Indian Zoo Year Book

VOLUME - IV, 2006

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Indian Zoo Directors' Association

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INDIAN ZOO YEAR BOOK

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Editors
L.N. ACHARJYO
S.K. SINHA

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Contact Address :

SECRETARY
INDIAN ZOO DIRECTORS' ASSOCIATION
C/o. Director, National Zoological Park
Mathura Road
New Delhi - 110 003

CONTENTS

PREFACE

Wildlife management is a great science and needs even greater skill and knowledge. Dissemination of such knowledge amongst the conservationists and all those associated with zoo movement helps in improving the living conditions of captive animals as well as the quality of life of mankind. In pursuit of such ideals the Indian Zoo Directors' Association and Central Zoo Authority for some years now have been continually publishing the Indian Zoo Year Book since 1996 covering various aspects of zoo and zoo life.

The delayed publication of the fourth volume of Indian Zoo Year Book, however, did not dampen the spirit of the zoo enthusiasts as evidenced by warm response, meaningful suggestions and generous contributions of articles and informative communications for sharing knowledge amongst the zoo fraternity and scientific community at large. We are proud to be a part of this process.

Despite sincere desire we owe an explanation for the late publication of this volume and it has mostly been due to certain circumstances beyond our control. We hope the readers will realise our limitations with all their goodness and continue to support the publication in future also.

We are thankful to all the contributors.

We record our gratitude to the Central Zoo Authority for the financial support to enable us to bring out the fourth volume of Indian Zoo Year Book.

We record our sincere appreciation of the assistance rendered by Dr. D.N. Mohanty and Dr. A.T. Rao for editing some of the papers.

Suggestions for further qualitative improvement of the subsequent issues will be gratefully acknowledged and acted upon in the interest of the zoo community.

Editors

REHABILITATION OF RESCUED STAR TORTOISES IN PRTOECTED AREAS OF ANDHRA PRADESH

B. Srinivas[1] and K. Tulsi Rao[2]

Introduction

The Indian star tortoise, *Geochelone elegans,* (Schoepff) is terrestrial and belongs to the family Testudinidae. It has domed carapace with conspicuous humps. Each hump has a yellow areola and radiating yellow streaks. It can grow to a size of 30 to 35 cm in straight carapace length. The maximum recorded length is 38 cm. The species is distributed in India, Sri Lanka and Pakistan. It is restricted to dry deciduous and scrub jungles of three countries. In India, they are commonly found in semi-arid and desert tracts of peninsular India and drier tracts of North-Western India. Though the species is common in its range, very little is known about its population dynamics. In recent years, the animal as a pet, is most sought after in the U.S.A, U.A.E and European countries. Some of the smuggled tortoises are also used for consumption as food in Oriental countries.

First Consignment

One such illegal consignment of star tortoises was confiscated by authorities at Singapore International Airport. The consignment was said to have originated from Chennai. This particular consignment was returned to India for the first time, due to the initiation and active campaign taken by governmental and non-governmental agencies. The Ministry of Environment and Forests, Central Zoo Authority, Andhra Pradesh (AP) Forest Department and Wildlife Institute of India, Dehradun collaborated and the first consignment of 1814 tortoises was brought back in 19 crates on 23rd August 2002 and housed at Nehru Zoological Park, Hyderabad (NZP).

[1]Curator, Nehru Zoological Park, Hyderabad-500064, Andhra Pradesh.
[2]Asst. Conservator of Forests(Bio-diversity), Nagarjunasagar Srisailam Tiger Reserve, Srisailam, Andhra Pradesh.

Second Consignment

Second such illegal consignment, seized at Kuala Lumpur Airport, Malaysia, was brought from Malaysia and the same was received at NZP on 11-8-2003. The total number of animals in this consignment was 513. The average size varied from 40 to 75mm (straight carapace length), which were higher than the average size of first consignment.

Project Rehabilitation of Rescued Torotises in Natural Distributional Areas

The authorities involved in the repatriation of consignment have decided to rehabilitate these tiny tortoises in Protected Areas, as per IUCN guidelines for introduction and international standards.

Thus, the project was divided into three components viz;

I. *Ex-situ* activities,

II. DNA molecular studies and

III. *In-situ* activites.

The idea of DNA molecular studies is to ascertain the origin of the rescued tortoises i.e. whether they belong to southern race, western race or northern race. The Centre for Cellular and Molecular Biology, Hyderabad (CCMB) which had long term collaboration with the AP Forest Department and NZP for LACONES project, has volunteered for conducting DNA studies.

Constitution of Monitoring Committee

To oversee the successful implementation of entire rehabilitation project, a monitoring committee was formed under the chairmanship of the Chief Wildlife Warden, AP. Other important members include the Member Secretary, Central Zoo Authority, Dr. Shivaji from CCMB, Mr. B.C. Choudhury, Scientist from Wildlife Institute of India, Dehradun and concerned Protected Area Field Managers and Curators.

Ex-situ Activities

Enclosures

The old crocodile complex which has central corridor and has cubicles (of size 4.5 X 4.5 X 3.0m) on both sides was used to house these tiny beautiful creatures. The cubicles were having only one meter high wall, above which 1/ 2inch (1.25 cm) chain-link was fixed with the help of M.S pipes as side walls up to a height of 3m. Roof was provided with 1/2 inch (1.25 cm) chain-link. For this purpose an A.C. sheet roof was provided covering the cell partially. Smaller animals were kept in these 9 cells.

Secondly, old mouse-deer enclosure (of size 12.0 X 3.6 X 2.40m) which was constructed using M.S pipes and 1/2 inch (1.25 cm) chain-link, was earmarked for housing second consignment from Malaysia.

The cubicles were made predator proof especially against rodents. A mosaic of sunlight and shady areas were provided inside the cubicle and care was taken so that enough sunlight was available to the animals. Inside each cubicle, all the corners have been rounded to prevent piling up of tortoises and thereby preventing deaths due to asphyxia. Utmost care was taken about the floor space to be provided to the animals and to avoid overcrowding. Animals that range between 40-70 grams were housed not more than 100-170 in number in each cubicle. Animals that range between 250-400 grams were housed, not more than 50-70, in each cubicle. Inside each cubicle simulated habitat was created using stones, xerophytes, other plants and earthen pots, which could be camouflaged with stones and dry grass. Dry grass and earthen pots have combined effect in retaining warmth inside. Cemented platforms were provided for feeding. Earthen saucers of low depth (not deeper than 5 cm) were provided inside the cubicles for providing drinking water to animals.

Cubicles were provided with low height bushy vegetation to facilitate proper hiding places for the animals.

Feed and Feeding

Star tortoises have more affinity for succulent vegetation. Initially tortoises were given a feed with composition shown in the column No 2 of the Table-1. But the feed composition was changed because urolithiasis was encountered after feeding of such stuff. Feeds like spinach and tomato, which are rich in oxalates contributed to the etiology of urolithiasis. The *Amaranthus sp.* green leaves, mulberry and lucerne were included as shown in coloumn No. 3 of Table-1. As per suggestion given during the first Monitoring Committee meeting, the feed composition was changed by including grasses, cacti and natural feed species like *Notonia sp.* etc.

Table - 1 : Feeding schedule of star tortoises

Items	Initially	Before 28-6-03	After 28-6-03	Remarks
1	2	3	4	5
Spinach / Green leaves	20%	-	-	Presently, i.e after IInd
Cabbage	25%	25%	20%	Monitoring Committee
Carrot	15%	15%	-	meeting, only iden-
Tomato	5%	-	-	-tified food plants and
Potato	10%	10%	-	grasses are being given.
Papaya	15%	15%	15%	All other food items
Bengal gram (soaked and crushed)	10%	10%	10%	have been stopped. This will condition the tortoises
Amaranthus sp.	-	10%	25%	for rehabilitation.
Mulberry+ Lucerne	-	5%	10%	
Tridax sp.+other food *sp.*	-	Occasionally	15-20%	
Cactus + *Notonia sp.*	-	Occasionally	2-5%	

Vegetables were cut to appropriate sizes. Feed additives such as 20 ml Vimeral / Viselam, 100 grams Galavit + Agrimin + Minamil were added to the feed. These feed additives supplement for Vitamins A, B2, D3, E and B complex and minerals like phosphorus, magnesium, iron, zinc, copper, cobalt, iodine and L-methionine.

The chopped feed was mixed with feed additives and provided ad-libitum to the animals. Occasionally, once in three or four days, other food species including mushrooms and wood ash were provided. It was observed that only

medium and large size animals were feeding on these items. The preferred items in captive condition was papaya, cacti, *Tridax procumbence, Amaranthus sp.*, *Notonia sp.*, Lucerne fodder etc.

Drinking water mixed with vitamins and mineral mixture was provided in each cubicle. Drinking water was changed twice daily.

Collection of Data

First Consignment

The biologist, who had been engaged for looking after these tortoises and to collect the basic data, collected the data on :

- Average feed consumption of the animal per day was recorded by weighing the feed supplied to each cubicle and deducting the weight of left over feed and the moisture losses.
- Average body weight, carapace length and width were recorded. For this purpose 10 animals of average size of each cubicle, have been selected at random and marked.
- Winter analysis was done for the duration of 3 months (December 2002 to February 2003). During the period maximum temperature, minimum temperature and relative humidity were recorded every day. Average feed consumed by the animal was recorded every day for one month. Body weight, carapace length and width were recorded once every month.

  As per winter analysis, average feed consumption in animals ranged from 30-60 grams accounting for 4-6 % of their body weight and in animals ranging from 100-140 grams it was 3-4% of body weight. Growth rate in small animals (average weight: 35-60 grams) was 10-14 grams, in medium (average weight:60-90 grams) was 6-8 grams and in large animals (average weight: more than 100 garms) was 4-5 garms (Fig.-1).

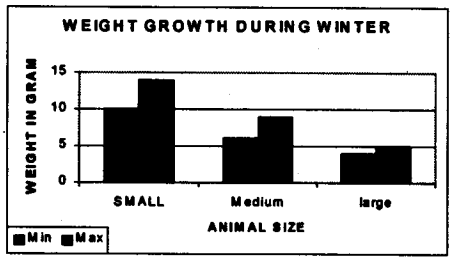


Fig. 1

- Similarly, summer analysis was done for 3 months (March 2003 to May 2003). According to the analysis, average feed consumption in animals ranging from 40-90 garms was 11% of their body weight and in animals ranging from 100-400 grams was 7 % of their body weight. Growth rate in small animals was 18- 20 grams, in medium 7-15 garms and in large animals it was 5-9 garms (Fig.2).

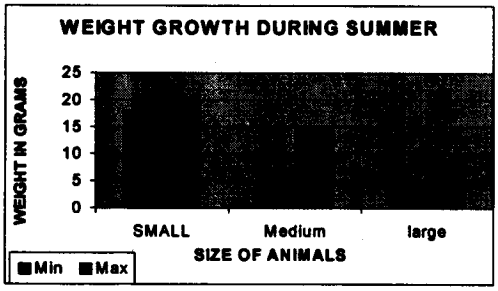


Fig. 2

- Rainy season analysis was done for 3 months (August 2003 to October 2003) with average day temperature 29^0 C and average relative humidity 57% (inside cell). Animals weighing between 40-99 garms consumed feed equivalent to 5-8% of their body weight and feed consumption in animals weighing from 100-500 grams was 4-6% of their body weight. Growth rate in small size animals was 12-16 grams, in medium sized animals it was 5-10 grams whereas in large animals it was 4-6 grams (Fig.3).

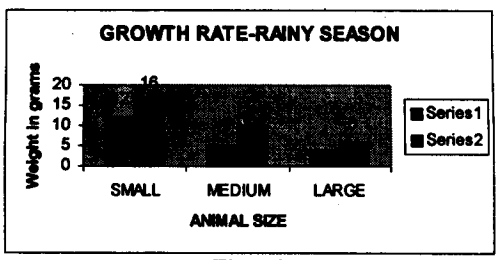


Fig. 3

Second Consignment

- In case of second consignment, the animals were divided, at present, into single group (carapace lengths varying between 4 to 7cm and weighing between 30-90 grams. They consumed feed equivalent to 4-7% of their body weight. The growth rate was 7-9 grams.

Veterinary Care

- 'Prevention is better than cure', is a well known fact in zoo management. Therefore, adequate measures have been taken for prevention of diseases. At the entry points of the star tortoise enclosures disinfectant footbaths were provided. Disinfectant hand-wash was kept at the entry point of the enclosures.
- Dehydration was one of the major difficulties faced initially on arrival of animals. To prevent this hazard, animals were given luke-warm water dips for 2-3 minutes. Dips facilitated absorption of water through cloaca. Dips were given twice a week even now.
- Faecal samples were collected once every month and sent to Veterinary Biological Research Institute, Hyderabad for detection of parasitic ova. During December 2002 samples were positive for *Strongyle sp.* All animals were de-wormed with Albendazole.
- Urolithiasis resulted by feeding oxalate rich feeds like spinach, tomato etc. On post-mortem examination in these cases 'uroliths'(stones) with hard consistency were found. Immediately, the oxalate rich feed items were substituted to prevent this disorder.
- Hepatitis and nephritis were the main cause for mortality. Hepatotonics and urocare were administered along with feed every day but the results were not satisfactory.

Mortality

In spite of best efforts, mortality in the first consignment of star tortoises has been a constant problem due to their small size and stress they underwent

during smuggling and until their arrival at NZP or for some unknown reasons. Although the second consigment was given similar food and treatment, the mortality was very less. After two and a half months, only 5 animals had died. However, the second consignment had the benefit of being given the natural food plants since beginning. In case of first consignment, after changing the food to natural plants, the mortality could have stopped or come down largely, but this did not happen. However, there was a slight decline in the mortality rate. In first consignment of animals, the mortality was as follows (Table-2).

Table - 2 : Mortality of first consignment of star tortoises

Sl.No	Month	Mortality
1	August 2002	13
2	September 2002	63
3	October 2002	60
4	November 2002	57
5	December 2002	53
6	January 2003	55
7	February 2003	59
8	March 2003	63
9	April 2003	71
10	May 2003	64
11	June 2003	58
12	July 2003	55
13	August 2003	43
14	September 2003	49
15	October 2003	54
16	November 2003	48
	Total	**865**

In case of second consignment the mortality was as follows (Table-3).

Table - 3 : Mortality of second consignment of star tortoises

Sl.No	Month	Mortality
1	August 2003	1
2	September 2003	3
3	October 2003	1
	Total	5

Mortality of star tortoise based on size of the first consignment

Number on arrival:	Small size (average weight 35 gm)-	528
	Medium sized (average weight 65gm)-	1201
	Large sized (average weight 85 gm and above)	85
	Total	**1814**
Total deaths of the first consignment		865

Present stock available of the first consignment

Small size (Average weight 35gm)-	89
Medium size (average weight 65gm)-	792
Large size (average weight 85gm and above)	68
Total	**949**

Thus, there was high mortality in small and medium sized animals. As many as 439 small animals and 409 medium sized animals have died, whereas only 17 large sized animals have died.

Animal Behaviour inside Cubicles

- Inside each pen, tortoises divide into 4-5 groups. The tortoises do not form any specific group and intermingling of members was frequently observed. The formation of groups may be probably based on the hiding places.

- During morning time when sunlight falls inside the pens, animals group themselves in the sunny areas and bask. When feed is provided, 40-60% of the population inside the cell approaches the feed. They have more affinity for succulent feeds like papaya, cactus and cucumber.
- They also relish *Tridax procumbence sp.*, Mulberry, *Amaranthus sp.* leaves and grasses . Each animal feeds for approximately 15-20 minutes and goes back to basking.
- Very rarely animals are observed drinking water. But few of them are found sitting in the water for some time ranging from 5 to 10 minutes especially in the afternoons.
- At about 3.00 to 3:30PM animals approach again towards the feed suggestive of their bimodal feeding habit. Around 4:30-5:00 PM animals go to their hiding places and housings.
- On 10-10-2003, it was observed that males were found, on different occasions, mounting on female tortoises.
- Aggressive behaviour (taking away the feed items like papaya, *Tridax sp.* leaves and scratching with front legs) is observed in large and medium sized animals.
- They were found eating some small insects like caterpillars and other larvae.
- The average body weight of male is 450 grams and that of a female is 350 grams. And the carapace lengths of male and female were 13.2 cm and 14.0 cm respectively. Though the length of the female is more, the weight is less in comparison to a male.
- Mating was observed on sunny period of the day.
- The approximate mating time recorded was 15-25 minutes.

Ex-Situ Activities - Daily Routine

- Work starts at 7:30 AM with cleaning of all the pens. Cleaning helps to free the cells from the left over feed, debris and faecal matter. Faecal

matter of tortoises is important source of *Salmonella* infection. It is an important source of zoonotic infection.

- To prevent zoonosis animal keepers maintain strict hygiene. They use disinfectant hand-wash and footbaths after every handling besides using hand gloves and aprons.
- At 8:00 AM drinking water is changed in the water troughs.
- At 9:30 AM thoroughly inspected feed is brought, cut and spread on the cemented platform in each cell.
- After spreading the feed in the cells human movement inside the cells is prevented to facilitate feeding.
- Inspection is made by the zoo veterinarian at 10:00 AM and in case of any mortality post-mortem examination is conducted at 11:00 AM and if required viscera are sent for further investigation.
- At 4:00 PM again feed is given, this time only grasses and other food plants of tortoises.
- At 5:00 PM water in the troughs are changed with fresh filter water.

Interaction with Scientific Bodies

- Regular interaction is maintained with Veterinary Biological Research Institute, College of Veterinary Sciences, Hyderabad and Centre for Cellular and Molecular Biology.
- Zoo Animal Health Advisory Committee meetings are regularly held with the above stated bodies to discuss the different aspects including star tortoise health management.

DNA Molecular Studies

The DNA molecular studies were conducted to identify geographical location of seized tortoises i.e. whether the confiscated tortoises belong to western region population or southern region population. The studies were conducted by the Dr. Shivaji, Deputy Director, CCMB, Hyderabad. They followed

two methods. 1) micro satellite analysis and 2) mitochondrial DNA sequence analysis

For this purpose, 120 blood samples have been collected from confiscated tortoises at NZP. For comparison they have collected 25 samples from Sri Venkateshwara National Park, Tirupati South Range, Punganur Area of Chittoor and Bannarghatta National Park of Karnataka for southern region race and 34 samples from Vadodara, Sirath Park, Junagarh and Surat Pakshi Ghar etc for western region race.

Out of six micro satellite markers used only GAL 50 showed significant intra specific differences in the range of alleles with western region tortoise samples showing higher range(105-153) compared to southern region range (85-105)

In mitochondrial method, 12 S and 16 S regions have failed to show any differences, whereas Cytochrome B and D-loop regions have showed distinct variations in the nucleaotide sequences. In phylogeographic partitioning, the neighbour joining tree showed that confiscated tortoise samples and the samples from southern region were more homologous or similar, while the samples from western region formed a distinct cluster. This means the confiscated samples are likely to be more similar to the samples collected from the southern region and as per sequence analysis of Cytochrome B and the D-loop regions, it is clear that the confiscated samples belong to the southern region.

For identifying specific geographic location in southern region, they need to extend the study with respect to the development of species-specific micro satellite markers etc.

In-situ Activities in Protected Areas of Andhra Pradesh

Initially, it was decided to conduct studies in those Protected Areas where natural populations are existing. Accordingly, the Protected Areas have been identified namely, Sri Venkateshwara National Park (SVNP), Koundinya Wildlife Sanctuary (WLS) in Chittoor district, Gundla Brahmeshwaram WLS (GBMWLS) in Kurnool district, Pocharam WLS in Medak district and Chilkuru National Park in Ranga Reddy district.

Four young and enthusiastic biologists, who have completed Masters degree in biology from Central University, Hyderabad were selected and sent to Nagarjunasager Srisailam Tiger Reserve (NSTR) with headquarters at Srisailam for preliminary training. The four biologists were trained in the Tiger Reserve forests by well experienced and dedicated Wildlife Officer Sri Tulasi Rao, who is working as Assistant Conservator of Forests (Bio-diversity) in Tiger Reserve. The field biologists were trained about the protocol of rehabilitation project, how to lay sample plots for habitat analysis and field botany etc., initially at NSTR and they surveyed and collected information accordingly. They were asked to collect information from the local people regarding the availability of natural population of star tortoises in that area.

They conducted reconnaissance survey in the allotted Protected Area. They used the format given in the Table-4

Table - 4 : Data format for reconnaissance survey

Sl. No.	Name of the Village	Tortoises sighted by whom	Evidence of past and present existence	Approximate population size	Remarks

Whenever they come across the information about the existence of the wild population of these tortoises, they visited that particular locality and collected the information on vegetation, fauna, food plants and other habitat factors using three different formats and quadrate model as shown below (Table-5, 6 and 7 and Fig. 4).

Table - 5 : Format for existing faunal species

Sl.No.	Fauna species	Impact of the species	Habitat	Remarks

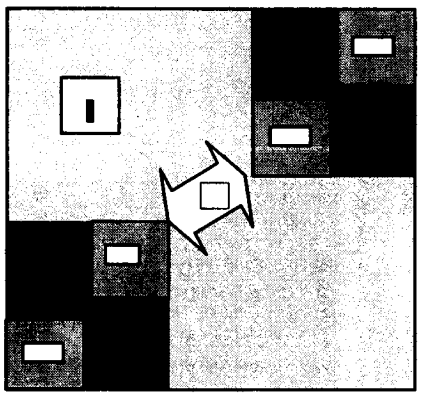
Table - 6 : Format for existing vegetation

Sl.No.	Tree cover	Shrub Cover	Grasses	Water availability	Remarks

Table - 7 : Identification of food plants and its details

Sl.No.	Flora species	Feeding part	Feeding intensity	Seasons	Remarks

Quadrate Model



I. 20 x 20 mts quadrates = 10 for trees
II. 5 x 5 mts quadrates = 20 for shrubs and climbers
III. 1 x 1 mts quadrates = 40 for herbs

Fig. 4

Other informations that were collected pertains to -

A) Cover type information:

- To know the food and shelter value
- Facilitate to locate new habitat where there is a possibility of species availability or introduction.

B) Water information;

- To know the availability of water in and around the selected habitats to provide dipping spots during breeding season.

C) Terrain information:

- Broadly four terrain classes i.e., valleys, plains, plateaus, moderate slopes and steep slopes.

Identified Food Plants

During the survey the following food plants of star tortoise were identified (Table-8) :

Table - 8 : Identified food plants of star tortoises

Botanical Name	Family
Cynotis cristata	Commelinaceae
Dicanthium pertusa/(Bothrioclora pertusa)	Graminiae
Cymbapogan sp.	Graminiae
Digitaria sp.	Ciliaris
Euriochloa panicoides	Paniceae
Spermococe hispida (articularis)	Rubiaceae
Alysicarpus pilifer (monilifer)	Fabaceae
Indigofera linnaei	Fabaceae
Aeshynomene indica	Fabaceae
Spermococe pusila (stricta)	Rubiaceae
Hybanthus enneaspermus	Violaceae
Hyptis suaveolens	Labiatae
Polygala elongata	Polygalaceae
Commelina sp.	Commelinaceae
Abutilon crispum (L)	Malvaceae
Euphorbia hirta	Euphorbiaceae
Urginea indica	Liliaceae
Merremia tridentata	Convolvulaceae
Cucumis pubescence	Cucurbitaceae
Spermococe pusila/(stricta)	Rubiaceae
Cassia absus	Caesalpiniaceae
Polygala elongata	Polygalaceae
Butea superba	Fabaceae
Martynia annua	Martyniaceae

With the help of wild tortoises, the biologists have identified preferred food species. For this they have placed all identified food species before the tortoises. The species which were consumed by the tortoises were identified as first preferred food plants (Table-9). For identifying second preferred food plants, all the first preferred plants were taken out and those food plants which

were consumed were treated as second preferred (Table-10). Like this preferred food plants have been identified.

Table - 9 : First preferred food plants

Alysicarpus pilifer (monilifer)	Fabaceae
Hyptis suaveolens	Labiatae
Urginea indica	Liliaceae
Cynotis cristata	Commelinaceae
Spermococe hispida (articularis)	Rubiaceae
Notonia glandiflora	
Hemedismus indicus	

Table - 10 : Second preferred food plants

Euphorbia hirta	Euphorbiaceae
Spermococe pusila / (stricta)	Rubiaceae
Polygala elongata	Polygalaceae
Tridax procumbence	

These tortoises feed on mushrooms (*Agaricus*), wood ash, snails, insects and other dead bodies. They were found feeding on other dead star tortoises.

Identified Areas for Release

Though, initially five Protected Areas (PAs) have been identified, only three PAs have qualified due to the fact that natural populations were still available in these three PAs namely Koundinya WLS, Sri Venkateshwara WLS and GBMWLS. Further, the NSTR with large wild star tortoise population was qualified as fourth PA for rehabilitation. During the Monitoring Committee review meeting, it was decided to include NSTR as a site for final release. The following table (Table-11) gives the names of ultimate locations for final rehabilitation of tortoises.

Table - 11 : Ultimate locations for final rehabilitation of tortoises

GBMWLS	SVNP	Koundinya WLS	NSTR
GBM East Beat 681, 682, 683	Tirupati Range (Mamandur)	Chittor West Range	Thummalabailu
GBM West Beat 679, 680, 684, 685	Balapalli Range	Punganur Range (Aruntlapalli Beat) (Somala Beat) (Boyakonda Beat)	Chinnarutla Srisailam
Chinnamanthanala	Chamala Range (Talakona South Beat)	Madanapalle Range (Penchupadu Beat) Palamaner Range	Srisailam Sundipenta Peddacheruvu Naramamidi Cheryu Chintala Amrabad

In Koundinya WLS the identified areas were Addakonda Reserve Forests (RF), Muthukuru RF and Eddulakonda RF in Punganur Range and Musalimadugu RF in Palamneru Range. Similarly in SVNP the identified areas were Kesarala bandlu (Talakona south Beat) in Chamal Range, Neraboilu, Kondiah plateau, Mamandur Ring Road etc. In GBMWLS compartment No 679 to 685 were suitable. In NSTR, the Srisailam plateau, Sunnipenta, Chinnauratla and Peddacheryu are suitable areas.

Threats and Mitigation Strategies

The biologists and field staff identified the threats for the star tortoises from the following namely, poachers, fire and habitat destruction besides natural predators. The strategies for mitigation of these threats were also enumerated as follows;

- Release at more safer sites
- Local peoples' participation for safety and monitoring
- Involve responsible environmental Non Government Organisations (NGOs)
- Awareness and motivation strategies needed

- Motivation of lower forest staff for taking up the responsibility to protect the species from poachers.
- Protect the areas from rampant fire.
- Improving the grass and other species on which star tortoise feeds.
- Special protection of egg -laying areas (from August and September)
- Conduct awareness camps especially in the identified threat villages.
- Include the Yanadies, Shikaries in eco-development programmes.
- Strict enforcement of Wildlife (Protection) Act,1972.
- Reward the informers of poaching.
- Publishing brochures, pamphlets on conservation and importance of star - tortoises.
- Displaying slides on star tortoises in Cine -Theaters.
- Writing slogans on star tortoise at all important places.
- Erecting hoardings on all highways and important places on conservation of star tortoises.

The two level threats mitigation strategy was planned i.e local strategy and state level strategy. At local level, action was taken to create awareness among local villagers with the help of NGOs, printing of posters in local languages, erecting boards and hoardings along the highways and other roads, rewarding informers for giving information about smugglers, giving advertisements in local newspapers, projecting slides in local cinema halls and involving Vana Samrakshana Samithies in protection and conservation of the species, motivating lower staff for strict implementation of Wildlife (Protection) Act etc. A workshop has already been organised at Palamaneru to sensitise the local people, NGOs and the press. Posters have been printed in local language, boards and hoardings have been erected and slides are being shown in cinema halls. The local field staff are taking action for protecting the identified areas against the fire and to improve the grasses and other herbs for star tortoise feed. Regarding state level strategy, these tortoises are abundantly available in Chittoor district especially, along border areas of Tamilnadu and Karnataka. The

three adjoining states i.e Andhra Pradesh, Karnataka and Tamilnadu have to combine to control the smuggling across the borders. Without cooperation from other states like Tamilnadu and Karnataka it is difficult for the field staff of Andhra Pradesh to control the smuggling of these tiny tortoises. Chief Wildlife Wardens of these states have to initiate action for inter state cooperation in the matter.

Conclusion

India's first ever rehabilitation of rescued star tortoises in the natural distributional areas, as per IUCN guidelines has began with the soft release of 100 tortoises in Nagarjunsagar-Srisailam Tiger Reserve in Andhra Pradesh state of India on 15-11-2003.

With the help of Wildlife Institute of India and especially, Sri B.C. Choudhury, Deputy Director, who has been associated with the project since beginning, it is proposed to mark these tortoises with bio-chip transponders and some of these will be monitored with the help of radio transmitters for one year. Further, the soft release in other Protected Areas; namely, Sri Venkateshwara National Park and Koundinya WLS was proposed to be taken up in December 2003 and the final release of these tortoises into wild was completed by the end of January 2004.

Thus, this project is a prestigious project for all wildlifers of India as it has shown the world that we are capable of reintroducing these hundreds of tortoises as per IUCN guidelines successfully.

Acknowledgements

We sincerely thank our Addl. Principal Chief Conservator of Forests (Wildlife), Andhra Pradesh for his guidance in the project. We express our gratitude to the Member Secretary, Central Zoo Authority, New Delhi for his constant association in the project and encouraging us. We express our thanks to the biologists and field staff and local people who have helped in identification of habitats of star tortoises in different Protected Areas of Andhra Pradesh. We also thank Dr. Shivaji and his team for their successful DNA molecular studies for identifying the geographical location of rescued tortoises.

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PROJECT RED PANDA AT PADMAJA NAIDU HIMALAYAN ZOOLOGICAL PARK, DARJEELING (WEST BENGAL)

B. R. Sharma[1], S. Pradhan[2] and M. Maity[3]

The Red Panda (***Ailurus fulgens fulgens***) belongs to Order - Carnivora and Family - Aluridae (Local names : Nepalese-wah, ye, nigalva, ponva; Bhutia-oakdonga, wakdonga, woker; Lepcha-sankam).

Distinctive Characters : Of the size of a jungle cat; coat bright chest-nut, with ringed tail. Rounded head, large erect pointed ears, stumpy muzzle and short hairy-soled legs characterize this animal. Face and lower lip white. Head and body length 51-64 cm; tail 28-48 cm.

Out of two subspecies, namely, ***Ailurus fulgens fulgens*** and ***Ailurus fulgens styani***, the nominate subspecies occurs in India and differs from the other in being smaller in size and less swollen forehead.

The first known written record of the red panda occurs in a 13th Century Chou dynasty scroll. But it wasn't until some six centuries later that Red Pandas became known to West. And Major General Thomas Hardwicke's 1821 presentation of "Description of a New Genus ..... from the Himalayan Chain of Hills between Nepaul (sic) and the Snowy Mountains" to the esteemed Linnaean Society of London is regarded as the moment the Red Panda became a bonafide species in Western Science, Hardwicke called the animal "Wha" because "It is frequently discovered by its loud cry or call, resembling the word 'Wha,' often repeating the same...." He also mentioned several other local names, including "poonya,' which was eventually anglicized to "panda".

It may be poetic justice that Hardwicke received only partial credit for his "find". Hardwicke was delayed in returning to England from India with his specimens and under the rules of taxonomic nomenclatural priority, was scooped by the unbiquitous French naturalist Frederick Cuvier, who gave the Wha its

[1] Director [2] Scientific Officer [3] Veterinary Officer
Padmaja Naidu Himalayan Zoological Park, Darjeeling, West Bengal.

official scientific name: *Ailurus fulgens*, the "fire-colored cat." Perhaps we should be grateful to the aristocratic Cuvier who crossed the finish line first. He provided an elegant Latin name, Christened Hardwicke's Wha "the Bright Panda," and described it as "a beautiful species, one of the handsomest of known quadrupeds." However, British Scientists saw it otherwise. They were incensed that Cuvier would "prevent England's reaping the Zoological harvest of her own domains," as irate British naturalist Brian Hodgson sputtered in 1847.

