeding room should be moisture free.

Records: A detailed nursery diary should be kept recording date, times fed, amount fed, body weight, urination/defecation, faecal condition, remarks/notes. Keeping a diary and accurate records will help to assess progress. This information can be used to determine if changes are needed/foresee any potential problems.

Normal Cub Temperatures: Rectal temperatures at birth range between 32.2 C and 33 C. The cub's eyes opened between 7 and 10 days, and the first teeth appeared between days 13 and 18 (Kitchener, *et al* 1975). New born cubs will cry when they are hungry and sometimes stray from the warmth of their mother's body.

A cub born in 2012 on reaching 133 days observed tobe dull, inactive and the eyes were looking drowsy. Immediately body temperature of the cub was taken, it was 103.6 □.The cub was suffering from fever. Without delay medicines were given: Intacef, Paracetamol and avil. Within an hour the cub recovered.

Age of Dispersal: Wild snow leopards between 18-22 months (Blomqvist and Sten 1882, Wharton and Freeman 1988, Sunquist & Sunquist 2002). Sibling groups may remain together briefly upon independence (Jackson and Ahlborn 1989).

Interbirth Interval: Snow leopards are said to breed every other year in captivity. Though some captive animals have come into oestrus every year (Kitchener, *et al* 1975).

14.7. RECOMMENDATIONS:

MANAGEMENT BEFORE AND AFTER BIRTH:

- During the week before parturition, and for at least the first week after, foot and vehicle traffic around the den building should be monitored and severely limited.
- It is extremely important to understand the physiological and behavioral changes that occur throughout an animal's pregnancy. Snow leopard pregnancy goes for approximately 96-105 days. During this period the dam will experience moderate weight gain which may not be physically visible till the third month. During this time extra food can be made available for the dam to compensate for the developing fetus (es).
- Snow leopards may show little or no behavioral changes until just prior to birth when denning behavior may start to become evident. Increased licking of the teats and their exposure from the fur indicate an impending birth. Also increased frequency of licking and cleaning of the vaginal area may also indicate imminent parturition. At this time staff should be prepared for any birth problems that might occur that may include the possibility of hand raising short or long term although this has been rare in snow leopard births to date. Birth usually occurs in the late evening or early morning hours with average 1 to 3 cubs produced. (4 to 5 cubs have been sometimes been produced.)

- The breeding room should be constructed of wood (which provides effective traction for the newborn cubs), and should be kept warm, dry and moisture free. All den preparation should be completed at least one month prior to birth, to allow the female to become accustomed to the changes. It is recommended that video cameras be set-up to allow remote monitoring of the nest box and maternity den (Wharton & Mainka 1997). Providing females with the choice of more than one nest box is highly recommended (Wharton & Mainka 1997).
- Assisted Rearing: It is recommended that cubs be mother-reared unless specific medical or behavioral issues would prevent this from being successful. Females that neglect their cubs (or nest box), or that show stress-related behaviors such as frequently carrying the cubs around the enclosure or leaving them outside of the nest box (e.g., Freeman & Hutchins 1978), should be carefully monitored, as hand-rearing may be necessary in these situations.

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15. DIETARY ANALYSIS OF SNOW LEOPARD (*Uncia uncia*) IN CAPTIVITY.

Snow leopard (*Uncia uncia*) in their natural habitat requires approximately 3000-4000 kcal per day, or alternatively about 40-45 g of food per kg body weight per day (Emmons 1987).A snow leopard would need 1.5 kg per day or 548 kg per year (Schaller 1977). Jackson and Ahlborn (1984) estimated the food requirements at 1.3-2.0 kg per day (at least 822 kg per year) and an adult snow leopard eats 20-30 blue sheep annually. He suggested that a blue sheep population of 150-200 animals would be required to support an adult cat. However, Wemmer and Sunquist (1988) estimated 1.5-2.5 kg/day) and an adult snow leopard eats 26 blue sheep annually. They estimated a population of 260 blue sheep sized prey would be required to support an adult cat. Snow leopard food requirements are roughly 1.5-2.5 kg/day (Jackson and Ahlborn 1984, Schaller et al 1988a, Wemmer and Sunquist 1988). Thus, 550- 900 kg of food are required per year, and because about 30% of wild prey weight is unusable (Hornocker,1970) between 700 kg and 1200 kg of prey are required to feed an adult snow leopard for a year. Snow leopards eat slowly, usually taking 3 or 4 days to consume a prey animal. During that time, the cat remains near the kill site to defend the meal from scavengers like vultures and ravens, eating every few hours until the carcass is bare. Snow leopards hunt a large animal every 8-10 days on average.

In 1940 ‘s a Snow leopard at Bronx Zoo was fed 1.8 kg of horse meat five or six times a week which was supplemented twice a week with bone meal and cod liver oil. Fowls and pigeons were offered two or three times week (Crandall, 1964).At St.Louis Zoo a pregnant or lactating animal was fed freshly killed rabbits, pigeons and chicken in addition to horse meat (Freuch, 1968) .In North American most zoos feed a commercial feline diet which consists of ground beefs or horse meat and mineral and vitamin supplements (Wharton and Mainka, 1997).Bones are provided to provided to promote healthy teeth and gums. At Bronx zoo each week commercial canine or feline diet is fed for 5 days and chicken back or beef knuckle is fed for 2 days. Mineral vitamin supplements are not necessary for properly balanced commercial ration. However, kitten upto 6 months old are given 200ml of kitten milk replacer and 5g of calcium daily. In Philadelphia Zoo, to each 22.2 kg of solid horse meat 5g of mineral mixture (9 parts oyster shell powder, 1 part skimmed milk and 1 part iodized salt) is added (Rosenthal and Ott. Joslin, 1988)

However no comprehensive studies with quantitative diet analysis of the Captive Snow leopard has been done so far. Therefore, inorder to know the captive diet of snow leopard a communication through a pre-prepared questionaire with other International Zoos housing Snow Leopard was carried out.

15.1. DIET REVIEW AND DATA ANALYSIS

Details of the feed and its quantity have been given in chapter 1 during the project initiation where the Snow leopard were fed with variable quantity and type of feed like complan, essence of chicken, pork which are not a part of the natural diet of the Snow Leopards. Later, review of the records of the diet showed that feeding charts were maintained in a monotonous way. This part of the study attempts to standardize the feeding of Snow Leopards in captivity and improve ways of enrichment through diets in the hope that captive animals will lead healthy and reproductive lives,

The most basic and simple tool that we can employ to access the general status of the animal is the measurement of feed intake.

- The basic level of any record keeping system has to be its recorders. In the zoo setting, this role falls traditionally to the zoo keepers.
- “It is the keeper who will note how the diet is being accepted, if the amount offered are adequate, His observation will be important in deciding if the adjustments are successful or not”(Woods,1987)
- There is a variety of dietary monitoring tools used at animal care facilities. Many of these facilities have implemented the use of diet chart sheets etc. These diet charts have been designed to be easily used in keeper’s daily routine.

15.1.1. METHOD

Any form of diet review requires correct data collection from the field of every individual animal, hence it is very important to have a correct format of a diet chart. The diet chart should include the identification of animal, sex, bith date, specific weight of each dietary item, dietary offering and any other remarks.

The formats of the diet chart lacked:

1. Absence of individual animal details.

2. Quantity mentioned i.e. given observed to be the same round the month.

3. No reasons specified for the left over feed.

4. Clearly specifies no formal training provided to the keepers concerned for keeping the diet records.

5. Such datas is of little significance in drawing up recommendations or suggestions in the snow leopards diet in captivity either in larger or in smaller scales.

Below given are the formats of the diet chart maintained at PNHZPark where Fig.1,2 and 3 lacks animal specifications ,reasons for left over feed etc.Therefore, the project also aimed at correct scientific data collection of the feed to modify the feed items ,their quantity ,method of presentation to ensure behaviorally healthy animals. To achieve this following measures were taken:

1. Modification of the diet chart as per fig. no.

2. Training the keepers at the conservation Breeding facility and display area as to how the records are to be maintained(Correct weight of the feed items, water given, left overs etc.)

3. Entry of the feed given every day to be recorded.

4. Submission of the report to the animal supervisor at the end of every month with their signature.

Below given are the formats of diet charts and its modification thereafter and the advantages obtained in drawing out various recommendations the details of which are given below.

FEEDING CHART

Name of the Animal : NEETA

Date	Type of Meat	Quantity of meat given in kg.	Quantity of left over meat given in kg.	Remarks
1·7·06	mutton	3·500 kg.	700 gms	2·800 kg accept
2·7·06	"	3·500 "	850 "	2·670 " "
3·7·06	Beef	3·500 "	520 "	2·980 " "
4·7·06	mutton	3·500 "	640 "	2·860 " "
5·7·06	"	3·500 "	765 "	2·735 " "
6·7·06	meatless day			
7·7·06	mutton	3·500 kg.	400 "	3·100 " "
8·7·06	"	3·500 "	600 "	2·900 " "
9·7·06	"	3·500 "	800 "	2·700 " "
10·7·06	Beef	3·500 "	640 "	2·860 " "
11·7·06	mutton	3·500 "	780 "	2·720 " "
12·7·06	"	3·500 "	875 "	2·625 " "
13·7·06	meatless day			
14·7·06	mutton	3·500 kg	740 "	2·760 " "
15·7·06	"	3·500 kg.	375 "	3·125 " "
16·7·06	"	3·500 "	520 "	2·980 " "
17·7·06	Beef	3·500 "	400 "	3·100 " "
18·7·06	mutton	3·500 "	700 "	2·800 " "
19·7·06	"	3·500 "	600 "	2·900 " "
20·7·06	meatless day			
21·7·06	mutton	3·500 "	500 "	3·000 " "
22·7·06	chicken	3·500 "		
23·7·06	mutton	3·500 "	800 "	2·700 " "
24·7·06	Beef	3·500 "	400 "	3·100 " "
25·7·06	mutton	3·500 "	900 "	2·600 " "
26·7·06	"	3·500 "	640 "	2·860 " "
27·7·06	meatless day			
28·7·06	mutton	3·500 "	700 "	2·800 " "
29·7·06	chicken	2·900 "		2·900 " "
30·7·06	mutton	3·500 "	800 "	2·700 " "
31·7·06	Beef	3·500 "	630 "	2·870 " "

Fig. 49a: Feeding chart of Snow leopard in 2006

D.O.B.-

FEEDING CHART

Animal Species- ~~Common~~ SNOW Leopard		House name- Malika								Local Id- ♀	
Date	Day	Chicken	Leftover	Taken	Mutton	Lftovr	Taken	Beef	Lftover	Taken	Remarks
1-4-010	thu	x	x	x	x	x	x	x	x	x	Dry day
2-4-010	fri				2.500	0	all				
3-4-010	Sat							2.500	0	all	
4-4-010	Sun							2.500	0	all	
5-4-010	Mon							2.500	0	all	
6-4-010	Tue	2.250	0	all							
7-4-010	wed							2.500	0	all	
8-4-010	thu	x	x	x	x	x	x	x	x	x	Dry day
9-4-010	fri				2.500	0	all				
10-4-010	Sat							2.500	0	all	
11-4-010	Sun							2.500	0	all	
12-4-010	mon							2.500	0	all	
13-4-010	Tue	2.300	0	all							
14-4-010	wed							2.500	0	all	
15-4-010	thu	x	x	x	x	x	x	x	x	x	Dry day
16-4-010	fri				2.500	0	all				
17-4-010	Sat							2.500	0	all	
18-4-010	Sun							2.500	0	all	
19-4-010	Mon							2.500	0	all	
20-4-010	Tue	2.200	0	all							
21-4-010	wed							2.800	0	all	
22-4-010	thu	x	x	x	x	x	x	x	x	x	Dry day
23-4-010	fri				2.500	0	all				
24-4-010	Sat							2.500	0	all	
25-4-010	Sun							2.500	0	all	
26-4-010	mon							2.500	0	all	
27-4-010	Tue	2.200	0	all							
28-4-010	wed							2.500	0	all	
29-4-010	thu	x	x	x	x	x	x	x	x	x	Dry day
30-4-010	fri				2.500	0	all				
Total											

Keeper's signature

Fig. 49b: Feeding chart of Snow leopard in 2010

FEEDING RECORD OF SNOW LEOPARD

SPECIES: SNOW LEOPARD
SCIENTIFIC NAME: *Uncia uncia*
NAME OF ANIMAL:
BEAT NO. :
DATE OF BIRTH: WEIGHT OF THE ANIMAL :
ID NO.:
MONTH:MAY

DATE	TIME	DIET	TOTAL AMOUNT GIVEN	TAKEN	LEFT OUT	METHOD

KEEPER'S SIGNATURE

....

Fig. 49c: Revised Feeding chart of Snow leopard in 2011

15.1.2. RESULTS:

At the end of the month, the diet charts are collected and the data are evaluated. The dietary data collected by keeper are turned over to the Animal supervisor .Keepers point out any observation that might explain any irregularities or trends noticed in the chart.

The above adopted methodologies helped in

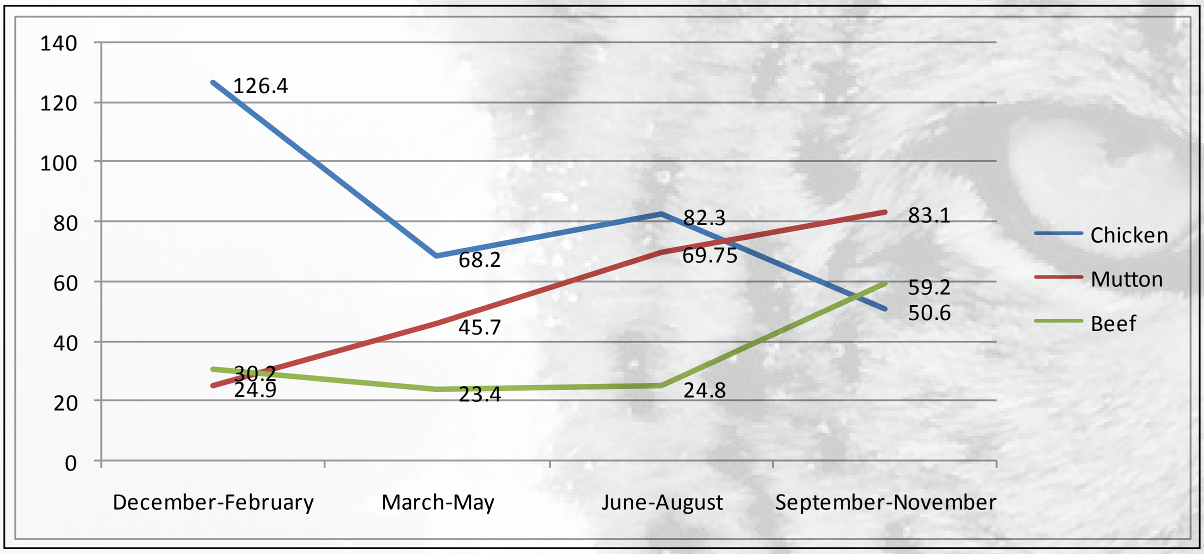
- **DIET PREPARATION:**

- The diet chart reminded the keeper about enrichment days (on diet chart enrichment is noted as items provided through different methods).
- The dietary information helped in reviewing their diets whenever required in circumstances like sickness, oestrus period ,parturation, post partum phase and age of the animals.
- With the data gathered the staff can then calculate monthly average intakes and objectively evaluate the diet consumed. The diet information documented provides good historical data for an animal over the season and year.
- Diet Charts are always a subject to review.