For almost five decades, *Ailurus fulgens* was the Panda. Then, in 1869, a large black and white bearlike animal with teeth and diet remarkably similar to those of the "Wah" was discovered in China by Pere Armand David, a French missionary. This animal was dubbed "giant panda." Instantly, *Ailurus fulgens* became the "lesser" panda, a pejorative name that has been used all but dropped in favour of the more apt and dignified red panda. In retrospect, the application of the same name to both species was prematurely based on superficial anatomical similarities and only fueled the controversy about how closely related these two species really are. Today scientists are still struggling to untangle the taxonomic knot that these unfortunate baptisms helped create.

After Hardwicke and Cuvier, only scant information about the red panda's biology was forthcoming. Then the events of 1869 turned the panda spotlight squarely on the giants and very little of substance about the red pandas came to light more than a century. But in the last 20 years, important new information has rapidly accumulated about red pandas from field and zoo studies.

Although far from complete, the picture of the red panda we have today gives us a reasonable idea of what this rare and beautiful species is all about and what we must do to preserve it.

Red pandas live only in temperate forests in the Himalaya from central Nepal through northern Burma (Myanmar) and in the mountains of southwestern China (Sichuan, Yunnan, and Xizang provinces) at altitudes between 4,900 and 13,000 feet. Their habitat occupies a cool montane/subalpine zone with little annual fluctuation in temperature. Seasonal monsoons, trapped by southern

ranges and slopes, support a mixed forest of fir, deciduous hardwoods, and rhododendrons, with bamboo understorey on which red pandas depend. Thus, while the arc of the red panda's distribution extends thousands of miles, from Kashmir in the West to northern Sichuan in the east, their requisite habitat lies in a very narrow and fragile ecological band.

Bamboo Budgets

The red panda's diet specialisation is very unusual in mammals. Only giant pandas, two bamboo rats (one in China and another in Brazil) and a small lemur in Madagascar are obligate bamboo eaters. Bamboo eating is apparently an ancient adaptation in this species. Red panda like fossils, complete with the massive dentition and robust skulls necessary for attachment of powerful chewing muscles, have been found in Miocene (25 to 5 million years ago) deposits of eastern Europe and Pliocene evidence suggests that the distribution of both bamboo and red panda like animals has expanded and contracted in response to macroclimatic temperature and moisture oscillations.

Their range expands during warm, moist periods and contract during cool, dry ones. Today's distribution with bamboo and red pandas confined to small, isolated refugia, appears to be a mere remnant of a much more widespread one in the past.

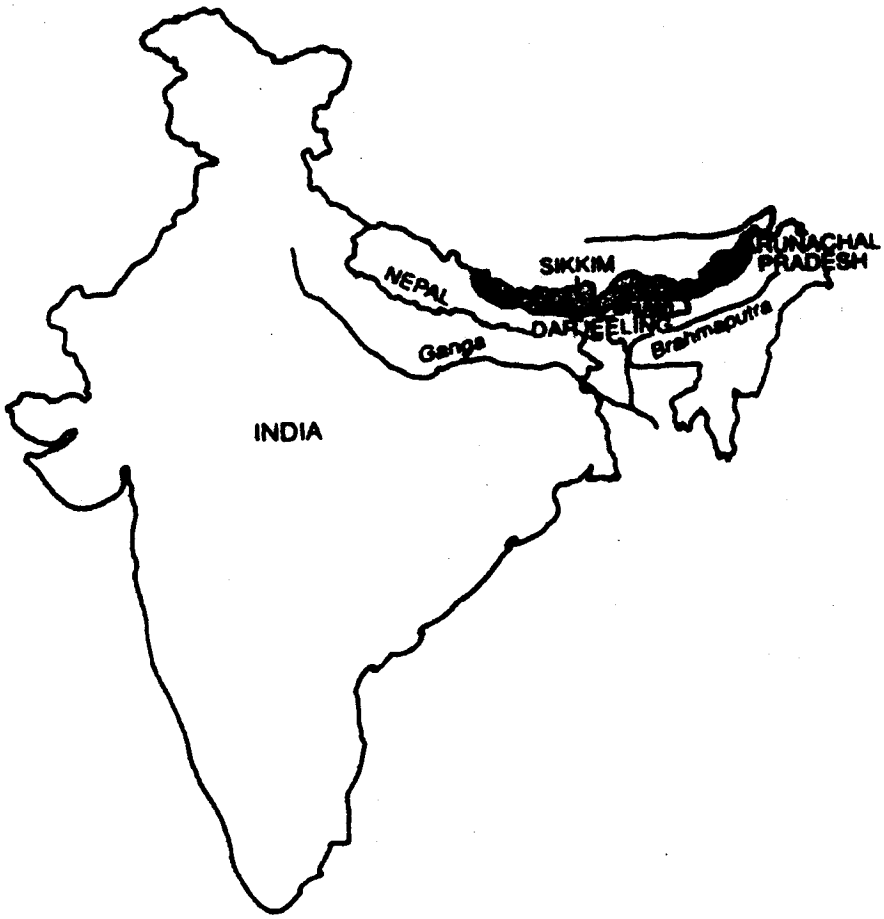
The red panda's ancient dietary specialisation on bamboo has had dramatic consequences for the rest of its biology. In essence, bamboos are giant grasses that have evolved woody stems and tough, leathery leaves to deter predation. Because they are so high in indigestible fiber and are loaded with abrasive siliceaus compounds, bamboos are difficult to eat and digest. Many mammalian herbivores, such as cows and horses, that eat grass like plants have evolved extra-robust teeth and special fermentation chambers in their gut to help them get as much energy as possible from their food. While the red panda does have massive teeth for crushing bamboo leaves, its gut is unspecialised. The gut retention time of bamboo in red pandas is a speedy six hours and only about 25 percent of the already limited energy is extracted from the bamboo. It is found that red pandas eating only mature bamboo leaves, which would be

typical for an adult in the wild from late autumn through early spring, could barely maintain their body weight. Some even lose as much as 15 percent of their body weight on this diet.

Clearly, red pandas are on a tight energy budget for much of the year. Not surprisingly, they have several strategies to help make energetic ends meet. Red pandas spend as much as 13 hours a day searching for and eating bamboo. In contrast to the giant panda, red pandas are very selective about what part of the bamboo plant they eat. The red pandas select only the tenderest young leaves and shoots and thoroughly chews each mouthful to increase digestibility. Giant pandas eat virtually every part of the bamboo plant except the roots and barely chew at all.

To cope with a low energy diet and cool environmental temperatures, red pandas have evolved an extraordinarily low metabolic rate, expending almost as little energy as a sloth. They also are able to temporarily lower their metabolic rate. These physiological adaptations, combined with dense fur covering the entire body (including the soles of the feet) and behaviours to regulate temperature (such as curling up into a tight ball when it's cold), serve to conserve body heat and energy expenditure.

A tight budget driven by the reliance on low-energy food also influences reproduction in the red panda. Reproduction is energetically expensive, so red pandas reproduce in the late spring and summer when tender, more digestible bamboo shoots and new leaves are available and temperatures are warmer. Although food energy is more available during gestation and lactation, red pandas still produce small litters, averaging just two cubs each. And at 135 days, the red panda has an extraordinarily long gestation period for an animal of its body size. Even though lactating mothers eat as much as they can, as fast as they can, young grow and advance to sexual maturity slowly. Young reach adult size at about 12 months of age, sexual maturity at about 18 months. These conservative features of reproduction and growth add up to a very sluggish rate of reproduction and consequently very slow recovery from population declines.



Map showing red panda (*Ailurus fulgens fulgens*) distributin in the wild.

Behaviour

The bamboo diet also influences the social behaviour of red panda. Because the young grow so slowly, the association between a mother and her offspring is extended, lasting over a year. The mother-young association is the only form of gregarious behaviour in red pandas except for an ephemeral mating consortship during the brief breeding season. Otherwise, red pandas are quite solitary.

Red panda ranging patterns are similar to those found in most Carnivora species on large, overlapping home ranges where they rarely meet one another. At first this seems somewhat counterintuitive for an animal feeding on something as abundant as bamboo. But because red pandas selectively feed on the tenderest shoots and leaves, usable resources are probably sparsely and patchily distributed in the habitat, much like the vertebrate prey of cats. Overcrowding and overuse of resources may be reduced by the dispersed social system.

Female red panda home ranges average about one square mile, while male ranges are about twice that size - exceptionally large for an animal weighing only about 11 pounds (about 5.000 kg). However, in keeping with the energy conservation strategy so paramount for survival in this species, individuals traversed their home ranges at the rate of only about 650 to 1,000 feet (about 195-300 m) per day and used only about 25 percent of the total home-range area per month.

In a pattern typical of many other carnivores, male home ranges generally overlap those of more than one female and may even expand in the mating season. Studies at the zoo show that individuals scent mark their territories and home ranges with urine and with secretions from anal glands and glands on the soles of their feet. They also use regular latrine sites. These "scent posts" communicate information that helps maintain social spacing and undoubtedly convey information about the sex, age and reproductive condition of the depositor. Red pandas use subtle body language, including head bobs and tail arching and vocalization, including a threatening "huff-quack", and alluring "twitter," and a warning "whistle," to communicate at close range.

Conservation

Recent field studies also provided vital new information about the red panda's tenuous status in the wild. A high canopy, composed of various species of conifers, most notably fir and hemlock, mixed with deciduous hardwoods, such as oak, chestnut, and maple, provides protection for a stable understorey of rhododendron and bamboo. Clouds enshroud these forests for much of the year, promoting extensive growth of mosses and lichens on every possible

surface. The densely packed intertwining root systems of this large amount of vegetation binds the soil on even the steepest slopes to maximize moisture retention and slow water runoff.

In recent years, however, this stable system has been profoundly disturbed by increasing human populations. People are logging the forests for building material and fuel, and their domestic animals consume understorey plants and compact fragile montane soils. Even minor disturbance in this fragile habitat, such as clearing a small patch for agriculture, can initiate a familiar and devastating chain reaction. The impact of heavy seasonal rains falling through the canopy damages the soil and loss of interlacing root systems promotes soil erosion and rapid water runoff, which extends to downslope areas not yet directly disturbed. During the rainly season, brooks and streams become raging torrents that carry away precious mountain soils to distant plains.

Little of the remaining red panda habitat, even that in natinoal parks and wildlife reserves, is spared this relentless degradation. People strip and cut trees for building materials, forage for livestock and fuel for cooking, tourism and cheese production. Not only do these activities eliminate food, shelter and nesting areas for red pandas, and other wildlife, but hunting and the depredations of feral dogs also take a considerable toll on the red panda population. We suspect the same scenario is being played out elsewhere in the red panda's range. Zoos have taken a special interest in the study and conservation of red pandas. At present about 85 zoos in the world hold more than 300 red pandas and in the last two decades more than 300 have been born in zoos. Virtually all zoos with red pandas participate in management progrmmes designed to ensure that a viable zoo population survives for the foreseeable future. This programme, maintains a stud book of all red pandas in zoos, uses genetic and demographic management analysis to determine which animals should be mated, and develops long-term management and research strategies for the species.

This sort of global conservation effort, linking the international zoo, academic, wildlife management and political communities, requires an enormous amount of time, energy, and money from many sources. But our efforts seem

to be paying a modest dividend. Field studies in Darjeeling hills are examining the exact status and quality for remaining red panda habitats and the nature of the human-environment-animal interactions occurring in them. Other studies are for assessing the levels and rate of loss of genetic variation in wild populatins, and zoo and wildlife biologists are being trained in the research, management and husbandry techniques necessary o preserve wild and zoo populations. We hope that these and other measures will help create a bright and shining future for the red panda.

Not much information is available on the exact population size of the red panda in wild in India. But it is rated as very rare. The red panda has been recently studied in the Singalila National Park, Darjeeling (West Bengal) and a small population is still found to exist in the area. However, the animal has been sighted on many occasions in the Neora Valley National Park, Darjeeling (West Bengal); in Singhik, Chunthang, Menshithang, Lachen, Yaksum and Lachung areas of Sikkim; and in Mehao Wildlife Sanctuary, Arunachal Pradesh by the survey parties. Neighbouring countries of Nepal and Bhutan are supposed to have sizable populations of the red panda in the forests over there.

The Padmaja Naidu Himalayan Zoological Park, Darjeeling (Zoological Park) is the only zoo having a good number of specimens of red panda in its stock in whole of its natural distributions zone. A pair has recently being sent to Himalayan Zoological Park, Gangtok (Sikkim) and has started breeding. Many zoos particularly in Europe are also holding red pandas in their collections.

Conservation measures taken : Enlisted in Schedule I of Wildlife (Protection) Act, 1972 and Appendix II of CITES. Some of the areas where it occurs have been declared as conservation areas.

Conservation measures suggested : A detail survey of its range in India is necessary to know its population size and area of its concentration to chalk out the future conservation strategy. As the red panda breeds well in captivity, release of captive animals in already identified suitable habitats may yield good result.

The Project

The sharp decline in red panda population in the past has been caused by large scale hunting, trapping and trading, and disturbance, fragmentation and loss of habitat.

Despite providing sufficient protection the low red panda population, may be affected by genetic problems. It is in danger of becoming extinct in the wild and in fact has already become extinct in certain areas.

The Zoological Park, Darjeeling dedicated to the conservation of endangered Himalayan fauna took a serious view of the situation of this rare species by embarking upon conservation breeding programme.

The Zoological Park, Darjeeling is ideally situated within the natural distribution zone of the red panda. There was no other captive breeding facility available in the vicinity of red panda (*Ailrus fulgens fulgens*) natural habitat.

The Zoological Park, Darjeeling has had proper housing facilities required for red panda even at that time and has had earlier records of success of breeding of red panda is captivity.

There are at least two (The Singalila National Park and the Neora Valley National Park) Protected Areas still having wild red panda populations in Darjeeling hills and one habitat (The Senchal Wildlife Sanctuary) with very recent history of red panda populations.

The main objectives of the **Project** are as follows :-

- It is a conservation effort aimed at planned conservation breeding and multiplication, to ensure their survival and then making efforts to restock the dwindling population of red panda in the Singalila National Park and the Neora Valley National Park and re-introduce the red pandas back in the Senchal Wildlife Sanctuary.
- Making efforts to establish subsidiary conservation breeding centers in suitable locations in Eastern Himalaya.

- To provide opportunity to scientists and naturalists for study various aspects of hitherto unknow biology / behaviour of the rare species.
- To arouse public consciousness about this endangered species and to cater popular and scientific information related to this species among people.

A planned conservatin Breeding Project as a part of the Glabal Captive Breeding Master Plan was initiated in early nineties in the Zoological Park in response to the Internatinal Conservation efforts, though initiation in the form of project formulation and improvement / modification of existing housing facility was already on, since 1986.

The Zoological Park, Darjeeling had one male (Basant) and three females (Amita, Chanda and Divya) all of wild origin in stock at the beginning of the project in 1990. Hence one male 'Oscar' (born on June 29, 1992) was brought from Rotterdam Zoo on April 1, 1993 to augment the existing populations of 4 red pandas in the Zoological Park.

- The first successful (planned) breeding of red panda occurred on 20.06.1994 when two cubs 'Ekta' and 'Friend' were born to 'Basant' and 'Amita'.
- 'Hari' (male, born on June 3o, 1993, Rotterdam), Gora (male, born on June 25, 1993, Koln) and Indira (female, born on June 26, 1993, Madrid) arrived in Darjeeling on November 10, 1994 to induce new blood and to continue the planned breeding programme.
- Again 'Omin' (original name Tsambo) (male, born on July 17, 1994, Rotterdam) and 'Vicky' (female, born on June 26, 1994. Antwerp) were further added into the already existing stock of the Zoological Park on December 25, 1996. Later 'Vicky' (renamed as Prity) along with 'Jugal' (male, Darjeeling Zoo born) were shifted to Gangtok (Sikkim) zoo to start another conservation breeding center over there.
- In the last 10 years there were in total 38 births of red panda in captivity in this Zoological Park. It is heartening to add that the pair at Gangtok has also started breeding.

- The red panda conservation Breeding Project at Padmaja Naidu Himalayan Zoological Park, Darjeeling is one of the most successful and only breeding programme (along with one subsidiary centre at Gangtok) of the species in its natural distribution zone.
- All the record keeping of the programme and animals is not only done in Zoological Park, Darjeeling, but is also recorded with the International Stud Book keeper of the species at Rotterdam (Netherland).
- 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 Projects in suitable locations.

Back to the wild

- Today the Zoological Park, Darjeeling has a stable and genetically healthy population of 21 red pandas in capivity. The pair at Gangtok (Sikkim) has also started breeding i.e. one subsidiary breeding center has also been established in the zone.
- And the Zoological Park is in a position of realising its long cherished dream and ultimate objective of the project of releasing zoo bred red pandas in the wild in the Singalila National Park (to begin with)
- All necessary clearance from Government of India and Government of West Bengal have been obtained for the purpose.
- For the first lot two females have been selected from the captive stock. Both the animals have been shifted to big off-display naturalistic open air enclosure to give them a feel of wilderness.
- Both the naimals have been given complete health checkup (vaccination/ deworming/ecotoparasite treatments and skin / urine/ stool and blood analysis).
- The daily diet of both the animals has been gradually changed from normal zoo diet to poorer and more natural diet of the red panda in the wild.

- Pre-release monitoring for Population Viability and Habitat Analysis in the Gairibas area of the Singalila National Park has been organised during November/December, 2002.
- IUCN guidelines for re-introduction/re-stocking of captivity born wild animals is being followed in totality for the programme.
- Intermediary release facility for soft release of the animals has been created near Gairibas Beat Office (around 8500 feet/2550 m) of South Singalila Range in the Singalila National Park. The construction cost is fully funded by the Central Zoo Authority, Government of India.
- DNA based analysis has been conducted in collaboration with Centre for Cellular and Molecular Biology, Hyderabad for Taxonomic Status analysis and Genetic Variability studies. Same has also been done theoretically using the animals pedigree charts, history sheets and international studbook and it is found out that the animals are ***Ailurus fulgens fulgens***, (the subspecies found in India) and in-breeding co-efficient is zero in both the cases.
- Meetings with the fringe people at Gairibas and surrounding areas have been organised to brief them about the Project and to get their co-operation and support.
- Both the animals have been shifted to the intermediary release facility at Gairibas for acclimatisation and kept there for 3-4 months. There the animals have been fed with natural diet in very natural environment, to make them fit for outside world.
- Both the females were re-captured from the intermediary release facility on 4/5th of November, 2003 and kept in a caged enclosure for radio collaring.
- Radio Collars of appropriate size have been procured and the animals were radio collared on 7/8th of November 2003.
- Another pair of two female zoo bred red pandas was shifted to the intermediary release facility on 6th November, 2003. These animals will be kept in the facility throughout the winter for acclimatisation.

- The Radio Collared pair of female red pandas was finally released in the wild on 14th November, 2003 near Gairibas.
- Two number field assistants are camping at Gairibas for the post release monitoring of the released animals.
- As per the last report both the released animals are doing fine and adjusted well in the wild and are occasionally seen in the company of their wild colleagues.

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BEHAVIOURAL STUDIES ON THE BEAR POPULATION IN BEAR REHABILITATION CENTRE, AGRA TO DEVELOP APPROPRIATE ENRICHMENT OF THE ENVIRONMENT

Brij Kishor Gupta[1], A. K. Sinha[2] and Sant Prakash[3]

Introduction

The Ursidae family consists of eight species of bear (AZAABAG, 1997), most of which are closely related, the evolutionary exceptions being the spectacled bear and giant panda. They are generally omnivorous, have a slow reproductive rate, good climbers and with an exceptional sense of smell. They have long maternal dependency, and cubs are born in poorly developed state. Sloth bears are found across the Indian subcontinent (India, Sri Lanka, Nepal and Bangladesh). They occupy lowland forests and adapted for feeding upon insects, especially termites. Their lips are flexible, they can close their nostrils, the upper incisors are missing, and they have long blunt claws.

The Bear Rehabilitation Centre at Agra had started functioning very recently and it was impoverished in terms of stimulation and other environmental aspect that encourages functional or manipulative activity. The present study was undertaken for the specific goal of environmental enrichment for sloth bears to encourage them to perform behaviours and activity as it would in the wild. The enrichment we used primarily targeted the elicitation of natural bahaviours, their enclosure design and manipulating models.

Conservation Status

i. Listed in Appendix I of CITES (Convention on International Trade in Endangered Species of Wild Fauna and Flora)

ii. Schedule I of Indian Wildlife (Protection) Act, 1972.

[1] Central Zoo Authority, Annexe VI, Bikaner House, Shahjahan Road, New Delhi - 110 011.
[2 & 3] Department of Zoology, Faculty of Science, Dayalbagh Educational Institute (Deemed University), Dayalbagh, Agra 282 005, Uttar Pradesh.
For correspondence: brijkishor 68@yahoo.com

Environmental Enrichment

Environmental enrichment aims at stimulating a wide range of species-specific behaviours, which are performed in normal sequences and frequencies. The use of environmental enrichment simultaneously reduces the stereotype behaviours in bears under study.

During the present study two approaches to enrich the environment of sloth bears rescued from "Kalandars" were used. Both had achieved positive results.

1. In enclosures facilities which enabled the animal to undertake a wide range of natural activities by providing a variety of appropriate natural materials, structures and substrates.
2. Day-to-day enrichment by offering a daily range of stimuli, which stimulated different senses and elicited natural behaviours.

About the Species

The sloth bear, ***Melursus ursinus***, is usually divided into two sub-species (Ellerman and Morrison-Scott, 1951) The nominate race ***ursinus***, found in India and sub-species ***inornatus*** from Sri Lanka were described by Pucheramn in 1855 on the basis of a young animal which lacked white markings on its chest (Pocock, 1933). However, Sri Lankan sloth bears are significantly smaller than Indian ones (Corbet and Hill, 1991) although further indepth study is required to confirm it in north-south cline.

The sloth bear gets its name from its slow shuffling gait. It specializes in feeding on termites and ants (Nowak and Paradiso, 1983) The long, strongly curved claws are used to dig into termite nests or rotten wood. The sloth bear then blows away the dust and sucks in the termites. It is said that this sucking and blowing can be heard up to 185 meters away (Nowak and Paradiso, 1983).

In order to facilitate this specialized feeding mechanism, the sloth bear shows a number of morphological adaptations. There is flap skin at the top of nose, and the lips are protrusible so that a tube can be formed through which air can be directed (Pocock, 1933). The nostrils can be closed up completely to

stop dust and stray termites entering the nose. The palate is hollowed out and the middle pair of upper incisors is missing to allow for an unimpeded flow of air. The molar teeth are relatively small, reflecting the softer and more easily digested diet compared with most other bears.

Activity Pattern

Stereotypic behaviour such as walking up and down restlessly, head swinging and weaving are regularly associated with animal housing conditions that deviate fundamentally from the natural environment of the species. They are widespread also in other animals characterized by extreme spatial confinement and monotonous environment (Sambraus, 1985). Such activity requires environmental enrichment for enhancing the natural life style. The aim of our study was to analyse various activity pattern which arrives due to the confinement and to device various enrichment models for effective application.

Following activities were studied:-

1. Lying
2. Sitting
3. Sitting without activity
4. Paw sucking
5. Pacing
6. Head swinging
7. Weaving
8. Walking naturally
9. Walking stereotypically
10. Chasing

Habitat Use

During this study on various occasions adult sloth bears were seen climbing over the trees of *Prosopis juliflora* and both the sub adult males and females had used trees to climb very often. The habitat in the open enclosures usually consists of heterogeneous groups of plants and trees. In Bear Rescue Facility at Agra the habitat consisted trees of *Prosopis juliflora, Acacia nilotica, Azardictha indica, Dalbergia latifolia, Salmalia malabarica, Bombax malabarica, Zizyphus mauritaiana, Cassia renigera, Roystonea regia, Ficus glomerata, Cassia cavandas* and *Pongamia glabra.*

The observation on 41 bears with respect to their tree preferences was 32.% of *Prosopis juliflora*. The main reason being that the high abundance of *Prosopis juliflora* which provided bears with various tangling branches. Apart from that, these bears over the years of captivity with "kalandars" had lost their natural ability to tackle the tough situation, hence preferred soft habitat environment.

Social Organization

In general, wild bears are solitary animals, tolerating each others' company only during mating season or when there is an abundance of food. During this study, bears were usually housed in male/female pairs with appropriate husbandry routines. The bears had benefitted from opportunities for free social interaction received at the facility compared to almost nil opportunity when they were with "Kalandars" where they never had opportunity to interact with other bears.

Feeding Technique

To stimulate the feeding and foraging behaviour following environmental enrichment techniques were used:

a. **Timing:** Bears were fed thrice a day rather than feeding once a day by "Kalandars".

b. **Variety:** By increasing variety of foods showed 80% increased interest of bears in feeding.

c. **Type:** The type of food changed frequently so that bears sharpen their food preference abilities while processing their food.

d. **Hidden Foods:** For hiding foods around enclosure, the bears used to explore, by using their sense of smell. Fifteen bears were constantly recorded at least 12 times for stereotype behaviour. Comparatively the pacing stereotype was reduced to 30%.

e. **Mechanical feeders:** Mechanical feeder like honey log was used to dispense honey to 16 number of bears at different times. The main objective of this feeder was provided to the bears with natural foraging behaviour at different times and to reduce the levels of stereotype behaviour. The head swinging behaviour was reduced to 22%.

f. **Scattered Feeds:** Scattering of feeds included hiding various food items to motivate bears to use the whole of their enclosures. This increased their foraging time by 40% in 18 bears.

Enclosure Designing

We have approached to enrich the animal's environment with the following understanding:

1. Within enclosure facilities, providing a variety of appropriate natural materials, structures and substrates, which enable the animals to undertake a wide range of natural activities,

2. Day-to-day enrichment by offering a daily range of external induced stimuli, which stimulated different senses and elicited natural behaviours.

To keep the best enclosure environment at bear rescue facility we kept the ground to be well drained. Natural ground vegetation used as the best substrate. Food was scattered for the bears to locate. The substrate had allowed them to scratch, dig and construct pits and holes for resting. In addition, areas covered with materials of different physical properties (Table 1) in shady and sunny places had created diversity so that the bears can select ground beds appropriately in different weather conditions.

Areas at the facility was provided with various materials such as dry leaves, hay, straw, wooden logs, which increased the possibilities for varying ground cover and microclimate when arranged appropriately in relation to the more permanent structures in the enclosure.

Table 1. Substrates and its distinctiveness in terms of microclimate

Substrates	Thermal Characterstics
Soil	High water absorption power
Leaf and bark litter	Safeguards humidity
Wooden twigs/branches	Absorbs water
Shed/dry leaves	Padding, if dry
Straw and hay	High insulating properties
Mat made of eco-friendly jute sacks	High insulating properties
Wooden logs/roots	Insulation

It is essential that the variety of functions of each structure must be considered when planning their shape, position and dimension. The combination of structures and substrates of importance has been listed out (Table 2), for example, the cooling properties of shady places in summer enhanced by providing humid bark litter and wet soil/sand as a ground substrates as preferred by 28 bears.

Table 2. Selection of structure for different task

Functions of Structures	Structure/Material
Creation of different microclimates: sunny, dry and sheltered in cool weather, shady and open to the wind in warm seasons.	Shrubs and trees; horizontal wooden logs, large roots, rocks, shelter made of bamboo and hay.
Provision of hiding places from conspecific and visitors on the ground	Dens made of cement/stone, wooden planks and soil.
Obstacles which deter bears from attacking conspecifics	Trees and shrubs, large tree trunks and logs, barrier made of wooden furniture.
Climbing opportunities for sub-adults/cubs.	Living trees, dead trees and large branches to help climbing.
Escape opportunities for small and newly introduced group members.	Living trees and dead trees creating climbing frames and thick roots.
Observation points, which allow viewing beyond, the enclosure, elevated resting places.	Trees, rocks, dead trees forming climbing frames with platforms,
Hiding places for food.	Piles of branches, wooden log, which can be moved by the bears.

Designing Environmental Enrichment Models

The following enrichment models in the enclosure were tested on 41 bears during December 2002 to July 2003, at the Bear Rescue Facility, Agra.

The Behaviour of the bears was categorized according to the method proposed by Forthman *et al.* (1992). Under this the highly investigating foraging, locomotion, auto play and all the activity in water fall under "active"; resting, alert and routine behaviour fall under "passive"; some self stimulating, stereotype

or periodic pacing type of unnatural behaviour fall under "abnormal". Table 3 depicts the comprehensive behaviour values observed under the following enrichment experiments.

a. **Elevated wooden platforms:** Utilization of the provided wooden platforms by bears was 100%. Climbing on platforms give the bears a new dimension to their environment and enable them to escape from potentially aggressive interactions. 70% bears appear to enjoy getting off the ground and viewing their area.
Active 82%

b. **Scented logs:** Scented log with 1 inch/2.5 cm hole drilled into them and filled with small pieces of fruit, seed and insects. Alternatively one can fill the holes with scented herbs like mint - "Pudina" etc. The size of the hole was important so that animals cannot get tongue or claws stuck in them. The logs were suspended on thick rope from trees so that the animal keeps them rolling around.
Active 70%

c. **Honey logs:** According to Chhangani (2002) sloth bears are seen quite often feeding on honey and honey bees in the wild. During this study the honey log has an interior chamber that had bottled honey. The log was hung with a climbing structure in an enclosure with thick rope. The honey log has a sort of sucking pipe, inviting bear attention to suck and get the honey, to stimulate as of sucking honey in the wild. A rabbit laboratory water bottle with the top cut off was used for sucking process initially. The narrow spout allowed a thin trail of honey to trickle through a small hole drilled in the tree trunk. Once the bottle of honey was placed, the honey log was firmly placed and with a lid sealed by way of locking.
Active 100%

d. **Natural substrates for instinct behaviour:** Normally bears enjoy digging and removing barks from tree trunks. The response to natural substrate supplements such as large wooden logs with barks were readily accepted.
Active 38%

e. **Bedding/Nesting materials:** All bears were given straw/hay to sleep on it and form the bedding/nesting material which they modified, interestingly, in their own individual pattern. The young bears were observed keener in this activity.
Active 42%

f. **Scattering of feed:** All the bears were provided by scattering ground nuts and seeds in the enclosures, which kept them busy all around in search of food.
Active 35%

g. **Water pools :** All the bears utilized the small pool provided in the enclosure, as they enjoyed the water by leaping about, splash and fall without hurting themselves. Some boulders were placed at the pool base for providing natural grip in climbing out. The maximum depth of the pool was kept maximum of 90 cm in the centre.
Active 40%

h. **Trees and Planting:** Tress and good planting in the enclosure helped to break up lines of sight for the animals, this made animals feel more secure and helped to cut down on stress and aggression.

Table 3. Percentage of behaviour observation (coded as active, passive, abnormal under enriched and unenriched conditions during December 2002 -April 2003)

Experimental	Condition		
	Active	Passive	Abnormal
Enriched	42.6+	39.6	2.5-
Unenriched	19.3+	71.5+	8.2_

Major Recommendations for Management

1. Enclosure should largely be kept as natural as possible that relates to the scenario in the wild to stimulate the natural behaviour. An artificial pond full of water without sharpen object shall be provided for bears as they enjoy being in water specially in the summer.

Fig. 1 - Rescued dancing sloth bear at elevated wooden platform.

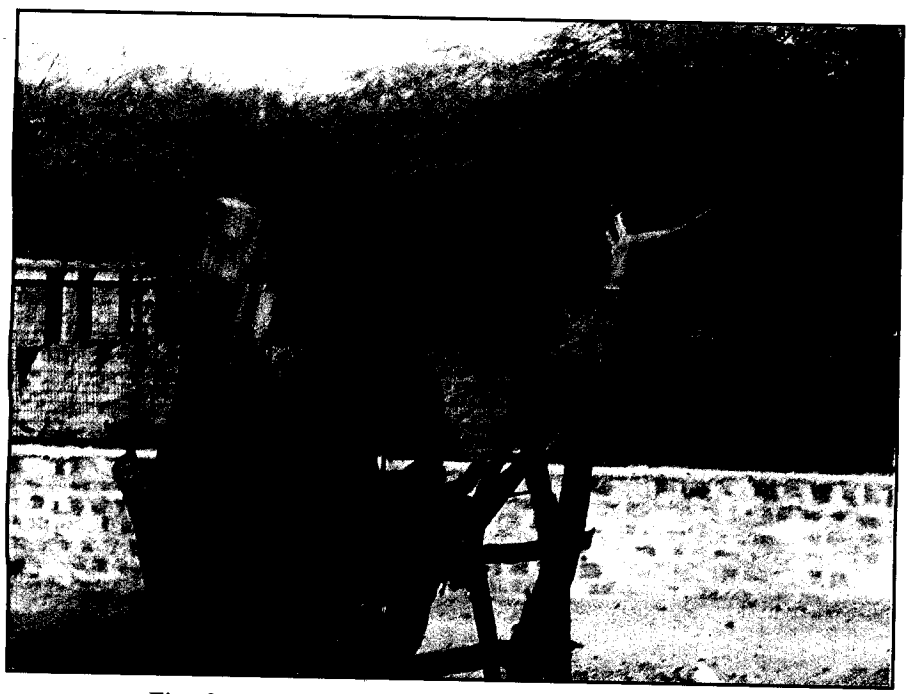

Fig. 2 - Bear engaged in playing with wooden logs

Fig. 3 - Honey log used frequently by rescued bear as feeding

Fig. 4 - Tress inside the enclosures helped to stimulate natural behaviour.

Fig. 5 - Wooden log with a hole drilled placed in the enclosure with a lid sealed by locking and sucking pipe was provided with a honey bottle inside.

Fig. 6 - Sloth bears utilizing ramp made of wooden logs between feeding and retiring cubicles/paddock area.

Fig. 7 - Trees inside enclosures provided climbing opportunities for bear to reduce boredom, helped to reduce stereotype behaviour.

Fig. 8 - Large, open, naturalistic enclosures for rescued dancing bears provided to stimulate natural behaviour.

2. The quarantine period for new bears should not be less than 60 days.
3. Visual barriers should be provided as this allows out of other's sight.
4. The socialization of the bears should be done under keen observation keeping in view the age of bears.
5. Smaller groups of animals in a well-designed enclosure would enable easier identification of individuals and observation of their health.
6. Enclosure should only be divided after careful consideration and evaluation of possible impact on the animals housed within the facilities.
7. Animal behaviour in the enclosures should be closely monitored to ensure good quality of life for all animals housed there.
8. Bears showing stereotype behaviour and those under stress should be kept separately and treated.
9. Bears should be provided with their main feed early in the morning, to help to reduce any stress associated with feeding time.
10. Food should not be left in the vicinity of the enclosure as it invites many diseases.
11. Mechanical feeders should only be used if they are well designed and tested.
12. The enrichment placed inside the enclosure should be carefully designed.
13. The old bears should never be mixed with young bears.
14. The bears received from zoos or other rescued from wild should never be mixed with bears rescued from "Kalandars".

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SETTING UP A HILL ZOO - AIZAWL EXPERIENCE

S. K. Patnaik[1] and Vanlal Sawma[2]

Mizoram is a state full of lofty hills interspersed by rivers, rivulets and hill streams with hardly any flat land worth the name, anywhere in the State. The 'Mizos' prefer to stay mostly on the top of the hills and hence 'Mizo' means highlander.

There was a mini zoo located inside the city, where the condition was very bad for its inmates, which had endangered species of animals and birds like hoolock gibbon, great Indian hornbill and Burmese peafowl. They were kept in small dingy enclosures due to want of proper accommodation.

Hence the government of Mizoram decided to set up a zoo for keeping animals of the region in a proper environment to educate the people and provide wholesome recreation. The Central Zoo Authority agreed to support the construction at a new suitable site.

A site was located near the Police Training College on the Silchar Road, about 22 km from the center of Aizawl city.

Though relatively less steep compared to the neighbouring hills, this was also quite steep, with slope varying from 30^0 to 60^0. Having no other alternative suitable site in view, it was decided to set up the zoo at this location. The entire slope, though had some tall trees, was full of bamboos. They came up like weeds and visualizing the topographic situation was rather difficult, as the ground was not visible through the thicket.

Obviously, the first priority was to lay the main internal road, so that the preparation of layout plan, placement of different exhibits and facilities can follow.

Relatively gently sloping land was selected for planning the first phase of the zoo and road was laid from the top going down the slope with three 'U'

[1]Plot No. 81, Fishery Lane, P.O.-Budheswari Colony, Bhubaneswar - 751 006, Orissa.
[2]Deputy Conservator of Forests (Wildlife) Aizawal, Mizoram.

bends after parambulating the area on foot. Adequate slope protection with random rubble parapet walls and proper drainage was essentially needed as the land was very slushy and it rained heavily for almost five months in a year. The boulders had to be transported from long distances and so was the case of sand, brought from Silchar area.

After the laying out of the main road only one relatively flat land was located not far from the lowest point of the zoo area. It was decided to give this to the hoolock gibbon, which deserved a large enclosure with wet moat for simulating their habitat.

The space, water availability and topography restricted our option for large enclosures with wet moats. Therefore, dry moats and chain link mesh was provided to non-climbing animals, while animals like leopards, small cats and macaques were given chain-link mesh exhibit with inclined steel plates on top to prevent escape. This type of exhibits had been tried earlier in very few zoos.

There was only one motorable road. It was felt difficult for visitors to approach all exhibits from there and return back the same way, up the hill. But providing another road link to this road was difficult as it was very steep and would unnecessarily spoil the scarce land and subject the land to erosion. In order to address this problem, it was decided to lay a footpath for the visitors, with proper paving. All paving options were very expensive due to lead for carriage of construction materials. After much thought, and exploring alternatives, over-burnt bricks were selected as paving material.

Even this narrow path was difficult to lay , due to steep slope. It needed slope protection, culverts and proper drainage arrangement. Some attractions had to be provided to minimize monotony of walking long distance before the first proper exhibit. It was decided to set up interpretation center and aviaries for cage birds, benches and informative signage, before one comes to animal exhibits of herbivores. These huge enclosures set up on steep slopes, continued to have its bamboo growth and enclosed into chain-link fence, with moat, only on a portion of visitors' gallery for unhindered view. Bamboo was kept mainly to prevent soil erosion. A visitor would go down this slope and slowly come up

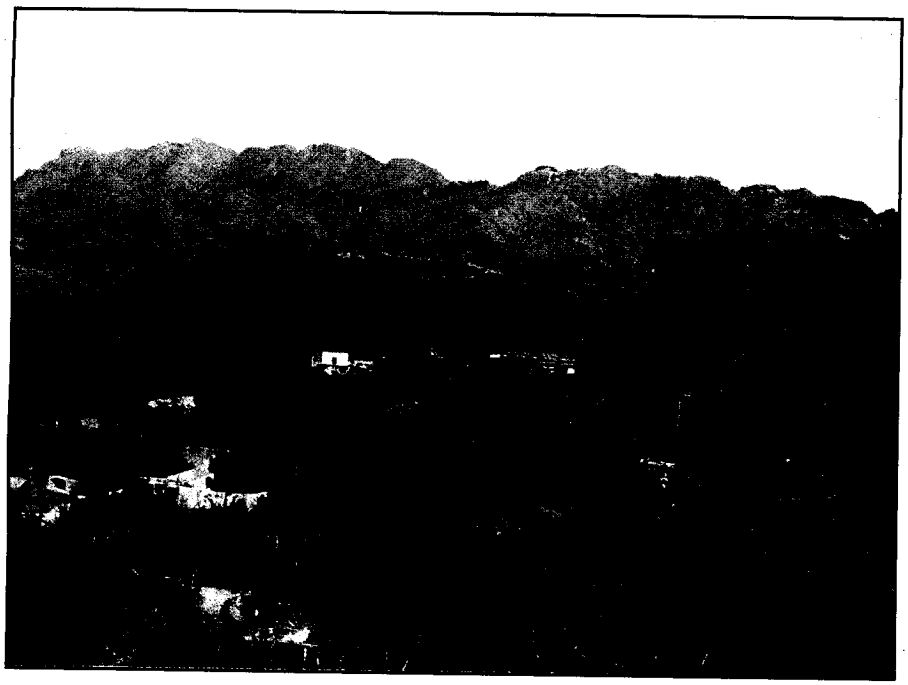


Fig. 1 - A view of Aizawl zoo under construction

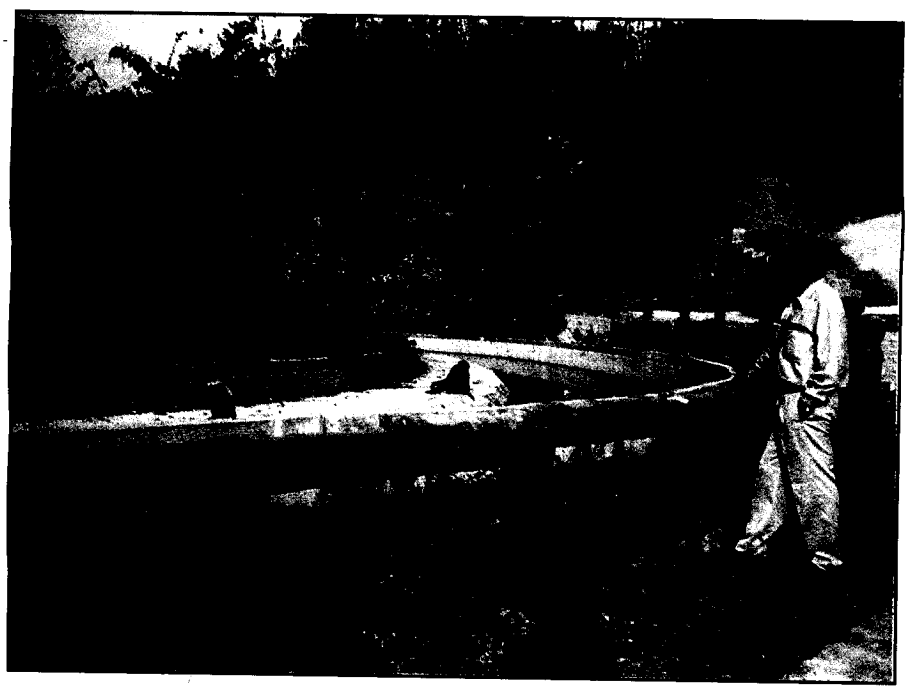


Fig. 2 - Hoolock Gibbon island

reproduced. There are much difficulties in breeding of many groups of animals.

4. Even if, we utilize the capabilities and existing capacity of all zoos and aquariums in the world, we may not be in a position to meet the present level of requirement for conservation breeding of threatened species. At the present level of available facility, a maximum of about 900 species of vertebrates can only be kept alive in captivity. But, more than 2000 species of mammals, reptiles and birds would have to be bred in captivity in near future for saving them from extinction.

Ulysses Seal (1991) had estimated that over 3000 vertebrate species and subspecies will require a captive propagation programme within the next 50 years to survive.

Number of threatened species (critically endangered, endangered and vulnerable) by major groups of organisms

Group of organisms	Number of described species	Number of species evaluated in 2004	Number of threatened species in 2004	Number threatened in 2004 as % of species described	Number threatened in 2004 as % of species evaluated
Vertebrates (Fishes, Amphibians, Reptiles, Birds & Mammals)	57,739	22,733	5,188	9%	23%
Invertebrates	11,90,200	3,487	1,992	0.17%	57%
Plants	2,87,655	11,824	8,321	2.89%	70%
Lichens	10,000	2	2	0.02%	100%
Total:	15,45,594	38,046	15,503	1%	41%

[Source: IUCN Red list of threatened species, 2004]

The above information shows the dimension of conservation need. There are a large number of species which are yet to be evaluated in terms of threat categories or status of threat. There may be species actually threatened in a particular region but not yet evaluated for the purpose. Naturally, there lies great task ahead for contributing significantly in Biodiversity Conservation.

5. There are two significant areas of concern worldwide.

   i) The percentage of threatened species for conservation breeding in the zoos have not gone up to the desired level over a period of time. This shows that we are missing our priorities.

   ii) There is no significant increase in breeding of threatened species in captivity. This shows a big gap in promise and delivery.

   A large number of genuine and varied reasons may be attributed to these problems. We may overcome many of these hurdles once we start thinking in this direction. It is important to make correct move based on scientific inputs or information and database. This will ensure survival and recovery of a large number of highly threatened species. Improvements in working situation of zoos for achieving conservation goals are important task . Now, zoos and aquariums must come up with their own conservation agenda in all seriousness. This will help improve situation. We may discuss and analyze here some of the issues involved. This may further facilitate a wide ranging discussion and exchange of information.

Zoos really had little inputs for conservation issues till seventies but the scenario started changing and lots of responsibilities are now entrusted on these conservation centres (i.e. zoos). In fact, ***in-situ*** conservation is ideal and the recovery of species are required to be ensured right on the site i.e. in the natural habitats of the species. In absence of ideal situation due to several adverse factors, the survival of species may not be possible in the wild or in their natural habitats. In such a situation, zoos may contribute a lot through conservation breeding and reintroduction programmes . It is desirable that no zoos should keep animals without looking after these animals in the wild. Conservation education, advocacy, research and training meant for conservation of species are also some of the key areas where zoos contribute a lot due to the unique position held by these organizations and the capability of interacting with a large number of people/visitors on regular basis.

It is appropriate to attend the following conservation strategies.

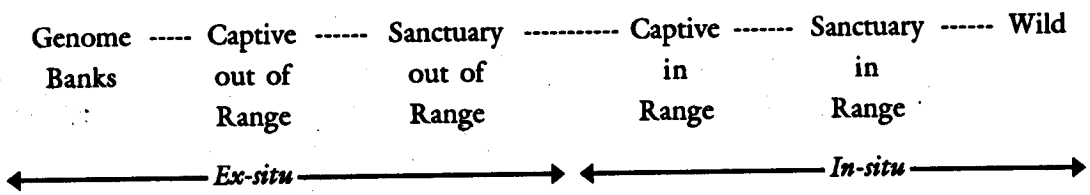
---- Protection of larger population in natural habitats/ecosystem.

---- Intensive *in-situ* management of smaller populations in natural habitats/ecosystem.

----- *Ex-situ* programmes to reinforce wild populations.

Zoos as vibrant conservation centres are in a position to contribute significantly in achieving above strategies

Captive (*ex-situ*) and wild (*in-situ*) are really poles of a spectrum. Mark Stanley Price (1993) has suggested a visualization of this spectrum as depicted below.



Conservation of species

World Association of Zoos and Aquariums in its publication,"Building a future for Wildlife — The World Zoo and Aquarium Conservation Strategy" defines conservation as follows.

"Conservation is the securing of long-term populations of species in natural ecosystems and habitats wherever possible".

Though definitions of conservation are many and varied but this definition is simple, straight forward and understood by everyone. The underlined words "natural ecosystems and habitats" signify that no efforts are of ultimate value if it does not ensure survival of species in the wild. In addition, these wild populations must be able to develop and evolve.

Prioritization — Immediate need

Zoos usually have limited resources (eg. space, finance, professionals etc.) at their disposal. It is essential to go through the prioritization exercise by

taking into consideration the resources available, conservation goals required to be attended and several other factors. It is desirable to prioritize according to degree of urgency. For example, it is a wise proposition to keep a small number of species of high conservation value and meet their conservation needs rather than keeping a large number of insignificant collection (without much conservation value) and also unable to attend the required conservation needs.

Once the priorities are decided, one may concentrate on effective planning and implementation of prioritized goals.

Selection of Species for Conservation Breeding

Again, it is guided by available resources, priorities, conservation goal or agenda set and capabilities and capacity of the zoo to handle such a species. The selection of species for conservation programmes is really very important for achieving conservation goals. The following important considerations may help in analyzing the situation. One may also integrate more than one situation for analyzing the scenario for selection of priority species for conservation breeding.

1) IUCN categories of threat : It may not be possible to quantify exactly what proportion of biodiversity now face extinction. It is not out of context to mention that a large number of World's organisms have not ever been named or studied and their status are also yet to be studied. However, a few groups of organisms/species are well known and their threat status has been comprehensively assessed using the criteria of the IUCN Red list. Over 40 years of these data on species, subspecies, varieties and sub-population and their status, based on objective information and scientific base which have contributed a lot, are available for formulation of conservation programmes. All criteria of threat status are not appropriate for every species. A species must meet one of the criteria to be listed under a particular threat category of Red List of IUCN. For example, the following criteria reflect the status of threat categories (mentioned briefly).

A taxon is Critically endangered, Endangered or Vulnerable when the best available evidence indicates that it meets any of the following criteria.

Rapid decline in population size : observed, estimated, inferred or suspected.

Critically Endangered : Population size reduction of ≥ 80% over the last 10 years or 3 generations whichever is longer.

Endangered : Population size reduction of ≥ 50% over 10 years or 3 generations whichever is longer.

Vulnerable : Population size reduction of ≥ 30% in 10 years or 3 generations whichever is longer.

Small geographic range - fragmented, declining or fluctuating

	Critically endangered	Endangered	Vulnerable
Extent of occurrence or Area of occupancy	Less than 100 km^2 / Less than 10 km^2	Less than 5,000 km^2 / Less than 500 km^2	Less than 20,000 km^2 / Less than 2,000 km^2

Declining Population Size

	Critically endangered	Endangered	Vulnerable
Number of mature individuals	Less than 250 Nos.	Less than 2500 Nos.	Less than 10,000 Nos.

An estimated continuing decline of at least :

25% within 3 years or 1 generation whichever is longer (up to a maximum of 100 years in the future). : Critically Endangered

20% within 5 years or 2 generations whichever is longer (up to a maximum of 100 years in the future). : Endangered

10% within 10 years or 3 generations whichever is longer (up to a maximum of 100 years in the future). : Vulnerable

Continuing decline observed, projected or inferred due to severe fragmentation in population structure:

With no sub-population estimated to contain more than 50 mature individuals : Critically endangered.

With no subpopulation estimated to contain more than 250 mature individuals : Endangered.

With no subpopulation estimated to contain more than 1000 mature individuals : Vulnerable.

Population very small or restricted :

Population Size estimated to number fewer than 50 mature individuals : Critically Endangered

Population Size estimated to number fewer than 250 mature individuals : Endangered

Population Size estimated to number fewer than 1000 mature individuals : Vulnerable

Percentage of probability of extinction in the wild :

At least 50% within 10 years or three generations whichever is the longer (up to a maximum of 100 years) : Critically Endangered.

At least 20% within 20 years or five generations whichever is the longer (up to a maximum of 100 years) : Endangered.

At least 10% within 100 years : Vulnerable.

(For more details IUCN Red List categories and criteria may be referred)

Such threat categories are highly useful in deciding conservation priorities and programmes.

2) Focus on endemic and endangered species : Species which are highly threatened (especially Critically endangered or Endangered) and endemic to particular area, may be considered as priority species after due assessment of entire scenario. For example, a number of islands and highlands (14% of globe's surface with 77% of World's endemic terrestrial vertebrates) are areas with high endemism and species are also more at risk in many of these locations. Species of islands and highlands are particularly vulnerable to extinction. Many of the species of Western Ghats of India, North eastern India and Himalayan range, are endemic to these areas and also face very high risk to their survival. In addition to these areas, there are threatened species endemic to many other

areas/eco-regions also. Such species may be identified on regional basis and enlisted for the purpose.

3) Regional priorities and representatives of the local eco-regions : Species native to a particular region may be considered for the purpose. The threat status of such species may be known and sometime, it is not known also. The status of all animals has not been evaluated as per IUCN categories of threats. Many threatened species of a particular region are thus, required to be assessed independently also as per regional priorities. Every zoo must keep threatened species, representative of that region or the local eco-regions where zoo is located. This will take care of regional priorities and biodiversity of local eco-regions. Such a thrust is quite significant for long term survival of highly endangered species of the region. A number of such species otherwise neglected, may be taken care by a number of zoos operating in the region.

4. Considering bio-geographic zones and Protected Areas : Representative threatened and endemic species in ten Bio-geographic zones of the country (i.e. Trans-Himalaya, Himalaya, Desert, Semi-arid, Western Ghats, Deccan peninsula, Gangetic plain, Coasts, North-east and islands) and different Protected Areas in these zones may also be taken into consideration in prioritization exercise. Other habitat specific considerations within these Bio-geographic zones such as Biotic Provinces, Bio-geographic regions and Biomes may be important and useful. The zoos of a particular region may emerge as specialist zoos of that region and take up well defined conservation breeding programmes for species, representative of these areas.

5. National priorities : There may be national priorities in complementing and strengthening national efforts in conservation and zoos may be required to focus on certain defined areas of conservation also. However, many such situation are usually overlapping in nature.

6. International commitments: Sometime, certain conservation programmes may be on account of international commitments to the biodiversity/species conservation.

7. Taxonomic uniqueness : There may be a situation where species of a particular taxonomic group may have uniqueness of their own and are likely to suffer a lot in near future in view of prevailing situation. Recovery programmes may not succeed if conservation activities are not started early.

8. Considering the Critically Endangered or Endangered species having the last remaining refuge : The focus on last remaining refuge of one or more Critically Endangered or Endangered species and considering these species for conservation breeding programmes is also one important area of much significance. The information maintained by Alliance to Zero Extinction may be useful in many ways for conservation efforts to be undertaken.

Alliance for Zero Extinction (AZE), a joint initiative of biodiversity conservation organizations (at present 52 nos. of such organizations in 18 countries) from around the world, aims to prevent extinctions by identifying and safeguarding key sites, each one of which is the last remaining refuge of one or more endangered or critically endangered species. AZE's goal is to create a frontline defence against extinction by eliminating threats and restoring habitat to allow wildlife populations to survive and grow. The purpose of alliance is to identify sites in most urgent need of conservation and to act together to prevent species extinctions. AZE is not led by any one group but it is a true alliance and all members can contribute to the level they desire and are able. The details are available on the site **www.zeroextinction.org**

9. Flagship species: The flagship species may also be considered while undertaking selection of species for such programmes.

10. Educational and research value: This may be an area of consideration for selection of species.

11. Other considerations: There may be certain other considerations which may be clubbed with highly threatened status of species. These may include Species with established husbandry protocols, species with already established and healthy populations etc.

Various considerations as stated may be overlapping sometime and it may be sometime repetitive in nature. But, integration of various considerations

Photo : Kamal Purohit

A hatching Gharial

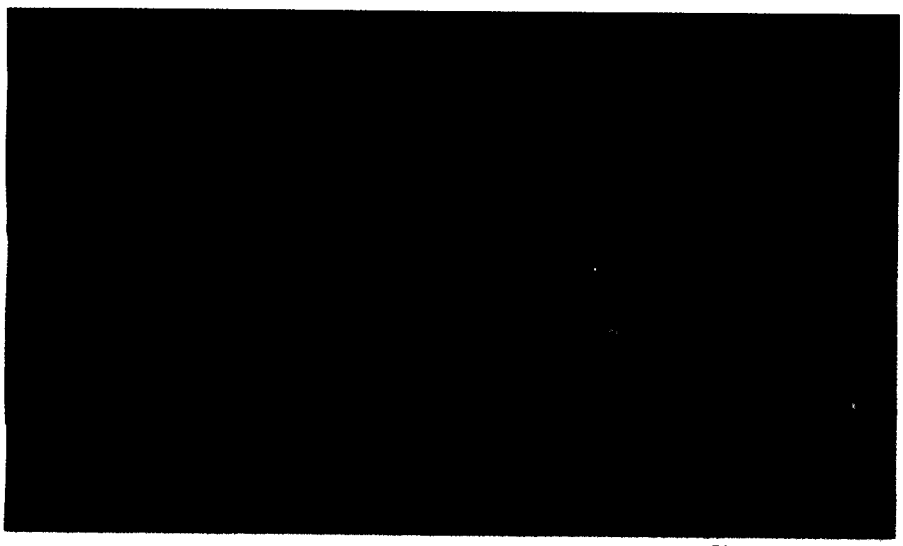
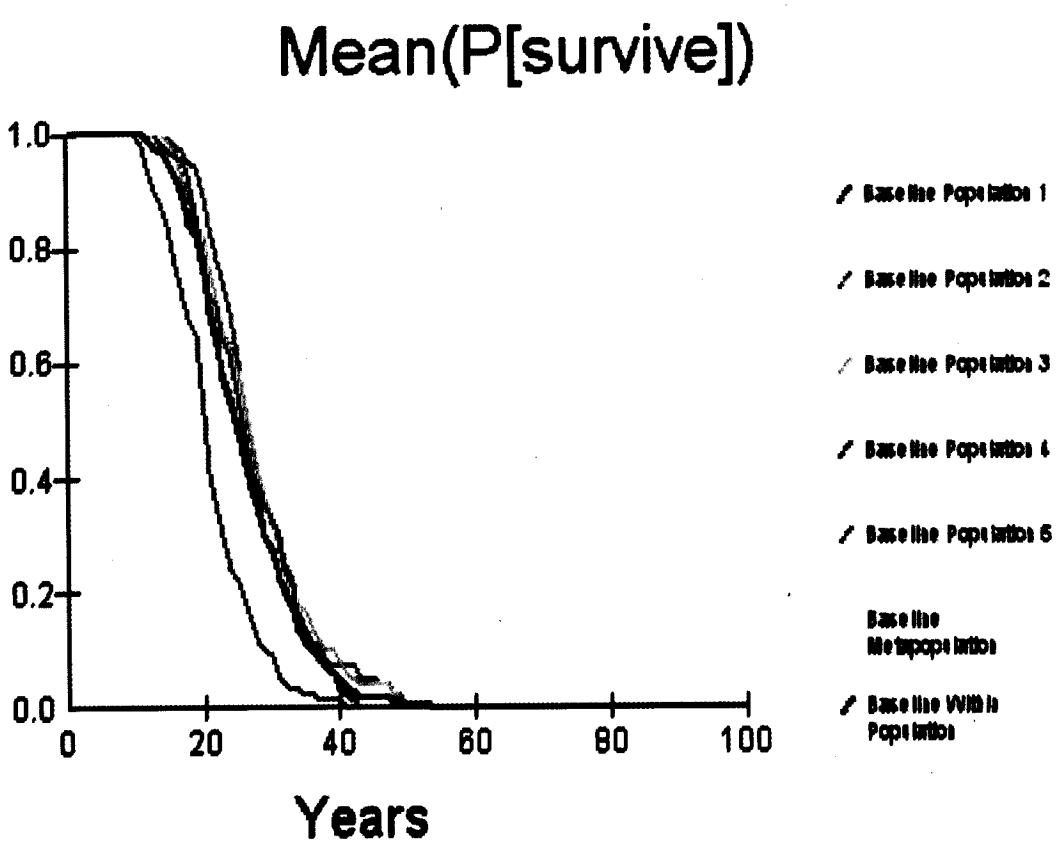


Photo : R. Marimuthu

A Gharial (*Gavialis gangeticus*) on the bank of waterbody

The family Gavialidae is represented by a single living species, *Gavialis gangeticus*. The small population of gharial is again fighting for survival as the drastic decline in population in the natural habitats has been noticed in recent years. Post-release monitoring and further follow up action and understanding of limiting factors for intensive management of the species for long term survival were some of the key areas required to be worked out effectively after successful conservation breeding and release of gharials during the implementation of Crocodile Conservation Project in India in seventies and eighties. Now, a fresh look on the entire situation is required.



A Projection of survival of Western Tragopan (*Tragopan melanocephalus*)

with holistic approach may yield well analyzed results for achieving conservation goals.

Evaluation for Population Management of species

Though IUCN Red List maintains threat categories and status of a number of species based on specific criteria.The field exercises for status survey of species, habitat analysis and such other evaluation for conservation of species are essential for population management. The Population and Habitat Viability Analysis (PHVA) is an important exercise which has been carried out for a number of species to analyze and evaluate their status.

VORTEX which is a computer simulation modeling tool and is utilized for seeking information to address the extinction process of species, habitat problems etc., may work well in analyzing and assessing the status of a species in the wild/natural habitats. We may analyze the situation through a number of parameters which contribute to the required management inputs. By using VORTEX, we may quantify a number of information such as Mean time to extinction, population size, Probability of extinction, Loss of genetic diversity, Final gene diversity, Inbreeding depression etc. and use them in various exercises for conservation and management of small population of wild animals. The population and habitat viability assessment can be made with the help of this tool.

For example, the Mean Projected Time for survival of an endangered pheasant of north-west Himalayan region, Western Tragopan (***Tragopan melanocephalus***) was derived by using VORTEX as a part of an exercise (only indicative representation here for discussion). The required inputs for analysis were prepared basing on available primary information and certain information from secondary sources for five sub-populations at five locations (total 2100 numbers) in Himachal Pradesh. The mean projected time for survival of Western Tragopan in it's natural habitats in Himachal Pradesh is 40-50 years. The extinction may be recorded early if situation does not improve but deteriorates. The analytical evaluation shows that effective management interventions in the wild are required to be planned and implemented. If the improvements in

in-situ management are achieved and elimination of hostile factors is ensured effectively, the species may survive on long term basis. In case, situation worsens, the conservation breeding in captivity and supplementation in the wild alongwith *in-situ* conservation measures may be appropriate solution. However, a large number of factors are required to be evaluated and analyzed for the assessment of long term survival of species.

Maintaining Viable Populations of Selected Species

It is important to maintain viable populations of selected species for long term survival. The *ex-situ* populations should be of sufficient size to meet multidimensional criteria for maintaining overall population and meeting other needs (such as social/behavioral needs of animals, availability of required animals for reintroduction etc.) The effective participation of various organizations in co-operative breeding programmes at regional or global level is highly significant for achieving good results. Unfortunately, many *ex-situ* conservation breeding programmes suffer due to various reasons such as very few founder animals, depleted genetic diversity, lack of cooperative participation of zoos in the conservation breeding programmes etc. These problems are required to be addressed properly. Zoos may expand breeding spaces in off exhibit areas, expand cooperation among zoos and other conservation centres for conservation breeding programmes and increase intensity of genetic management by properly complying breeding recommendations. Improvements in husbandry practices, behaviour of animals, nutrition and healthcare are necessary for better success. Research for better reproductive performance may also be needed in many species. The inclusion of additional animals from the wild or other such regional programmes are required in phases for effective population management.

It is important that the population management which includes demographic management, genetic management, upkeep of animals /husbandry and healthcare, is attended effectively with a well coordinated approach. The constraints of one area affects the other areas of management adversely.

Demographic management is related with monitoring the age, social and sex structure of the population, and number to ensure reliable reproduction as

well as determining the number of animals that need to be bred to achieve desired growth rate. The analytical software using data of stud book , is used for estimation of various desired parameters and applying the same in management of population. Genetic management includes verification of taxonomic identity of animals and designing of breeding programmes to meet primary genetic challenges such as deleterious effects of inbreeding, genetic adaptation to the zoo environment (similar to domestication), loss of genetic diversity, appearance of deleterious traits etc. It is necessary to ensure scientifically sound and well managed upkeep of animals and husbandry practices.

A well attended veterinary care ensures a good population of healthy animals, essential for conservation breeding.

Behavioral needs of animals are required to be met through proper social group structure, correct housing facility and exhibit design and adequate enrichment of living spaces. There are many areas of research activities required to be attended. The monitoring exercises for maintenance of viable population are essential on regular basis.

Data Bases and Record Keeping

Databases and record keeping are basic tools to manage a viable and sustainable population in any conservation breeding programme. It is very important to keep records on individual animals in the collection of a zoo using standardized software package eg: Animal Record Keeping System (ARKS) developed by ISIS. The important data bases required to be developed, include place of origin, date of birth and death, parentage and off springs, information on diet/feeding, healthcare and treatment, breeding habits etc. Records for particular species are also kept in studbooks, either internationally, regionally or nationally. Stud books are maintained by Studbook Keepers. International Studbooks are the responsibility of World Association of Zoos and Aquariums and regional stud books are the responsibility of the relevant Zoo Associations in the region or any Zoo Organization representing them in the region for the purpose. There are also some specialized software packages for analyzing

studbook data and providing management inputs or recommendations. The packages may be utilized in various ways as per requirement.