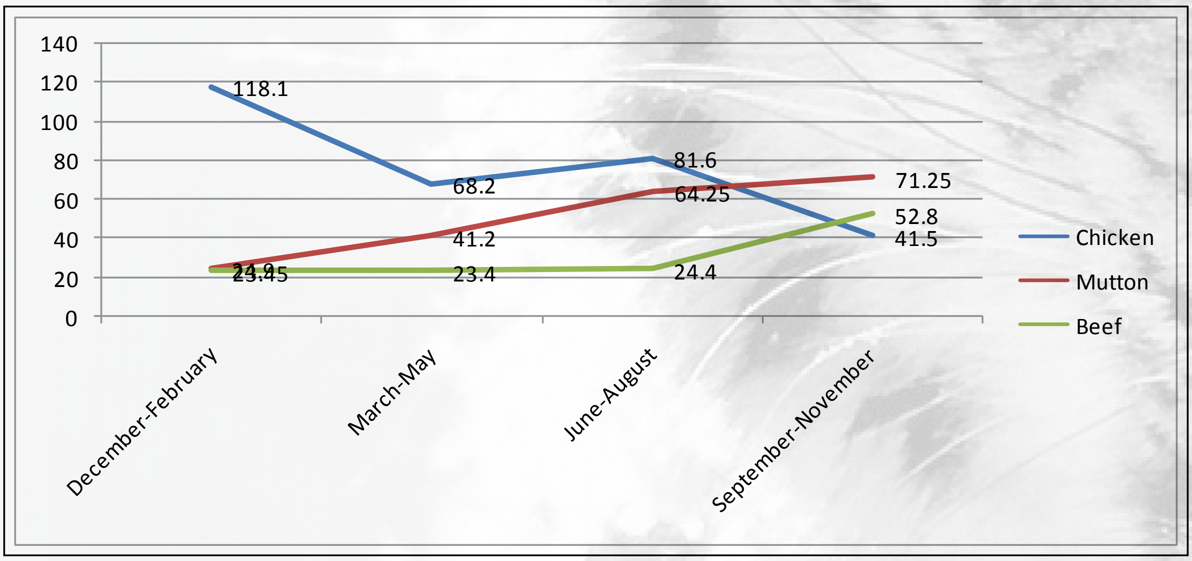
- **RECORDING LEFTOVERS:**

- The method which is used to record the leftovers amounts is by weighing back each item that was offered on the previous day, the leftovers are collected and before cleaning of the trays. Recording left over has been a method to avoid wastage and also an indication of animal coming into oestrus or nearing parturation.
- The feed is immediately reduced or the item is changed posing animal's dislike for the item.
- Following are the examples presented as case studies of diet review per month.

15.2. Seasonal variation in diet pattern of Snow leopard



(A)



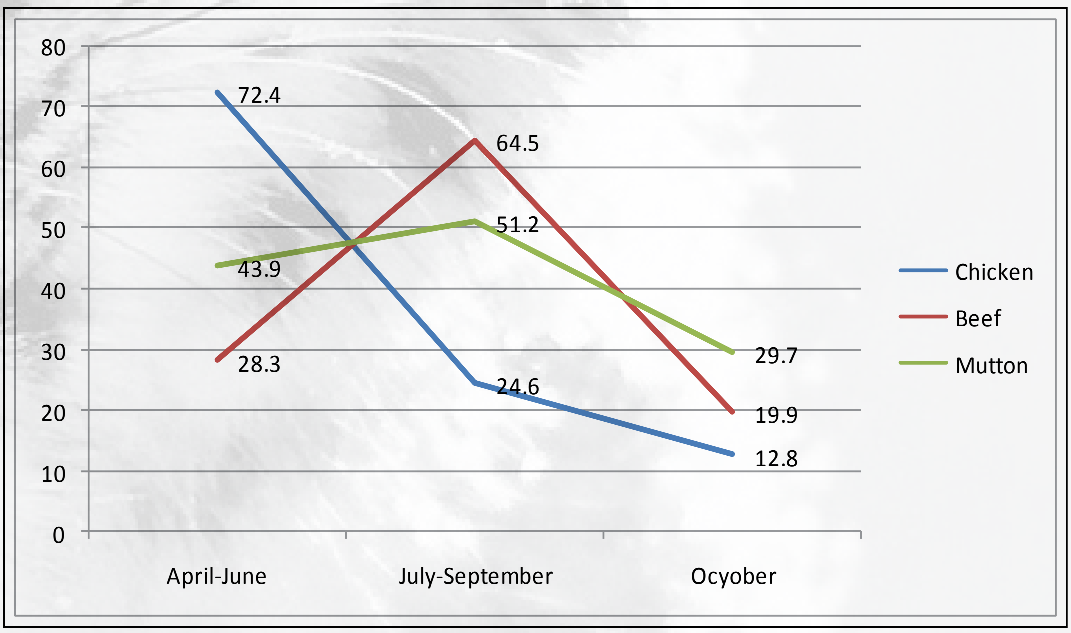
(B)

Fig. 50: Seasonal variation in A. Feed given B.Feed consumed by Female Snow leopard "Ritu"

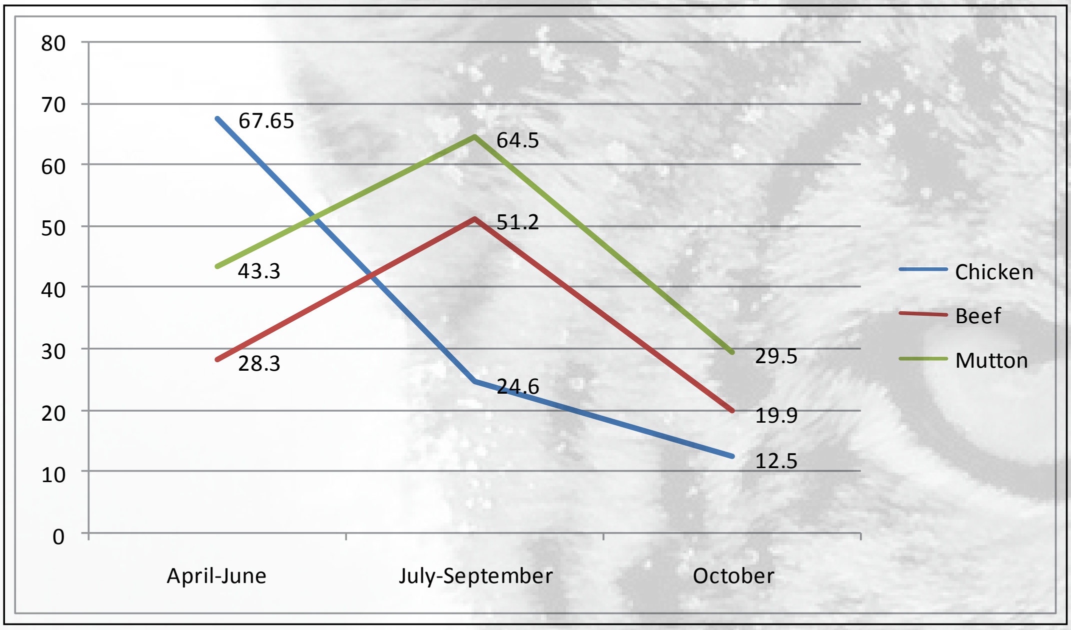
At PNHZ Park, Snow leopards are fed with Chicken, Mutton and beef in alternate days, raw egg and boiled water every day. Prior to feeding the items are weigh and make sure that the animals doesn't get overfed. As mentioned earlier 700-1200 kg of prey is required to feed an adult snow leopard a year in the wild. The above graph gives a detail idea on the seasonal variation in the diet pattern of Snow leopard at PNHZ Park. At the park approximately 690-700 kg is feed to an adult Snow leopard with variation in items being fed in different season and also depending on the health and age of the animal. It has been observed that Snow leopard prefer chicken rather than mutton and beef. Hence it is suggested that unhealthy, sick and old age animals should be fed with chicken. In the wild Snow leopard hunt a large animal in every 8-10 days on average and sometimes remain unfed due to unavailability of prey wheras in captivity the animals are fed throughout the year. Hence to match up with the condition of the wild diet by Snow leopard the animals are kept unfed for one day in every week.

A nine year old male Snow leopard (House name "Subash") taken to Shimla Zoo was being fed with 3kg of meat four eggs and ½liter of milk every day. The animal on returing back to PNHZ Park had gained a weight of 60.3 kg and he was looking very stocky and physically unhealthy. After his arrival at PNHZ Park the animal was kept under a controlled feeding. He was fed with 1.5 kg of meat and one raw egg every for seven months. So gradually the weight of the animal came under a controlled situation and after nine months he was 39.180kg.

The below given graph shows diet given to the male snow leopard "Subash" at PNHZ Park.



(A)



(B)

Fig. 50.1.: Seasonal variation in A. Feed given B.Feed consumed by Male Snow leopard "Subash"

Table 20: The following table gives the details about the feed type and quantity provided in different global captive facilities.

Sl.no.	Name of Zoo	Feed given	Quantity	Fasting day
1.	Rosamond Gifford Zoo, New York	Horse meat (Milliken Meat Products Company)and rabbit meat	2½ lbs-3lbs,	no fast day
2.	Cat Haven Zoo,	Cubs are fed Zoologic 33/40 formula supplemented with DiCalcium Phosphate and Chicken/Turkey flavored baby food		no fast day.
3.	Toronga Zoo, Australlia.	chicken	1kg	no fast day.
		kangaroo	1.3 for females 1.7 for males	
		Liver	500gms	
		Beef	1.3 for females 1.7 for males	
		Horse	1.3 for females 1.7 for males	
4.	Porter park Zoo, Lansing Michigan	Nebraska carnivore diet	2.5 lbs	One day /week receives bone on that day
5.	Wuppertal Zoo	cow meat/animal	2-3 kgs	Monday

6.	Grandby Zoo,Canada.	meat	2-3 kgs	
7.	Kaunas Zoo	Raw horseflesh or Beef sometimes rabbit, chicken and rats		Sunday
		Egg	1	
		Trivitum (A,D,E)seasonally	0.5 ml	
		Chalk	20g	
		Milk	0.3 l	
8.	Himalayan Zoological Park, Gangtok.	Beef, chicken and Mutton.	3 kg	
9.	Kufri Zoo,	Chicken	3kg five days in a week	Once in a week.
		Mutton	3kg once in a week	
		egg	4 no. once in a week	
		Milk	500gm. Once in a week	
10.	Padmaja Naidu Himalayan Zoological Park,Darjeeling	Chicken	2-2.5 kgs	Thursday
		Mutton		
		Beef		

- **Avoid these common feeding errors in Felids:**

Overfeeding can lead to the number-one nutritional disease, obesity. Excessive body weight can increase the risk of liver disease, heart disease, respiratory problems, and constipation. Furthermore, obese cats are at greater risk of developing diabetes and arthritis.Hence, fasting the animal once a week is essential.

- **FASTING DAY:**

Many institutions fast their cats one night each week .The theory behind this is that wild cats do not necessarily eat every day. Offering the cats bones on fast night is enrichment for them and helps to keep their teeth clean. Weekly fasting may help to keep the cats from becoming obese.

Besides feed water is one of the most important nutrient necessary to sustain normal functions of all living cells. Water helps to regulate body temperature, cushion the joints and internal organs, digest food, eliminate waste, lubricate tissue and allow salt and other electrolytes to pass through the body. Decreased urine volume may be an important factor for the development of Urolithiasis in Felids. Diets that cause a decrease in total fluid turnover can result in decreased urine volume increased urine concentration, both of which may contribute to urinary tract disease in Felids. Hence a study was carried out at PNHZ Park on three different seasons to see whether the Snow leopard housed at the park are taking the water in an adequate amount of not.

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- Sample size:6 (3:3)
- Duration: 3 months.

Month: November

SL. NO.	NAME OF ANIMAL	TOTAL WATER GIVEN (in lt.)	WATER CONSUMED (in lt)
1.	Ritu	42.9	19.5
2.	Karan	42.9	40.47
3.	Prabhat	42.9	35.52
4.	Tyson	42.9	25.20
5.	Yashmin	42.9	25.62
6.	Teesta	42.9	15.32

Month: February

SL. NO.	NAME OF ANIMAL	TOTAL WATER GIVEN (in lt.)	WATER CONSUMED (in lt)
1.	Ritu	43.5	13.47
2.	Karan	43.5	21.86
3.	Prabhat	43.5	17.51
4.	Tyson	43.5	14.09
5.	Yashmin	43.5	18.44
6.	Teesta	43.5	11.72

Month: March

SL. NO.	NAME OF ANIMAL	TOTAL WATER GIVEN (in lt.)	WATER CONSUMED (in lt)
1.	Ritu	46.50	20.03
2.	Karan	46.50	24.95
3.	Prabhat	46.50	24.34
4.	Yashmin	46.50	21.77

5.	Teesta	46.50	19.31

Result: From the above given data we find that almost all the Snow leopard are taking the water in an adequate amount ensuring adequate hydration, that is preventing the individual from developing Crystallogenic substances that will later interfere with normal urinary function.

Remarks:

- This is important consideration for male cats. Cats that cannot urinate for more than 24hrs due to urinary tract obstruction can die from acute renal failure and /or severe damage to the urinary bladder. In addition to the removal of crystals, benefits of increased water intake include dilution of any noxious substances in urine, and more frequent urination to decrease bladder contact time with urine that may reduce the risks of urinary tract disease.
- Cats can live for long periods without drinking water when receiving food containing 67-73% water but becomes dehydrated when the water content of the food is 63% or less.