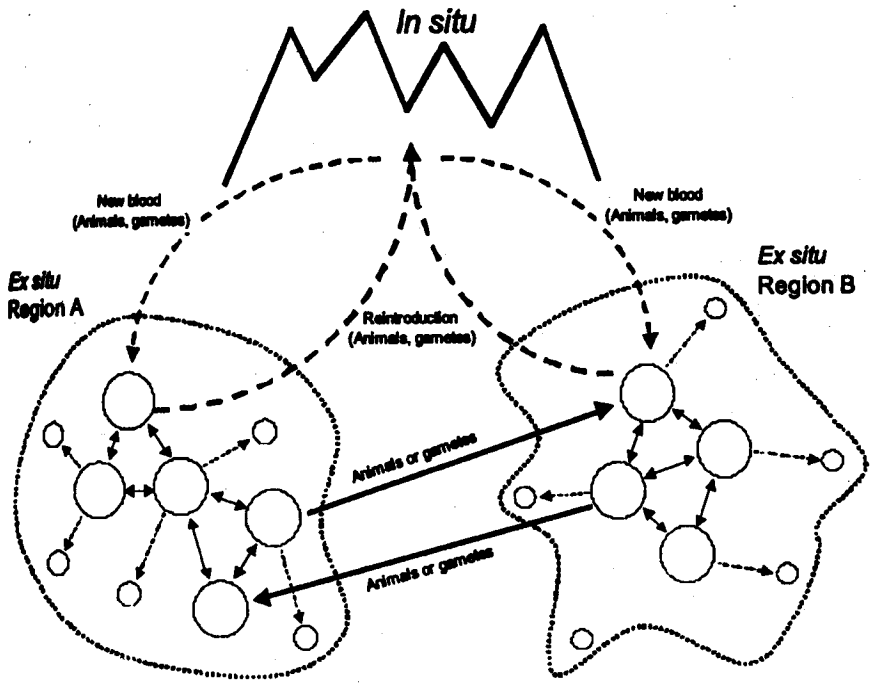
It is desirable to promote the establishment and widespread use of data bases and resource banks in zoo conservation efforts. In order to achieve greater efficiency in managing data and to support a wide range of animal management and conservation activities, a comprehensive and integrated web-based information system called Zoological Information Management Systems (ZIMS) to be run by ISIS, will be available for access soon.

Metapopulation Management

The main aim which we must focus is ensuring survival of endangered species in the wild. For the purpose, the cooperative *ex-situ* breeding programmes are required to support *in-situ* conservation of species in it's natural habitats. Various ways of supporting species for survival may be through rescue of species threatened with extinction in the natural habitat and undertaking conservation breeding and reintroduction programmes, research, education or promotion efforts that support *in-situ* populations or simply serving as genetic and demographic reservoirs as back ups for *in-situ* endangered populations. The role of *ex-situ* populations can vary from functioning as such genetic or demographic reservoir, with little interactions with *in-situ* population to maintaining population with extensive gene flow in both directions (reintroduction and periodic inflow of new founder animals). Many of the problems of *in-situ* populations may be similar to *ex-situ* populations in certain situation due to small size of the population of highly endangered species restricted to very few natural habitats or pockets. The techniques and science of small population management developed for managing *ex-situ* populations , will prove highly useful in handling situation in such *in-situ* condition. Zoos and aquariums are in unique position of providing necessary inputs and expertise in attending such needs. Reintroduction is an important link and component between *in-situ* and *ex-situ* conservation of species.

A useful model describing the potential relationships between *ex-situ* and *in-situ* population management is the Metapopulation Management model

(as illustrated below), a set of interacting populations being managed under one conservation goal.



An Indicative illustration of Metapopulation Management

This may involve a number of components for exchanges among breeding organizations (larger circles), disposition of post-reproductive or non-breeding animals in peripheral institutions (smaller circles and dotted lines), transfer of animals between regions, reintroduction of zoo born animals into natural habitats and periodic transfer of wild animals to the *ex-situ* population. With future advancement in reporductive technologies, transfer of genes among units of the metapopulation could be through animal or gamete transfer.

(Source : WAZA (2005) : Building a future for Wildlife -- The World Zoo and Aquarium Conservation Strategy)

These plans for management of populations depend upon several factors and species - specific and site-specific conditions vary on case to case basis.

Principles and Protocols in Conservation Breeding ----- Salient features

Some of the issues have already been discussed and found place in different sections of this chapter. The other salient features which are required to be mentioned, are presented briefly here.

- Selection of breeding stock of founder members of species is required to be attended carefully and these individual members are to be marked. The record keeping for these animals are essential right from the beginning.
- The genetic screening and health screening of these animals ensure the availability of good breeding stock.
- The familiarization with reproductive behaviour, pairing and grouping of selected individuals, recognition of secondary sexual characters, sexing of monomorphic species, understanding the importance of pair compatibility, avoiding inbreeding, seasonality in reproduction and artificial control of breeding cycles (if necessary). and many other areas , is required for devising appropriate management practices for the species.
- The mating of individuals are to be ensured in a way that off springs will have low inbreeding coefficients.
- The mating success depends upon several factors such as age of individuals, mate-choice, social structure etc. It is important to maximize mating success on the basis of various considerations.
- The judicious application of artificial methods of reproduction / rearing such as incubation, artificial insemination, double clutching (clutch extension), fostering, embryos transfer or manipulation, cryo-preservation etc. improve reproductive performance.
- It is desirable to closely monitor the infertility frequency, development of abnormalities and birth or hatching problems and attend the same effectively.
- The multiple populations are to be established by separating the main population meant for conservation breeding into various groups or colonies to reduce the risk of diseases, epidemic or disasters.

- In many cases, the high reproductive rate, resulting into unwanted growth in captive population, may be required to be regulated. Various methods such as direct methods like separation or through contraception (eg: drugs, surgery etc.) may be required to be considered.
- Proper Nutrition and hygiene are important factors. The diet chart and protocols to be followed for maintaining hygiene are to be developed for routine follow up action. The substitute diet when prepared, should be as similar as possible in content, taste and nutrition to the wild diet. It should be palatable (preferred by animals), nutritionally balanced, uncontaminated, toxin free and easily and cheaply procured. The situation in captivity is different from that of wild and it is necessary to pay due attention to feeding, proper space for comfortable and stress free environment and adequate hygiene.
- Food must be recognizable and acceptable to the animal. Different species have specific and different feeding habits and needs. The delivery of different types of food must be staggered in order to maintain nutritional balance. For example, the least preferred but nutritionally important food can be provided first in a fixed feeding area as a hungry animal may consume it readily. Highly preferred food items can be provided later and made less accessible, hidden or scattered so that animal works and searches food as in natural wild condition. This also enables animals to perform occupational exercises.
- The spatial distribution of food must be carried out according to group size and social structure. Problems of dominamace and competition can be avoided by dispersing food appropriately at different places or separating individuals at the time of feeding.
- The level of disturbance is to be reduced in captive animals. The animals may fail to reproduce successfully due to prolonged stress. The frequent and prolonged stress makes the animal susceptible to diseases.

- The special attention towards diet and nutrition for breeding females and young ones is to be paid as per requirement for ensuring proper growth and development.
- It is necessary to fulfill considerable amount of physical and behavioual needs of animals in captivity so that they express their normal behaviour. Sufficient space and proper facilities (for free movement and social and behavioural interactions) and suitable environment including proper shelter, resting area and occupational exercises are necessary for them.
- The environmental enrichment of enclosures and living spaces is one of the focal areas of planning in captivity as it allows the animals to live normal life and behave normally. For example, suitable vegetation or furniture and facilities that facilitate natural movement and behaviour (eg: climbing, swimming, running, burrowing, digging, bathing, wallowing etc.) are important considerations. Environmental enrichment may be natural (for recreating the natural environment for meeting social, physical and psychological needs) or artificial (mechanical devices or behavioural supporting system to promote natural activities in the animal).
- Necessary health care (with prevention of injury and disease, rapid diagnosis, treatment etc.) is to be ensured.
- It is important to maintain optimum levels of temperature, humidity and light to simulate an environment similar to the animal's natural habitats. It also influences the reproduction of many animals in addition to expression of normal behaviour. In case of extremes of weather/seasons, appropriate steps for moderation of environmental conditions may be needed in many groups of animals.
- The private areas where the animals can retreat whenever it wants to, should be planned and in no case, approach of visitors should disturb or alarm the animals.
- Social animals should be taken care by keeping them in compatible social groups with appropriate age, sex, structure, dominance, hierarchies etc.

- It is not only number of animals that is important but also their quality or genetic make up.
- It is important to gain proper understanding of reproductive biology, physiology, identification of species and subspecies, determination of sex, age and fertility status, signs of pregnancy, parturition and behaviour, correct social grouping, pair compatibility, signs of courtship and mating etc.
- Handling, restraining and transportation are some of the activities required in captivity. It is necessary to plan these activities (such as feeding, cleaning and other management activities) in a way that a minimum stress is caused to the animals. However, the handling of animals is to be attended only when it is absolutely necessary for management or veterinary needs. Transportation of animals should be comfortable with adequate space and as quickly as possible.
- It is necessary to minimize logistic difficulties for ensuring success in conservation breeding.
- There are five important stages of species restoration.
  - --- Knowledge about the species (life history, ecology, population size, distribution etc.)
  - ---- Understanding Limiting factors
  - ---- Intensive Management (in case of critically endangered or endangered species)
  - ----- Population Management (includes addressing of controlling factors)
  - ----- Research and Monitoring.

Education, Advocacy, Training and Research

These are some of the focal areas for success of any such project for conservation breeding and reintroduction / supplementation. These activities are required to be properly planned, coordinated and attended. The training of frontline staff , biologists, researchers and educators is needed at various stages.

Reintroduction

The IUCN/SSC Reintroduction Specialist Group has issued guidelines for reintroduction projects. The principal aim of such reintroduction projects should be the establishment of a viable and free ranging wild populations of a species or subspecies, which has become globally or locally extinct or facing very high risk of extinction, in the wild. It should be reintroduced within the species' former natural habitats/range and should require minimal long term management. IUCN/SSC Reintroduction Group has defined a number of terms such as Reintroduction (taken up in historical range of species), Introduction (in an area outside its recorded distribution range), Conservation or Benign Introductions(outside its recorded distribution but within an appropriate habitat and eco-geographical area for the purpose of conservation), Re-enforcement/ Supplementation/Restocking (addition of individuals to an existing population) and Translocation (deliberate mediated movement of wild animals to an existing population of conspecifics) and has issued a set of guidelines to be followed for reintroduction. It is necessary to follow these guidelines to handle reintroduction projects effectively on scientific line and for achieving desired conservation goals. It is also important to follow IUCN technical guidelines on the management of ***ex-situ*** populations for conservation.

The following important action points may be undertaken for conservation of species through conservation breeding and reintroduction.

- Such projects are to be scientifically managed with clear objectives.
- Population Management (both under ***ex-situ*** and ***in-situ*** conditions) is required to be scientifically planned for long term survival and sustainability.
- Required protocols and IUCN Guidelines are to be followed for reintroduction/ supplementation/release.
- A Conservation Breeding Plan and a Reintroduction Plan(by attending various considerations) should be formulated and implemented.
- Integrated and multidisciplinary approach are required for success.

- Pre-release surveys and assessments of release sites, population structure and other factors and post release monitoring on regular basis are to be attended.
- The long-term preservation and protection of these potential sites of reintroduction are to be ensured.
- Involvement of local community is also desired.
- Research/Scientific Study form the integral part of such efforts on long term basis .
- Education/Awareness and Advocacy are essential ingredients for desired result.
- The information base/data for successful efforts and even on unsuccessful results are important (there may be many learning inputs from failures also).

The result of reintroduction may not sustain long in absence of effective post release monitoring. It may not be sufficient and lasting in many cases . It may be a long and expensive process in different situation. Thus, it is important to support field units of conservation professionals for ***in-situ*** conservation activities in the natural habitats of the species. Zoos must come forward to formulate such conservation programmes and implement the same in the field.

Conservation Projects in India — Recent Initiatives

A few recent initiatives which are in different stages of implementation , are described in brief here for better appreciation of the facts.

Conservation Breeding Programme for Pygmy Hog (*Sus salvanius*) and Reintroduction/Supplementation : The pygmy hog (*Sus salvanius*) is the smallest and the rarest wild suid in the world. It is on the brink of extinction as only a few isolated and small populations survive in the wild. The wild population of pygmy hog, today, is restricted to a few pockets along Assam's border with Bhutan and Arunachal Pradesh (In the past, it was found in the tall, wet grasslands in the area south of Himalayan foot hills from Uttar Pradesh

to Assam through Nepal terai and Bengal duars). In fact, the only viable population of the species now exists in the Manas Tiger Reserve and no where else in the world. The number of wild pygmy hogs is estimated to be less than 500. The world conservation Union (IUCN) has accorded the highest priority conservation rating (Critically endangered) to the species putting it among the most endangered mammals. It is listed in Schedule - I of the Wildlife (Protection) Act, 1972.

The main threats to survival of pygmy hog are loss and degradation of habitat due to human settlement, agricultural encroachments, flood control schemes and improper management of their wild habitats. The survival of pygmy hog is closely linked to the existence of the tall, wet grass lands of the region which, besides being a highly threatened habitat itself, is also crucial for survival of a number of endangered species such as one horned rhinoceros (*Rhinoceros unicornis*), tiger, swamp deer, wild buffalo, hispid hare and Bengal florican. The important recovery programme for highly threatened species and their equally endangered habitats is being conducted under the aegis of a formal International Conservation Management and Research Agreement (ICMRA), signed between IUCN/SSC Pigs, Peccaries and Hippos Specialist group, Durrell Wildlife Conservation Trust (DWCT), the Forest Department, Govt. of Assam and MoEF, Govt. of India, later renewed through MOU. A local governing body consisting Indian experts and officials has been formed for the management of the programme. The DWCT is the main financial sponsor for programme and funds for the first three years were largely provided by the European Union through the trust. Currently, donations to the trust by individuals and organizations were helping in continuation of the programme.

The main aim of this collaborative programme is conservation of the pygmy hogs and other endangered species of tall grass lands of the region through field research, captive breeding and reintroductions after adequate restoration of degraded former habitats.

In 1996, six wild hogs (2 males and 4 females) were caught from Manas National Park and transferred to a custom built research and breeding centre

unit at Basistha near Guwahati. Five more hogs were caught and released at the capture site after fitting three males and a female with radio harness for radio-telemetry studies. There are 73 hogs (as on October, 2005) at the centre after successful breeding of these hogs. A population of about 70-80 hogs are maintained at the Research and Breeding Centre. The DNA studies to determine relatedness among the wild caught and the wild sired individuals to maximize the heterogeneity in captivity in captive population for long term survival has been carried out with the help of Centre for Cellular and Molecular Biology, Hyderabad. The introduction of few more wild hogs into the present population from time to time has also been planned. In addition to the concluded first phase of radio-tracking studies in Manas, a wide ranging survey of known and suspected sites of pygmy hog distribution has been carried out. Grassland studies are being carried out in collaboration with Gauhati University to provide grassland management guidelines for conservation of natural floral and faunal diversity of the grassland habitats. Field works are underway in Manas where camp has been established. Surveys to locate possible reintroduction sites were carried out and couple of sites in Assam were short listed. As the captive population of the pygmy hogs at Bisistha comprised the entire global population of captive pygmy hogs, it was important to shift some of the hogs to a second site. The site for a pre-release centre was identified at Potasali near Nameri National Park and this large facility is being constructed in phased manner. Four holding enclosures has already been constructed and four large pre-release areas are being established. These facilities are part of the soft release process and consist of near natural habitat where hogs earmarked for release to the wild would be reared before taking them to reintroduction sites. Sonai Rupai Wildlife Sanctuary, situated about 20 km west of Nameri, has been selected as one of the first release sites.

The reintroduction/release of these hogs are now at the advanced stage of planning. This excellent effort undertaken, will be able to secure the future of pygmy hogs.

Project Red Panda : The red panda (*Ailurus fulgens*) is one of the striking creatures of the north eastern forests in India (best seen at Singhalila National

Park in West Bengal) and they are endangered (as per IUCN Red list) and protected under Schedule - I of Wildlife (Protection) Act, 1972. The major conservation threats are habitat loss and poaching. The population in the wild is declining. Padmaja Naidu Himalayan Zoological Park (PNHZP), Darjeeling, has taken major steps in conservation of red panda by conservation breeding and release programme. The project red panda was started in the 1990s as a part of the Global red panda Management Programme. The zoo received six red pandas from various foreign zoos to augment the existing population of five wild red pandas in the zoo. The project aimed at systematic breeding of red pandas in captivity and their ultimate release in the wild. A total of 37 red pandas were born in the zoo during the last nine years under this programme.

The two female red pandas (named Mini and Sweety) were released in the soft release facility at Gairibans where they were kept under observation and were given time to get acclimatized to the area of release. They were then released into the wild on 14th November, 2003. They were radio collared before their release for subsequent monitoring. The area of release which was in compartment No.3 of Gairibans beat (approximately 1 km from Gairibans) in Singhalila National Park, Darjeeling, was carefully selected on the basis of an assessment and prior pre-release survey. The monitoring of the two released red pandas started soon after their release.

The monitoring of the released red pandas was done following the non-triangulation location technique known as **Homing in on the Animal methods** and the positional data are obtained by following the transmitted signal's increasing strength until the radio collared animals is actually observed. In the present case, this method is followed by direct observation and closer look of red pandas to ensure their well being.

The radio collaring and monitoring the captive female red pandas has been able to record death, birth, movements and also their behaviour to some extent.

Unfortunately, Mini (one of the released pandas) was predated in the wild, probably by a leopard in the month of March, 2004. Sweety (another

released panda) is doing well in the wild habitats of Singhalila National Park, Darjleeing. She gave birth to a cub in the tree hallow on 7th July, 2004.

Another captive born female Red Panda (named Neelam), born on 11.06.2001 at PNHZP, Darjeeling was shifted to the intermediary release facility at Gairibans on 14.11.2003 for acclimatization and adoption to the environment there before her release to the wild. Neelam was radio collared on 12.10.2004 and released on 14.10.2004 at Gairibans where Sweety was also doing well. She is now monitored regularly and reported to be in good condition till the last reports received sometime back.

The project is in a preliminary stage of release programme and progressing very well. It is expected that the desired results will be achieved in due course.

Vulture Conservation Projects : Tens of millions of vultures used to be present across India, Pakistan and Nepal. Since the early 1990s, three vulture species of Asia belonging to *Gyps* Genus i.e Oriental White backed vulture (*Gyps bengalensis*), Long billed vulture (*Gyps indicus*) and Slender billed vulture (*G. tenuirostris*) have undergone catastrophic declines.

Populations have decreased by at least 90-95% over the last 12 years . Vulture numbers continue to decline at around 40% a year, placing these three critically endangered species on the brink of extinction.

Extensive research has identified the cause of declines to be Diclofenac, an anti-inflammatory drug routinely administered to livestock in Asia. Vultures are exposed to the drug when they consume carcasses of animals that were treated with Diclofenac, a few days before death. Diclofenac is highly toxic to vultures, causing them to die of kidney failure. The potential loss of these vulture species has profound ecological and social consequences. Through an active program of research, captive breeding, release of captive bred vultures and advocacy, the conservation of these vultures has been taken up at various locations.

Because of unprecedented scale and speed of population declines, it is necessary to bring vultures of all three species into captivity to ensure the

survival of these species. Removing Diclofenac from the environment will allow the eventual recovery of vulture populations but because this process may take sometime, it is essential to protect these vultures in an environment where they will not be exposed to this drug. Captive breeding will enable the number of vultures to increase and will eventually allow the release of vultures into wild. The successful captive breeding and release programme of Eurasian Giffron Vultures in Europe demonstrates that this approach can work. The vulture conservation breeding centre was established at Pinjore in the State of Haryana (India) in 2003 when the cause of the vulture population declines was unknown. Now that diclofenac has been identified as the threat, the centre (originally designated as care centre for treating such vultures) has been expanded and modified into a breeding centre. The centre was inaugurated in February, 2003. The Forest Department of the Govt. of Haryana State has been a full partner in the establishment and construction of captive care facilities. Financial support for the construction of aviaries and for purchasing laboratory equipments has been provided by the RSPB, Zoological Society of London, International Centre for Birds of Prey and the U.K. Govt., Darwin Initiative.

There are two big colony Aviaries in this centre. The second colony aviary, capable of holding 40 pairs of vultures has recently been completed. The centre has a variety of facilities, including large communal aviaries, aviaries for rearing chicks and smaller isolation `hospital' aviaries. Vultures have been captured and brought to the centre from various states in India including Rajsthan, Madhya Pradesh, Maharastra and Haryana. There are at present 50 nos. of vultures (white backed and long billed vultures) in this centre. Though these vultures have not yet started laying eggs and rearing young ones but the colonies of these vultures maintained here have highly promising future. The recovery plan of vultures can be ensured through such centers. The International Vulture Recovery Plan Workshop convened by BNHS and Haryana State Govt. in India was attended by representatives of a large number of conservation organizations in India and abroad from 12th to 14th February, 2004. This workshop provided excellent platform for useful discussion and recommending conservation priorities.

The construction of a second vulture conservation breeding centre has also begun at Buxa with the cooperation and support of the West Bengal State Govt.

Recently, Central Zoo Authority, New Delhi has decided to initiate the recovery and conservation breeding programme for the three vulture species in Indian zoos. Nandankanan Zoological Park, Bhubaneswar (Orissa), Sakkarbaug Zoo, Junagarh (Gujarat), Van Vihar National Park, Bhopal (Madhya Pradesh) and Nehru Zoological Park, Hyderabad (Andhra Pradesh) have been identified to start the programmes with financial assistance from Central Zoo Authority.

Western Tragopan Conservation Project : Western Tragopans (***Tragopan melanocephalus***) are endangered (as per IUCN status) pheasants of North West Himalayan region covering temperate and subalpine forest zone extending from North West Pakistan to Indian region from Jammu & Kashmir to Himachal Pradesh and Uttaranchal between 1800 - 3700m above msl. The species is protected under Schedule - I of Wildlife (Protection) Act, 1972.

As per the present estimate (2003-04), there are 1600 - 2100 numbers of these pheasants in Himachal Pradesh.

The conservation breeding and release programme has been taken up recently with the assistance of Central Zoo Authority, New Delhi and State Govt. of Himachal Pradesh at Sarahan Pheasantry in Himachal Pradesh. There are 8 numbers of specimens of founder western tragopan (5 males and 3 females) of wild origin in the Sarahan Pheasantry. Three pairs of them were involved in conservation breeding initially. Four chicks were raised in captivity on hatching during June, 2005 after integrated efforts. This is a good achievement. The long term aim of this project is to ensure conservation breeding of western tragopan (and other Himalayan Pheasant species) and provide a regular number of birds on sustainable basis for reintroduction. As per recent report, only one chick has survived now. Though, there may be initial difficulties in survival of chicks but efforts undertaken ensure promising future for conservation breeding and release of western tragopans.

Liontailed Macaque (LTM) Conservation Project : The Lion-tailed Macaque (*Macaca silenus*) is the endangered (as per IUCN status) monkey of evergreen forests. They are protected under Schedule - I of Wildlife (Protection) Act, 1972. The population (app. 3000-4000, declining) is mainly confined to Western Ghats and associated hills of Karnataka, Kerala and Tamilnadu. They are best seen at Silent Valley National Park, Kerala, Kalakkad and Anamalai Wildlife Sanctuary, Tamilnadu. They are threatened with habitat loss and poaching. The Central Zoo Authority, New Delhi is funding and supporting the lion-tailed macaque conservation project for conservation breeding and release programme of lion-tailed macaque in three collaborating zoos (namely, Arignar Anna Zoological Park, Vandalur, Sri Chamarajendra Zoological Gardens, Mysore and Thiruvananthapuram Zoo, Thrivananthapuram). At present, population under planned breeding programme is being maintained in three zoos and it is aimed to build a viable sustainable population in due course through conservation breeding. A number of lion-tailed macaques have bred since the inception of the project last year (eg. 3 numbers of LTM baby born during last one year in Arignar Anna Zoological Park, Vandalur). The viable population of LTMs will be released to the wild after proper assessment and following required protocols and guidelines once a good sustainable population base is built up.

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HAND-REARING OF TWO STRIPED HYENA CUBS (*HYAENA HYAENA*) AT ARIGNAR ANNA ZOOLOGICAL PARK, CHENNAI

K. Senthilkumar[1] and R. Thirumurugan[2]

Introduction

Hand-rearing of abandoned, orphaned or rescued young ones of wild mammals is one of the important tasks for the zoo staff in general and zoo veterinarians in particular. The protocol for hand-rearing vary with the type of the young to be reared, their age, whether they have received colostrum or not and the general health status of the young. Many authors have reported incidences of successful hand-raising of neonates and juveniles. Successful hand-rearing experiences will serve as a guide to manage such situations that will arise in future and give confidence to the concerned staff.

A member of the family Hyaenidae, the striped hyena (*Hyaena hyaena*) is a much smaller animal, greyish in colour, with transverse stripes of black or brown on body and legs (Crandall, 1964). The species has been listed under Schedule III of Wildlife (Protection) Act, 1972. Gradual depletion of its natural habitat has caused its population to decline.

Though, hyenas breed well in captivity, the main problem with this species is the large failure rate in rearing young (Rieger, 1979). The option for hand-rearing the abandoned young should be considered in such conditions. There are few reports on the hand-rearing of striped hyena cubs. Rao *et al.* (1995) reported the hand-rearing of a striped hyena cub and studied its growth rate from day 7 to day 84. Kholkute (2001) reported the successful rearing of orphaned striped hyena cubs from the age of one month. Batwe (1988) reported a hand-rearing episode of two striped hyena cubs at Sanjay Gandhi National Park, Mumbai. The present study aims at providing information about a hand-

[1]Veterinary Assistant Surgeon, [2]Zoo Veterinarian
Arignar Anna Zoological Park, Vandalur, Chennai-600048, Tamilnadu.

rearing episode of two striped hyena cubs from the age of 5 days at the Zoo Veterinary Hospital, Arignar Anna Zoological Park, Chennai.

The Stripped Hyena Enclosure

The striped hyena enclosure at Arignar Anna Zoological Park (Fig.1) consists of a main animal house; an additional animal house and a dry moated exhibit area. The cells have concrete floor, side-walls and roof. The main animal house has four separate cells, connected through wiremesh transfer doors and to the additional animal house through a wiremesh passage. The inner length of the cell-a measured 2.50 m and with a gradual reduction through cells-b and c, the length was 2.10 m in the cell-d. The breadth and height of the cells were 2.10 x 2.20 m. The additional animal house has three cells each measuring 2.85 x 1.85 x 2.20 m and is connected to a squeeze cage. The cells can be accessed from outside through keeper access doors for the purpose of cleaning and feeding.

The animals are released in an open dry moated exhibit area measuring 42 x 23 m. The animals are released in the morning to the exhibit area and are housed in the animal houses in the evening for feeding.

Feeding

The adult striped hyenas are fed with the following diet :

Chopped boneless beef - 3 kg

Liver - 100 gm
(Six days a week with fasting on Tuesdays)

Dressed chicken (Weekly once) - 500 gm

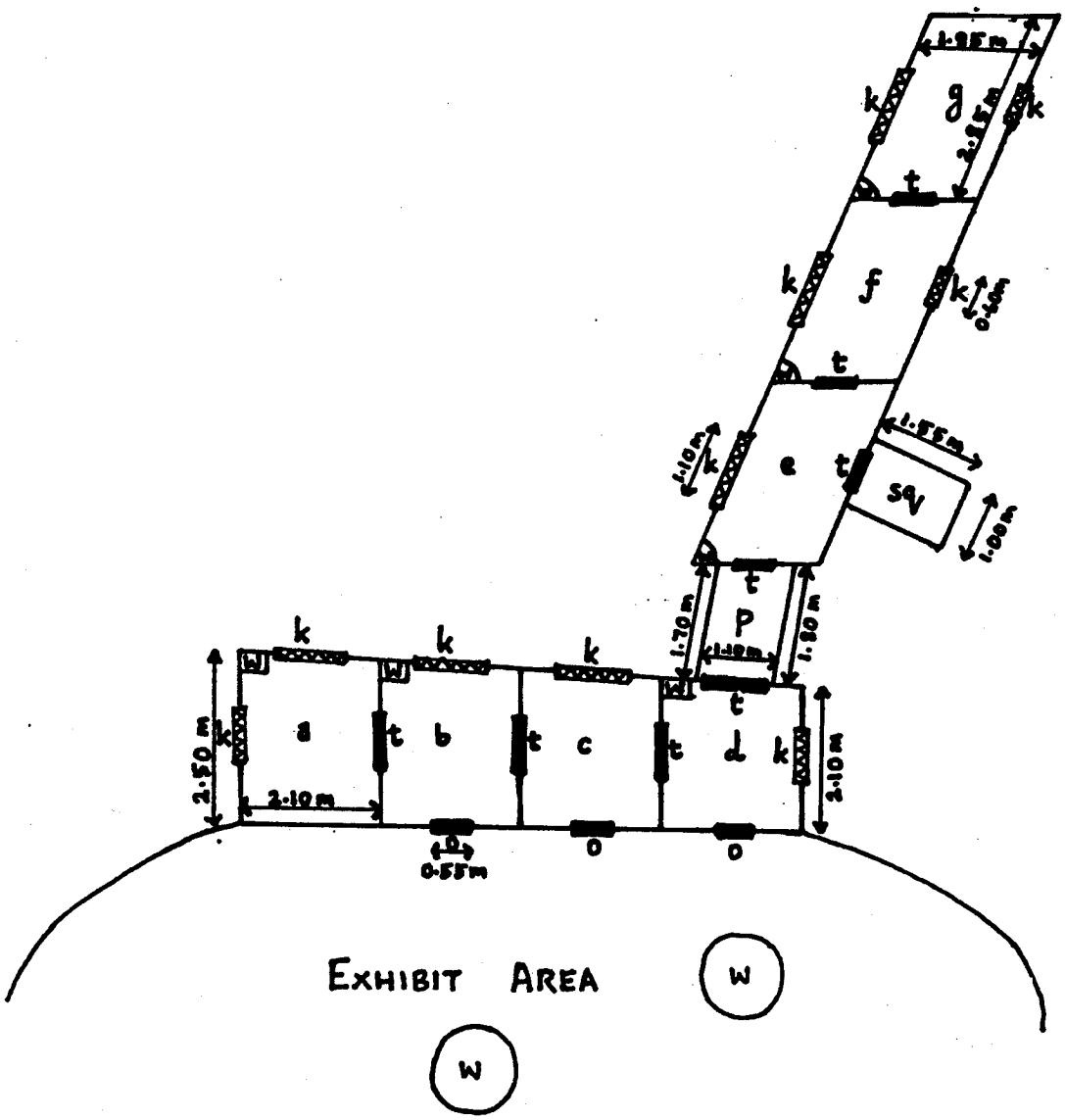

Fig.1 The striped hyena (*Hyaena hyaena*) enclosure at Arignar Anna Zoological Park, Chennai

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a-d. main animal house, **e-g.** additional animal house, **k.** keeper access wiremesh door, **o.** open moated exhibit access, **p.** wiremesh passage connecting the main and additional animal houses, **sq.** squeeze cage, **t.** wiremesh transfer door, **w.** water trough

Birth and Separation of the Hyena Cubs

After observing the signs of pregnancy, a female hyena approaching parturition was separated from other inmates and kept in the cells-a and b. The access and transfer doors were covered with gunny bags to avoid undue stress on the animal caused by any disturbance. The floor of the animal house was covered with straw as bedding and to provide warmth. The quantity of feed was increased and was supplemented with vitamins and minerals to take care of the mother and the foetus.

The hyena gave birth to three cubs on 17-11-2002, at about 10 PM. She was very aggressive and the presence of any person except the animal keeper near the house provoked her. So human presence was restricted near the house. The feeding, cleaning and changing the bedding material was done by the animal keeper by confining the animal and her cubs to one cell. She was an exemplary mother and no aberrant behaviour could be noticed. On 20-11-2002, the mother was found restless and was retrieving the cubs frequently by its mouth. Due to this aggressive retrieval one male cub died from head injuries. To save the other two cubs, it was decided to wean the cubs and hand-rear them. The two cubs (1:1) were brought to the Zoo Veterinary Hospital on 21-11-2002, 4.30 PM for hand-rearing (Fig.2)

Hand-Rearing of the Cubs

Housing

The cubs were kept in a cardboard box of 2' x 2' x 2 (0.60 x 0.60 x 0.60m) size with sufficient bedding material to protect them from the extremes of temperature. A 60-Watt electric bulb was placed at a height of about 0.60 m from the box to give warmth to the cubs and the height was adjusted depending on the temperature needed. The body weights and measurements of the cubs were taken at regular intervals. Physical examination was carried out to rule out any deformities. Though sufficient bedding was provided in the cells, lacerated wounds were noticed in the paws and carpal joints and these wounds

were cured after appropriate treatment. The male and female cubs were named 'Hari' and 'Harini' respectively.