15.3. DISCUSSION:

- Keeping the diet chart to basic relevant information is key to a good diet chart. The diet chart allows the keepers to easily incorporate it into their routine. Time spent on this aspect of the keepers' routine is minimal, but necessary to obtain dietary information.
- Many keepers may wonder how diet charts are important to them. It gives the keeper a quick view of animal's dietary trends and leftovers for the month. These trends may give possible warning signs to possible health, behavioral or diet acceptance troubles which need to be reported.
- The data which is collected provides animal managers and nutritionist information need to offer better diets. The overall health of the collection will, hopefully benefit from improved dietary and management programs.

- When selecting a proper dietary monitoring tool to use with staff, one must keep in mind the following ‘Keepers provide the basic information that make the assessment of diets possible (Woods, 1987)
- For this reason diet charts need to be used in the keeper’s daily routine without involving a lot of time, simplicity is the key. Diets need to be evaluated on regular basis. This evaluation need to consider the information.

Besides, the most practical and efficient method utilized in captivity to ensure a proper balanced diet to the animal laboratory methods for feed analysis can also assist in improvement of health, immunity, reproduction and life span In this view under the Central Zoo Authority project on “Standardization of animal diets in Indian Zoos” done by Indian Veterinary Research Institute have provided dietary recommendations the report details of which are as follows. The recommendations are being followed at the park with a close review of day to day feeding of the Snow leopard in captivity.

The feeding trials were conducted on eleven no. of Snow Leopard in Darjeeling, one animal each in Kufri and Gangtok and two animals in Nainital Zoo. During the trial period measured amount of food was given to each animal .Residues and feces were collected in full. Fecal samples were collected by both direct measure and also by using markers. Nutrient composition of food offered, residues and fecal samples were analyzed using standard laboratory analysis.

Table 21: Chemical composition of diet fed to Snow leopard in different zoos

	Dry matter %	On dry matter basis							
		GE (Kcal/kg DM)	CP%	Fat%	Ca%	P%	Fe ppm	Zn ppm	Cu ppm
PNHZPark									
Beef									
Offered	42.11	5140	67.49	27.14	3.22	1.94	78	178	15
Residue	64.33	4170	75.03	13.14	7.94	3.89	98	225	16
Mutton									
offered	31.03	4790	75.04	20.14	3.57	1.98	81	182	14
Residue	58.38	3980	73.21	12.18	10.42	5.11	112	230	14
Gangtok Zoo									
Offered	39.84	5020	69.2	25,14	3.24	1.94	84	210	17
Residue	65.44	4180	73.43	14.57	8.04	4.15	95	220	17

15.4. Recommendation:

Following are the recommendations drawn up by IVRI for the diet of Snow leopard in captivity.

1. Feeding 3.5 kg of meat would provide adequate amount of nutrients and will allow considerable amount of safety for left-over meat.

2. Mutton would be a better source of nutrients than beef.

3. Food should be offered in the latest hour of the afternoon as would be practicable for management.

4. One time feeding is sufficient except for nursing mothers whose total ration may be divided into 2- 3 equal meals.

5. If bones are consistently chewed, metabolic bone diseases are unlikely to occur. However, excessive of bone is left over than precaution might be taken. In such cases calcium maybe supplemented @5-7 g/kg meat.

6. Advantage and disadvantage of weekly off day has not been scientifically authenticated .Zoo management may take an appropriate decision.

7. A few drops of vitamin A concentrate may be supplemented. However, excessive supplementation is harmful.

8. Most important is regular monitoring of body condition. Wherever animals are sedated, body weight should be measured and entered into the record .Diets could be modified accordingly with response to the change in body weight .Such changes should however gradually implemented.

9. Water should be made available at all times.

- Apart from these captive Snow Leopards can be fed with meat mixes, bones, whole prey or carcasses and some slab meat.

- Bones or whole prey should be included in the diet for abrading qualities, in order to reduce plaque formation. A significant reduction in plaque and calculus can be achieved offering bones twice a week (Haberstroh et. al. 1984.)
- Cats cannot convert provitamin A compounds, such as beta-carotene, to retinol. Consequently, retinol, retinyl acetate, or palmitate is required in the diet (NRC 1986). Additionally, a dietary source of niacin is also required. Other mammals convert the amino acid tryptophan to niacin, while in the cat this conversion does not occur (NRC 1986). The whole prey diets consumed by free ranging cats are good sources of preformed vitamin A and niacin, precluding problems in the wild.

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16. GENERAL BEHAVIOUR OF SNOW LEOPARD

Before getting deep into the behavioural aspects of Snow leopard in captivity, it is vital to give some basic information about its normal behaviour while existing in the wild. In the wild, Snow leopards are crepuscular in nature (Schaller et al. 1994) .They tend to spend the middle of the day and night bedded on cliffs, in rocky outcrops or other secluded and protected places. Activity differs according to month although the diurnal differences are not as strong and in the case of one individual these were not significant. In terms of daily activity, the crepuscular pattern is most pronounced during the fall/winter and spring.Sex was found to be highly correlated with activity in snow leopards, along with time of day and interactions between sex, season and time interval. Daily movements of a kilometer or less in snow leopard were also reported by Chundawat (1990a) who monitored a radio-collared male over a 35 day interval in late winter in the Hemis National Park of Ladakh. No seasonal differences in the daily movement rates of snow leopard were detected. Female leopards moved 50% further during the breeding season. Females with cubs moved significantly shorter distances each day than females without cubs: three females without cubs averaged 1.9 km/day compared to 1.2 km/day for three females with cubs. The distance moved decreased from 1.4 km/day to 1.1 km/day after parturition, with movement being most restricted during the first six months after birth. (Jackson, 1996)

16.1. Common Behaviours in Captivity:

It is accepted that the captive environment will differ from the wild environment in a number of ways such as lack of life threatening challenges by predators, diseases and hunger. Hence animals show abnormal levels of behaviours in captivity either reduced activity or hyper activity. Studies of captive snow leopards indicate that they are most active early in the morning and again in the evening at nightfall, with only short activity phases during other hours of daylight (Hemmer 1968; Freeman 1975).

16.2. CAPTIVE BEHAVIOURAL PROBLEMS

Wild animals are kept in captive conditions for a variety of reasons. Giving animals, especially wild ones, what they need can prove a bit challenging to say the least! It's important that the needs of the animal are met; the best captive environments will mimic elements of an animal's natural surroundings. This isn't to say the wild is an idyllic place free from all problems – it's not! But animals have evolved over thousands of years, adapting to live in certain types of natural environment.

Hediger (1950) discussed the misconception that wild animals are "free" when in fact they are constrained by many behaviorally imposed barriers. In his opinion neither wild nor zoo animals are truly free. However, there is one major difference. One could argue that **an animal with the most choices has the most "freedom"**. In human societies, the most heinous crimes are punished by death- the complete absence of choice (Coe, John1992).
Placing animals in very different surroundings can cause stress and behavioural problems. Abnormal behaviors may develop in animals housed in human-made environments, if those environments do not allow them to carry out their natural behaviors (such as swimming, climbing, stalking, and predation). Captive environments in zoological parks often do not provide for natural behaviors due to spatial constraints and negative public reaction. Zoological parks depend on the expression of "normal" behaviors by the animals displayed to successfully achieve their goals (Baldwin, 1991). Normal behaviors can be defined as "the exhibition of a phenotypic trait within the environmental context for which primary selective forces have shaped it, the outcome of which being maximal, inclusive fitness" (Eisenberg, 1981). In captivity, these "normal" behaviors are often replaced by abnormal, or "stereotypic" behaviors such as pacing (Carlstead, 1996). **Stereotypy which is defined as the repetitive behavioural pattern without any apparent goal or function.**

What exactly causes stereotypic behaviours? sums up the state of current knowledge as follows:'Overall, captive animals perform stereotypic behaviour for the following, non-mutually exclusive, reasons:
(1) internal states induced by the captive environment, and/or cues external to the animal, persistently trigger or motivate a specific behavioural response; and/or

(2) the environment creates a state of sustained stress which affects how [specific brain regions] elicit and sequence behaviour, resulting in abnormal perseveration; and/or

(3) a past, early rearing environment has affected C.N.S. development, again resulting in abnormal behavioural sequencing, with effects evident long past infancy. . . . in some cases this might. . . be further promoted by endogenous effects such as reinforcing consequences from the behaviours [and increased] predictability may . . . emerge through repetition'.

Thus these are the fundamental causes of repetition; while, more speculatively, some stereotypic behaviours may additionally involve 'coping' effects and/or the development of habit-like properties

Stereotypic behaviour and offspring mortality are recognized indicators of poor welfare. In an extensive analysis of these stereotypes and infant mortality in captive carnivores around the world, Clubb & Mason (2007) found both to be related to home range size and daily travel distance. Put simply, wide-ranging carnivores kept in small enclosures do not fare well. The study suggests that to facilitate good welfare, enrichment for captive carnivores of species with large natural ranges should focus on ranging behaviour, including larger space, multiple dens, and greater daily environmental variety.

Abnormal behaviors exhibited by wild animals in captive condition are as follows:

a. Pacing: Repetitive ambulatory movement, transversing the same pathway at least twice (Shepherdson, 1998).

b. Head toss: So-called "weavers" swing their heads rhythmically. At the same time pawing alternately with their feet .

c. Auto-mutilation: Some individuals turn a normal grooming behavior into an excessive cleaning behavior. This behavior, an exaggerated licking, gnawing and scratching at parts of the body, which may cause serious wounds

d. Abnormal aggressiveness: Explosion of aggressive behavior that can be directed to a conspecific or other another animal, including humans. Capture and restrained life of captivity may repress the impulse of self-defense. The thwarted drive than suddenly finds an outlet in an attack upon the first "adversary" at hand (Hediger, 1935).

e. Apathy: Separation from a mate or companion to which an animal is strongly attached can evoke a state of apathy comparable to depression and mourning of man .

f. Prolonged infantile behavior: Hand reared passerine birds show the gaping behavior for a longer time. Even, when they are quite able to peck food from the ground, they react by gaping upon the appearance of their human foster parents .

g. Tameness: Reduction in escape tendency to zero .

h. Overeating: Constant foraging caused by boredom, overfeeding or monopolizing other animal’s food source (Ortega, 1999).

i. Refusal of food: Food can be refused after stressful situations like capture, manipulation or after a change of quarters .

j. Aberrant appetite: The tendency of animals eating objects that could affect their health (Ortega, 1999).

Stress: The word ‘‘stress’’ has become used in so many different contexts that it has been argued by some to be an essentially useless term (McEwen, 2000). Stereotypic behaviors are thought to be an indication of stress (Carlstead, 1996) Stress inhibits maternal behaviour and may sometimes cause maternal cannibalism, or interrupt or delay delivery and cause brain hypoxia in the young. Stress caused by an inadequate or new environment often causes anorexia, which may in some cases compromise the animal's health or even its life. Some circumstances related to the housing and husbandry of wild felids in captivity, e.g. introducing new animals, competition for resources and altering the typical social dynamics of the species, may increase the frequency or intensity of aggressive interactions.

Managing behaviors is not easy and predictable. Captivity can drastically affect an animal’s behavior (Morris, 1964). Reduced complexity can induce different behavioral responses such as boredom or stereotypes. A distressed animal is unable to adaptively cope with external stressors. Isolation in social species and boredom that results from certain husbandry practices are considered by some to be more distressful than pain (Wolfe, 1987). Behavioral Enrichment techniques should be designed to stimulate responses and reduce the impact of captive stress without endangering the welfare of the animal (Van Wormer, 1999).

16.3. SOURCES OF STRESS IN CAPTIVITY:

Intraspecific Compatibility: Aggression may occur when two males or two females are housed together after they have reached sexual maturity. It is advisable to remove any offspring before this occurs if housed with their mother.

Male and female interactions during Breeding season are characterized by an increase in the precopulatory contact behaviours of sniffing of the anogenital area of one individual of the other, social grooming followed particularly by the male ,head and body rubbing of one individual by the other, incidence of low intensity vocalization of “Prusten” and playful stalks and pounces.(Kleiman and Eisenberg ,1973)

The incidence of ritualized threat behaviour (i.e. where the female strikes out at the male with her forepaws) is extremely low in Snow Leopards.The highest occurrence is when pairs are newly introduced.

Successful individuals of both sexes demonstrate a high degree of activity than unsuccessful animals. Unsuccessful males continue to pace during the female estrus cycle, while males whose mates become pregnant have dramatic drop in behaviour during the estrus time block. This may suggest the possibility that males may be able to detect a female’s reproductive capability, continuing to be restless and pacing if the female is unlikely to become pregnant (Freeman, H.1983)

Sound

Animals continuously subjected to intense noise manifest stress responses by exhibiting elevated levels of arousal (Gamble, 1982), both behaviorally and physiologically. Loud sound is well known to have adverse effects on blood pressure and heart rate in humans (Hagerman et al., 2005; Smith, 1991) and other animals (Geverink et al., 1998; Salvetti et al., 2000). Physiologically, prolonged exposure to intense noise is associated with increased activity in the sympathetic division of the autonomic nervous system. Its prolonged activation is correlated with increased activity in the hypothalamic-pituitary-adrenal (HPA) system, elevated metabolic rates, increased blood pressure, and tachycardia (Ames, 1978; Anthony et al., 1959; Henkin and Knigge, 1963). This arousal can have deleterious long-term effects on animals that experience it directly but also on offspring in utero. Exposure of pregnant animals to noise-induced physiological arousal results in immunosupression (Sobrian et al., 1997), exaggerated distress responses to aversive events (Morgan and Thayer, 1997), changes in auditory threshold (Canlon et al., 2003), increased disturbance behaviors (Schneider et al., 2002), impaired learning (Nishio et al., 2001; Morgan et al., 1999), abnormal social behavior (Clarke and Schneider, 1993; Morgan et al., 1997), and suppressed exploratory behavior (Poltyrev et al., 1996) in offspring. Such long-term effects of exposure to loud sound are important considerations for conservation-minded managers of animals housed in the typically noisy surroundings of captivity.

Since the Snow Leopard inhabits in extremely harsh and often impossible terrain, very little is known of its habits and behaviour in the wild. We do not know exactly what type of behaviour the species actually exhibit in its natural/wild environment. So it’s really hard to say whether the captive environment provided in Zoological parks are meeting the animal’s need. In captive management thus meeting the psychological and behavioural needs of the species requires special attention and is mainly achieved through “Enrichment”.

16.4. ENVIRONMENTAL ENRICHMENT:

Environmental enrichment is the probably the most common means of tackling ARBs. It has been extensively reviewed elsewhere, and will be very familiar to readers. Enrichment is usually thought of in terms of changes to the structure and content of enclosures, although other changes in husbandry (e.g. reductions in visitor noise, changes in keeper-animal interactions) can also sometimes be subsumed under this label. Good enrichments are thought to offer animals opportunities to perform activities that they prefer over stereotypic behaviours, reduce the motivations driving ARBs, and/or offer enhanced control (including opportunities to hide/ retreat) (e.g. Swaisgood and Shepherdson, in press).