Feeding

The protocol for feeding the neonate that received enough colostrum differs from those who have not received colostrum. Since the mother nursed the cubs for about five days it was presumed that they might have received enough colostrum. The cubs were fed initially with boiled cow's milk, diluted with equal quantity of boiled water. The lukewarm milk was fed through a feeding bottle fitted with pinpoint slit nylon nipple. The cubs were fed with their head in an elevated nursing position (Fig.3). After feeding, the perineal region was wiped with cotten soaked in warm water in a circular fashion to stimulate defecation and urination reflex. Initially the cubs were fed once in 3 hours, 15 ml at a time. The feeding bottle was cleaned with hot water prior and after feeding. Opening of both the eyes were noticed on 23.11.2002 (6th day of their age). The feeding schedule is given in the following Table - 1

Table - 1 : Feeding schedule

Age		Quantity of diet given at a time	Frequency
In days	In weeks		
8-14	2	Diluted boiled cow's milk-25 ml	15
15-21	3	Diluted boiled cow's milk - 30 ml	12
22-28	4	Diluted boiled cow's milk - 60 ml	12
29-35	5	Diluted boiled cow's milk - 75 ml	10
36-42	6	Diluted boiled cow's milk - 100 ml	10
43-49	7	Diluted boiled cow's milk - 125 ml	10
50-63	8-9	Boiled cow's milk - 150 ml Beef soup - 100 ml	6 2
64-84	10-12	Boiled cow's milk - 250 ml Beef soup - 200 ml	4 2

Table - 1 : Feeding schedule (continued)

85-98	13-14	Boiled cow's milk - 250 ml Beef soup - 200 ml Boiled chopped beef - 100 gm (mixed in the soup and fed)	4 2 2
99-112	15-16	Boiled cow's milk-500 ml Boiled chopped beef (mixed in the milk and fed)-250 gm	2 2
113-119	17	Boiled cow's milk-500 ml Boiled chpped beef - 200 gm + Raw chopped beef - 250 gm (Both were mixed in milk and fed)	1 2
120-133	18-19	Cow's milk-500 ml Boiled chpped beef - 100 gm + Raw chopped beef - 400 gm (Both were mixed and fed separately)	1 2
134-147	20-21	Cow's milk - 500 ml Raw chopped beef - 750 gm	1 2
148-161	22-23	Cow's milk - 250 ml Raw chopped beef - 1 kg	1 2
162-175	24-25	Raw chopped beef - 2 kg + Liver - 100 gm	 1
176-196	26-28	Raw chopped beef - 2.5 kg + Liver - 100 gm	 1

Supplements

- ABDEC syrup (from 5-30 days)
- Ostocalcium B12 suspension (from 15th day)
- Liv-52 vet liquid (45th day onwards)
- Vimeral liquid (30th day - 161 days)

Growth Rate

The body weight and measurements of the cubs were recorded when the cubs were brought for hand-rearing (Table-2).

Table-2: Body weight nad measurements at five days of age

Weight & Length	Male (Hari)	Female (Harini)
Weight	780 gm	740 gm
Body length (tip of the nose to tail tip)	20 cm	19 cm
Tail length	6 cm	6 cm
Fore limbs	8 cm	8 cm
Hind limbs	9 cm	9 cm

Body weights were taken at weekly intervals upto 10 weeks (Fig.4) and weight gain was calculated and tabulated below in Table-3 and Graphs 1 and 2.

When the cubs were 4 weeks old they started jumping out of the cardboard box, and were seen exploring the room in which they were kept. So they were shifted to sand filled indoor enclosure near the hospital and were fed in the room adjacent to the yard.

The cubs started to burrow a den in the yard and remained in that burrow whenever seen and came out only during the feeding time.

At the age of 7 months of age the cubs were shifted to the striped hyena enclosure in the zoological park (Fig.5) and are fed with adult hyena diet.

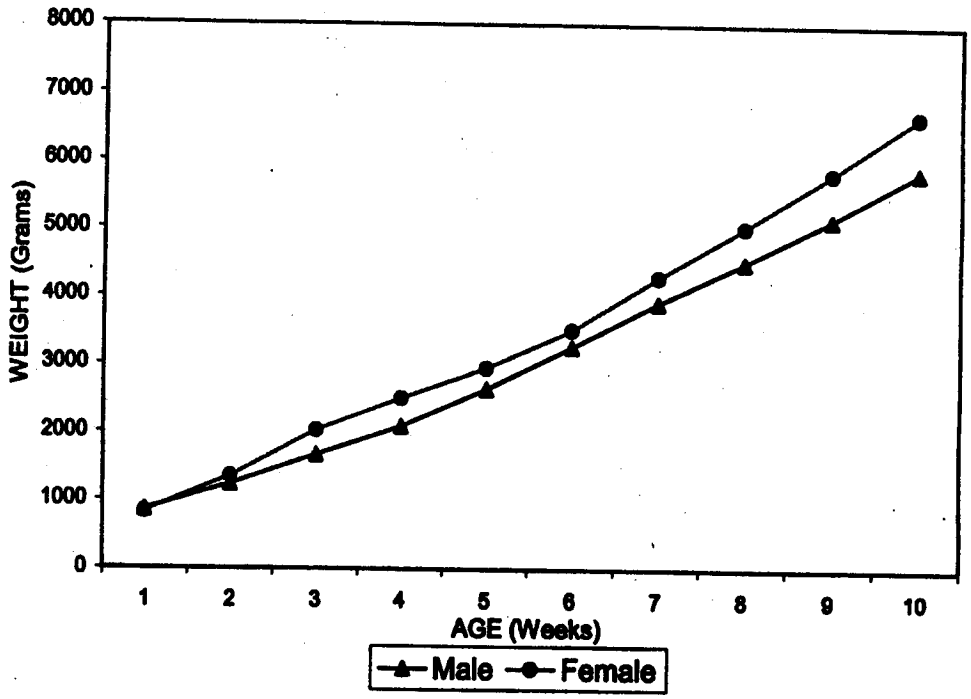
Table-3: Body weight and Weight gain of the hand-reared hyena cubs

Age in weeks	Body weight in grams		Weight gain in grams	
	Male	Female	Male	Female
1	860	830	-	-
2	1230	1350	370	520
3	1670	2030	440	680
4	2090	2500	420	470
5	2640	2950	550	450
6	3260	3510	620	560
7	3910	4290	650	780
8	4510	5030	600	740
9	5150	5830	640	800
10	5860	6680	710	850

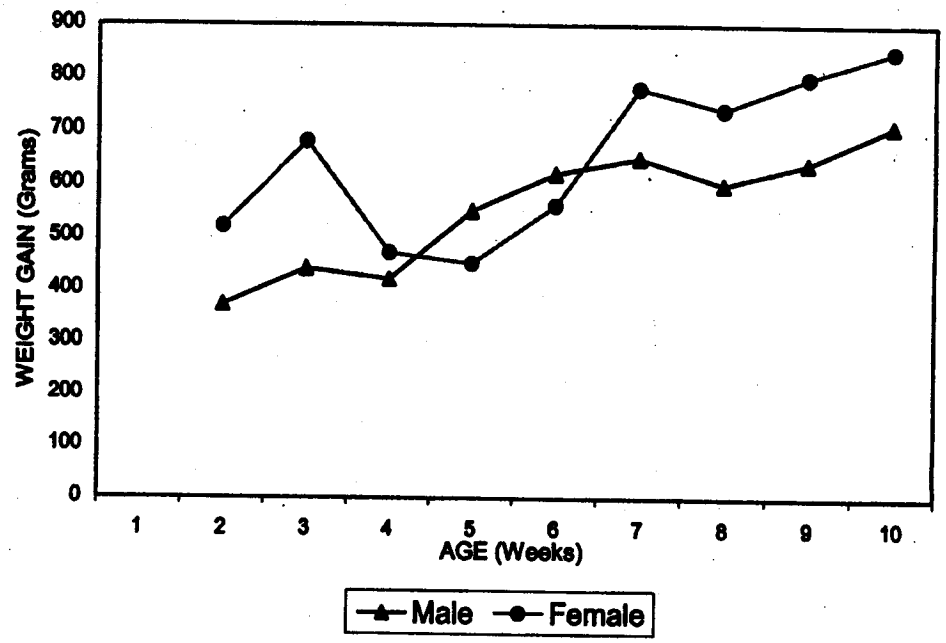
Discussion

Rieger (1979) discussed in detail various factors leading to hand-rearing of striped hyena cubs and suggested some management techniques for successful mother-rearing. He reported 35% mortality in zoo-born hyenas in the first 10 days and upto 40% in the first two months. He opined that cub mortality is high even in zoos where human help is available to hand-rear or to provide foster mother and suggested that maternal experience has a bearing on infant survival and the experienced mother appears to be a better mother and a primiparous female cares for her offspring only in exceptional circumstances. But Naaktgeboren and Slijper (1970) asserted that cub mortality in primiparous mammals is no higher than in multiparous. In the present case, the mother was primiparous and this might be one of the causes that led to hand-rearing of the two cubs.

Under unfavourable conditions all hyena species tend towards stereotyped movements and infanticide (Lang, 1958). Kinsey and Krieder (1990) reported similar stereotyped behaviour in a spotted hyena, which became agitated when



Graph-1 : Body weights of the hand-reared hyena cubs



Graph-2 : Weight gain in hand-reared hyena cubs

Fig. 2 - 'Hari' and 'Harini' - the striped hyena cubs

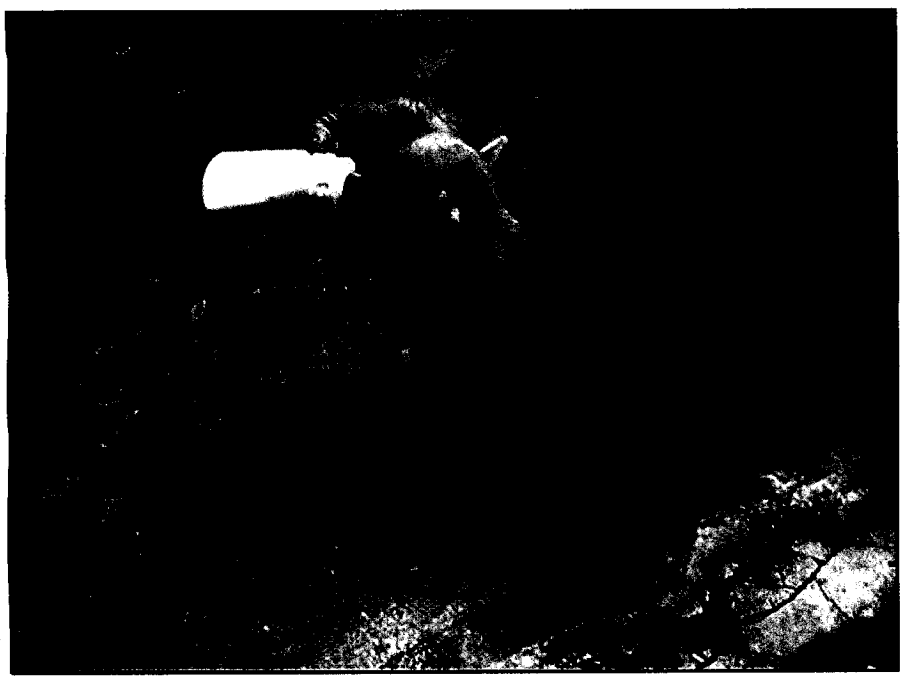


Fig. 3 - Bottle-feeding of the striped hyena cub

Fig. 4 - Weighing of the striped hyena cub

Fig. 5 - 'Hari' and 'Harini' - after release in the striped hyena enclosure

disturbed due to movements of lions housed in the adjaent enclosure. Later she carried the cub in her mouth continually and the cub was separated and hand-reared. Rao *et al.* (1995) reported infanticide behaviour of a striped hyena and the subsequent hand-rearing of the remaining two cubs. In the present case, though human presence and unwanted movements were restricted to avoid undue stress, a male cub was killed by the mother due to frequent aggressive retrieval and the remaining two cubs were separated for hand-rearing.

In Arignar Anna Zoological Park the mother and the cubs were housed in the two cells a and b (Fig.1) with an area of 10.5 m^2 and the connecting door remained open except during cleaning and feeding. No nest box was provided in the cells. Rieger (1979) opined that the size of the enclosure is one of the possible parameters influencing rearing success and enclosures with a ground area smalleer than 30 m^2 don't permit natural rearing.

The size of the nest box or maternity den is also a very important factor and the artificial maternity facilities in zoos are often too spacious. He suggested two outside enclosurers of 100 m^2 each with the connecting doors remain open, providing at least two nest boxes, substrate that is easy to dig a den, portion of the enclosure under subdued lighting and keeping away from visitors will make these animals comfortable with minimal stress.

Rao *et al.* (1995) described an episode of hand-rearing a cub by feeding boiled and cooled cow's milk during the first four weeks and the introduction of minced meat thereafter. Kholkute (2001) fed two 10 weeks old cubs with cow's milk and commercial human infant milk formula and mutton was added in the diet after a week. Batwe (1988) reported feeding the cubs on a diet with diluted toned milk, toned milk as such, commercial human infant milk formula, and meat diet.

In the present case, the feeding schedule was formulated in such a manner that introduction of any new ingredient should be gradual to be accepted readily by the cubs. Initially the cubs were fed with diluted boiled cow's milk, then the same without dilution and the cubs were provided beef soup which they liked very much. The adult diet of beef was initially provided in the form of boiled

chopped beef mixed in milk and beef soup and later gradually the milk and beef soup were withdrawn and replaced with raw beef.

At the age of seven weeks hair falling was noticed in both the cubs and the female looked almost hairless with rat-tail appearance. It took nearly a month for the cubs to get new haircoat. Batwe (1988) observed shedding of natural coat in two hand-reared hyena cubs between 40-50 days and the full growth of coarse coat by the end of nine months. Rao *et al.* (1995) reported new growth of hair at the age of six weeks in a single hand-reared cub. Arora (2001) observed loss of hair in most hand-reared felids at 6-8 weeks due to unknown dietary deficiencies. He opined that adding liver homogenate to the diet helps in preventing and correcting this alopecia.

At the age of one week the body weight of the male and female cubs were 860 gm and 830 gm respectively. Rao *et al.* (1995) reported the weight of a lone hand-reared male cub as 1.90 kg at the same age.

The male and female cubs weighted 5.86 kg and 6.68 kg when they were 10 weeks old. Rao *et al.* (1995) also reported that the lone cub weighed 6.25 kg at the same age. Kholkute (2001) observed the weights of two male hyena cubs at the same age as 3 kg and 2 kg respectively. Golding (1969) recorded the weights of two hand-reared spotted hyena cubs as 8.6 kg and 7.25 kg and a single cub as 5.9 kg at 8 weeks of age.

The male and female cubs gained weights of about 5.00 kg and 5.85 kg during the period of two to ten weeks. Rao *et al.* (1995) reported a gain of 4.15 kg in a hand-reared cub during the same period.

The female gained more weight than the male throughout the period and looked bulkier. The development of diarrhoea and the resultant dietary restriction led to the reduced weight gain in the female between 3 and 6 weeks.

Crandall (1966) opined that the hand-reared specimens are advantageous as they are quite accustomed to people and are active most of the day contrary to their naturally shy and retiring as well as essentially nocturnal behaviour. The hand-reared hyenas remain perfectly tame, even after they have become adult. Out

hand-reared 'Hari' and 'Harini' are extremely playful and respond to the calls of the keepers and veterinarians and allow them to examine their body thoroughly.

Veterinary Aid

The female cub started to pass watery faeces from day 30 and developed dehydration. The cub was treated with oral trimethoprim + sulphamethaxazole combination @ 25 mg/kg body weight. It responded to the treatment and consistency of faeces returned to normal in about 15 days. But the cub lost its weight sufficiently in this brief period and it took nearly four weeks to regain its weight. Batwe (1988) also reported occurrence of diarrhoea in one of the hand-reared cubs.

Faecal examination was carried out once in a month to rule out helminthiasis. *Ancylostoma sp.* eggs were detected in the faeces at 15 days of age and the cubs were dewormed with pyrantel pamoate @ 5 mg / kg. Thereafter the cubs were dewormed once in a month with different combinations to avoid parasitic resistance.

Products mentioned in the text

- ABDEC syrup: Multivitamins with minerals syrup, manufactured by Parke-Davis (India) Ltd., Mumbai.
- Liv 52 vet liquid: Herbal liver tonic, manufactured by Animal Health Products Division, Himalaya Drug Company, Bangalore.
- Ostocalcium B_{12} syrup : Suspension of Calcium, Vitamin D and B_{12}, marketed by GlaxoSmithkline Pharmaceuticals Ltd, Mumbai.
- Vimeral liquid: Multivitamin supplement, marketed by GlaxoSmithkline Pharmaceuticals Ltd, Mumbai.

Acknowledgements

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EX-SITU CONSERVATION OF SWAMP DEER (CERVUS DUVAUCELI) - A CASE STUDY AT SRI CHAMARAJENDRA ZOOLOGICAL GARDENS, MYSORE

Kumar Pushkar[1], Shivanna[2] and S.S.M.S. Khadri[3]

Introduction

Swamp deer or Barasingha inhabits Terai region of Uttar Pradesh, Assam and the Sunderbans distinguished by its splayed hooves and larger skull (*Cervus duvauceli*) and *branderi* race found in the hard open ground of Madhya Pradesh with smaller well-knit hooves (*Cervus duvauceli branderi*) (Prater, 1971).

Mysore Zoo houses *Cervus duvauceli* of Terai region. Their habitat in Assam is in high ground in the proximity of water. They are highly gregarious, less nocturnal than sambar. They feed till late in the morning and again in the evening and rests during the day. They prefer reeds and other plants of the swamp; they also eat grass, herbs, leaves and buds (Grzimek, 1972).

The swamp deer is a schedule species classified as Schedule-I under the Wildlife (Protection) Act, 1972 and considered as highly endangered. Needs protection in free range and *ex-situ* conservation efforts in zoos.

Distinctive Characters

The summer coat is amber to golden brown in colour with pale spots. The antlers are beautiful reaching a length of more than one meter; they look better proportioned and elegant in matured stags. Each antler usually have 6 tines and in both the antlers, there will be 12 or more tines, giving the popular name to this species as "Barasingha". The adult male stag measures 4-5 feet (1.2-1.5 meters) at the shoulder and weigh around 150-200 kg.

Feeding in Captivity

A balanced diet, meeting all the requirements of carbohydrate, fat, protein, trace minerals, essential amino acids, vitamins and water are given in hygienic

[1]Executive Director, [2]Junior Administrative Assistant, [3]Veterinary Officer
Mysore Zoo, Mysore, Karnataka.

condition. The food is checked at the store level and at the enclosure level on daily basis to ensure right quantity and quality of the food items. Feeding and watering troughs are provided within the enclosure. The concentrates used in the diet and the roughages issued per adult animal is as follows :

Concentrates

1. Wheat bran 2.0 kg
2. Horse gram 0.4 kg
3. Groundnut cake 0.1 kg
4. Bengal gram as and when required

Roughages

1. Hay 02.5 kg
2. Green grass 10.0 kg
3. Branch fodder 05.0 kg

Healthcare Management

Supplements

1. Kemp trace dry
   A blend of orgnic minerals with viable yeast and vitamins
   Adult stag 15 grams
   Adult female 10 grams
2. Ostocalcium + Vimeral
   (Ca, P, Vitamin D_3 and B_{12}) + Vitamin A + D_3 + E + B_{12})

Deworming

Deworming is attended every 4th month and three times in a year with either Albendazole or Fenbendazole broad spectrum anthelmentics.

1. Albomar Power
   Albendazole 5% w/w to control and treatment of gastrointestinal and pulmonary nematodes, cestodes and trematodes 5-7.5 mg/kg body weight.
2. Fenbendazole 5 mg/kg body weight for the control and treatment of gastrointestinal and pulmonary nematodes, cestodes and trematodes.

Vaccination

The captive population of all deer species including swamp deer are susceptible to bacterial and viral diseases. Foot-and-mouth disease and haemorrhagic septicaemia are endemic to this region. So the animals are vaccinated whenever they are tranquilized and restrained.

The swamp deer are regularly monitored on daily basis by the keepers and zoo veterinarians. In case of illness or trauma they are chemically restrained and taken to the holding room and treatment is provided.

Enclosure Enrichment (Micro Captive Habitat)

Mysore Zoo has declared the year 2003 as an enclosure enrichment year (captive habitat). Apart from good nutrition, hygiene and healthcare we need to provide semi-natural to natural environment required for the concerned species within the enclosure. The enrichment has got many advantages in the management of captive wild animals. It reduces stress and the animal gets withdrawal area for rest and relaxation. It also stimulates natural behaviour and provides psychological satisfaction to the animal.

The enclosure for swamp deer at Mysore Zoo has a water pool to create swampy area, for wallowing of the animals, having natural substrate. The withdrawal area has good number of rain trees providing shade and shelter to the animals. Natural camouflage material in the form of tree branches and leaves has been provided to shelter young fawns. This has reduced infant mortality due to trampling and attack by any free ranging predator animals. During rainy season the up stream "Karanji" tank seepage flows into the swamp deer enclosure making it a very ideal naturalistic enclosure to the species.

Breeding Success

Two pairs of swamp deer were received from the Prince of Wales Zoological Trust, Lucknow during July 1991. The stock started breeding from 1993-1994. Young fawns are born almost every year indicating good management practices (housing, nutrition and healthcare) and environment in which they are housed.

Twenty seven (27) births were recorded. Mortality in young fawns is due to trampling and rejection of young ones by the mother. Death in adults is recorded due to infighting trauma, old age, dystocia (difficulty in parturition) and other non-specific causes. The yearwise stock position of swamp deer of Mysore Zoo is given as follows :

Sl. No.	Year	Birth	Acquisition	Death	Total	Total Stock
1.	1991-92	0	4	0	4	4
2.	1992-93	0	0	0	0	4
3.	1993-94	2	0	0	2	6
4.	1994.95	2	0	0	2	8
5.	1995-96	2	0	0	2	10
6.	1996-97	3	0	2	1	11
7.	1997-98	3	0	0	3	14
8.	1998-99	2	0	1	1	15
9.	1999-2000	3	0	3	0	15
10.	2000-01	4	0	1	3	18
11.	2001-02	0	0	0	0	18
12.	2002-03	5	0	3	2	20
13.	2003-04	1	0	2	-1	19

Presently Mysore Zoo has 19 swamp deer (7 males, 11 females and 1 young fawn of unknown sex) as in the inventory stock. We would like to distribute surplus stock to some of the zoos on exchange programme.

Conslusion

Indigenous endangered species can be bred in captivity by providing suitable environment, balanced nutrition and good healthcare. The captive population of endangered species, free from diseases can be shifted to herbivorous safaris in a large enclosure. Removing biotic interferences and

conditioning them in natural environment over a period of time can facilitate the animals for reintroduction in natural habitat.

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Indian Zoo Year Book, Volume - IV (2006)

INVERTEBRATES IN ZOO EDUCATION AND THE NEED FOR INVERTEBRATE EDUCATION

B.A. Daniel[1] and Sally Walker[2]

Introduction

Invertebrates constitutes over 98% of all described living animal species. Because of their number, variety and influence on larger organisms and entire ecosystems, the invertebrates are called as "the little things that run the world" (Wilson, 1992). Some invertebrates do have negative impact on humans. All the negative impacts caused by few invertebrates become insignificant when compared to their beneficial actions. Invertebrates act as recyclers, pollinators and key food-chain organisms. Aprt from this, ivertebrates have an important economic, scientific, cultural and aesthetic value for mankind. A majority of the animals in the animal kingdom depend on invertebrates for food. Some invertebrates also serve as food for insectivorous plants. Invertebrates aid and hasten the process of degradation of dead plants and animal matter by microbes. Most of the human and animal wastes is thought to be decomposed by invertebrates. Pollination of human food crops and all other plants come from invertebrates especially hymenopterans. According to Biologist E.O. Wilson *"if all the vertebrates were to be wiped out, the world's ecosystem would be upset for several years but if the invertebrates were to be wiped out our planet would never recover"*. We will not be able to survive for more than a few months without invertebrates. We consider invertebrates as pests, agents of diseases, nuisance and generally useless creatures. We strike them, spray them and stamp them. The truth of the matter is that we need invertebrates but they don't need us ! We have to understand these diverse and wonderful creatures - ants, beetles, bugs, butterflies, dragonflies, spiders, crabs, snails, etc. which are indicators of healthy environment.

[1] Co Chair, IUCN/SSC South Asian Invertebrate Specialist Group, [2] Founder Secretary, Zoo Outreach Organisation, Coimbatore-641004, Tamilnadu.

Care about invertebrates

Invertebrate populations are most sensitive of all animal groups. Various threats, specially man made are driving many taxa to the brink of extinctin. The fact that the largest and most important animal group is fast disappearing from the ecosystem is evidenced by well documented cases of more endangered invertebrate species than any other animal or plant group.

The importance of invertebrates and its fast disappearance is not fully realised. Invertebrates therefore, require and deserve much consideration than the attention given to vertebrate conservation. The need for conservaiton of invertebrates should reach common man and the public at large. Zoos can do a lot to achieve this goal.

Invertebrates in zoo education

Zoos contribute to conservation by playing a major role in educating public about nature and value of biodiversity. According to a status survey made in the year 1995 involving selected zoos in India none of the zoos had invertebrates in their collection or in their education programme (ZOO, 1995). Vertebrates constitute only 3% of the animal diversity. Invertebrates constitute about 97% of all animal forms. However, zoos do not include invertebrates rather display the tiniest fraction of the animal diversity - the vertebrates. People see charismatic vertebrates like lions, tigers, elephants, snakes and birds in the zoo and think that they see a good representation of earth's biodiversity. This presents a highly biased impression of biodiversity. Zoos should give attention to invertebrates which will help educate visitors on the way how nature works and the importance of considering and valuing all species. Hence zoos should include invertebrates either as exhibits or by emphasizing their importance by relating them to other species.

Microorganisms have special importance as the indicators of ecosystem health. Microorganisms present in fresh water systems and soils are indicators of ecosystem stress. Critical role of insects and other invertebrates can be well understood in forest soils. Experiments have shown, that insects and other micro arthropods control the metabolic activity of fungi and bacteria, which

liberate nutrients through litter decompositin and chemical transformation of the soil. Awareness on the astonishing facts about invertebrates has to be created among the public. And this is where zoo keepers and educators come in. Zoos are in an unique position to influence children, and all citizens through programmes presented at the facility.

Invertebrates offer endless educational opportunities. Pollination, recycling, medicine, forencsic science, genetic research, pollution and of course, conservation are more bound up with invertebrates than with any other animal group. If a zoo does not attend invertebrates, it is missing out an exhibit attraction and additional resource that could pull in many more visitors. The costs involved in setting up of either individual invertebrate exhibit or as an eco-interpretation exhibit is practically nothing when compared to bigger mammals. So for the establishment of an invertebrate exhibit, more than money, creativity and will of the staff is required.

At the 18th Geneal Assembly of IUCN held in Perth in 1990 a resolution was adopted on the conservation of insects and other invertebrates, urging action to strengthen invertebrate displays by zoos and butterfly houses linked to captive breeding and re-establishment programmes (IUCN, 1991) This initiated the formation of CBSG Invertebrates Group. One of the six objectives of CBSG invertebrate Group is education. The group's stated objective about educaiton is:

1. Promote awareness of the vital ecological roles played by invertebrates and particularly the need to conserve invertebrates as important natural resources;
2. Support the use of invertebrates as exhibit animals in zoos and aquaria, and as such encourage the use of invertebrates as educational tools.

How invertebrates can be used in zoo educaiton ?

Invertebrates make up an enormous part of the animal kingdom. They have many diverse characters and lend themselves to various methods of presentations. Because invertebrates are unpleasant to most people, invertebrate

exhibits need to stress beauty, reactivity, cleanliness, its value to humankind and the positive qualities possessed by many invertebrates.

The following are some of the methods of using invetebrates in zoo educaiton.

Live exhibits

Live displays can be done in different ways. Separate invertebrate exhibits including both terrestrial and aquatic invertebrates can be established as tool of special educaiton. Another way is to establish an invertebrate display adjacent to a vertebrate display (e.g. Dung beetle and an elephant, invertebrates and reptiles explaining their food chain, insects and amphibians etc). This kind of display will enhance the charm of both displays and will also add to the ecological interpretation of the exhibit. Any facility suitable for the need can be created. As part of education, characteristics of invertebrates such as, diversity, abundance and biomass, complexity of radiation, history, biological and economic importance, biology, interaction with other organisms etc. has to be stressed.

Zoos as habitat : by attracting insects by its host plants

By planting native plant species one can setup an area conductive to butterflies and other insect species with a minimum of work or cost. To make these exhibits more educational, signs describing and depicting the common species of the region and identifying the plant material should be erected. Graphics and a brochure detailing the species, that has been used or expected to come to the insect garden can be provided. Information about how to setup their own butterfly garden along with a bibliography of references would give them the stimulus to start their own garden and thus make more habitats available to these wonderful creatures.

Educational talk

We are familiar with some of the invertebrates around us, such as, ants, spiders, honeybees, dragonflies, scorpions, butterflies, beetles and multitude of others. This familiarity can be used by educators to remove misunderstanding or misconception about these animals and can be used as building blocks to educate people about exactly how important these animals are to our future,

e.g. honeybee: pollination. The beneficial role played by invertebrates for man can be high lighted e.g. insects serve as pollinators of most of our food crops, produce silk and are useful as indicators of our environment. To create interest among visitors certain interesting examples may be used. Ants can carry 50 times their weight ! Certain butterflies are sensitive to sweet than man ! Dragonflies can see 360 degree ! A flea can jump 300 times their body length ! Insect animal interaction etc.

Man is using insecticides and pesticides there by indiscriminately killing all invertebrates. The fact is, in nature there are natural enemies like predators and parasites to control invertebrates harmful to humans. Over use of insecticides and pesticides result in environmental pollution. Change in this attitude can be achieved only through education.

Use of live animals in programmes

In using live specimens in demonstrations one must be aware of state and international regulations governing their status in the wild as many are now threatened or endangered. All individuals that handle specimens should be aware of some of the possible hazards such as harmful hairs of some caterpillars, stings of scorpions or bites of centipedes, cuts from some stick insects, fluid release from millipedes, that could be harmful. Certain species can be maintained in the zoo to remove myths and misconceptions.

Using molted skin of invertebrates like spiders, scorpion

Artifacts like shed molted skins of scorpions, spiders, bugs, abandoned nests of wasps, bees, cocoons sealed in plastic boxes after the adult has emerged, branches of trees with tunnels of boring insects and spider web caught in black paper which is sprayed with shellac can be used to highlight the wonders of invertebrates. Some white papers can be given to visitors to allow them to sketch what they have seen. All our exucation programmes should be sound scientific methods.

Use of preserved or pinned specimen

Some species can be easily reared in captivity. Other species of the same family of genus may not be suitable for captive propagation. In such cases

preserved specimens or pinned specimens can be used to make the visitors understand a large cross section of invertebrate life.

Using big invertebrate models

Big models of invertebrates made out of thermocole cut-outs can be used as teaching aids for kids. It can be transported easily and can be used for outdoor education programmes.

Exhibiting drawings and photographs, slide and film shows

Invertebrates can be used as exhibits or used in more formal education programmes. Many invertebrates are small. Hence difficult to attract observers even when displayed in large numbers. So techniques such as photo enlargements, its drawings to highlight features like mouth parts, stranglers and the method used to deploy them, insect eggs how they differ from other animal eggs, leg structure and how they are used in different modes of locomotion etc., can be used.

Providing graphics showing correct percentage of biodiversity displayed in the zoo as opposed to invetabrates — Workshops and training programmes

In any zoo keeper-training programme or in a workshop for local school teachers, invertebrates can be used as examples in addition to birds, mammals, reptiles and amphibians. A class or even a whole workshop cab be dedicated to teach invertebrates. They can be taken out to an outdoor learning facility on zoo grounds to collect specimens which are then brought back to the education building to be identified and should be released back in the field after study. Before the field trip general characteristics of insects, such as possession of a hard exoskeleton, jointed legs, number of legs, antennae, segments and different feeding structures they use, similarities and dissimilarities within arthropods. If necessary live specimens can be used for demonstration and discussion.