The process of environmental enrichment, as it is commonly termed, is difficult to optimally manage due to difficulty in meeting natural hunting requirements within a confined space. Captive environments have difficulty providing behaviours like hunting (the “hide, stalk and chase”) due to spatial constraints and negative human reactions to predatory behaviour. It is certainly necessary to develop more fully felid enrichment programmes based on understanding felid behaviours within set spatial parameters.

However, it is vital to consider that introducing any enrichment programme, a careful cost-benefit analysis, weighing up the advantages and disadvantages of the environmental enrichment should be made before it is put into practice. Significantly, such strategies should be done with the ultimately aim to improve the biological functioning of the species under scrutiny

There is huge number of animals living in captive conditions worldwide. Some of the captive environments can be zoos and safari parks, rescue shelters and laboratories. In such settings, the welfare of animals is under a considerable amount of attention in order to improve their social and physical enclosures. The most common term for improving the captive environment of the studied felids and improving its biological functioning as being similar to the wild one is called **environmental enrichment.**

According to Shepherdson, Environmental enrichment is a concept which describes how the environment of captive animals can be changed for the benefit of the inhabitants."Behavioural opportunities that may arise or increase as a result of environmental enrichment can be appropriately described as behavioural enrichment.

Environmental Enrichment (sometimes called Behavioural enrichment) is a term that is often misunderstood .According to the Oxford English Dictionary, there are two definition that relate to this discussion and answer the questions: en-rich-ment (noun): the act or process of increasing intellectual or spiritual resources; enrich (verb) :the act of making something better (richer) by the addition or increase of some desirable quality or ingredient.

Ideal Enrichment programme:

A successful enrichment programme provides a balance between risk factor associated with enrichment and maintaining species appropriate behaviours, and also promotes the physical and psychological well- being of captive animals. Incorporation of enrichment as a part of the keepers' daily husbandry routines can help ensure the health of the animals, and therefore the educational value of the exhibit and thus creates a positive perception among the zoo-visitors.

As Wells (2009) suggests, auditory, olfactory and visual stimulations can be ways of environmental enrichment for captive tigers. Auditory stimulation includes sounds specific to the species' natural habitat. However, the olfactory stimulation takes into account the odours specific to the species' natural habitat and pheromone stimulation.

Each case has its own way of management, therefore, a number of factors such as sex, age and housing conditions are considered individually. The personality of the captive animal is equally important, too, as the enrichment for one animal in a group may well be aversive to another and vice versa.

Overall, environmental enrichment describes the efforts made to alleviate the incidence of boredom in captive animals and reduce undesirable behaviours. A successful enrichment programme not only prioritizes enrichment needs, resources, money and people power, but it makes such a programme a priority itself.

Behavioral enrichment framework

- **S**etting goals -What do we want to achieve with this enrichment?

  A series of questions are used to gather information on natural history, individual history, and management constrains

  Generate specific enrichment ideas.

  Prioritize those ideas

- **P**lanning –How do we want to get to that goal?

  Completing the approval process

  Acquiring/ building enrichment items

- **I**mplementing - Who will do what by when?

  Roles and responsibilities

  Schedules

- **D**ocumenting-How and want to document?

  Keepers document animal's response to enrichment daily

  Identify the animal and enrichment provided

  Record the animal's response

  Observe and record the animal's behavior

- **E**valuating- How to assess effectiveness?

  Staff routinely discusses progress and looks for trends in the data

  Trends that maybe detected- Frequency of delivery, animal's response, relative success

- **R**e-adjusting

  Based on the evaluation of trends in the data, the goals and plan can be re-adjusted and the process started over again.

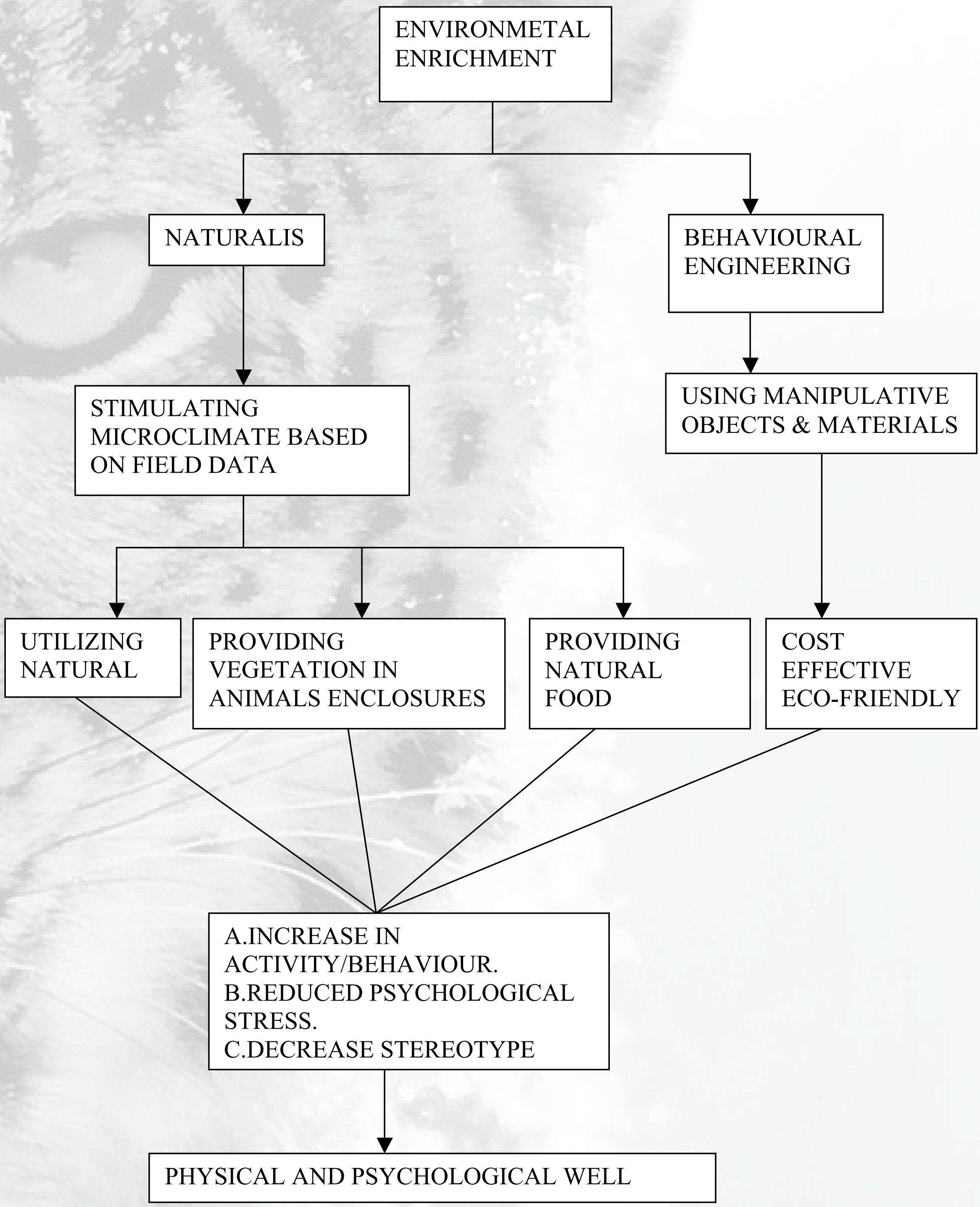

FIG. 51: ENVIRONMENTAL ENRICHMENT MODEL

16.5. ENVIRONMETAL ENRICHMENT OF SNOW LEOPARD AT PNHZPARK.

At PNHZPark the health and welfare of animals have always been given prior importance. The theme of Environmental Enrichment has always been followed right from enclosure designing to enclosure furnishing taking care of all safety considerations.

Enrichment programmes in zoos are intended to limit the stereotypical behavior, which are repetitive and ritualistic behavior that are thought to be caused ultimately by artificial environments that do not allow animals to satisfy their normal behavioral needs and can actually cause harm to the animals.

Because poor animal well being can be a significant obstacle to the reproduction, much effort is made to monitor signs of poor adjustment and captive conditions, including assessment of stress and abnormal behaviour and to determine what environmental provisions are necessary to sustain the species physically and psychologically (Sheperdson,1994).The highly endangered Snow leopard *(Uncia uncia*)makes a good case study illustrating just how integral such efforts are for successful captive breeding. Konstant says "Captive breeding is not a science, it is still an experiment, but it is a wonderful conservation tool for restoring a country's natural history.

Environmental enrichment can be defined loosely as an animal husbandry principle that seeks to enhance the quality of captive care by identifying and providing environmental stimuli necessary for optimal psychological and physiological wellbeing (Shepherdson, 1998).

The relatively new, but rapidly expanding, field of environmental enrichment aims to provide environments of greater physical, temporal, and social complexity that affords animal more of the behavioral opportunities found in the wild. In so doing, enrichment may improve the reproductive potential of individual animals (Beck and Power, 1988)

Environmental enrichment involves changing the environment of the zoo animal to provide opportunities or choices not available before.

Aim of Environmental enrichment:

1) Increase the number and range of normal behaviors shown by the animals;

2) prevent the development of abnormal behaviors or reduce the frequency or severity;

3) Increase the positive utilization of the environment (e.g., the use of space); and

4) Increase the animal's ability to cope with behavioral and physiological challenges such as exposure to humans, experimental manipulation, or environmental variation. Environmental enrichment is built into the design and furnishing of our animal .Considering their natural wild habitat i.e. rocky mountainous areas with shrubs, grasslands, steppe or coniferous forests above the tree line, enrichment for Snow leopard in Zoo was designed in such a way as to meet their natural habitat and tried to elicit their wild behaviour.

16.5.1.METHODS:

Six number of captive born Snow Leopard were observed during the study period. Each individual had been housed at the facility for a minimum of nine years.

16.5.2. DATA COLLECTION PROCEDURE:

Behavioural observation was recorded using a continuous focal animal sampling method (Altman 1974).Datas were collected by using a standard behavioural check sheet. The starting time of change in each behaviour was recorded and the behaviour was later grouped into four categories. Two chain linked enclosures were considered for behavioural observation each with an area of :

Enclosure A	207.98 sq.mt.
Enclosure B	230.00 sq.mt.

Fig. 52a: Enclosure no.1

Fig. 52b: Open exhibit

Fig.52c: Open exhibit

OBSERVATION TIME:

Morning observation: 9:30 a.m. -12:30 p.m.

Afternoon observation: 3:00-4:30 p.m.

Total no. of days of observation: January to May

September to December for a period of two years.

Behaviours were categorized as :

I. PASSIVE:

- Maintenance: grooming self with mouth and paws, cratches,defecates, urinates, shakes, rubs its body on an object.
- Orient to human: Locomote towards keepers/ observers ,sniffs the air.
- Passive/ alert: Sits or stands, lies with head up and eyes open
- Sits or stand with head down or eyes visibly closed.

II. ACTIVE:

- Aggression: Hostile behaviour or action directed towards other individuals.
- Auto play: Vigorous, exaggerated movements typify play, with or without any object.
- Climb: to move upwards or mound climbing structure.
- Scrape: To turn over earth or sand for. Eg.with claws or paws.
- Locomote: walk or run.
- Prusten, yowling, Flehmen.

- Object investigation: Snow leopard peers closely at dead branches or logs, rocks, leaves, exhibit wall and so on.
- Play: Playful behaviour directed towards other individual.

III. ABNORMAL:

- Pace: traverses some path repetitively, usually a walk.
- Mastrubate: Frequent genital licking.

(Modified from Forth man et al. 1992)

Before beginning with the programme the behaviour in captivity and wild was compared thus leading to the designing and implementing the enrichment which is as follows:

Sl.no.	**Enrichment type**		**Goal behaviours targeted**	**Set up**	**Remarks**
1.	Exhibit enrichment	Climbing structures: Trees, wooden poles, ropes, logs, and rocks. Weather considerations: rain cover, shade structure, sunny spots and wind brakes. Substrate for lying sleeping: grass, hay, straw, leaves. Substrate for Scraping.Soil, sand, grass, mulch, rotten logs. Visual barriers: log piles, trees, rocks,caves,dens, Options for hanging. high raised platforms	An increase in exploration and play An increase in predatory and foraging behavior (moving about to look for “prey”; stalking, killing, and consuming of “prey”	Maintain exhibit with a variety of substrates, dirt, leaves, mulch, woodchips, short, medium and tall grass Exhibit modification, placement of large logs High platforms can be build by wooden logs, provide them with high vantage points.	Can become a permanent exhibit feature and adjusted based on conclusions. This can be a permanent exhibit feature, as the Snow leopard love to sit on high points and make a survillence.

2.	Dietary enrichment	Variable feed items Different forms of feed presentation and randomization of feeding times.. Live animal feeding Mix of whole versus processed or chopped feeds.	An increase in predatory and foraging behavior and promote prey location instinct.	Regular meat are tied with a rope and hanged at different heights Regular meat is placed in some other places than their normal feeding cells in late evening	At least a two week interval for this activity to avoid habitualizatin
3.	Social enrichment	Compatible individuals left in the enclosure.	Social opportunities i.e. species appropriate groups	Individual of opposite sex kept for Socialization.	Successful mating, enhanced behavioural activities.

RESULTS:

Name of Animal	CONTROL						TEST					
	ACTIVE (IN %)		PASSIVE (IN %)		STEREOTYPE (IN %)		ACTIVE (IN %)		PASSIVE (IN %)		STEREOTYPE (IN %)	
	M	A	M	A	M	A	M	A	M	A	A	A
Tyson	17.33	14	34	22.12	8.5	9.6	18	20	11	18	4.3	3.6
Teesta	18.16	29	31.83	28.13	12	2.8	19	35	22	25	9	2.1
Karan	24.7	22.5	7.7	6.8	28.1	33.9	30.1	25	8.1	9.4	20.1	18.2
Yashmin	25.3	10.6	18.8	26.5	38	13.3	35	18	16	22.6	22	11.5
Ritu	33	29.16	15.94	8.3	15	23.5	34.1	29	14	16	11	15.3
Prabhat	36	23	14.05	11.8	9.9	36.3	40	32	15	18	6.5	20.01

Table 22: Activity budget of different behaviour

M: MORNING

A: AFTERNOON

The percentage of activity pre and post enrichment gives an indication that for behavioural diversity including health the captive environment should always be enriched. The enrichments should be planned according to the behavioural needs of the animal and it should always be aimed towards reducing the stereotypic behaviour that captive animals develop in sterile environment .However certain precautions needs to be taken up before using any enrichment of the mentioned enrichments.

1. Animals could get entangled in ropes and hanging apparatus or extremities may be caught.
2. Animal may fall while trying to reach an enrichment place high in the enclosure.
3. Dietary enrichment can lead to tooth decay, obesity, allergic reactions, impactions, diarrhoea, choking or aggression from cage mates.

4. Items or pieces of them may be toxic or hazardous if ingested.
5. Objects if broken can produce sharp edges that can injure animals.
6. Social or mixed spices exhibits can lead to injury or death due to aggression or harassment by cage mates.
7. Plants or parts of plants may be toxic to animals. Prior to offering animals, the leaves should be checked for toxic elements.
8. Enrichment might cause excessive stress to animals.
9. Safe keepers' access for providing enrichment requires a secure safe area.
10. Parasites may be transmitted through enrichment items if not properly cleaned and disinfected.
11. Safety should be a primary consideration when introducing new enrichment, Input from supervisory and veterinary staff is important and animals should always be closely monitored when new items are offered.
12. Horticulturist/ botanists should be consulted regarding browse or plant toxicity.
13. An individual animal response to the same enrichment can be different, careful observation and documentation is necessary.
14. A written assessment of each enrichment event is desirable .This provides a permanent record that can be valuable in reducing future problems, such as the potential for ingestion, entanglement or aggression from or towards cage- mates.
15. In addition, documentation and evaluation of enrichment can lead to additional applications for medication delivery and other methods of improving animal management. One animal may wrestle with an item for extended periods, while another might destroy it immediately and leaves it, and yet another might try to ingest it. Documentation of individual differences will allow keepers to tailor enrichment to maximize benefits (Gupta B.K. et al.2007).

(A)

(B)

(C)

(D)

(E)

(F)

(G)

(H)

(I)

(J)

(K)

(L)

(M)

(N)

(O)

(P)

(Q)

(R)

Fig. 53(A-R): Enrichment techniques implemented at PNHZPark.

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17. TRANSPORTATION:

The conservation Breeding Programme of Snow leopard at Padmaja Naidu Himalayan Zoological Park involves regular exchange of animals, ensuring proper and safe transfer of animals. Earlier various exchange programmes have taken place at the park but the records of transportation (1986-2000)lacks proper scientific specifications like the crate size, amount of feed given to the animal during the journey, behaviour of the animal, distance travelled, veterinary care etc.though the record clearly specifies the successful transportation of all the animals .

In the later phase the Central Zoo Authority and IUCN guidelines for transportation are taken into consideration. Following are the findings that includes the crate size, veterinary care and feeding during transportation.

17.1. Species specific consideration:

- Preferably only one animal should be transported in each crate/container. When more than one animal have to be transported in a crate, it is preferable to have animals from the same enclosure or those that have lived together.
- Male need tobe transported separately in individual crate.

Species	length (cm)	Width (cm)	Height (cm)
Leopard	120	60	90

Table 23: Indicative dimensions of crates for Leopards (CZA guidelines)

Frame: MS angle 40mm ×40mm ×6mm

Sides: 12mm thick waterproof plywood with cover of 3 mm thick iron sheet.

Floor: 19mm thick waterproof ply on MS flat 35mm × 4 mm @ 350 c/c floor, two sides also covered from two sides also covered from inside with 2mm thick iron sheet .Holes on floor 20 mm in diameter .Whole crate should rest on 50 mm × 50mm iron pegs. Two removable trays of depth 25 mm tobe provided below the floor to receive urine and excreta.

Roof: 12mm thick waterproof plywood.

Doors: 12mm diameter MS bar @50mm c/c should be welded with frame and covered with 5mm thick plywood. Bolt and chain system for closing and opening the doors.

17.2. Veterinary Consideration:

A valid health certificate by a qualified veterinary surgeon to the effect that the animal is in a fit condition to travel by a rail, road, inland waterway, sea or air and are not showing any sign of infectious or contagious disease including rabies, shall accompany each consignment and the certificate shall be in the form specified.

During transportation by air:

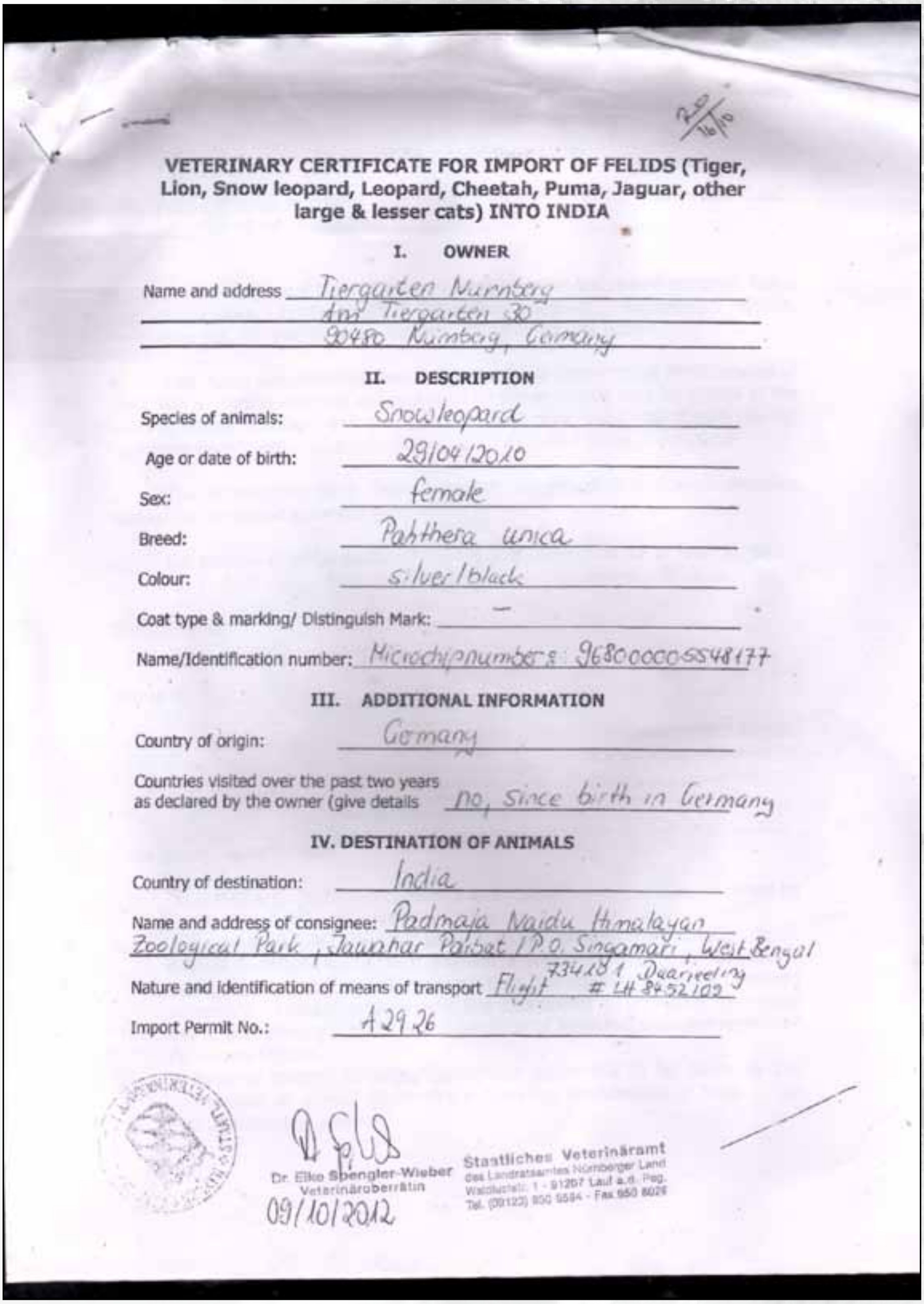
(a) The cages shall be properly cleaned and disinfected before the animals are put in the cages.

(b) Sufficient paddy straw or saw dust or paper cuttings shall be provided in the cages as resting material.

(c) For international transport, the animals shall be kept in pressurized compartment with regulated temperature.

Sanitary information during transport of animal.

The undersigned official veterinarian certifies that the animals described above and examined on the day shows no clinical signs of diseases including Rabies, Feline enteritis, Feline Pan Leucopenia, Leptospirosis, Distemper, Scabies, Aujesky's disease, Toxoplasmosis, Babesiosis, Anaplasmosis, Trypanosomiasis etc.



29/10/10

VETERINARY CERTIFICATE FOR IMPORT OF FELIDS (Tiger, Lion, Snow leopard, Leopard, Cheetah, Puma, Jaguar, other large & lesser cats) INTO INDIA

I. OWNER

Name and address: Tiergarten Nürnberg
Am Tiergarten 30
90480 Nürnberg, Germany

II. DESCRIPTION

Species of animals: Snowleopard

Age or date of birth: 29/04/2010

Sex: female

Breed: Panthera unica

Colour: silver/black

Coat type & marking/ Distinguish Mark: –

Name/Identification number: Microchipnumbers: 968000005548177

III. ADDITIONAL INFORMATION

Country of origin: Germany

Countries visited over the past two years as declared by the owner (give details: no, since birth in Germany

IV. DESTINATION OF ANIMALS

Country of destination: India

Name and address of consignee: Padmaja Naidu Himalayan Zoological Park, Jawahar Parbat / P.O. Singamari, West Bengal 734101, Darjeeling

Nature and identification of means of transport: Flight # LH 8452 102

Import Permit No.: A 2926

Dr. Elke Spengler-Wieber
Veterinäroberrätin
09/10/2012

Staatliches Veterinäramt
des Landratsamtes Nürnberger Land
Waldluststr. 1 - 91207 Lauf a.d. Peg.
Tel. (09123) 950 5584 - Fax 950 8026

Fig. 54: Veterinary certificate for the import of Felids in India.

17.3. Transportation of Female Snow leopard from Nurnberg Zoo, Germany to Padmaja Nadu Himalayan Zoological Park,

A case study of Transportation of Female Snow leopard from Nurnberg Zoo, Germany to Padmaja Nadu Himalayan Zoological Park, Darjeeling ,required permission from CZA , CITES ,DGFT,Dept. of Forest, Govt. of West Bengal & Animal Husbandry Dept.After getting hold of all the permission the animal landed at Kolkata Airport on 10th October 2012 via. Lufthansa flight no. 8452/09.The animal was accompanied with all the relevant records from its previous captive facility.

For the transport of animal from Kolkata the recipient team carried medicine/drugs and tranquilization equipments as listed below which are required for the proper veterinary care in the transportation. List of tranquilization equipments:

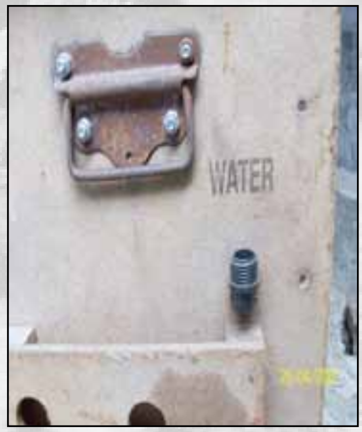
- Pressure gun
- Sirens and dart
- Injection Ketamine batch no.;-110503 expiry :-may 2013
- Injection Xylazine batch no.;-10922 expiry:-September 2013
- Injection Reverzine batch no.;-101043 expiry:-expiry July 2013

Feed and Behaviour: The animal arrived at Kolkata airport at around 7:30 p.m.After that she was given 3 kg dressed chicken and ORS water. The animal was observed to be in a good health. She was alert and responsive. She was not showing any type of stereotypic behaviour. Throughout the journey the animal was given ORS water. After 24 hours of long road journey the animal arrived PNHZPark at around 7:30 to 8:00 p.m. The animal was provided 1.5 kg chicken with ORS water. The animal was kept for about a month in a zoo hospital for quarantine. Body weight of the animal was 30 kg.

Fig. 55 (A-H):Transport box that was used to transport one of the Snow Leopard from Nurnberg Zoo Germany to PNHZPark, Darjeeling on 2012 as part of the Exchange program.

(A)

(B)



(C)

(D)

(E)

(F)

(G)

(H)

Weight of crate: 62.260 kgs.

length (cm)	Width (cm)	Height (cm)
180	51	76

Table 24: Crate size used during the transportation of female Snow leopard "Kim" at PNHZPark.

17.4. Quarantine Requirements

Proper quarantine of newly arrived animals is an essential part of a preventative medicine program. Although the animal may have been considered free of transmissible diseases at the previous facility, it may have been exposed during transport. Alternatively if a disease is slowly progressive (such as tuberculosis) or subclinical (such as the early stages of many parasitic diseases), the facility shipping the animals may not realize a health problem exists (Ed. Kleiman et al, 1996)

Ideally, new animals should be housed in separate quarters from those of the resident animals for a predetermined length of time. While this length of time depends on several factors, the usual length is for 30 days for transport within state, 45 days for transport interstate and up to 6 months for transport between countries. The new animals should be cared for by keepers who have no contact with the resident animals. And the air and waste disposal systems should be isolated from resident animal systems. However these stringent requirements are not always feasible. In that case close physical contact should be prevented between the animals, such as an empty den between the new tiger and the resident group. Cleaning and feeding of the new animal should be done after the resident group's to avoid carrying material back and forth, and with separate tools assigned for use only with the new animal. A disinfectant footbath, in conjunction with coveralls and rubber boots will also minimize transfer through dust and manure (Ed. Kleiman et al, 1996).

It should also be noted that quarantine may not be the best time for vaccinations. This is because the efficacy of a vaccine depends on the animal's immune competence. The most beneficial response to the vaccine develops in a healthy animal under minimal stress. Transport to a new facility and the subsequent period can be stressful; therefore, necessary vaccines should be administered at least weeks before shipment, or two to four weeks after quarantine (Ed. Kleiman et al, 1996).

At PNHZPark the Female Snow leopard "Kim" brought from Nurnberg Germany was quarantined for a period of 30 days at the Zoo hospital during which the animal's full physical examination at the beginning of the quarantine period was done that included –weighing, taking blood for hematological and biochemical examination, parasitological test and appropriate serological test. No important pathogen or parasite found during regular examination in its quarantine phase. After the completion of the quarantine a full physical examination was finally carried out and the animal was transferred to the display area.