Common species that could be used in a classroom can be discussed. Invertebrates such as crickets, zoo-plankton, ants, cockroaches, earthworms, millipedes and stick insects, praying mantis etc., can be used. Information sheets on how to rear and use these common species may be issued in the classroom.

The sheet should include life cycle, habitat design, food requirments and diseases along with important husbandry instructions. By doing all these, zoo must be prepared to act as a clearing house for information and for identification of native species, which the lay person can not identity.

Linking with local school teachers

Linking with the teachers should be the ultimate goal. Educational materials like books, puppets, biological facts, slides, posters, photographs and drawings have to be collected and be circulated in local classroom. A special workshop inviting experts from the museum or an invertebrate specialist from the university for school teachers should be conducted. Teachers in turn can teach about invertebrates and its conservation to their students. If we start educating children about such important matters, they will make good policy makers in future who might save the Earth.

Conclusion

Many people develop an innate fear and hatredness regarding invertebrates. Fear and dislike are passed from generation to generation and are based largely on ignorance. We pass on to children, fear and hatred of insects and other spineless creatures. But it is this lack of understanding of natural systems, fueled by anthropocentrism that distorts the human view of the world and may be the root cause of many political, social, economic and environmental problems. We need to be aware of the bias that exit in education, and as educators, promote creative change.

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BIRTH SEASONS OF MAMMALS AT ARIGNAR ANNA ZOOLOGICAL PARK, CHENNAI

A. Manimozhi[1], M. Sekar[2] and N. Krishnakumar[3]

Introduction

Arignar Anna Zoological Park (AAZP) is one of the largest and best maintained modern zoological parks in India and it is maintaining large number of endangered animals. This park was established in the year 1985. Since then it is maintaining all aspects of animals in the animal record. This study aims to look into the birth seasons of mammals to understand the mammalian reproductive pattern. Observations made in zoos can make a valuable contribution towards our understanding of the sexual periodicity of various mammalian species (Mihai and Maria, 1976). Several studies on birth seasons of mammals have already been published (Zuckerman, 1953; Jarvis and Morris, 1962; Crandall, 1964; Reuther and Doherty, 1968; Schmidt, 1973; Strahan *et al.* 1973; Mihai and Maria, 1976). The birth data of 28 mammalian species collected at AAZP between 1985 to 1999 are intended to supplement the existing informations.

Material and Methods

Birth records of animals were maintained routinely in birth register since the opening of the AAZP in 1985. Any questionable record has been omitted for this study. Figures in parenthesis indicate individual litter size. Other figures are the total of single births recorded for a species each month. Some species are marked with an asterisk to denote that breeding of these species was stopped by the zoo authority.

[1, 2] Zoo Biologists, [3]Director
Arignar Anna Zoological Park, Vandalur, Chennai - 600 048, Tamilnadu.

Results and Discussion

I. Order : Marsupilia

Eastern Gray Kangaroo (*Macropus giganteus*)

This park is maintaining Eastern Gray Kangaroo (*Macropus giganteus*) since August 1987. It showed regular breeding between 1989 to 1995. After that no breeding was recorded due to incompatibility of paired animals and partial eye blindness of both sexes. Zuckerman (1953) recorded births from February to October, while the red kangaroo breeds the year round. The seven single births of AAZP were recorded in the months of January, February, April, June, July, August and November respectively (Table-1).

II. Order : Primates

In general, the macaques breed freely in captivity when properly kept. Most zoological gardens have bred atleast some of the numerous species of primates. Stott (1954) lists eight species that had produced young in the San Diego Zoological Garden. The AAZP is keeping 11 species of primates in moated nature simulated environment with an animal house in each enclosure. The details of birth seasons recorded in five species at AAZP are discussed as follows.

Rhesus Macaque (*Macaca mulatta*)

Since August 1982 AAZP is maintaining rhesus macaques and they are regularly breeding. In total out of 9 births observed between May to December, June and July showed two births in each month and single birth in other months except November (Table-1). Mihai and Maria (1976) recorded births in the months of February, March, April, May, July and October in Bucharest Zoo. Reuther and Doherty (1968) recorded births in the months of March, August and October in San Francisco Zoo.

Liontailed Macaque (*Macaca silenus*) :

Though the AAZP is keeping liontailed macaques since February 1983, the actual breeding started only from August 1986. The Central Zoo Authority

designated the AAZP as the National Stud Book keeper for this critically endangered species. Fourteen young have been born here as follows; January, 3; February, 1; May, 1; June, 1; July, 2; August, 2; September, 1; October, 2 and December, 1. No births have been recorded during March, April and November (Table-1). Reuther and Doherty (1968) reported only one birth in September in San Francisco Zoo and that covers the period from 1929 to 1967. Sankhala and Desai (1969) recorded 7 births in Delhi Zoo between January and October.

Common Langur (*Semnopithecus entellus*)

In spite of the almost universal difficulty in keeping langurs in captivity, there are breeding records for a number of kinds (Crandall, 1964). The common langur is reported by Sanyal (1892) to have bred frequently in the zoological gardens. Nine births were recorded in AAZP during the months of January, February, March, May, August and October, out of which February, May and October months reported two births each and single birth in other months (Table-1). Sankhala and Desai (1969) recorded births in February in Delhi Zoo. In a South African Zoo births occurred in almost every month (Schultz, 1969).

Nilgiri Langur (*Semnopithecus johni*)

Out of eleven births observed in AAZP, four births occurred in the month of July, two births in March and single birth in the months of February, May, June, November and December respectively (Table-1). Sankhala and Desai (1969) recorded a birth in April in Delhi Zoo.

Chimpanzee (*Pan troglodytes*)

A pair of chimpanzee named "Victor" and "Kepa" were received from the Honolulu Zoo, Hawai, U.S.A. on animal exchange programme on 10th September 1986. They bred twice, one on 26th October, 1988 and another one on 27th June, 1992 (Table-1). The female ("Kepa") died on April 21st 1994. Reuther and Doherty (1968) recorded births in the months of January, February and March. But Mihai and Maria (1976) observed births in the months of June, October, November and December.

III. Order : Rodentia

Widely, though, they may vary in appearance and habits, all rodents possess a common character - a single pair of possing chisel teeth (incisors) in each jaw. These teeth are essential, of course to the gnawing practices for which the group is well known (Crandall, 1964). AAZP is maintaining three species of squirrels of which two species bred successfully. They are Indian giant squirrel (*Ratufa indica*) and Malayan giant squirrel (*Ratufa bicolor*). They bred between 1985 to 1987, each six times. Single birth was observed in each occasion. They occurred in the months of February, April, May, August, September, October and November (Table-1).

IV. Order : Carnivora

AAZP have bred eight species of carnivores. They are discussed species wise as follows.

Jackal (*Canis aureus*)

Four births have been recorded in the park between 1984 to 1996. Of the four births, three births occurred in 1995 and 1996. The litter size varied from two to four and births were recorded in the months of January and February (Table-1) Zuckerman (1953) lists five births of this species in the Zoological Gardens of London, occurring in March and April. In an account of the Asiatic jackals in the Zoological Gardens of Calcutta, Sanyal (1892) said that "(Asiatic) jackals have never been bred in captivity". However, Zuckerman (1953) lists numerous births in London Zoo. Mihai and Maria (1976) recorded 9 births in the month of April.

Indian Wild Dog (*Cuon alpinus*)

Of the total fifteen births, fourteen births were observed in the months of November and December, each month equally comprised of 7 births. Only one birth occurred in January (Table-1). The litter size ranged from two to eight. The mean litter size was 4.2 (n=15). Zuckerman (1953) recorded four births of the Indian dhole in the Zoological Gardents of London, the average number of young per litter was 3.5.

Himalayan Black Bear (*Selenarctos thibetanus*)

Single birth was recorded on January 24th 1998 with the litter size of two in AAZP (Table-1). According to Crandall (1964) two Himalayan black bears gave birth in the St. Paul zoo, Minnesota, on January 11, 1961.

Common Palm Civet (*Paradoxurus hermaphroditus*)

The palm civets seem to adopt particularly well to the conditions of captivity, and several of the forms have been bred (Crandall, 1964). Three births were recorded at AAZP during January (2) and February (1) (Table-1). The litter size varied from 2 to 4. Zuckerman (1953) recorded single births in the month of September in this species and other palm civets produced young ones in the months of February, March, April, May, June, August and November.

Striped Hyena (*Hyaena hyaena*)

Six births have been recorded in this zoological park, of which two births were noticed in October and single births were observed in January, February, June and December respectively (Table-1). The litter size varied from two to five with mean of 3.0 (n=6). None of the cubs have been reared by parents. In all cases cannibalistic nature was observed in mothers. Inspite of their unsavory reputation, they were hand reared. Zuckerman (1953) lists three births of the striped hyena in the Zoological Garden of London, numbering 2 young in one instance and 3 in another.

Panther (*Panthera pardus*)

Properly adjusted and well-mated pairs of leopards breed freely in captivity, and many zoological gardens have been successful with them. Single birth was recorded in June 1997 with the litter size of 3 cubs in this park (Table-1). Thereafter, the zoo authority completely stopped further breeding of this species. Zuckerman (1953) recorded twenty-seven births of leopards in the Zoological Gardens of London. These occurred in every month of the year and the litter size varied from one to three. Reuther and Doherty (1968) recorded sixteen births distributed in all months except in February, March, June, September and

December. Mihai and Maria (1976) noted 7 births which were distributed in the months of January, February, May and July.

Lion (*Panthera leo persica*)

The breeding of lions in captivity is very common. Thirteen births have been observed in AAZP. The litter size varied between one to six. Lion births were noticed in January, June, July, September, October and November. Among the above months June had the maximum births of four followed by three births in October and two births in January and september (Table-1). The lioness is polyestrous and they can produce throughout the year. Breeding of lions was stopped from 1998 onwards by the zoo authority. Reuther and Doherty (1968) recorded lion births in all months except February, June and December in San Francisco Zoo. Mihai and Maria (1976) recorded lion births in all months except in June and October.

Tiger (*Panthera tigris*)

Our experience indicates that the female is polyestrous, heat recurring at intervals of about 3 weeks as reported in lion (Asdell, 1946). Three births were recorded of which single births were noticed in the months of March, April and October respectively (Table-1). Breeding of tigers was stopped from 1998. Reuther and Doherty (1968) reported births of tiger in the months of February, March, June, July and August.

V. Order : Proboscidea

Asian Elephant (*Elephas maximus*)

In the month of April, single successful birth was noticed in AAZP (Table-1). After that no compatible adult animals were kept in AAZP. Asdell (1946) reported that the Indian elephants are polyestrous, estrous lasting 3-4 days in captivity.

VI. Order : Perissodactyla

Zebra (*Equs burchelli boehmi*)

So for 4 births were recorded in AAZP of which two births occurred in January and single births were observed during November and December respectively (Table-1). According to Zuckerman (1953) extensive records of births for Grey's zebra in the Zoological Gardens of London showed occurrence in every month excepting February, May and September.

Hippopotamus (*Hippopotamus amphibius*)

Three births have been observed in AAZP to a pair of hippopotamus. All births occurred in the month of March (Table-1). But literature showed that the births occurred in other months too (Crandall, 1964).

VII. Order : Artiodactyla

Llama (*Lama glama*)

The lamoids breed freely in captivity (Crandall 1964). Among three births, which occurred in AAZP, two births were noticed in December and one in November (Table-1). In South America there seems to be a more or less restricted season of births (Cabrea and Yepes, 1940), but in northern zoological gardens it appears to be less sharply defined, 38 llama births have taken place in every month except February, the largest number (11) in September in northern zoological gardens (South America). Reuther and Doherty (1968) noted births in all months except February and April in San Francisco Zoo. Mihai and Maria (1976) recorded 23 births of which no births could be observed during March, June and October.

Barking Deer (*Muntiacus muntjak*)

Zuckerman (1953) showed that thirty births of Indian muntjacs in the Zoological Gardens of London were distrbuted through every month except January. But in AAZP, of the 12 births recorded four births occurred in February, two births each in April and September and single births in the months of May, June, October and November respectively (Table-1).

Spotter Deer (*Axis axis*)

In spotted deer, fawns may be born at any season. Out of seventy births observed, the number of births varied from 2 to 11 on every month (Table-1). The maximum fawns were recorded in the month of March (11) followed by February (9). No twins were observed. The above findings also coincide with the study of Crandall (1964) and findings of Reuther and Doherty (1968).

Hog-Deer (*Axis porcinus*)

Twenty-nine single births were observed in AAZP in all months except October (Table-1). Crandall (1964) noted 32 single births distributed over all months. A similar distribution is shown by Zuckerman (1953) for seventy-eight births in the Zoological Gardens of London.

Sambar (*Cervus unicolor*)

As said in chital and hog-deer, births in sambar may occur at any season. Forty-one fawns were born at AAZP in all months except February (Table-1). The similar experience have also been reported by Zuckerman (1953) in London Zoological Gardens in sambar.

Brow-Antlered Deer (*Cervus eldi eldi*)

The breeding season in Burma is from March to May, the youngs are born in October and November (Blanford, 1888-91). Crandall (1964) reported 25 births distributed from September to March. Most of these months were fall within cold months. The recorded 15 births in AAZP coincides with the report of Crandall (1964) except in January and March (Table-1)

Nilgai (*Boselaphus tragocamelus*)

It is the largest of the Asiatic antelopes. Fourteen births were recorded in AAZP of which three births were twins. Crandall (1964) reported eight births scattered from January to November. Zuckerman (1953) reported sixty-one births in the Zoological Gardens of London, occurring in every month. But our report showed that among 14 births, 7 occurred in September, three

in October, two in August and one each in January and March (Table-1). Reuther and Doherty (1968) noticed births in the months of March, April, May, August, September, October and November in the San Francisco Zoo. Mihai and Maria (1976) recorded births in all months except January, March and June in Bucharest Zoo.

Blackbuck (*Antilope cervicapra*)

Crandall (1964) reported that births of blackbuck (97) occurred in all months of the year. In support of this, our records also coincide with the above findings. Out of 89 births, single birth was observed in the month of January and maximum of 26 births observed in August in AAZP (Table-1). Reuther and Doherty (1968) recorded birth of blackbucks in all months except in October and November.

Nilgiri Tahr (*Hemitragus hylocrius*)

AAZP maintained this species from October 1987 to December 1990. In the month of May 1989 a female gave birth to a female young (Table-1). Zuckerman (1953) reported that the Himalayan tahr births were noted between May to October in Zoological Park, London, with the greater number in June and July.

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Sl. No.	Name of the Species	J	F	M	A	M	J	J	A	S	O	N	D	Total
22.	Spotted Deer *Axis axis*	4	9	11	4	6	7	7	4	6	5	5	2	70
23.	Hog-Deer *Axis porcinus*	4	3	3	2	3	3	1	3	3		1	3	29
24.	Sambar *Cervus unicolor*	2		1	1	2	2	4	7	11	3	6	2	41
25.	Brow-Antlered Deer *Cervus eldi eldi*		1							1	1	7	5	15
26.	Nilgai *Boselaphus tragocamelus*	1		1					2	7	3			14
27.	Blackbuck *Antilope cervicapra*	1	2	10	5	6	5	3	26	13	2	4	12	89
28.	Nilgiri Tahr *Hemitragus hylocrius*					1								1

N.B. : *J, F, M, A, M, J, J, A, S, O, N, D stands for January, February, March, April, May, June, July, August, September, October, November and December respectively.*

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PREVALENCE OF BLOOD SUCKING FLIES, VECTOR OF TRYPANOSOMIASIS IN THE NANDANKANAN ZOOLOGICAL PARK, BHUBANESWAR (ORISSA) AND THEIR CONTROL BY INTEGRATED PEST MANAGEMENT

B.D. Parashar[1], Vijay Veer[2], Shri Prakash[3] and Vinod Kumar[4]

Abstract

The population density and species composition of blood sucking flies (Tabanids, Stomoxys and Muscids) the vectors of animal trypanosomiasis was carried out at the Nandankanan Zoological Park, Bhubaneswar, Orissa and two adjacent villages. An integrated pest management (IPM) strategy comprising use of insecticides Butox a pour on application on animals, residual wall spray of K-othrine WP 25, use of mechanical canopy/tabanid traps and removal of breeding sites of flies like animal faeces and other wastes was employed to control the blood sucking flies on tigers.

Introduction

Haematophagous flies are serious pests of animals and responsible for transmission of bacterial, viral and protozoan diseases among domestic and wild animals. Many species of tabanids, stable fly *Stomoxys calcitrans* and buffalo fly *Haematobia irritans exigua* have been incriminated as mechanical vector of haemoparasite *Trypanosoma evansi*, the causative agent of trypanosomiasis or surra among animals in India and elsewhere (Soulsby, 1982). Beside surra, tabanids have also been reported to act as vector for equine infectious anemia virus (EIAV) and bovine leukemia virus (BLV) in animals. In India, trypanosomiasis is common and fatal not only for cattle and equines but also for wild animals (Acharjyo, 2000), due to high prevalance of tabanids, *S. calcitrans* and *H. irritans exigua* (Parashar *et al.* 1989; 2001; Vijay Veer *et al.*

[1, 2, 3] Entomology Division, Defence Research and Development Establishment, Jhansi Road Gwalior - 474 002, Madhya Pradesh.
[4]Nandankanan Zoological Park, Mayur Bhawan, Sahid Nagar, Bhubaneswar-751007, Orissa.

1999). Among zoo animals also trypanosomiasis is not a new phenomenon. Animals in various Indian zoos have been reported to get infected from trypanosomiasis time to time. In Calcutta Zoo, deaths of 4 tigers, 2 jaguar and 1 leopard during November - December, 1967 and 2 tigers in August, 1971 (Sinha *et al.* 1971), 1 leopard and 3 wolves in December, 1974 (Sen Gupta 1974 a; 1974b) have been reported. Death of one tiger and one wolf in Mysore Zoo has been reported due to trypanosomiasis (Ziauddin *et al.* 1992 a; 1992 b). Gopalakrishna (1982) reported trypanosoma infection in a tiger at Madras. In Darjeeling zoo, 8 Siberian tigers and one leopard suffered from trypanosoma infection out of which two tigers died (Das Gupta and Ghosh 1979). Infection of trypanosomes has also been reported from jackal, tiger, puma, lion and panther of Hyderabad Zoo (Alikhan *et al.* 1985; Alikhan 1986; Choudary *et al.* 1986). Saxena (1993) reported trypanosome infection among tigers kept in captivity in Madhav National Park. Arora (1994) stated that trypanosomiasis caused high mortality among chitals in Bhilai Zoo. In Lucknow Zoo also, a tiger suffered from trypanosoma infection, during December 1996 - January 1997, however, it was cured (Singh *et al.* 1997). In 1999, 5 tigers suffered from trypanosomiasis in Nandankanan Zoological Park, out of which three died and 2 were cured (Acharjyo, 2000). This was followed by death of 13 tigers in June-July 2000, as a result of epidemic of trypanosomiasis (Anonymous, 2000).

The present study describes the prevalence of tabanid and muscid flies, vector of trypanosomiasis, their population density and results of various control measures adopted to reduce the vector population in Nandankanan Zoological Park, after epidemic of trypanosomiasis.

Material and Methods

Flies density / Prevalence

Studies were carried out at Nandankanan Zoological Park, Bhubaneswar, Orissa during 20-25th August 2000 and 9-15th June 2001. The areas where tigers, lions, sambars, mithuns and zebras kept, were selected for study.

During the course of study, number of heamatophagous flies mainly *Stomoxys calcitrans* and *Haematobia irritans exigua* present over body of tigers, lions, sambars, muthuns and zebras were recorded before and after chemical treatment. For the study of density of tabanid flies ten to twenty canopy/tabanid traps (Fig.1) were deployed around the area of tiger den, tiger safari, lion den and safari, sambar, mithun and zebra enclosures, Tabanid flies were collected during morning (9-11 hrs) and evening (16-18 hrs) hours. Flies were identified and number of flies trapped in different locations/areas was recorded.

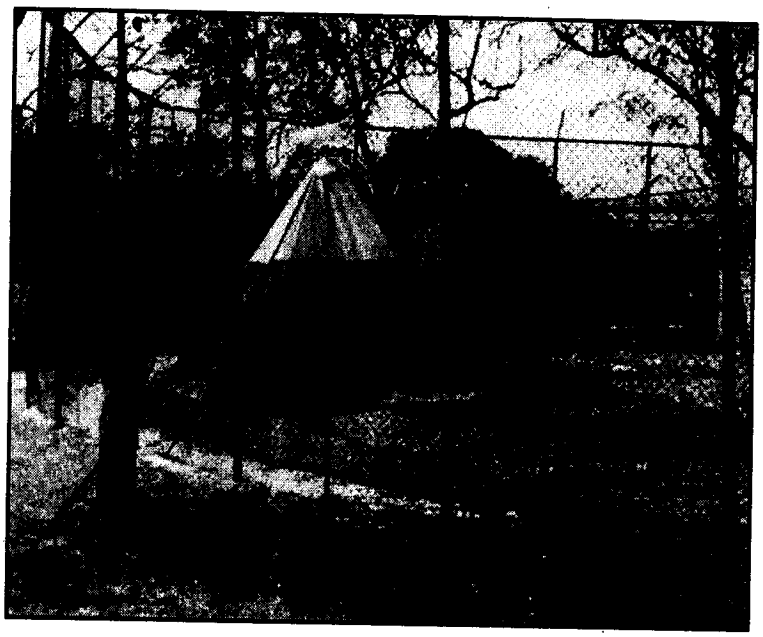

Fig. 1 - Canopy/tabanid trap

Control of Flies

For the control of *S. calcitrans, H. iritants exigua* and tabanid flies, following control measures were implemented :

i. **Chemical Control :**

1. A deltamethrin based formulation BUTOX (1.25%, Hoechst - Schering Agr. Evo Ltd.) was applied after every three months on the body of tigers with the help of a knapsack sprayer at 0.005% concentration in water. The number of *S. calcitrans* and *H. irritans exigua* was recorded on tigers

before and after treatment in August 2000 and June 2001, to assess the efficacy of Butox treatment against fly population. Butox application was not carried out on any other animals except tigers.

2. K-otherine flow (deltamethrin based formulation marketed by M/s Hoechst-Schering Agr. Evo Ltd.) was sprayed every 2-3 months at the dose of 30 mg/m^2 on wire fencing which surrounds the tiger dens, wall of room within tiger den, floor as well as all other objects present in and around the tiger dens which offer resting sites to the flies.

ii. Physical / Mechanical control measures

1. The faecal waste and other materials present in tiger dens, which can provide ideal sites for breeding of *S. calcitrans* and *H. irritants exigua* were collected daily and burnt to ashes.

2. For the control of tabanid flies by trapping, canopy/tabanid traps were deployed around each tiger den. Simultaneously few traps were also put up in Raghunathpur and Darutheng villages which are located nearby Nandankanan Zoological Park with an objective to find out any variation in the density or species composition of tabanid flies present in villages and in Nandankanan Zoological Park.

Number of *S. calcitrans* and *H. irritans exigua* was also recorded on cattle of Raghunathpur village so as to compare the variation in density of these flies on untreated cattle and treated tigers.

Results

Eight species of tabanids and five species of muscid flies were collected from the park and its vicinity (Table 1 and 2). Of these, 5 species of tabanid and 2 species of muscid flies are incriminated as carrier of surra disease.

Table-1 : Species composition of flies and ticks collected from Nandankanan Zoological Park, Bhubaneswar during 20-25 August 2000.

Family	Species name	Found on or near	Trypanosomiasis vector status
1. Tabanidae	i. *Tabanus rubidus*	Tiger, Dear enclosure Ragunathpur village Mithun enclosure	Potential vector
	ii. *Tabanus triceps*	Tiger	Vector
	iii. *Tabanus sp.*	Tiger, Ragunathpur Village	-
	iv. *Tabanus striatus*	Tiger area	Vector
	v. *Tabanus striatus*	Tiger, Deer enclosure Mithun enclosure	Potential vector
	vi. *Atylotus cryptotaxis*	Ragunathpur village School Campus	-
2. Muscidae	i. *Stomoxys calcitrans*	Tiger, Deer, Mithun enclosure	Vector
	ii. *Stomoxys dubitalis*	Tiger enclosure	--------
	iii. *Haematobia irritans exigua*	Tiger, Dear enclosure	Vector
	iv. *Musca (Philaematomyia) crassirostris*	Tiger, Deer enclosure	Vector
	v. *Musca sp.* (under determination)	Tiger	-
3. Hard ticks	i. *Haemaphysalis* sp. (under determination)	Tiger	-

Table-2 : Species composition of blood-sucking flies collected from Nandankanan Zoological Park, Bhubaneswar during 9-15th June 2001.

Family	Species Name
1. Tabanidae	a) *Tabanus rubidus* b) *Tabanus triceps* c) *Tabanus partitus* d) *Tabanus optatus* e) *Atylotus cryptotaxis* f) *Chrysops dispar*
2. Muscidae	a) *Stomoxys calcitrans* b) *Haematobia irritans exigua* c) *Musca crassirostris*

Table-3 shows the density of *S. calcitrans* and *H. irritans exigua* on the body of tiger, lion, sambar and mithun located in their respective dens/enclosures as well as number of tabanids trapped at various location during 20-25 August 2000 before implementation of control measures. The density of *S. calcitrans* was quite high ranging from 8.5 - 16.3/animal. In case of tiger and sambar, maximum (16.2 - 16.3 flies/animal) density has been recorded. The density of *H. irritants exigua* varies from 7.0 - 7.5 flies/animal in case of lion and tiger while it is maximum (16) in case of mithun. Tabanids were present in higher number (6 flies/trap) around tiger dens while in surrounding of sambar and mithun enclosures, their density was low ranging from 1 - 2 flies/trap. In Raghunathpur, an adjoining village, the number of tabanids recorded was no less than that of Nandankanan Zoological Park. Around lion dens, tabanids were not present during the period of this study.

Table-3 : Population density of blood-sucking flies on different animals and in traps in Nandankanan Biological Park, Bhubaneswar before implementation of control measures during 20-25th August 2000.

Location	*Stomoxys calcitrans* (per animal)	*Haematobia irritans exigua* (per animal)	Tabanids (in traps)
Tiger den	16.2 ±5.1	7.5 ±0.7	6
Lion den	13±1.4	7±1.4	Nil
Sambar enclosure	±16.3	Nil	2
Mithun enclosure	8.5 ±0.7	16 ±1.4	1
Raghunathpur	-	-	-

Table-4 depicts the population density of *S. calcitrans* and *H. irritans exigua* per animal on tiger, lion, sambar and mithun of Nandankanan Zoological Park and on cattle located in Raghunathpur and Darutheng villages along with density of tabanids/trap in different locations during 9 - 15 June, 2001 after chemical treatment and deployment of mechanical traps. On tiger, infestation of *S.*

calcitrans and *H. irritans exigua* was completely absent as none of the flies belonging to these two species was observed on them during the course of studies. On sambar the density of *S. calcitrans* was quite high being 11.4 flies/animal. On cattle located in two adjacent villages, the density of *S. calcitrans* ranged from 7.5 - 12.6/animal. The density of *H. irritans exigua* was very high on untreated animals in Rathunathpur and Darutheng villages ranging from 26.8 - 35.4/animal.

Table-4 : Population density of blood-sucking flies on different animals and in traps after adoption of control of measures during 9-15th June 2001.

Location	*Stomoxys calcitrans* (per animal)	*Haematobia irritans exigua* (per animal)	Tabanids (in traps)
Tiger den	0	0	6
Tiger safari	-	-	-
Lion den	14.8	11.6	-
Sambar enclosure	11.4	0	8
Zebra	-	-	2
Raghunathpur village (cattle)	12.6	35.4	6
Darutheng village (cattle)	7.5	26.8	2

The overall density of tabanids ranged from 3 - 6 flies/trap in tiger den and tiger safari while around sambar and zebra enclosures the tabanid density was 8 and 2 flies/trap respectively. In Raghunathpur and Darutheng villages, the tabanid density ranged from 2 - 6 flies/trap. It is also interesting to note here that no tick was found on the tigers' body after chemical treatment.

Discussion

Various methodologies such as use of insect repellent (Parashar *et al.* 1993), insecticide impregnated ear tags (Hillerton *et al.* 1985; Parashar *et al.* 1989) application of insecticide to the animal body (Wright *et al.* 1984; Parashar

et al. 1991; 2001) have been tried successfully by various workers for the control of haematophagous flies or protection of animals from their bite for different periods depending upon the feasibility as well as efficacy of a particular management strategy. The repellents were also tried for protection of animals from biting of blood sucking flies. Granet *et al.* (1949) reported Stabline^{R} as effective repellent against haematophagous flies such as horn flies, stable flies and horse flies. Bruce and Decker (1958) reported ineffectiveness of 0.25% piperonyl butoxide and 0.025% pyrethrins against tabanids on cattle. Carboxide (1, 1'- carbonylbis (hexahydro 1 N - azepine) and melanomata extended protection to animals against tabanids for 8 hours, however, ineffective against deer fly, *Chrysops nigripes* and *Haematopota pluvialis* (Polyakov and Simetskii, 1994). Diethylphenylacetamide (a new and highly safe insect repellent) and DEET have been reported to give protection time of 120 - 360 min and 105 - 345 min against *S. calcitrans* on animals respectively (Parashar *et al.* 1993). However, in case of wild animals like tigers daily repellent application would not be cost effective as well as it will pose application problems.

The behaviour of a particular group or species of flies is very important in relation to its host for planning and execution of specific control programme. The haematophagous flies prevalent in Nandankanan Zoological Park are so varying in their behaviour that no single control measure shall be applicable to all group of flies. Since *Haematobia irritans exigua* prefers to remain attached to host body for major part of its life span, these can be better controlled by application of some insecticide over host's body keeping into consideration the dermal toxicity of insecticide and susceptibility of flies as well as host skin. At the same time the *Stomoxys calcitrans* comes in contact with host body for blood-feeding and later take shelter on the adjacent objects like fencing of den or wall or any other object present in the vicinity in addition to host body. Due to this duel behaviour these can be controlled by application of insecticide over animal body as well as with residual application of insecticide on the objects which may provide shelter / resting sites to these flies. Contrary to this, tabanid flies are very different to control to a greater extent by insecticide application alone on animal body and residual insecticidal application inside the den or

enclosure as these flies are very fast fliers and come in contact of host body for a very short duration with the purpose of blood feeding, after which these flies fly away and do not rest in animal enclosures. Since these flies come in contact of animal body for little duration, many times, they do not pick up the dose which is toxic enough to cause their mortality. Similarly residual spraying of insecticide will not be cost effective in very large area while application within the enclosure will also be of little consequences due to feeding nature of tabanids. Therefore, in addition to application of some safe and effective insecticide, use of mechanical traps (Canopy/Tabanid Traps) shall be a viable alternative, which will not alone reduce the host-vector contact by trapping the tabanid flies, will be cost-effective and highly ecofriendly. Keeping in view the effectiveness and ease in applicability of dermal application of insecticide over the body of livestock has been considered an effective method of management of these blood-sucking flies by various workers (Lang *et al.* 1981; Parashar *et al.* 1991; 2001).