REFERENCE:

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18. POPULATION MANAGEMENT AND GENETIC PROFILING OF SNOW LEOPARD (*Uncia uncia*) IN CAPTIVITY

Endangered species usually have small and/or declining populations; the effect of small population size is a major concern in conservation breeding. Populations in captivity may deteriorate due to loss of genetic diversity, inbreeding depression, genetic adaptations to captivity and accumulation of deleterious alleles. These factors could seriously jeopardize the successfulness of ex situ conservation and need to be investigated thoroughly in order to optimize conservation breeding program. The ultimate goal of ex situ conservation is to provide support for the survival of species in the natural environment (e.g. Wheater et al., 1993) **Moreover every ex-situ breeding programme is to manage the captive population in such a way that after 100 years, there will be a viable population of the species with a minimum of 90% of the original genetic diversity retained.**

The World Zoo and Aquarium Conservation Strategy developed by the World Association of Zoos and Aquariums (WAZA 2005) recognizes the need of population management and calls for increased attention and implementation of animal management at the population level and the need to establish truly viable populations. This is both a biological and organizational challenge.

The aim of the present chapter is to review genetic aspects of ex situ conservation and to discuss how populations should be managed in captivity for a successful reintroduction. The success of any captive programme depends largely on the genetic and demographic health of the population

18.1. OBJECTIVE OF POPULATION MANAGEMENT:

- The purpose of population management is to ensure that populations of species of our choosing are available, healthy and viable for the foreseeable future. Thus, the contribution of zoos to exsitu conservation via captive breeding programs requires prudent population management planning.
- The overall demographic goal for captive populations is, as rapidly as possible, to increase the population to a sufficient size to avoid extinction due to accidental or chance events, and then to maintain that population with an age and sex structure that promotes reliable reproduction when needed (and possible surplus reproduction for a reintroduction programme). The demographic challenges here are to maintain stable populations that neither overshoot the capacity available nor leave zoos with empty exhibits.
- The genetic goal for these populations is to retain the founders' genetic diversity, as unchanged as possible over time, so that the population can serve as a genetic reservoir for the species (from which genetic diversity may be reintroduced back into the wild). Achieving this goal means confronting the challenges of loss of genetic diversity, inbreeding and inbreeding depression and adaptation to captivity (Frankham et al. 2002; Bryant and Reed 1999). Management strategies attempt, as much as possible, to retain every aspect of the genetic diversity of the founders over time: essentially stopping evolution in the captive population. There are organizational challenges involved in managing groups of individual zoo collections as cross-institutional biological populations. The international zoo community has responded to this additional responsibility by forming regional zoo associations and programmes to organize and coordinate cooperative population management efforts,

18.2. THE VALUE OF POPULATION MANAGEMENT

Managing captive populations is time consuming (maintaining the data, making recommendations), costly (shipping animals), and sometimes risky (disease transfer between institutions, stress on animals). However, its benefits are clear. These include:

- **Increasing value to conservation**

Intensive management can help populations to retain the genetic characteristics of wild counterparts. This increases their value as genetic reservoirs for use in reintroduction, should this be needed.

- **Improving animal welfare**

Population management attempts to avoid production of inbred animals, as inbred animals often suffer from a vast assortment of ailments. These include: reduced longevity, inanition (failure to thrive), metabolic diseases, morphological deformities, abnormal birth weights and growth, organ (eye, brain, spleen, adrenal gland, thyroid) malformations, impaired reproductive traits, modified temperament, immune diseases, reduced temperature tolerances, and increased susceptibility to stress (Wright 1977; Frankham et al. 2002)

- **Verifying taxonomic origin**

Because captive breeding plans require effort in ensuring accurate studbook data, working within a population management plan increases the chances that zoos actually receive what they ask for.

- **Managing zoo space efficiently**

Population management is not only for species that we want to maintain over the long term, but also can be used to control populations of common species that compete for space with more endangered species.

- **Reducing collection from the wild and shipping costs**

Programmes are designed to reduce the frequency and distance of shipping and/or to reduce the rate of wild collection. This saves time and costs of collecting trips, permit applications and International transaction arrangements.

SMALL FOUNDER POPULATION:

Population derived from small number of founders typically have lower genetic variation because of genetic drift (Frankel and Soule 1981; Williams et al .2002;De Young et al. 2003;Wilson et al.2005) and many existing population of endangered species may genetically compromised . Increased homozygosity in small population results in greater exposure of deleterious recessive alleles and reduced reproduction and survival (increased depression)(Keller and Waller 2002). The effect of inbreeding depression on population viability are exacerbate by stressful environmental condition (Armbruster and Reed 2005) and it is expected that the loss of genetic diversity will reduce species' capacity to adopt to future climate change (Rice and Emery 2003)

Of the many variables that affect the structure of a pedigree , the number of founders is particularly important, when the number of founders are small ,inbreeding occurs early in the breeding programmes ,often between half siblings (F=0.125 ,where "F" is the inbreeding coefficient) subsequent births will cluster at a level of inbreeding higher than the first generation of the inbred births. When there are more founders, there are more opportunities for non inbred births and inbreeding can be avoided for longer. In addition, the first inbred births in pedigree with many founders are generally less inbred than the first inbred births of pedigree with few founders.

Offspring born to closely related parents commonly show reduced fitness (Crnokrak and Roff 1999;Ralls et al.1979;Saccheri et al. 1996)This phenomenon has long been recognized to as **Inbreeding Depression** and is thought tobe one of the primary selective forces opposing the build-up of deleterious recessive mutation (Lynch 1993)

18.3. DATA FOR POPULATION MANAGEMENT

The most important task in the development of a captive breeding plan is compiling the basic data required for population analysis and management. Data already may have been compiled in variety of different forms if a captive population exists or has existed in the past. The best source of compiled data is a studbook, which is a chronology of a captive population listing vital information on animal identities, sex, parentage, and birth and death dates, as well as information on animal movements between institutions (Shoemaker and Flesness 1996; Glatston 1986). Studbooks serve as excellent data sources because studbook keepers validate and edit data to enhance quality. Currently there are over 1150 regional and 145 international studbooks (ISIS 2007), most of which are available as computerized databases on the ISIS/WAZA Studbook Library CD-ROM distributed annually (ISIS/WAZA 2004). If a studbook does not exist or is out of date, one must be compiled from original sources. Historical and current data should be collected from all institutions that have had or currently have individuals of interest. Historical data are critical for determining the relationships between living animals and estimating important population parameters.

POTENTIAL SOURCES OF DATA ARE:

- International Species Information System (ISIS). ISIS is a computerized database containing information on animal identities, birth and death dates, genealogies, and movements (Flesness 2003; ISIS 2007). ISIS collects data from over 700 institutions from 70+ countries worldwide and is the best starting point for compiling population data if no studbook is available. ISIS is currently developing a single web-based global Zoological Information Management System (ZIMS 2007; ISIS 2007; Cohn 2006). This will provide, for the first time, a single unbroken record of an animal's significant events throughout its life. ZIMS will be replacing the current ISIS animal record keeping software currently being used by most zoos worldwide (ARKS, SPARKS, MedARKS).
- **In-House Institutional Records :** In-house inventory records are the primary source of data. Once institutions that have had or currently have specimens of interest are

identified, they can be contacted for information on the history, status, and details of their collection.

The basic data required for each animal for population analysis and management is:

- species (scientific and common name)
- specimen ID number assigned by your institution
- sex of the specimen
- date of birth or estimated age, birth type (i.e., wild, captive, unknown), and place of birth or wild
- capture
- parentage, if captive bred
- Previous locations and ID numbers, if any. For other than established institutions, the record should include complete names and addresses.
- all transactions (with dates and names of other parties) which involve the specimen, including information at past locations if known
- tag, band, tattoo, and transponder numbers, their locations and dates of application, and identifying marks or physical features
- permits relating to the specimen
- studbook number(s), if registered (Interanation/National)
- the date and cause of death, if the specimen is dead
- as much other information as is possible and practical.

Accession Log / Ledger)

This is a listing of accession numbers and the specimens to which they were assigned. This log (preferably a large, difficult-to-misplace, bound ledger) includes AT LEAST the following:

- The sequential listing of accession numbers,
- The species of animal that each number was assigned to,
- The transaction date, and
- The transaction type. It may also contain a daily journal detailing the day-to-day account of specimen transactions by recording the basic facts about collection activities occurring at the institution.

Inventory (Census) records

Each institution should generate annually some type of inventory of the species in its collection. Regardless of the format, an inventory answers the question "How many?" for each species in collection on a specific date. Minimum information for an inventory includes:

- The number of individuals of each species on the start date.
- The number of births/hatches for each species during the report period.
- The number added by other means (non-birth acquisitions) for each species during the report period.
- The number of deaths for each species during the report period.
- The number removed by other means (dispositions) for each species during the report period.
- The number of individuals of each species on the end date.

Other Types of Records

- loan agreements - the documents detailing terms and conditions of breeding, exhibit, or study loans.
- animal transaction papers - any of a variety of documents associated with transfers, usually filed alphabetically by institution (other party).
- permits - permit applications, permits issued, letters of authorization, etc. This file includes all permits (or copies thereof) issued to the institution; copies of permits specific to individual specimens are also placed in that specimen's file.
- "animals removed" (inactive files, archives) - the complete record files of animals which are no longer part of the collection. These files are stored safely, yet may be referenced easily. It should be noted that no records are discarded when an animal leaves the collection. These records become historic files which can be referenced should the need arise. Although the living animal is no longer at hand, the history of that animal still retains value.

Standandarized Central Zoo Authority's Formats for Record Keeping in Ex-situ facilities.

INEVETORY REPORT

Animals Listed Under SCH-I & SCH-II Wildlife (Protection) Act

Name of the Zoo……………………….

Sl.No	Species	Stock as on 01. 04. ___ M : F : U : T	During the year				Stock as on 31.03___ M : F : U : T
			Birth M : F : U	Acquisition M : F : U	Disposal M : F : U	Death M : F : U	
	Birds						
1							
2							
	Total Birds						
	Mammals						
1							
2							
	Total Mammals						
	Reptiles						
1							
2							
	Total Reptiles						
	Total Animals						

KEEPER'S DIARY

_____________Zoological Park

Keeper's Diary

Name of the Zoo Keeper__________

Section/Beat _________

S. No.	Enclosure	Species /Individual /Sex	Observation

Signature of Keeper

Signature of Supervisor

DAILY REPORT

____________Zoological Park

Daily Report

Day & Date _____/_____

S.No	Section /Beat /Enclosure	Species / Individual	Observations	Action Taken /Required

In charge animal section **Biologist** **Veterinary officer** **Director**

SUMMARY OF DEATH REPORT FOR THE YEAR _____

____________Zoological Park

Sl.No.	Name of species	Sex	Date of death	Cause of death
	Birds			
1.				
2.				
	Mammals			
1.				
2.				
	Reptiles			

1.				
2.				

Signature of Veterinary Officer

CAPTIVE BREEDING AND REINTRODUCTION PROGRAM

The original wild population may have declined for any number of reasons - habitat loss, competition with invasive species, disease, etc. Some or all of the few remaining wild-born individuals may be captured to establish the captive breeding program in the founding phase. If these founders are the last remaining individuals of the species, they represent the total genetic future of their species (e.g., blackfooted ferrets). Unfortunately, captive breeding programmes are often initiated with few founders, compromising the genetic health of the programme from the start. Basic husbandry knowledge may be lacking, so the population initially remains small, further compromising the genetic health of the population. Lack of reproduction may even cause the population to go extinct (e.g., i'iwi, apapane, and omau). As knowledge is gained, reproduction becomes more reliable, generating the population's growth phase. Population managers will set a target size for the population based on resources available, the genetic and demographic status of the population and the captive breeding needs of similar species competing for limited captive resources. The population will be maintained during the management phase at zero population growth to establish a stable population. And for certain populations, reintroduction of individuals back into the wild may be an option

19. HISTORICAL OVERVIEW OF SNOW LEOPARD IN CAPTIVITY

Snow leopards, *Uncia uncia,* have been kept under human care since 1851 when the first specimen was exhibited in Antwerp Zoo *(Sunquist & Sunquist 2002).* In those days snow leopards were kept as display animals only and although the first cubs were born as early as in 1910 *(Blomqvist 1998)*, there was only little emphasis on their breeding. Proper records for captive populations did not become common until the 1950s, and it took almost thirty more years before the need for self-sustaining populations and management above the level of a single institution was commonly recognized. The species has been the subject of intensive focus since 1976 when snow leopards were provided with an international studbook *(Blomqvist 1978).*

"Studbooks are primarily a compilation and source of genealogical data of individual animals which make up a particular zoo population. Studbooks can, however, also assist with recommendations on which animals should breed, with whom, how often and where.''

The most notable aspect of the breeding programmes is that although they work on a regional basis, the entire captive population is considered as a "metapopulation" where the global studbook co-ordinates all animals involved in the continental programmes recently also in India. The first regional breeding program for snow leopards was thus launched in North America in 1984 *(Wharton & Freeman 1988, Wharton & Mainka 1997),* to be followed by an EEP three years later. In the 1990s, breeding programs have also been established in Japan, Russia Australia and recently also in India.

19.1. CURRENT *EX SITU* STATUS:

The International Studbook for Snow leopard has been kept by Helsinki Zoo since 1976.At the beginning of 2008, 205 institutions outside China exhibited 445 (206.239) snow leopards. The stock has, however, been larger than the current population and in 1993, when the peak was reached, the captive stock comprised 588 animals. To avoid a future uncontrolled population expansion, breeding restrictions were recommended for the two main captive populations, the SSP (Species survival Plan) and EEP.The restrictions proved effective and the population started to decrease. In 2004, the stock dropped below 500 individuals for the first time in 15 years. Although attempts have been made during the last years to increase the breeding potential, the global population has continued to fall. While the population grew with an annual rate of 8% in 1983-1993 *(Blomqvist 2003)*, the lambda value had turned negative in 2000-2007 reaching a value < 1.0. The population expansion, breeding restrictions were recommended for the two main captive populations, the SSP and EEP. has therefore decreased with an annual rate of 4.5% in 2000-2007.The decline has mainly been caused by a reduced number of litters produced per year. While an average of 30 cubs were born each year in the 1970s, their amount doubled in the 1980s, to culminate in the 1990s when a mean of 79 cubs were born each year. During the last seven years, the number of annually bred cubs has ranged from 35 to 71 with a mean of 55 cubs/year. The current population is aging and at the same time, the number of deaths has exceeded the number of cubs born during the past seven years.

Table 25: SNOW LEOPARD STUDBOOK DATA AS ON 1.01.1993.

	MALES	FEMALES	UNKNOWN	TOTAL
Total registered	815	786	98	1699
Total wild caught	148	146	11	305
Total captive bred	667	640	87	1394
Alive as on 01.01.1993	297	293	0	590
Wild origin	4	5	0	9
Captive bred origin	293	288	0	581
Breeding animals				
Total number that have bred	212	233	0	445
Wild born that have bred	48	51	0	99
Captive born that have bred	164	182	0	346
Total breeding animals alive	127	133	0	260
Wild born	4	4	0	8
Captive born	123	129	0	252

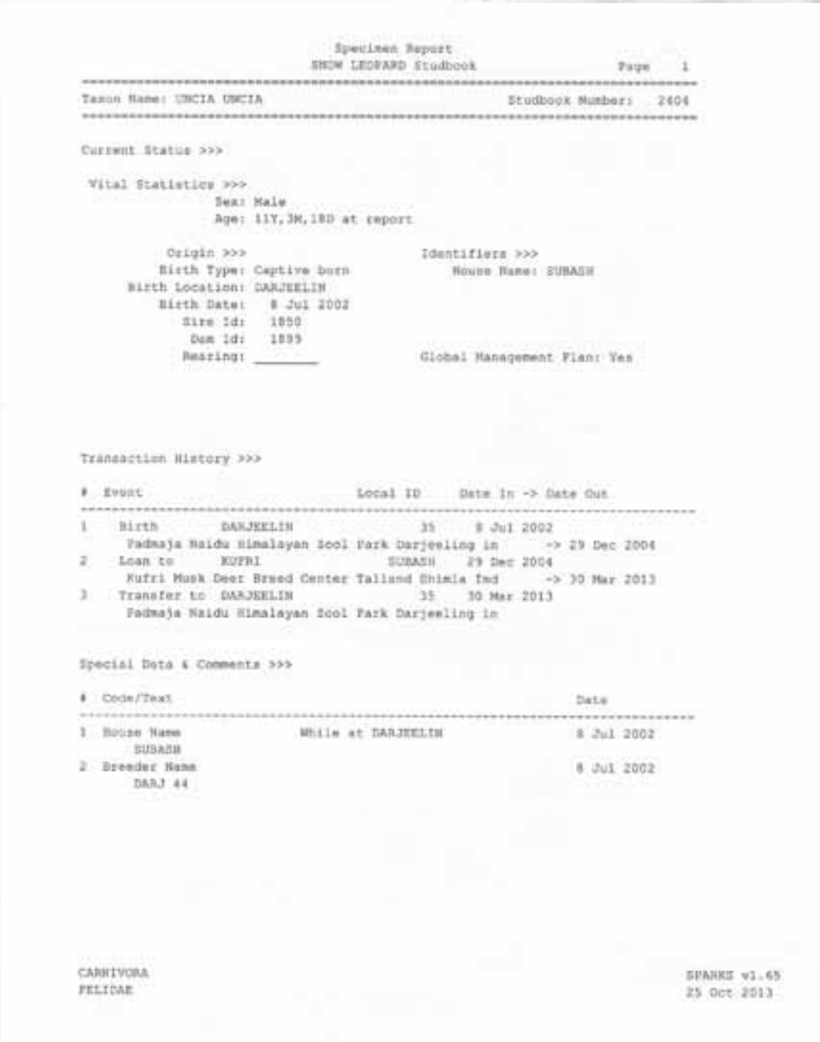
TABLE 26: SNOW LEOPARD STUDBOOK DATA AS ON 1.01.2008.

Total animals registered	1230	1256	217	**2703**
Wild-caught	157	153	11	**321**
Captive-bred	1073	1103	206	**2382**
Total alive 1.1.2008	206	239	0	**445**
Wild-caught	3	2	0	**5**
Captive-bred	203	237	0	**440**
Breeding animals				
Total number that have bred	363	399	0	**763**
Wild-caught that have bred	51	56	0	**107**
Captive-born that have bred	312	344	0	**656**
Total breeding animals alive 1.1.2008	89	105	0	**194**
Wild-caught	1	2	0	**3**
Captive-bred	89	104	0	**193**

Post-reproductive animals:	
Females were considered post-reproductive at:	**>15-16 years according to International Pedigree Book for Snow Leopards 2003**
Males were considered post-reproductive at:	**>17-18 years according to International Pedigree Book for Snow Leopards 2003**

A critical statistic in the management of captive population is the number of founders. Demographic data indicate that female snow leopards in North America zoos have bred from 2 to 15 years of age and males have been shown to breed between the ages of 2 and 19.

The International Studbook volume 9 published in the year 2008 indicates a total of 239 females in the Global conservation Breeding programme of Snow Leopard .As the above data indicates the breeding age of females,further analysis requires to know the age of the females that can be considered in the breeding programme which shall leave an option for not only increasing the number of cubs and increasing the genetic variability but also for future exchange programmes for Padmaja Naidu Himalayan Zoological Park to maintain the current and future captive stock as there has been very few exchange programmes since the initiation of the project thus limiting breeding and also decreasing the possibility of having potential individuals for the programme.



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                         Specimen Report
                      SNOW LEOPARD Studbook                 Page    1
=====================================================================
Taxon Name: UNCIA UNCIA                        Studbook Number:   2404
=====================================================================

Current Status >>>

 Vital Statistics >>>
                 Sex: Male
                 Age: 11Y,3M,18D at report

         Origin >>>                    Identifiers >>>
        Birth Type: Captive born          House Name: SUBASH
    Birth Location: DARJEELIN
        Birth Date:   8 Jul 2002
           Sire Id:   1850
            Dam Id:   1855
           Rearing: ________           Global Management Plan: Yes


Transaction History >>>

#  Event                          Local ID    Date In -> Date Out
---------------------------------------------------------------------
1   Birth        DARJEELIN           35      8 Jul 2002
     Padmaja Naidu Himalayan Zool Park Darjeeling in      -> 29 Dec 2004
2   Loan to      KUFRI            SUBASH    29 Dec 2004
     Kufri Musk Deer Breed Center Tallend Shimla Ind      -> 30 Mar 2013
3   Transfer to  DARJEELIN           35     30 Mar 2013
     Padmaja Naidu Himalayan Zool Park Darjeeling in

Special Data & Comments >>>

#  Code/Text                                              Date
---------------------------------------------------------------------
1  House Name               While at DARJEELIN          8 Jul 2002
      SUBASH
2  Breeder Name                                         8 Jul 2002
      DARJ 44


CARNIVORA                                                  SPARKS v1.65
FELIDAE                                                    25 Oct 2013
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Fig. 56a: Studbook maintained at PNHZPark

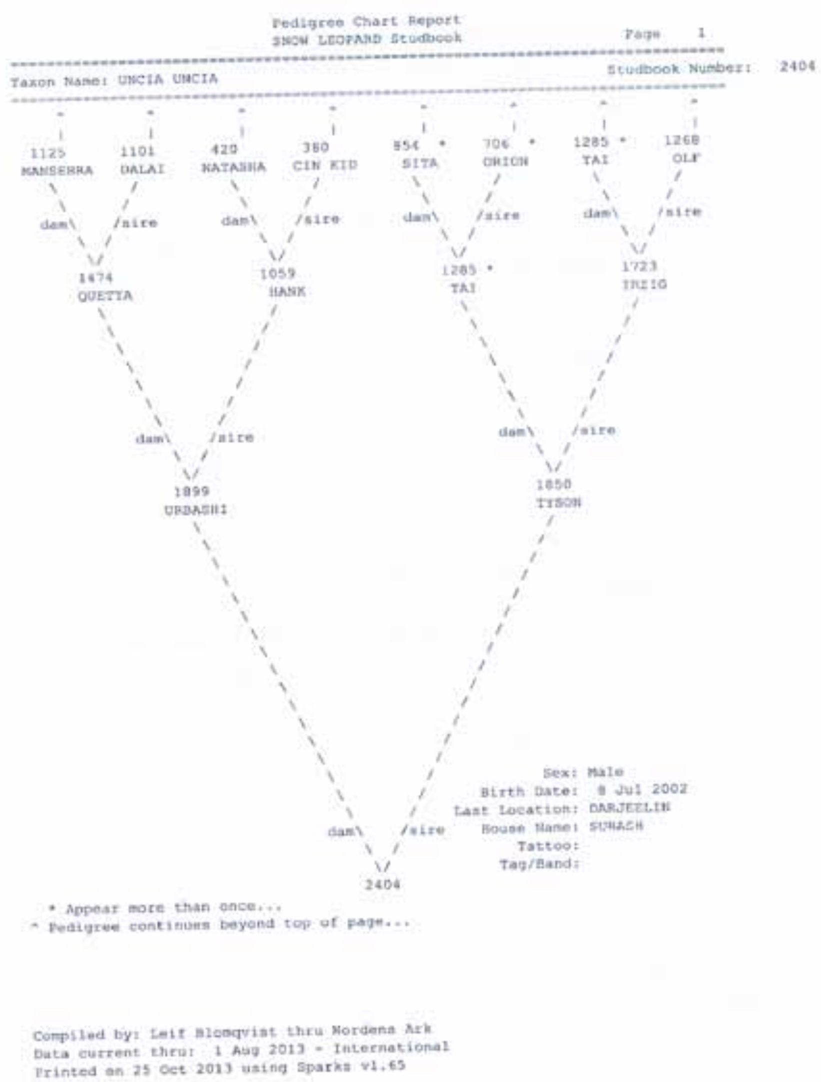

Fig. 56b: Pedigree chart maintained at PNHZPark.

19.1.1. Regional studbook

A series of discussions were held on the issue of compilation of studbooks for endangered species in India Zoos between the Member secretary, Central Zoo Authority(CZA) and the Director .Wildlife Institute of India ,the nodal officer and the Research Associate ,Captive Breeding and Zoo Management Cell for deciding on the modalities of the project and species to be included in the studbook programme.A proposal in this regard was submitted to the CZA for the financial approval on 29th September 2006,vide letter no.WII/Stud 06/CBZM-49 of this office. A MoU was signed between Wildlife Institute of India ,

Dehradun and the Central Zoo Authority ,New Delhi on 29th September 2006 regarding the update of studbooks for fourteen Endangered species(Red Panda,Snowleopard,Tibetan wolf, clouded leopard, Hoolock Gibbon, one horned Rhinoceros, Indian Bison, Wild dog, India Wild ass,Grey peacock pheasant, Asiatic lion, Nilgiri langurs,Lion tailed macaque and Royal Bengal Tiger)

19.1.2. Scope of the Studbook

The present studbook of snow leopard has been compiled for the Indian region and the data used is current till June 30th 2009. The data has been provided by four zoos(Himalayan Zoological Park, Gangtok; Pandit Govind Ballabh Pant High altitude Zoo,Nainital; Himalayan Nature Park,Kufri; Padmaja Naidu Himalayan Zoological Park, Darjeeling.)

19.1.3. Methods Used

The data collected for the compilation of the studbook was by through mailed Questionaire surveys. The data collected was entered in SPARKS 1.5. and studbook Report was generated using the reports option. The SPARKS software was used to create ~.prn and ~.ped files for demographic and genetic analyses by PM2000. PM 2000 was used to produce the census report, life tables and population projections, as well as founder statistics, inbreeding coefficients, possible pairings and population planning.

Specimen details								**Transaction history**			**Results of genetic molecular analysis (attach separate sheet if require)**	**Rescued / Wild origin animals Date and place of capture**	**Released animals Date and site of release**
Name Zoo Studbook No. National Studbook No. Intl Studbook No. Transponder/Tag No./ Any other unique identification marks	**Sex**	**Date of Birth**	**Place of Birth**	**Date of entry in zoo**	**Date / cause of death**	**Sire Name Zoo Studbook No. National Studbook No. Intl Studbook No. Transponder/ Tag No./ Any other unique identification marks**	**Dam Name Zoo Studbook No. National Studbook No. Intl Studbook No. Transponder/ Tag No./ Any other unique identification marks**	**Zoo name**	**Date of entry**	**Date of exit**			

Table 27: Porfoma for Pedigree analysis for Endangered Species(Wildlife Institute of India)

The stock details of the Snow Leopard are annually send to Wildlife Institute of India. The institute have come up with the analysis in a joint publication with Central Zoo Authority book entitled "Development and maintenance of Studbooks of Selected Indian Faunal Types in India Zoos" final report January 2012 where the detailed analysis of the captive stock from four Indian Zoos have been assessed in terms of current population size, current effective size, ration of Ne/N,current gene diversity, maximum allowable population size, population size needed to meet goals, year to start adding founders, year to stop adding founders, year between addition events etc.thus providing demographic and genetic analysis including population planning and recommendations.

19.1.4. DEMOGRAPHIC ANALYSIS:

On the basis of study carried out by Wildlife Institute of India on "Development and maintenance of Studbook of selected endangered faunal types in Indian zoos" the captive Snow Leopard population has only one founder of wild origin which has contributed to the population and has seven descendents. Thus, the genetic diversity retained by the present population is 0.428 while the genetic variability of the population (GV)is 0.4270 and the founder genome equivalent (fge)is 0.88. Though, the mean kinship coefficient for the Snow Leopard captive population is very high at 0.5535 yet its breeding coefficient is zero.

19.1.5. POPULATION PLANNING AND RECOMMENDATION:

It is suggested that new founders be added to the captive population and the population size be increase to at least 100 individuals with equal sex ratio in the period of next 10 years.

The population projection for both actual and modeled population suggest that the goal of maintaining at least 100 genetically viable and demographically stable individuals in captivity in

India cannot be achieved without the addition of fresh founders and utilizing the reproductive potential of the captive population to the maximum.