In the present study 100% reduction in density of *H. irritans exigua* and *S. calcitrans* on tigers was observed after dermal application of 0.005% deltamethrin solution (Butox^{R}) when done after every 2-3 months. However, large number of *S. calcitrans* (12.6 and 7.5 flies/cow) and *H. irritans exigua* (35.4 and 26.8 flies/cow) were recorded on untreated cattle in Raghunathpur and Darutheng villages which are located in vicinity of Nandankanan Zoological Park, as well as (*S. calcitrans* 16.2/flies tiger, *H. irritans exigua* 7.5/flies tiger) on body of tiger before beginning of insecticidal application programme in August 2000. This indicates that Butox application is very effective for control of *S. calcitrans* and *H. irritans exigua* on tiger at 0.005% and at every 2-3 months interval application during peak density period. Bay *et al.* (1976) observed effectiveness of a permethrin spray at 0.05% and 0.1% on horses and calves against *Tabanus subsimilis* Bellardi, *T. sulcofrons* Macquart and *T. profimus* Bigot for 9 and 14 days respectively. Stubbs *et al. (1982)* reported control of the buffalo fly *H. irritans exigua* for 28 days by dipping cattle in 0.007% cyhalothrin. Control of stable fly *S. calcitrans* for 7-10 days at 0.5, 1.0 and 1.5% permethrin as a rub-on application has been reported by Lang *et al.* (1981). Parashar *et al.* (1991) reported control of hippoboscid fly *Hippobosca maculata* on equines by application of deltamethrin based Butox

formulation for 3 months in a small scale trial at 0.005% concentration. Total control of *H. irritans* on cows for 25 days by pour on application of 3% cypermethrin and 90%, 39%, 0% control using a self application dust bag containing carbaryl (10%) after 24, 96 and 114 hours of application respectively has been reported. Rothwell *et al.* (1998) reported control of *H. irritans exigua* for 14 days with a spray formulation of cypermethrin on cattle. Uzuka *et al.* (1999) observed 100% control of *H. irritans* for 7-35 days post-treatment on topical application of ivermectin (0.5%) at the rate of 500 ug/kg along dorsal mid line. Parashar *et al.* (2001) reported 100% control of *H. irritans exigua* for one, two and four weeks at 0.03, 0.04 and 0.05% concentrations of fenvalerate respectively, while deltamethrin brought about 100% control for two, three and six weeks at 0.003, 0.004 and 0.005% concentrations respectively. Campbell *et al.* (1987) reported the economic threshold for *S. calcitrans* to be less than two flies per front legs or six flies per animal in relation to weight gain and feed efficiency of the animal. In the present study, the number of *S. calcitrans*/tiger and number of *H. irritans exigua*/tiger was 16.2 and 7.5 flies/animal respectively, before BUTOX application which is too high and may result not only in deterioration of health but productivity as well.

In the present study, K-othrine flow formulation has been sprayed once in every three months, on walls, floor and fencing of tiger dens, as a result of which not even single *Stomoxys calcitrans* and *H. irritans exigua* has been recorded in tiger dens. This shows that K-othrine is very effective against *S. calcitrans* and *H. irritans exigua* as a residual spray on walls etc. Parashar *et al.* (1990) reported efficacy of K-othrine EC 25 formulation for 15 days at 15 mg/m^2 concentration and 67.2% reduction in fly population at 30 days post-treatment with K-othrine WP-25 formulation. At 20 mg/m^2, the reduction in fly population was 100% in case of K-othrine WP-25 and 60% in case of K-othrine EC-25, while at 25 mg/m^2 concentration, K-othrine EC-25 formulation effectively controlled *S. calcitrans* for two months, on the other hand effectiveness of K-othrine WP-25 formulation (92% reduction in fly density) was 3 months at the same concentration. It is advisable to use K-othrine WP-25 formulation for residual spraying for control of *S.calcitrans* and *H. irritans exigua* in place of K-othrine EC-25 as in latter case,

the microcrystals of the insecticide may get entry into the coating of sprayed surface like wall of the den etc. thus becoming unavailable in large number for biological activity against the flies when they come in contact with it, while in case of WP formulation, the macrocrystals of insecticide may remain available on the treated surface in large number for activity.

In the integrated pest management (IPM) strategy, source reductionof breeding sites of flies is also considered to be very effective measure. Treatment of breeding sites with insecticides or removal of faeces and fermenting vegetation which provide ideal breeding ground both for *H. irritans exigua* and *S. calcitrans* would also be highly effective in addition to insecticide application on host body and resting sites. In the present study removal of faeces from dens of tigers is also one of the contributing factors which have resulted in complete control of *S. calcitrans* and *H. irritans exigua* in tiger dens.

Conclusion

Based on these studies, it is concluded that for the control of blood-sucking flies, pests of wild animals at Nandankanan Zoological Park an integrated approach comprising of following control measures should be used after considering the diversified nature and behaviour of haematophagous flies prevalent;

1. Dermal application of BUTOX (deltamethrin based formulation) solution (1-2 litre) at the concentration of 0.005% or 50 ppm once in a month. Keeping in view the body surface of area of animals, in such a way that complete body including legs, abdomen and flanks which are most preferred sites for fly attack/ attachment get treated with insecticidal solution. Depending upon degree of infestation, the frequency of application may be extended to two to three months.

2. K-othrine WP-25 (deltamethrin based formulation) should be sprayed on walls, fencing, floor etc. as residual spray once in three months.

3. Each den should be surrounded with 2 canopy / tabanid traps, which should be properly maintained for control of tabanid flies. Preferably the area surrounding location of trap should be cleaned with the objective of providing visibility of tabanid trap.

4. The animal faeces and other garbage etc. which can provide breeding ground to muscid flies should be removed from dens.

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A SUSPECTED CASE OF TETANUS IN ZEBRA (EQUUS GREVYI)

Pratibha Singh[1] and Rajiv Tripathi[2]

On 16.6.2002 the zebra keeper reported that a zebra had wounds on both hind legs. On examination there were lacerated bleeding wounds present on both stifle joint about 4 cm in diameter. The above zebra (female) was previously suffering from weakness of hind legs and probably had wounded herself in an effort to stand up. Both stifle joints were injured in the process. The animal was kept on oral antibiotics and anti-inflammatory drugs. i.e. Bolin bolus (2) and Sulcoprim bolus (2). Distant dressing was done by Himax lotion with a pressure spray machine. The above treatment continued till 24.6.2002. The wounds showed improvement and started healing.

On 25.06.2002 the animal showed signs of sickness, and symptoms of disinclination to move about and laboured breathing. On close examination there was spasm of a group of muscles of head, neck and especially masseter muscles. Masseter muscles were in a state of spasm. Forelegs were spread outwards-wooden horse posture. The animal was highly sensitive to any sudden movement and sound. There was a spasm of group of muscles usually around the head and neck and later involving the whole skeletal muscles (clonic spasm). There was protrusion of third eyelid (nictitating membrane). Suddenly the animal fell on its right side and showed signs of violent muscular contractions accompanied by pain. The tail was stiffly quivering.

Because of uncherished comments from passing public, the path near zebra enclosure was closed immediately to the visitors. This was done to prevent the sick zebra from getting disturbed by loud voices of visitors. The animal was provided a comfortable straw bed. The following treatment was given at 9 AM on 25.6.2002

Inj. Binocin -2.5 gm

Inj. Avil -10 ml

[1]Director, [2]Veterinary Officer
Kanpur Zoological Park, Kanpur, Uttar Pradesh.

Inj. Curadex-10ml

Inj. Conciplex-10ml

Inj Butagesic-20ml

As the animal was in right lateral recumbancy it was quite easier to administer the drugs parentally. At 11 AM on 25.6.2002 the animal was treated as follows:

Inj. Binocin -2.5 gm

Inj. Avil -15 ml

Inj. Curadex-5ml

Inj. D.C,. 2.5 gm

On the same day at 6 PM the animal was again treated with

Inj. Procaine penicillin 80 lakhs i/m

Inj. Tetvac-5 amp s/c

The animal showed signs of improvement and on 26.6.2002 at 9 AM the animal stood up on its own. There was no signs of spasm. The animal started moving frequently and now it became difficult to administer the injectable drugs as she would not allow anybody to come near her.

Inj. Procain penicillin 80 lakhs was given with the help of blow pipe. Bolin bolus and Neurobion forte tablets (5) were given in banana. Distant dressing of wounds was done with Himax lotion. The animal showed signs of improvement and was kept on oral antibiotics, anti-inflammatory drugs and B1+B6+B12 preparations.

On 29.6.2002 the animal was given a shot of Procain penicillin 80 lakhs, i/m with the help of blow pipe. The animal was kept on oral antibiotics, anti-inflammatory drugs and B1+B6+B12 preparations from 30.6. 2002 to 6.7.2002.

On 7.7.2002 the treatment was stopped and the animal became normal.

Tetanus is caused by the action of a potent neurotoxin formed in the body by *Clostridium tetanii.* Resistant spores of the organism can be found in the soil

littered with horse dung and the spores enter the body through contaminated wounds. Toxins enter the axons of the nearest motor nerves at the neuro muscular end plate and spread by retrograde transport with in motor axons to the neuronal cell body within the spinal cord or brain stem.

Clinical signs of tetanus usually occur within 5 days to 3 weeks of injury. The diagnosis is done by the history of recent wounds and clinical signs. Isolation of *Cl. tetanii* from wound can be a difficult procedure which is unrewarding in most cases. Tetanus may occur in an animal which has had a slight wound which appeared to heal without any complication. The commonest situation of wounds which became affected with the organisms is in the feet and lower parts of limbs of zebra around the anus and in the inguinal region.

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CAPTURE AND TRANSLOCATION OF THE CROP-RAIDING TUSKER AT CHITOOR DISTRICT (ANDHRA PRADESH)

M. Navin Kumar

One tusker aged about 18 years had strayed from its herd in the border district of Andhra Pradesh from the adjacent forest of Tamilnadu. This lone tusker was happily moving about in a stretch of 15 sq km in Chitoor district at Bhoomireddypally village under Yadamari mandal. The tusker was raiding the crops that were available in abundance (sugarcane, banana, paddy, etc.) and wallowing in a tank adjoining the village. On 11th February 2003 the tusker had killed one old man when there was direct confrontation in his mango orchard. It was decided that the tusker should be captured with the help of available resources with the State Forest Department (Andhra Pradesh) like ***kunkis***, ***mahouts*** and ***trackers*** and persons exposed to earlier capture of tuskers in the border areas like Kuppam and Chitoor. Sensing the urgency, the in-charge Conservator of Forests (Wildlife), Ananthpur Sri Bhaskar Reddy was assigned the task of capturing the loner.

A capture team was organised comprising the author, because of his earlier involvement in capturing of three tuskers in the same region, Sri Raghunath, Section Officer, Palmaner and other staff under Sri Bhaskar Choudary, Forest Range Officer, Chitoor. Two tuskers from Sri Venkateswara Zoological Park, Tirupathi (SVZP) along with their ***mahouts*** namely Arigesun and Ponnu Swamy and trackers from Kuppam mandal who earlier assisted in previous capture operations in 1996 and 1998 were used for this compaign.

The tuskers which were earlier captured (Jaya and Ganesh) were only domesticated and never trained as ***kunkis***. Decision was made by Chief Wildlife Warden, Andhra Pradesh and Director of Zoos to capture the tusker as early as possible. The capture team surveyed the daily track of the strayed tusker with the help of trackers. In preliminary procedures of capturing the elephant the construction of the kraal was taken up on 20th February 2003. The kraal

Deputy Director, Nehru Zoological Park, Hyderabad - 500064, Andhra Pradesh.

was constructed using Palmara trunks only. The dimension of the kraal was 12 x 12 x 18 feet (3.60 x 3.60 x 5.40 m) and it was constructed under the supervision of Sri Raghunath and the author. The elephants from SVZP were transported to the site by truck. This was the first time when these two tuskers of SVZP, Tirupathi were being used as ***kunkis***. Tuskers reached the spot and were stationed on 21st February 2003, by that time construction of the kraal was still in progress. At 4 PM trackers tracked the lone tusker coming towards the village. At one point in the village, angry mob of villagers chased the crop- raider by lighting a fire and the tusker vanished in the dark. Anticipating the approach of the crop raider to the ***kunkis*** the dart (Immobilon 3 ml + Acepromazine 1ml) was prepared and loaded in disinject rifle. At about 11 PM it was tracked approaching towards the ***kunki*** elephants. Tusker appeared once and retreated back into the bushes and re-appeared, when it turned back to return to the bushes the animal was darted at it's right thigh. The dart hit the animal and bounced back. The animal ran near a culvert about 100 meters away and stood there flapping it's ears and swaying it's head unmindful of trackers approaching the animal within 10 feet (3.0 m) vicinity. Then it was presumed that the drug might have been partially injected and henceforth one more dart (Immobilon 2ml + Acepromazine 1 ml) was prepared. After one hour the second dart was fired, the animal moved slowly alongside of the culvert and dropped itself in sternal recumbancy, which was not desired. Since the capture team followed the elephant along with the ***kunkis*** it was decided to immediately revive the animal. Quickly the animal was neck roped and sharp ends of tusks were cut with the help of hacksaw blade and the animal was revived (Revivon 5 ml) in no time. After 30 seconds the animal was on its feet chained to the ***kunkis***. The revived elephant was toed forward for few meters and injected with zylazine and acepomazine using hand syringe to facilitate standing sedation. The animal was toed with the help of the ***kunkis*** to the spot where the kraal was being constructed. The animal could not be put into the kraal as by then, the kraal was not ready. However, the elephant was secured and chained for the whole night with the help of ***kunkis*** and was shifted into the kraal only on early hours of the next day.

The task of training the animal was taken up as a challenge by the ***mahouts*** Sri Arigesun and his son. During the first week it learned only two commands, however, with in a month it learned two more commands and at the same time responding to calls. The second son of Sri Arigesun also joined and helped his father in training the elephant that was named as "Vinayak". After a month when the author visited the kraal he was amazed to see "Vinayak" responding to major commands and also to see the ***mahout*** going inside the kraal for cleaning. After a week it was noticed that ***mahout's*** sons were mounting the elephant. On 27th April 2003 instructions were received to estimate the kraaled elephant which is undergoing training for it's change in it's behaviour, so that it could be transported to SVZP, Tirupati. In compliance to the instructions of the Director, Bhoomireddipally village was visited and the elephant behaviour was estimated. The elephant had become docile and hence it was decided to release "Vinayak" out of the kraal. In the presence of the Divisional Forest Officer and other staff the animal was released out after chaining the legs. Without much resistance "Vinayak" slowly stepped out and finally came out of the kraal and was tied with the left forelimb in front to a coconut tree and the right hindlimb chained to another coconut tree behind. It was decided to summon two more ***mahouts*** from SVZP, Tirupathi for transportation of "Vinayak" by truck to the zoo, which was 86 kilometers away. Throughout the evening and night the animal did not show any signs of aggressiveness with the ***mahouts*** attending to it. The additional ***mahout*** called joined the team and after 2 PM the elephant was given mild sedation with xylazine and acepromazine (2:1 ml) in a jab and was easily pushed into the truck. It was transported by truck and reached SVZP, Tirupati at 11 PM. "Vinayak" was easily unloaded and secured with the help of chains, tied near the elephant house which already had three tuskers and a cow elephant.

Conclusion

After successfully capturing the wild crop-raiding tusker, the author was confident enough that Andhra Pradesh has an excellent team for such operations as compared to earlier salvations where the capture teams were called from Tamilnadu (Mudumalai and Topslip) along with their ***kunkis***. The whole process of hiring the capture teams involved lot of time and money.

With the present experience it may be possible to take up similar operations involving wild crop-raiders.

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ANIMAL HEALTHCARE IN ARIGNAR ANNA ZOOLOGICAL PARK, CHENNAI

P.C.Tyagi[1] and K.Senthil Kumar[2]

Arignar Anna Zoological Park (AAZP) is a modern *ex-situ* conservation centre set up in 1985, with large naturalistic moated enclosure providing simulated natural environment to the animals as found in the wilderness. There are 75 moated enclosures and other 50 enclosures housing mammals, aves reptiles, amphibians and fishes as defailed below (Table-1).

Table - 1

	No. of Species	No. of animals
Mammals	45	405
Aves	77	561
Reptiles	30	371
Amphibians	5	72
Fishes	21	265
Total	**178**	**1674**

At the time of setting up of the park in 1985 there was a wide range of animal collection transferred from the Corporation zoo, Madras. However, in due course of time it was decided that the collection should mainly focus on the local and regional species found in the Eastern and Western ghats of the south Indian sub-continent and the exotic and less threatened animals already available will be maintained for the purpose of education.

A new animal collection and breeding plan for AAZP has been formulated including 34 species of mammals, 15 species of birds and 20 species of reptiles in our endangered species conservation breeding programme. As per this new plan we will enlarge our collection to 61 species of mammals, 75 species of birds and 35 species of reptiles.

[1]Director, [2]Veterinary Asst. Surgeon
Arignar Anna Zoological Park, Vandalur, Chennai-600048, Tamilnadu.

The housing and habitat requirement for the animals must be planned as per the species specific physiological, biological and ecological requirement. Meticulous planning of animal enclosures with night shelter, feeding cells, kraal and yard for movement and exercise of the animals form a vital component of the *ex-situ* conservation centre. Sanitation measures with proper waste water drainage, potable uncontaminated drinking water, cleanliness and hygienic environment to the animals is most important function of the zoo. The animal must be provided physiological and biological comfort, security of clean food and water supply and security from death or injury due to predation, aggression etc.

AAZP has commenced a co-ordinated captive breeding programme of lion-tailed macaque (LTM) with assistance from the Central Zoo Authority. The zoos participating in this programme are Mysore zoo, Thiruvananthapuram zoo and AAZP. The animal collection in all three zoos will be pooled together to assemble five social groups, which will be observed and studied for collecting information on the biological, reproductive and ecological health of the animals. The enclosure will also be redesigned to conform with the behavioural, social and reproductive profile of the animals. The LTM population in three zoos under co-ordinated captive breeding programme is given of follows (Table-2).

Table - 2

Name of the zoo	Male	Female	Total
Arignar Anna Zoological Park	8	5	13
Thiruvananthapuram zoo	8	6	14
Mysore zoo	3	3	6
Total	**19**	**14**	**33**

The animal collection in AAZP has increased gradually through animal exchange programme, addition of rescued and orphaned animals from the wild and few problem animals received from the forest area. The animal collection was primarily used for exhibition purpose and concerted effort was not made for commencing endangered species breeding programme. The animals have bred in the zoo, however, there is inbreeding of animals. The zoo must look for

animals for varying lineage for maintaining the genetic variability of the population.

AAZP has given utmost importance to animal health care, sanitation and hygiene. There is a well developed veterinary health care infrastructure manned by 3 full time veterinary doctors along with para veterinary staff, laboratory assistant and full time attendants. The veterinary facilities available in the zoo is of a high standard comprising of operation theatre, radiology units, laboratory with adequate instruments and equipments and inpatient ward with a convalescent yard, necropsy room and a modern incinerator system. The veterinary staff structure is given as follows (Table-3).

Table - 3

Full time veterinary doctor	1
Full time veterinary assistant surgeons	2
Lab. assistant	1
Full time Lab. assistants	3

The mortality percentage for the animals in the *ex-situ* conservation facility for the last ten years is given below (Table-4).

Table - 4

	92-93	93-94	94-95	95-96	96-97	97-98	98-99	99-00	00-01	01-02	02-03	03-04 up to 30.9.03
Mammals	8.4	4.86	8.0	10.53	7.73	8.59	7.77	9.36	9.85	11.91	7.75	2.53
Aves	3.30	3.88	2.01	4.45	3.42	2.47	2.47	3.35	3.38	2.47	4.26	2.25
Reptiles	4.44	3.72	5.19	11.79	2.25	1.81	0.98	2.71	2.98	3.89	6.28	1.34

The mortality of mammals over the years have shown a range between 4.86% to 11.91 %, the highest were recorded in the year 1995-96 (10.53%) and 2001-2002 (11.91%). The mortality of aves and reptiles have not shown a large variation over the years except for 11.79% mortality of reptiles in 1995-96.

Causes for Mortality

The causes of mortality in animals during the years 1996-97 to 2002-03 are tabulated and analyzed for future reference. The causes given below are based on the necropsy findings that serve as guide in formulating various managemental strategies to reduce the mortality in captive population.

Mammals : The various causes of mortality in mammals during the study period are as follows (Table-5).

Table-5

Causes of Death	Carnivores				Herbivores	Primates	Other Mammals	Total
	Tigers	Lions	Panthers	Others				
GI tract infections	1 (10.00%)	1 (8.33%)	1 (10.00%)	4 (11.11%)	2 (2.30%)	1 (4.00%)	1 (3.70%)	11 (5.31%)
Resp.tract infections	3 (30.00%)	1 (8.33%)	5 (50.00%)	10 (27.78%)	13 (14.95%)	7 (28.00%)	7 (25.92%)	46 (22.22%)
Liver affections	2 (20.00%)	1 (8.33%)	1 (10.00%)	1 (2.78%)	3 (3.45%)	1 (4.00%)	2 (7.41%)	11 (5.31%)
Uro-genital infections	--	--	--	3 (8.33%)	1 (1.15%)	--	--	4 (1.93%)
Peritonitis	--	--	--	2 (5.56%)	2 (2.30%)	--	1 (3.70%)	5 (2.42%)
Neoplasms	--	--	--	--	--	--	2 (7.41%)	2 (0.97%)
Shock and Heart failure	--	--	1 (10.00%)	2 (5.56%)	10 (11.50%)	5 (20.00%)	5 (18.52%)	23 (11.11%)
Toxemias	1 (10.00%)	--	--	--	--	--	--	1 (0.48%)
Neurological disorders	--	--	--	2 (5.56%)	3 (3.45%)	--	--	5 (2.42%)
Cold shock	--	--	--	--	6 (6.90%)	--	--	6 (2.90%)
Drowning	--	--	--	--	--	1 (4.00%)	2 (7.41%)	3 (1.45%)
Trauma and wounds	2 (20.00%)	5 (41.67%)	--	8 (22.22%)	20 (23.00%)	3 (12.00%)	3 (11.11%)	41 (19.81%)
Musculoskeletal affections	2 (20.00%)	--	--	--	1 (1.15%)	--	--	3 (1.45%)
Senility	--	3 (25.00%)	2 (20.00%)	1 (2.78%)	10 (11.50%)	6 (24.00%)	1 (3.70%)	23 (11.11%)
Rejection by mother	--	--	--	2 (5.56%)	2 (2.30%)	--	--	4 (1.93%)
Obstetrical causes	--	--	--	1 (2.78%)	3 (3.45%)	1 (4.00%)	2 (7.41%)	7 (3.38%)
Predator bite	--	--	--	--	11 (12.64%)	--	1 (3.70%)	12 (5.80%)
Total	10	12	10	36	87	25	27	207

Among the various causative factors of mortality of mammals, respiratory infections accounted for the maximum death of 46 animals which is 22.22% of the deaths followed by trauma and wounds which caused death of 41 Mammals and constituted about 19.81% of the deaths. Trauma and wounds was the main cause for death in herbivores with 23% deaths mainly due to intra species fighting followed by senility with 11.50% of deaths.

Among the number of animals died, ungulates recorded the highest number i.e. 87 deaths, followed by carnivores (68 deaths).

Birds : The various causes of mortality in birds during the study period (1996-97 to 2002-03) are as follows (Table-6).

Table-6

Causes of Death	Terrestrial Birds	Aquatic Birds	Birds ofPrey	Total
Shock and heart failure	16 (17.02%)	4 (13.33%)	3 (37.50%)	23 (17.42%)
Predator bite	33 (35.11%)	9 (30.00%)	--	42 (31.82%)
Trauma and wounds	7 (7.45%)	2 (6.67%)	--	9 (6.82%)
Respiratory tract affections	7 (7.45%)	2 (6.67%)	1 (12.50%)	10 (7.58%)
Gastrointestinal tract affections	14 (14.90%)	5 (16.67%)	1 (12.50%)	20 (15.15%)
Liver affections	5 (5.32%)	2 (6.67%)	--	7 (5.30%)
Senility	1 (1.06%)	3 (10.00%)	2 (25.00%)	6 (4.55%)
Musculo-skeletal affections	--	2 (6.67%)	--	2 (1.52%)
Other causes	11 (11.70%)	1 (3.33%)	1 (12.50%)	13 (9.85%)
Total	94	30	8	132

The highest incidence of death in birds was due to predator bites constituting 31.82% (42 birds out of 132 birds). Shock and heart failure was the next with 17.42% of total deaths. Terrestrial birds mortality was the highest among various classes of birds that died during the study period.

Reptiles : The various causes of death in reptiles during 1996-97 to 2002-03 are as follows (Table-7).

Table-7

Causes of Death	Snakes	Crocodiles	Turtles & Tortoises	Lizards	Total
Inanition	8 (25.80%)	--	--	1 (14.29%)	9 (11.25%)
Liver affection	2 (6.45%)	3 (10.00%)	--	--	5 (6.25%)
Senility	6 (19.36%)	1 (3.33%)	1 (8.33%)	1 (14.29%)	9 (11.25%)
Respiratory tract affections	2 (6.45%)	1 (3.33%)	--	1 (14.29%)	4 (5.00%)
Gastrointestinal tract affections	2 (6.45%)	4 (13.33%)	1 (8.33%)	4 (57.14%)	11 (13.75%)
Trauma and wounds	4 (12.90%)	16 (57.14%)	3 (25.00%)	--	23 (28.75%)
Neoplasms	2 (6.45%)	--	--	--	2 (2.50%)
Predator bite	--	--	6 (50.00%)	--	6 (7.50%)
Shell rot	--	--	1 (8.33%)	--	1 (1.25%)
Other causes	5 (16.13%)	5 (16.67%)	--	--	10 (12.50%)
Total	**31**	**30**	**12**	**7**	**80**

Among the various causes of death in reptiles, trauma and wounds were the major causes with 28.75% of deaths followed by gastrointestinal tract affections with 13.75% of deaths. In turtles and tortoises, incidence of deaths due to predator bites were high with 50% of deaths followed by trauma and wounds (25%).

Management Strategies to Avoid Mortality

The management strategies formulated for animal health care are given below

1. Strict quarantine measures

The acquired animals are housed in a separate quarantine area, far away from the zoo exhibit areas. The animals are monitored at frequent intervals for any signs of illness. Faecal and urine samples are taken at scheduled periods and blood samples are taken whenever necessary and thorough laboratory investigation is done. The animals are provided with balanced diets, healthy environment and stress free conditions.

These measures keep the mortality rate low in the newly acquired animals.

2. Regular deworming and vaccination schedule programmes

All the animals housed in the zoo are regularly dewormed with suitable anthelmintics. Faecal samples of each and every individual are examined microscopically and the animals having helminthic infestation are given an additional course of anthelminthic treatment.

The animals are given protection against major contagious diseases like FMD, HS, BQ, FPL, IFRT and CV. Quinapyramine is given once in 3 months to tigers seized from circuses and once in 6 months for zoo tigers and lions.

3. Meat Inspection

Ante-mortem inspection of the animals to be slaughtered at the corporation slaughter house are examined by a veterinarian at the slaughter house and further the meat is also examined prior to transport.

The supplier brings the whole animal carcass after removal of the visceral organs and cutting is done in the zoo kitchen. Visceral organs like liver, lungs, heart, kidney and spleen of each animal are brought separately for examination.

In the zoo, the sensory examination of the meat is carried out followed by microscopical examination of the impression smear from muscle, viscera and lymph nodes for any haemo-protozoan parasites.

4. Antagonism in animals

In the past years, the major cause of death in ungulates was due to intra-species aggression among males, so a plan was devised to prevent further losses due to infighting by separating surplus males from the herd and restraining them in the kraal during rutting season.

5. Retention of oestrus females in Lion Safari

During the previous years death of lions in the lion safari occurred during breeding season due to competition among males for the females in oestrus. To avoid this, individual female oestrus cycle length is calculated based on daily observations. When they are found in oestrus, the females are retained in the yard itself and the remaining members of the pride are released into the safari.

This has reduced considerably the incidence of infighting injuries and unwanted fatalities.

6. Elimination of inbreeding

The inbreeding of carnivores and primates have been prevented by segregation during the oestrous cycle period. The tiger cubs born as a result of in-breeding, did not survive due to congenital anomalies in the recent past. The breeding of tigers have been discontinued, since the zoo tigers were from a single lineage. Under animal exchange programme it is proposed to acquire tigers of a varying lineage.

7. Providing optimum environment

High stocking rate and improper ventilation resulted in higher incidence of respiratory tract infections. The incidence reduced gradually to a minimum by maintaining the number of animals well below the maximum stocking density of the enclosures and providing good ventilation and light.

8. Fly control measures

Fly problem is a menace specially during the summer months. To avoid the spread of disease to the zoo animals through flies, various measures have been adopted with good results. The bushes and over grown vegetations were

trimmed to destroy the fly breeding places. The left over feed from the carnivore enclosures are burnt in an incinerator. Deltamethrin is sprayed in and around the fly breeding areas. Recently, the feeding and resting cubicles of the carnivores were provided with metal fly proof sheets and electronic flycatcher.

9. Ring vaccination

In order to avoid the spread of diseases to zoo animals from their domestic counterparts, annual ring vaccination is carried out in the domestic animals of the villages surrounding the zoo with the help of Animal Husbandry Department. The total number of cattle vaccinated in the adjoining villages in co-operation with the Animal Husbandry Department is about 10000.

10. Hand rearing protocols

The last term of pregnancy in animals is a crucial period from veterinary point of view. The animals are observed for any signs of ill health. The diet is modified to cope up with the nutrition loss during and after parturition and the animals are kept in the stress free environment as far as possible. The post-partum dam and the young ones are carefully monitored. In certain unavoidable instances as maternal aggression and maternal rejection, the young ones are separated and hand reared. Hand rearing protocols were developed for each species and gave high success rate in the recent past. The following animals were hand reared successfully in the veterinary hospital :

1. Panther cubs
2. Hyena pups
3. Wild dog pups
4. Elephant calves
5. Emu chicks

By adopting proper management strategies and good nutrition for the expectant mothers, this zoo has the following new additions to existing collection :

1. Binturong- 2
2. Capuchin-1

3. Mufflon-3
4. Lion cubs-7
5. Liontailed macaque-1
6. Silky fowl-7

Problems faced in the Treatment of Animals

1. Treatment of snakes for ecto-parasites

Many methods of treatment have been tried to treat tick infestation in snakes, which included s/c injection of Ivermectin, topical application of diluted Deltamethrin, topical application of Carbaryl powder and disinfection of the enclosures. But the treatments resulted in high percentage of mortality. The reptiles died within three to four days of treatment.

2. Alopecia and corneal opacity in sambars

Majority of the sambars maintained in the zoo are having diffused patchy alopecia and bilateral corneal opacity. Haematological and serological examination of the animals revealed normal parameters. Skin scrapings were negative for any pathogens. The diet schedule was also changed with additional quantity of tree fodder and concentrates. Even then, the condition persists.

3. Equipment for reading transponders from distance

The marking of animals was done by fixing 'Trovan' passive transponders in mammals as identifiers. The hand held reader currently used is capable of reading transponders within 15 cm range. The zoo would like to acquire reading transponders having range of 20 metres.

4. Traumatic myiasis in lions

The common problem observed in lions is external injuries and majority of the cases can be diagnosed only after infestation of the wounds with maggots. The incidence of myiasis is higher in lions than in any other carnivores.

5. Lumps and bumps in snakes

One serious problem in case of pythons is the occurrence of lumps. Even though the sand is changed frequently and the area is effectively disinfected and suitable temperature and humidity are maintained the problem persists.

Co-operative Health Programme

The zoo veterinary establishment have to deal with a large number of wild species for which enough information on conservation biology and captive management is not readily available. The zoo encourages networking and collaboration with other organizations to pool information and resources for providing better health care to the animals. The wild animals co-operative health programme is very essential for any zoo. The Central Zoo Authority has identified Madras Veterinary College (TANUVAS) as a nodal centre for wildlife health and disease diagnosis. A Memorandum of Understanding (MOU) has been signed between the Central Zoo Authority and Madras Veterinary College (TANUVAS). The essential features of this memorandum is to extend the facilities of diagnosis and clinical health care capability to the south Indian zoos. AAZP encourages active co-operation and collaboration with Madras Veterinary College for conducting collaborative studies on the following aspects

- Periodical examination of animals with chronic illness
- Periodical veterinary health care for the animals (once in a week)
- Veterinary internship training to Madrass Veternary College students on wildlife health management in AAZP
- Examination of samples of the viscera of animals after post-mortem examination
- Post-mortem examination of some important animals
- Analysis of various feed items fed to the zoo animals.

This collaboration and co-operation will strengthen the capability of Arignar Anna Zoological Park to provide health care to the captive population housed in the zoo.

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PATHOLOGY OF SPONTANEOUSLY OCCURRING DISEASES IN CERVIDS AT NANDANKANAN ZOOLOGICAL PARK, ORISSA

A.T Rao[1] and L.N. Acharjyo[2]

Abstract

The materials formed for this study were based on gross and histopathological examination carried out on 103 cervids (43 spotted, 23 barking, 13 hog-, 21 sambar, 2 sika and a brow-antlered deer) which succumbed at Nandankanan Zoological Park during 1967-1990. Among infectious diseases, pulmonary tuberculosis was the most common malady in all the species. Foot-and-mouth disease in spotted and sambar deer and bluetongue-like disease in barking deer were encountered. One case of pulmonary nocardiosis and one of zygomycosis was reported in hog-deer. Among parasitic diseases, specific lesions of hepatic fascioliasis in spotted deer and hepatic amphistomiasis in sambar were described. No specific lesions were seen in pulmonary hydatidosis in spotted deer and sarcocystosis in sambar. *Moneizia expansa* caused intestinal obstruction in a barking deer. Nodular hyperplasia in liver of hog-deer and nephrosis in all species were common lesions. Rare case reports of congenital anomaly involving skeleton in a newly born spotted deer, ethmoid tumors in 7 spotted, a sika and a brow-antlered deer and traumatic pericarditis in another sika deer were also described.