Other variables:
Current Population size : 21.0000
Current effective size :42.0000
Ratio of Ne/N :2.0000
Current gene diversity :0.4286
Maximum allowable population size:100.0000
Population Size needed to meet goals:100.0000
Year to start adding founders :1.0000
Year to stop adding founders :25.0000
Years between addition events :2.0000
FGE Recruited per new founder :0.4000

Goal settings
New founders per addition events :2
Program Objectives
90% gene diversity at the end of 50 years

POPULATION MANAGEMENT OF SNOW LEOPARD IN INDIAN ZOOS

Table 28: Current captive population of Snow leopard (July 2013)

Zoo name	Male	Female	Unsexed	Total
Himalayan Zoological Park, Gangtok	0	1	0	1
Pandit Govind Ballabh Pant High altitude	0	0	0	0

Zoo, Nainital;				
Himalayan Nature Park, Kufri;	0	0	0	0
Padmaja Naidu Himalayan Zoological Park, Darjeeling	5	5	0	10
Total	5	6	0	11

Table 29: Details of ex-situ Status of Snow leopard (*Uncia uncia*) in India

SL.no.	Name	Stud #	Birth Date	Sex	Sire	Dam	Location	Local ID	Breeder #	Transponder
1.	KARAN	1897	23RD October 1995	M	1059	1474	DARJEELING	15	DARJ 15	981098102057256
2.	TISTA	2399	29TH March 2002	F	1897	2228	DARJEELING	40	DARJ 40	00-0611-4DB1
3.	BUDHA	2401	19TH June 2002	M	1850	1797	DARJEELING	37	DARJ 37	00-061-FA9B
4.	PRABHAT	2405	8TH July 2002	M	1850	1899	DARJEELING	36	DARJ 36	00-0618-24E0
5.	RITHU	2538	11TH March 2004	F	1897	2228	DARJEELING	43	DARJ 43	981098102056547
6.	YASMIN	2540	25TH May 2004	F	1850	1797	DARJEELING	45	DARJ 45	00-00F6-8A38
7.	RARE	2994	19TH June 2012	F	2405	2538	DARJEELING	_	_	_
8.	KIM	2846	29TH May 2012	F	2566	2430	NURNBERG DARJEELING	–	–	968000005548177
9.	SUBASH	2404	8TH	M	1850	1899	DARJEELING		DARJ	00-0617-C8C5

			JULY 2002				KUFRI 29.12.2004 DARJEELING		44	
10.	ZIMA	2861	6th MAY 2010	F	2469	2274	LEPZIG,LOD Z 06.10.2013DA RJEELING	-	-	9680000055428 46
11.	LAVANI	2862	6th MAY 2010	F	2469	2274	LEPZIG,LOD Z 06.10.2013DA RJEELING	-	-	9680000055452 93

Table 30: Founder stock of Snow leopard at PNHZPark (1986-2012)

Sl. No.	Name of animal	Sex	International stud book no.	National stud book no.	Obtained from
1.	Kashi	F	1005	_	Zurich
2.	Vishna	M	620	_	Helsinki
3.	Persia	F	697	_	Toledo Zoo
4.	Hank	M	1059	_	Litterock
5.	Quizil	M	1472	_	Zurich
6. \	Quilla	F	1473	_	Zurich
7.	Quetta	F	1474	_	Zurich
8.	Tyson	M	1850		Hunbstrnd,Sweden
9.	Neeta	F	2228		Leh
10.	Meeta	F	_	_	Srinagar

An attempt has been made to analyze the founder statistics of captive stock of snow leopard population in India that has only one founder of wild origin which have contributed to the captive population. One additional wild caught founder (Female "Meeta" 2227)who was included in the programme died without making any contribution. The Wild caught founder (2228) Female Snow leopard has produced nine offspring of which eight died.(Blomqvist, 2008)

A total of forty six snow leopard births have been recorded in the Park. The table below depicts the birth at an interval of every five years and their survivality.

Table 31: Birth rate and survivality in every five year

YEAR	SEX RATION/TOTAL BIRTH						
	M	F	U	TOTAL	M	F	TOTAL SURVAVILITY
1086-1991	0	2	2	4	0	0	0
1992-1996	6	3	1	10	1	2	3
1997-2001	8	5	0	13	1	2	3
2002-2006	11	7	1	19	5	4	9
2007-2013	6	4	0	10	0	1	1
TOTAL	31	21	4	56	7	9	16

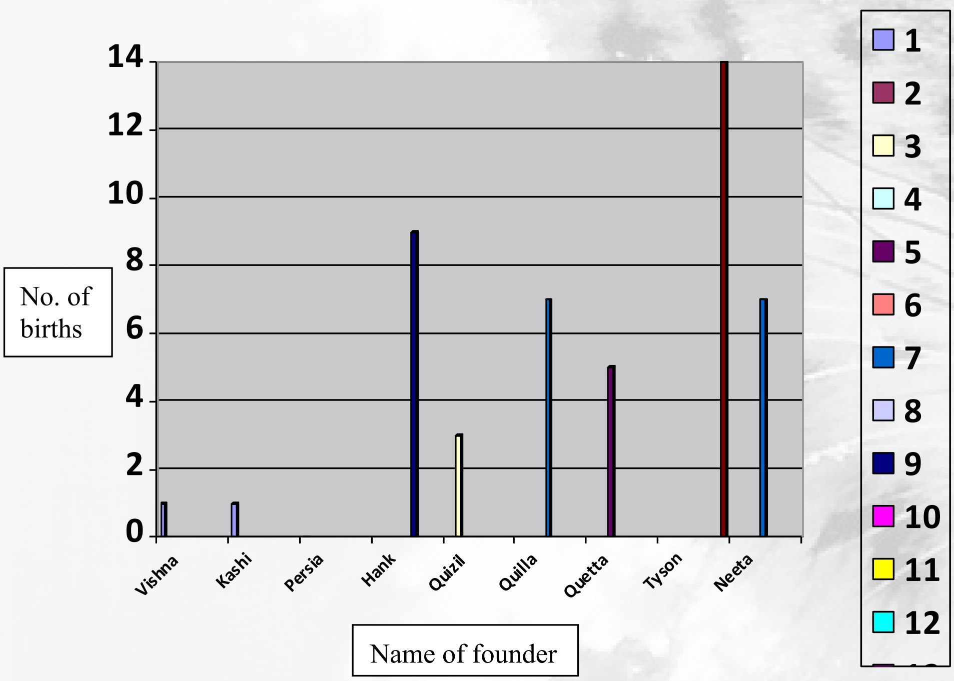

Fig. 57: The above graphical representation shows the over representation of the same individual for breeding.

In 2003 the Park had a total population of 18 individuals (9:9). Six individuals (3:3)were transferred to three high altitude zoos in India to start with a similar breeding programme.
In between 2004 to 2013 three individuals died with one cub survival that skewed the options for breeding leaving the captive stock with ten individuals and with limited breeding pairs. The analysis done so far regarding the population management of Snow leopard in the facility and worldwide comes up with the following recommendations.

In order to maintain the genetic variability and to provide with larger breeding options animal exchange should be made regularly after prior checking up with the International Studbook keeper Individuals >16 years should not be considered for the breeding programme.

Newer breeding facilities should come up as the breeding area will be unnecessarily occupied by the older individuals.

Demographic and genetic analysis is mandatory for the captive stock for managemental interventions.

With the park receiving 1:3 individuals from different captive facilities that shall provide larger options in choosing the pairs. Hence for the next few years the breeding pairs can be recommended as follows:

Sire	Dam
Prabhat	Ritu
Prabhat	Teesta
Budh	Ritu
Budh	Teesta
Karan	Yashmin
Subash	Ritu
Subash	Teesta
Karan	Malaika
Prabhat	Kim
Budh	Kim
Karan	Kim
Subash	Kim

The male “X” arriving from Zhilava zoo and the Females”X1” “X2” from Lodz Zoo, Germany shall further widen the breeding options. The population management thereafter will depend on the cub survivality and further exchange programmes ensuring a genetically and demographically healthy captive stock for conservation breeding of Snow leopard.

20. REPORT FOR GENOTYPING OF SNOW LEOPARD SAMPLES

Seven (4:3) Snow leopard blood samples were send from Padmaja Naidu Himalayan Zoological Park, Darjeeling to LaCONES (laboratory for Conservation of Endangered Species) Hyderabad to access the genetic health of the captive Snow Leopards for future involvement in the Conservation of Breeding program of Central Zoo Authority.

Procedure for genotyping (DNA testing) of the samples:

Genomic DNA was extracted from the blood samples of seven (4:3) Snow leopard using Phenol-Chloroform extraction procedures. These DNA samples subjected to PCR amplification using primers for nuclear microsatellite loci. Fluorescent- tagged amplification products were size fractionated and visualized on ABI 3730 DNA sequencer, an allele size was determined using Gene Mapper 3.1 software. The genetic status of the individual was accessed in terms of its being heterozygous /homozygous at each locus.

Results of examination:
Genotypes Allelic distribution of seven (4:3) Snow leopard samples for seven microsatellite loci are given in table 25.The male Prabhat and Female Kim was found to be heterozygous at more number of loci (6 out of 07) as compared to other individuals.

Animal identity		LOCUS													
sl.no.	Animal ID	L1	L1	L2	L2	L3	L3	L4	L4	L5	L5	L6	L6	L7	L7
1.	Tyson (male)	109	113	94	96	94	98	121	123	177	177	107	107	79	79
2.	Prabhat (Male)	109	113	88	96	98	98	121	123	173	177	107	111	79	87
3.	Karan (male)	109	113	88	88	88	98	113	121	173	173	103	111	79	79
4.	Budh (Male)	113	113	88	94	88	98	121	121	173	173	103	107	79	87
5.	Yashmin (Female)	113	113	88	96	94	98	123	123	173	177	103	107	79	79
6.	Teesta (Female)	113	113	88	94	88	98	113	113	173	179	103	107	79	79
7.	Kim (Female)	109	109	88	90	92	94	121	127	173	175	107	111	87	89

Table 32: Microsatellite based genotypes od seven (4:3) Snow leopards.

Conclusion:

On the study the genotypes of the seven (4:3) Snow leopard samples , it is concluded that Snow leopard Prabhat (Male) and Kim(Female) are genetically more vibrant when compared to other samples and may be used for Conservation Breeding.

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SUMMARY

Firstly, a behavioural study of the species was conducted with total of six individuals. The behaviour was observed using Focal and continuous sampling method (Altman 1974)using a standard behavioural observation sheet. An intensive study on the breeding behaviour was studied that included oestrus period. Gestation period, mating, birth, parturition, nursing, feeding, post-partum activities and interaction of mother and cub. Simultaneously methods and ideas were researched, developed and implemented concerning their husbandry in captivity-modifications of the breeding den, provision of CCTV cameras, installation of UV-bulbs, use of dehumidifiers, ventilation for proper aeration and light access by having sky lights on the roof of the night shelters and limited access to the breeding area and regular monitoring on their feeding and behaviour.

Secondly, enrichment programme was undertaken at the park since captive carnivores in the park are known for exhibiting stereotypic, self-destructive, abnormal behaviour, over activity, inactivity and pacing in order to cape with the adequate sterile environment or they could be expressing directed searching behaviour, mate finding, home range patrol or hunting. Loud noise, construction, small quarters being locked inside, expectations of food once a day etc. are some of the factors that contribute stereotypy in carnivores, thus undertaking such enrichment programmes aimed at providing a better quality life, benefits with greater choices, changes and challenges. The enrichment programme was successful to some extent in reducing the stereotypy making the individual well adjusted, curious, active and healthy.

Thirdly, in terms of veterinary aspects, global captive facilities veterinary cases were reviewed which resulted in finding that the commonly occurring diseases of Snow leopard in captivity were Multiple Occular Coloboma, respiratory diseases, cub mortality, skeletal deformities and parasitic load. Parasitic findings were conducted at the park during the study period where the more frequently occurring parasites were *Toxocara sp. and Ascaris sp.*

All the above works conducted and findings will help towards the better management of the species in captivity exhibiting their natural wild behaviour free from any form of diseases and a wider implication on the global conservation breeding programme.

CONCLUSION:

The Snow leopard (*Uncia uncia*) formerly known as Panthera uncia is a carnivore of the high mountains of Central Asia, noted for its rarity as an indicator of the ecological health of high altitude ecosystem. The Snow leopard is classified as an endangered species by the IUCN(International Union for Conservation of Nature and Natural resources),Appendix I of the Convention on International Trade in Endangered species of Flora and Fauna (CITES) and schedule I as per WPA (Indian Wildlife Protection Act)

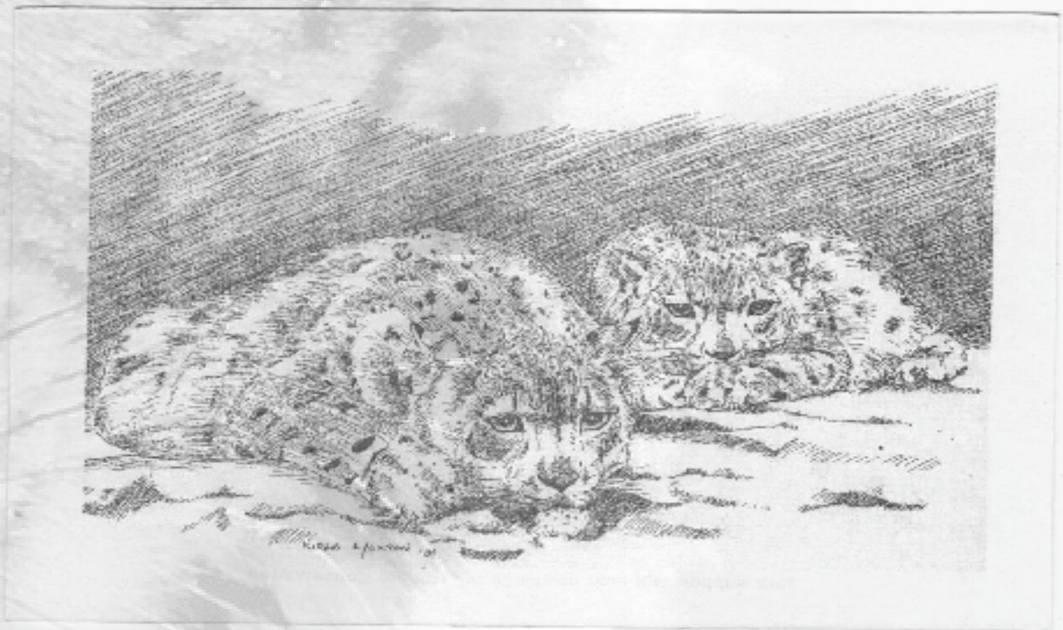
The Snow leopard has been extensively studied in the ranging countries, the study majorly confining to its ecology, habitat, habitat, food habit, estimation ,home range with limited studies on its behavior in the wild perhaps because of its illusive and shy nature. Studying the behavior of the Snow leopards in captivity thus provides a wide array of opportunities essential for not only knowing the species better but also for the best managemental interventions as Snow leopard in captivity is a priority species in the Global Conservation Breeding Programme of Endangered species.

The research titled “Study of Snow leopard (*Uncia uncia)* at PNHZ Park” was initiated at the Park to study the behavior of species in captivity and to draw out and to modify the existing managemental practices according to the behavioural needs of the animal and also to prepare a Conservation Breeding management plan for the species in Indian scenario. The study at the end have formulated protocols for husbandry techniques: cage, enclosure design and sizes, hygiene, environmental enrichment, diet, types, quantity, preferred diet, reproductive biology and post breeding behavior, health and veterinary implications and communication.

SNOW LEOPARD IN ARTS


KIRAN MOKTAN


KIRAN MOKTAN



The photo credit goes to Mr.Kiran Moktan, ex-supervisor of Padmaja Naidu Himalayan Zoological Park, Darjeeling.

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