Introduction

Captive cervids in India invariably die suddenly without exhibiting clinical signs and a thorough physical examination and laboratory tests are not always done due to several reasons. However, during routine necropsy examination coupled with histopathology, several interesting spontaneously occurring diseases have been encountered, the pathology of which has been briefly described.

[1]Former professor and Head of Pathology, Orissa Veterinary College, Orissa University of Agriculture and Technology, Bhubaneswar - 751 003, Orissa.
[2]House No. M-71, Housing Board Colony, Baramunda, Bhubaneswar - 751 003, Orissa.

Materials and Methods

The materials formed for this study were based on gross and histopathological examination conducted on 103 captive cervids belonging to 6 species which succumbed at Nandankanan Zoological Park during 1967-1990. Different tissues with or without gross lesions were collected from 43 spotted deer *(Axix axis)*, 23 barking deer *(Muntiacus muntjak)*, 13 hog-deer *(Axis porcinus)*, 21 sambar-deer *(Cervus unicolor)*, 2 sika deer *(Cervus nippon)* and a brow-antlered deer *(Cervus eldi eldi)*. The formalin fixed tissues were processed by routine histological technic and paraffin sections were stained by hematoxyline and eosin. Special staining methods such as Ziehl-Nielsen's technic, Giemsa, Gram's, Periodic acid-Schiff's reaction (PAS), Van Kossa's, Brown and Brenn and phosphotungstic acid hematoxyline (PTAH) staining technics were employed, wherever appropriate.

Results and Discussion

a) Infectious diseases

i. **Foot-and-mouth disease (FMD) :** Of the 16 spotted deer and 34 sambar at risk at the time of outbreak, 4 and 6 respectively, exhibited typical lesions of FMD on tongue, muzzle and interdigital space of which 2 former and 1 latter succumbed to the disease. Type 'O' virus was indentified from the affected cases. It is believed that this infection must have been contacted from domestic cattle as it is the most common type recognised in India. Clinical disease was not noticed in hog-and barking deer which were also maintained in the same enclosure at the time of outbreak. It is quite possible that they might have had a subclinical course which had escaped our attention confirming the findings of Gibbs *et al* (1975) who showed that there was interspecies variation so far as the severity of the disease was concerned. However, according to McDiarmid (1983) in UK, no natural cases of FMD were confirmed in deer.

ii. **Bluetongue-like disease :** Of the 15 barking deer at risk at the time of outbreak, 3 animals were dull, depressed, listless, anorectic and exhibited

lungs had a marbled appearance which on microscopical examination revealed necrosis surrounded by epithelioid cells. PAS stained slide showed numerous broad and thin walled hyphae with non-parallel sides in the necrotic lesions of lungs and nasal chambers. The organisms were often empty and had bulbous dilatations with irregular branching. Since the organisms are widely distributed in nature it is logical to assume that primary infection must have occurred in the nasal chamber through inhalation and then extended into the lungs.

b. Parasitic diseases

i. **Fascioliasis** : The affected livers of 10 spotted deer revealed pale parenchyma/extensive hemorrhagic areas and/or multiple greyish white scars. The surface of the organ was usually rough due to fibrin flakes. The enormously thickened bile ducts were invariably packed with adult *Fasciola gigantica* admixed with inspissated bile. The thickening of the bile duct was due to proliferation of periductular connective tissue and infiltration of mononuclear cells. The lining epithelial cells of the bile duct showed extensive hyperplasia / desquamation due to presence of mature flukes in the lumen which invariably contained catarrhal exudates / inspissated bile admixed with numerous ova. In one liver, some of the ova were invaded by epithelioid and giant cells, the latter was seen ingesting the internal embryonic mass. Some of the eggs were calcified where as others manifested densely stained eosinophilic club-shaped radiating structures on their external surface resembling Hoepli bodies. These structures were deeply stained in PTAH. The lobular architectue was lost due to cirrhosis. In some cases, the hepatic cells were overloaded with bile pigments. Immature flukes causing destruction of hepatic tissue leaving trail of hemorrhagic tracts were encountered in a number of cases.

Fascioliasis has been considered as one of the common parasitic diseases in most of the zoos of this country (Rao and Acharjyo, 1972; Dutta *et al.* 1972; Gaur *et al.* 1979; Rathore and Khera, 1981; Baruah, 1983). The essential lesions described herein are akin to those seen in bovines (Sinclair, 1967) which are most comonly affected in most of the Indian villages with marshy areas. It is fascinating to observe that only spotted deer suffer from this disease in spite

of the fact that other species of deer are also kept in the same enclosure with identical feeding and management practices.

ii. **Hepatic amphistomiasis :** The affected livers in 5 sambar were firm to cut due to cirrhosis. The comon bile ducts were distended with pink coloured conical flukes identified as ***Paramphistomum explanatum***. Histologically, the mucosa of the comon bile duct was thrown into several folds due to hyerplasia of lining epithelial cells and a flask shaped projection was drawn into the concavity of posterior sucker. In some areas, the mucosa showed ulceration associated with cellular infiltration. The lumen contained inspissated bile admixed with flukes. There was periductular fibrosis. The pathology described herein is similar to those described (Kulasiri and Seneveratne 1956) in buffaloes. These parasites were not recovered from other species of deer. Sambar has been considered as the new host species for this parasite.

iii. **Other parasitic diseases :** Hydatid cysts displacing the lung parenchyma were seen in 2 spotted deer. The small intestine of a barking deer fawn was packed with ***Moneizia expansa*** causing obstruction to the lumen and catarrhal enteritis. Sarcocysts with clearly demonstrable cell wall containing typical banana shaped bradyzoites displaced the cardiac muscles and Purkinje fibres without any inflammatory reaction in the heart of a sambar.

c. Miscellaneous diseases

i. **Systemic diseases :** The occurrence of some systemic diseases in cervids is in Table 2. Detailed symptomatology and gross and histopathology of traumatic pericarditis in a sika deer has been described herein. A zoo-born male sika deer aged 4 years and 4 months had partial anorexia, was disinclined to move, depressed and had respiratory distress a month prior to death. Three to 4 days prior to death the animal raised its head frequently giving a star gazing posture and brisket was swollen due to oedema. The animal did not respond to treatment with antibiotics, steroids and supportive therapy. At necropsy about 3 litres of purulent dirty coloured liquid admixed with blood was seen in thoracic cavity. The markedly thickened pericardial sac was distended with foul smelling greyish fluid containing fibrin and pus. The heart presented

Histologically, in six animals, the lesions had features of adenocarcinoma with numerous acinar structures lined by single and / or multiple layers of cuboidal or columnar cells with hyperchromatic nuclei and basophilic cytoplasm. In the seventh animal, the lesions were of anaplastic carcinoma with extreme pleomorphism, tumour giant cells, hyperchromatism and numerous mitotic figures.

b. Sika deer : A zoo-born sika deer aged 4 years exibited epistaxis and swelling of frontonasal region 4 months prior to death. Trephining of frontonasal region twice and removal of tumour growths were ineffective. Soft tumour growths collected from ethmoid region at necropsy showed typical picture of squamous cell carcinoma with epithelial pearls.

c. Brow-antlered deer : An 8-year-old animal had swelling of frontonasal region between eyes. While in life, the animal produced abnormal breathing sounds and had dyspnoea apart from purulent rhinitis and debility.

At necropsy the nasal chamber was filled with fleshy smooth greyish white sessile/pedunculated growths admixed with purulent material. Histologically acinar structures lined by cuboidal / columnar cells with papillary projections or distension of acini with pink stained protenaceous material in acinar lumens lead to diagnosis of cystadenocarcinoma. These neoplasms were considered to be rare in wild animals as there are only 2 case reports, one in a spotted and another in elk deer in the world literature.

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HOOF TRIMMING IN ZEBRA

Pratibha Singh[1] and Rajiv Tripathi[2]

The Kanpur zoo has bred over 14 zebras in the past 23 years i.e., from 1980 onwards. The zebras born here have also been sent to various zoos across the country- Madras, Calcutta, Ahmedabad, Patna and Lucknow. Presently the zoo has one male and two female zebras out of which one is a baby. The male zebra was suffering from over grown hoofs in the forelegs. The hoofs were over grown and its hind foot also out sized. He had abnormal gait because of this. It was also felt that due to this problem he could not successfully mate with the female as he could not run or mount with ease.

The hoofs had to be trimmed as overgrown hoofs lead to permanent damage to tendons and ligaments.

Hoof Cutting Operation

The hoof cutting operation started at 7.30 AM on 08.08.2003. The male zebra was tranquilized by Inj. Immobilon 1.30 ml. i/m. with a blow pipe. He showed some peculiar movements. He came to left lateral recumbency 8 minutes after being hit by the dart. As it was humid and hot we tried to make the zebra fall in shade under a tree. A sack full of straw (pillow) was applied under the head of zebra to provide him full respiration and to prevent him from cerebro-oedema. Respiration was abdominal which was counted to 32/minute Palpaberal reflexes were present during whole operation. There was no wagging of tail. Slight shivering of whole body was observed. There was nasal respiration which was normal. The animal showed signs of paraphymosis (The penis could not be retracted during the whole procedure.)

First the cornium layer was clipped. The sensitive part bled a bit. The rotten part of matrix was removed with the help of a sharp knife .The solar matrix was then sharpened with a knife. The cornium layer was cut with clippers.

[1]Director, [2]Veterinary Officer
Kanpur Zoological Park, Kanpur, Uttar Pradesh.

Both the hoofs of the forelimbs were clipped. The right hoof was only slightly overgrown. All hoofs were rasped and bought to normal dimension. The respiration rate and pupillary reflexes were constantly monitored. The respiration noted during operation was 24/minute Abdominal respiration turned to thoracic respiration soon after administrating 1.5 ml of inj. Revivon i/v and O.5 ml i/m. The zebra became normal and he stood with staggering gait and walked normally. He took water within an hour and resumed normal feeding. The zebra remained under sedation for full one hour when the hoofs were being trimmed.

Length of total hoof- anterior	-	11.5" (28.75 cm)
Length of hoof cut	-	5.0 " (12.50 cm)
Length of hoof remained	-	6.5 " (16.25 cm)

A second hoof trimming exercise was done on all four limbs under tranquilization with Inj. Immobilon 1 ml (i/m) and Revivon 1 ml (i/v). The other drugs given were i/m Inj Biocin 2.5 ml, Avil 5 ml, Inj Curadex 5ml and Inj Zodic 15 ml.

Now the zebra is fine and has a normal gait.

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RABIES IN NILGAI (BOSELAPHUS TRAGOCAMELUS)

M. Navin Kumar[1] and M.V.A. Akbar[2]

The Nehru Zoological Park, Hyderabad (NZP) has in its collection a herd of nilgai numbering fourteen. They are kept in an enclosure with moat on one side and chain-link mesh fence on the other side with an animal house and a holding kraal.

On 2nd December 2001 the animal keeper came running to the Zoo Hospital and informed that one stray dog had jumped into the moat and started chasing the nilgais and in the process bitten two female pregnant nilgais. Both the nilgais were bitten on the hind limbs. The keeper noticed the same and chased the dog, which accidentally fell into the wet moat and died.

The dog bitten nilgais were immediately treated with antiseptic spray on the wounds and administered Megavac-R inactivated cell culture antirabies vaccine manufactured by the Indian Immunologicals Ltd. Hyderabad from 5th December onwards. On 16th December 2001 one of the two nilgais was observed to lie down with muscle tremors and having frothy salivation. The animal was made to stand upright and was driven into the animal house, which is along the holding kraal, thereby segregating from other nilgais. Whenever it was shown few blades of grass it consumed. It also consumed a little water. However, the animal was treated with injection Atropine Sulphate 2 ml i/m to counteract the effect of any possible toxicity and also about 2 ml of injection Dexamethasone was administered intramuscularly. The animal was also provided with fresh drinking water mixed with Glucose-D. By evening the nilgai was seen running in circles with salivation, tail kept vertically upwards under excited state and also grinding of teeth was noticed. It did not consume any feed or water and was found dead in the kraal on the next day i.e. 17th December 2001.

The Post-mortem examination was conducted on the dead nilgai and sections of visceral organs were collected in 10% formalin and the whole brain

[1] Deputy Director, [2] Vety. Asst. Surgeon
Nehru Zoological Park Hyderabad - 500064, Andhra Pradesh.

was carefully collected in ice and sent to Veterinary Biological Research Institute, Hyderabad. The carcass was disposed off by deeply burying along with lime and bleaching powder. Every precaution was taken to thoroughly disinfect the equipments and the personnel attending the post-mortem. The results of the Veterinary Biological Research Institute, Hyderabad received by NZP showed positive for RABIES.

Acknowledgments

We are thankful to the Director Sri A.V. Joseph for his keen observation on the typical signs and behaviour of the affected animal suspected for Rabies and timely intervention in segregating the affected animals thereby protecting the spread of rabies among other zoo animals.

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VANISHING FREE LIVING FAUNA OF NATIONAL ZOOLOGICAL PARK, NEW DELHI

A.K. Malhotra[1]

The National Zoological Park, New Delhi is spread in an area of 176 acres. The entire area is rolling and punctuated with a number of ponds, moats and channels which hold the water throughout the year except for a few moats. According to Warman (1983) the park has over 400 indigenous and exotic species of plants. The important tree species includes Kikar, Haldu, Neem, Dhak, Peepal, Bargad, Pilkhan, Prosopis and shrubs like Lantana, Bouganvillieas and herbs like Euphorbia and Amarantnus.

There are four ponds which are meant to display pinioned birds and also act as ideal habitat for water fowls. They attract a large number of land and water birds. The park used to receive a number of birds particularly the water birds from the river Yamuna in the past (Annon., 1986). Over the years drastic changes have occurred in the park due to cleaning of lawns, ponds and other areas. The park used to get unfiltered water from Yamuna. This water had fish fry in it. The Yamuna has become a sewage canal and the quality of water has deteriorated so much that it is neither suitable for drinking by the animals nor for gardening purpose. The park has only tubewell water at its disposal for filling the ponds and canals.

Water samples from tubewells were collected and got tested. It was found that ground water from tubewells was highly saline with very high TDS, Sodium, Calcium and Sulphate levels. This is again not suitable for either drinking or gardening (Annon., 1995).

Algal growth on water due to weak flow or stagnation was noted which float on the surface and gives obscence appearance. It also hinders fish to come over to the surface for breathing which is the main food for a number of water birds. As a result of the changes in entire habitat of the area, there has been

[1] Curator (Education), National Zoological Park, Mathura Road, New Delhi-110003.

change in the status o free living species in National Zoological Park. Malhotra (1984) recorded 102 species of free living birds in the Park. The species which have declined in number is given in Table-I while those who have vanished are given in Table-II.

Table - I : Species which have declined in numbers at National Zoological Park, New Delhi

Birds

Sl.No.	Common Name	Scientific Name	Remarks
1.	Pintail duck	*Anas acuta*	Winter visitors About 300 recorded during 1999-2000.
2.	Shoveller duck	*Anas clypeata*	Winter visitors, number has gone down considerably to the extent of below 200 during 1999-2000.
3.	Common teal	*Anas crecca*	Migratory number less than 50 during 1999-2000.
4.	Spotbill duck	*Anas poecilorhyncha*	Resident, used to breed till 1996.
5.	Comb duck	*Sarkidiornis melanotus*	Resident, but number has declined considerably
6.	White or Rosy Pelican	*Pelecanus onocrotalus*	No new bird from outside, zoo's own stock is breeding. They are seen flying over zoo and nearby area.
7.	White Ibis	*Threskiornis aethiopica*	Now-a-days breeding in zoo pond, earlier (1984) the number was very less.
8.	Painted Stork	*Mycteria leucocephala*	Numbers have consderably declined. Earlier the number was in thouands, now-a-days (1999-2000) it is between 500 to 600 only.
9.	Shikra	*Accipiter badius*	Very few are seen

10.	Common Green Pigeon	*Treron phoenicoptera*	A very small flock seen
11.	Crow Pheasant	*Centopus sinensis*	Below 10 are left in all.
12.	Redwhiskered Bulbul	*Pycnonotus jocosus*	Fewer in number
13.	Black Drongo or King Crow	*Dicrurus adsimilis*	A number of nests were seen earlier but now-a-days hardly 1-2 nests are seen.
14.	Golden Oriole	*Oriolus oriolus*	Below 10 seen.
15.	Common Weaver Bird	*Ploceus philippinus*	Earlier large colony of nests was seen in Pump House, in the Palm tree of ponds, but now-a-days nesting activities are restricted in the Palm tree in residential area only. The number has considerably gone down.
16.	Purple Sunbird	*Nectarinia asiatica*	Hardly 1 or 2 nests seen now-a-days in comparision to 10-15 nests.
17.	Coot	*Fulica atra*	Number below 5 only.

Mammal

1.	Jackal	*Canis aureus*	Were seen at night in good number but now-a-days 1 or 2 are seen in the area.
2.	Porcupine	*Hystrix indica*	Fewer in number still exists.
3.	Common Palm Civet	*Paradoxurus hermaphroditus*	Very few in number, seen at night
4.	Indian Small Civet	*Viverricula indica*	Very few in number.

Retiles

1.	Indian Python	*Python molurus*	Very few in number.
2.	Cobra	*Naja naja*	Few in numbers.

Table - II : Species which have vanished

Birds

Sl.No.	Common Name	Scientific Name	Remarks
1.	Brahminy Duck	*Tadorna ferruginea*	Not seen since 1990
2.	Common Pochard	*Aythya ferina*	Not seen since 1989
3.	Gadwall	*Anas strepera*	Not seen since 1989
4.	Garganey teal	*Anas querquedula*	Not seen since 1989
5.	Whitebacked Vulture	*Gyps bengalensis*	Not seen since 1996
6.	White Scavenger Vulture	*Neophron percnopterus*	Not ssen since 1996
7.	Tawny Eagle	*Aquila vindhiana*	Not seen since 1994
8.	Purple Moorhen	*Porphyrio porphyrio*	Not seen since 1992
9.	River tern	*Sterna aurantia*	Not seen since 1992
10.	Pied King fisher	*Ceryle rudis*	Not seen since 1996
11.	Blackheaded oriole	*Oriolus xanthornus*	Not seen since 1996
12.	Streaked Weaver Bird	*Ploceus manyar*	Not seen since 1996

Mammal

1.	Indian Hare	*Lepus nigricollis*	Not seen since 1992
2.	Indian Pangolin	*Manis crassicaudata*	Not seen since 1996

The probable reasons for declining / vanishing of various species of fauna are:

i) Non-availability of unfiltered Yamuna river water and providing of tubewell water which is saline in moats and ponds.

ii) Encroachment of the adjoining habitat viz. the nearby garbage where thousands of birds (kite, vulture, mynah, etc.) used to harbour, has now been overtaken by Railway Authorities for use as Railway Washing Yard.

iii) The conversion of Yamuna, the sole source of shelter, feed and watering of the birds into a sewage nullah full of foul smelling water.

iv) Shrinkage of jungle due to removal of dead and wind fallen trees.

v) There is increase in pollution of air and water around National Zoological Park.

vi) Banning of eatables into the park by the public.

vii) There has been change in climatic conditions viz. variable temperature and rainfall.

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MANAGEMENT OF INJURIES SUSTAINED DURING INFIGHTING IN BARKING DEER (MUNTIACUS MUNTJAK)

Pratibha Singh[1] and Rajiv Tripathi[2]

On 26.04.2002 at 1.00 PM the keeper reported a big fight between 2 male barking deer in enclosure.

On reaching the spot we found both the male barking deer were bleeding profusely. The bigger male had an incised wound about 15 cm long on left scapular region probably caused by the hard antlers. There were several lacerated wounds at the left abdominal region probably due to bite. The pulse, respiration rates and pupillary reflex were examined. The animal was tranquilized by diazepam and ketamine hydrochloride combination i/v .

The wound was thoroughly cleaned by Betadine and the damaged muscles were sutured with the help of 1/o catgut (continuous suturing). The skin was sutured by nylon thread (vertical mattress suture). The sutured wound was dressed with Loraxane cream. Inj. Binocin 500 mg, Inj. Avil -2ml and Inj. Conciplex 2 ml. were given i/m for 5 consecutive days.

The comparatively smaller barking deer was also bleeding profusely. Efforts were made to arrest haemorrhage with the help of Tr. Benzoin Co. but it was of no use. The pulse was very feeble and heart beat was arhythmic. It was due to severe blood loss from some major artery due to a punctured wound at right thoracic region. There was also an incised wound of about 10 cm long at right hock joint region. There were several lacerated wounds on the back. As the pulse was very weak 5% dextose along with 1 ml of Inj. Dexona was given as i/v infusion immediately. The bleeding artery was detected in the punctured wound and bleeding was arrested with the help of an artery forceps. Artery was ligated with help of 1/0 catgut. After 300 ml of i/v infusion of 5% dextrose the pulse became normal and heart beat rhythmic.

[1]Director, [2]Veterinary Officer
Kanpur Zoological Park, Kanpur, Uttar Pradesh.

The animal was tranquilized by xylazine Hcl @ 1mg/kg body weight, continuous suturing of muscles were done with the help of 1/o catgut and skin was sutured with nylon (vertical mattress suture). The animal was given 200 ml dextrose 5% i/v slowly and Inj. Binocin 500 mg, Inj. Avil and Inj. Conciplex 2 ml were given i/m. The wound was dressed with Loraxane cream. Both the animals were kept under parenteral antibiotics umbrella for 5 consecutive days and aseptic dressing was done daily.

On 10th day the nylon suture was removed. Aseptic dressing was done with Loraxane cream for few more days.

Both the animals recovered and are still with us in Kanpur Zoological Park.

RENAL CALCULI IN A MALE SWAMP DEER (CERVUS DUVAUCELI)

M. Navin Kumar[1] and M.V.A. Akbar[2]

Four (2:2) numbers of swamp deer (*Cervus duvauceli*) were received at the Nehru Zoological Park, Hyderabad (NZP) from Prince of Wales Zoological Garden, Lucknow (Uttar Pradesh) in exchange of lions on 19.06.1996. They were introduced near the Lion Safari Park area in a moated enclosure with a wallowing pool. One of the males jumped out of the enclosure immediately after introduction and joined free ranging spotted deer within the zoo. The stock bred well and both the females gave births to one fawn each every year. The NZP has in its collection 4:6 numbers of swamp deer at present. The feed schedule of the animals is given in Table-1.

Table - 1

Sl. No.	Feed item	Quality in kg/gm
1.	Cattle feed	1 kg
2.	Lucerne grass / Palak leaves	3 kg
3.	Carrot	500 gm
4.	Sweet Potato	250 gm
5.	Tomato	200 gm
6.	Para grass	5 kg
	Feed supplements	
1.	Supplivet-M	10 gm
2.	Agrimin	20 gm

The animals are provided with protected water for drinking from the municipal corporation water suply in the animal house, whereas they also drink water from the open moat, which is unfiltered, filled in the moat from the adjacent lake.

On 23rd January 2002 one male deer which was proposed to be shifted to another area for making a different group, received injuries in the form of contusions and bruises all over the body caused because of repair works taken

[1] Deputy Director, [2] Vety. Asst. Surgeon
Nehru Zoological Park Hyderabad - 500064, Andhra Pradesh.

up by the workshop personnel. This made the animal panicky and received injuries while trying to jump out of the kraal. The animal was subsequently off feed and dull. The following treatment was given.

1. Injection Proxivet d.s (Diclofenac sodium paracetamol) 5 ml i/m.
2. Inj. Dexona (Dexamethasone sodium phosphate) 2 ml i/m.
3. Inj. Munomycin forte (Fortified Procaine penicillin and Streptomycin sulphate) 1 gm i/m.
4. Dressing of the wounds with Loraxane ASD cream and Neem oil.

The same treatment was repeated next day but the animal did not respond and showed signs of weakness and became recumbent, did not pass urine and faeces and totally anorectic.

The line of treatment was changed from the next day as the condition detoriated.

1. Inj. Mikacin (Amikacin sulphate) 500 mg bid.
2. Inj. Ringer's lactate 500 ml i/v.
3. Inj. Woktrose 25% soln. 450 ml i/v.
4. Inj. Beplex forte (B-Complex) 2 ml i/v.
5. Inj. Dexona 1.5 ml i/v.

The animal succumbed while on drips.

Post-mortem findings revealed no internal haemorrhages and when gastro-intestinal tract was opened, injesta was seen obstructing partially from reticulum to omasum and abomasum. Abomasum was seen to be highly congested. There was retention of urine in the bladder and when probed at the level of prostates, there was obstruction. When the kidneys were opened a number of calculi were present in both the kidneys. Sections of visceral organs along with pieces of calculi were collected and sent to Veterinary Biological Research Institute, Hyderabad for histopathology and identification of salt. The result is awaited.

Acknowledgements

The Authors are thankful to Sri A.V. Joseph, Director, Nehru Zoological Park, Hyderabad for his cooperation.

PEOPLES PARTICIPATION IN ZOO MANAGEMENT : ADOPTION SCHEME

B. Prabhakar

Of late the zoo has become important center for conservation of endangered wildlife and conservation education programme. But the maintenance of these zoos has become very expensive. Many zoos in the country are dependent on State Government and Central Zoo Authority for the day-to-day maintenance of the zoo. The major expenditure required for the day-to-day maintenance is for the feeding, medication and salaries of the employees. The funds provided to the zoos for these expenditures are meagre or insufficient. In many zoos generally the revenue collected in the form of entry fee goes to Government exchequer. This left the zoo either with no money or insufficient money. At the same time in the day-to-day maintenance there is less involvement of the people except for their coming to zoo. Visitors to the zoo sometime raises questions like the zoo is poorly maintained and the animals are not fed properly.

This happens due to the ignorance about intricacies of the zoo management and non-involvement of people in the conservation activities. To dispel the misconception and involve the people in day-to-day management many activities are generally taken up is zoos such as guided tours, keepers talk, tours during the feeding time, film shows, touch table shows etc. In all these activities individual is only sensitized, but he does spend money from his pocket. Further to dispel the misconceptions and actively involve people in the management, schemes like adoption of zoo animals have been introduced.

This scheme was started in the Lucknow Zoological Garden previously known as Prince of Wales Zoological Gardens on 15 August 1994.

What is adoption scheme ?

It is the welfare and conservation scheme under which any person who is interested in the wildlife conservation and animal welfare can adopt an individual

[1]Lucknow Zoological Garden, Lucknow-226001, Uttar Pradesh.

or group of animals or entire enclosure for the feeding, medication and maintenance for six months, one year or more by paying actual costs.

Who can adopt ?

Any individual, government, semi-government institutes, voluntary organisations, non-government organisation (NGOs), industrial houses, any society, nature club, eco-clubs etc. can adopt zoo animals under this scheme.

How can they Approach ?

Any one who is interested can approach Chief Wildlife Warden, Uttar Pradesh or Director, Lucknow Zoological Garden either in writing or verbally expressing his desire to adopt animals in the zoo.

What are the facilities under Adoption Scheme ?

1. Under this scheme who ever adopt the animal, his name will be displayed at enclosure.
2. One free pass will be issued to the adopter to visit the zoo to check the maintenance of his adopted animal.
3. The amount for which the animal is adopted in the zoo is exempted from income tax under Sec. 80G of Income Tax Act.
4. The adopter can send the money to the Director of the zoo in any form i.e. cheque / draft / cash at his/her liberty.

The list of the contributions received under adoption scheme from 1994-95 - 1999-2000 and contributors for 2000-01 and 2001-02 are given in Table 1 and 2 respectively.

This scheme has evoked good response from the individuals and corporate houses not only to look after the animal but also help in the maintenance of the other establishments of the zoo like Children Train, Children Park and Baradari etc.

This scheme has not only reduced the financial burden of the zoo but also reduced the dependency for the funding and made the zoo self-sufficient for the maintenance of certain animals.

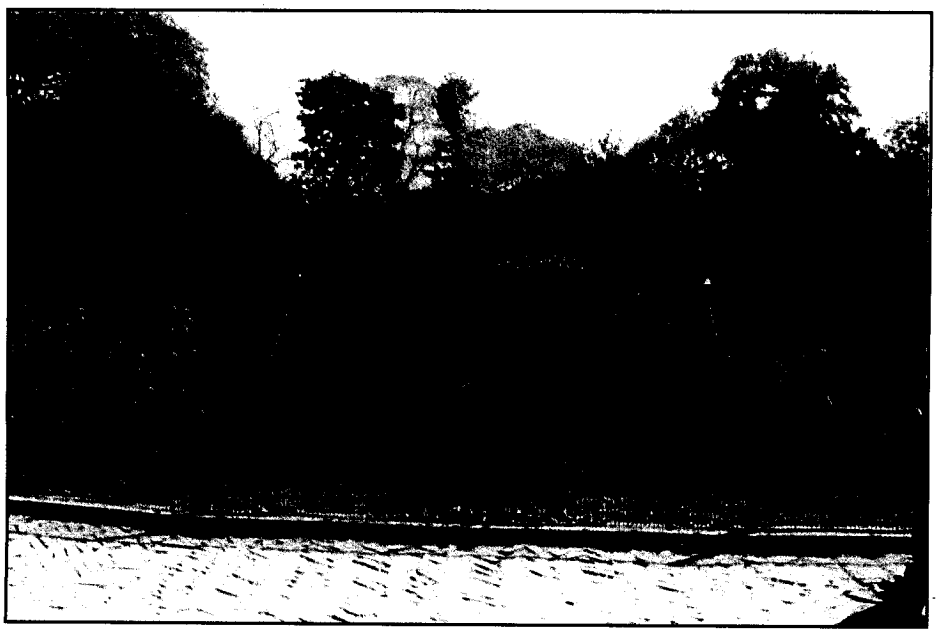

Fig.1 : Duck pond adopted by State Bank of India for the year 2001.

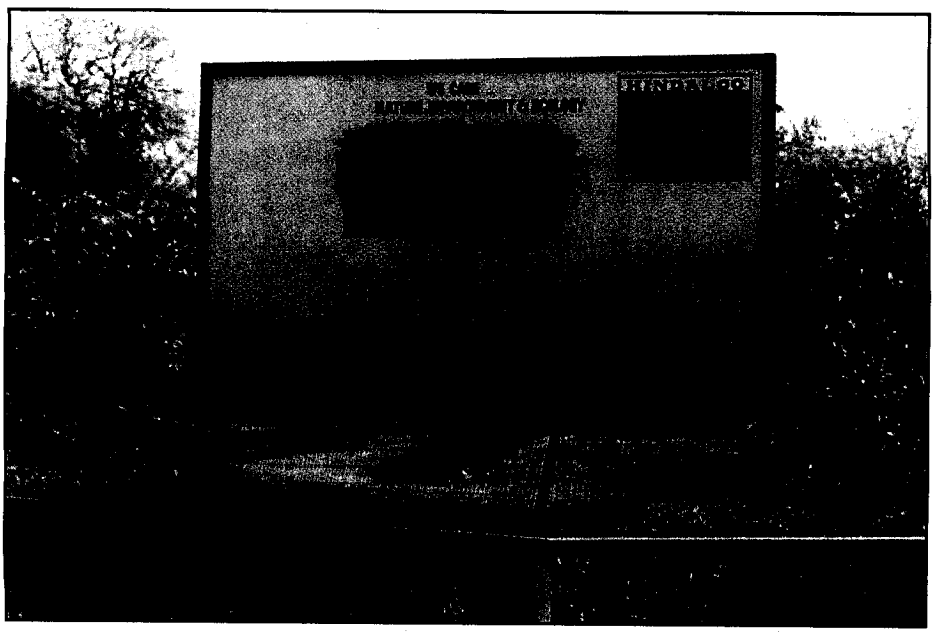

Fig.2 : Rhino adopted by Hindalco Industries Ltd., Lucknow.

Fig.3 : Great Indian Onehorned Rhinoceros (*Rhinoceros unicornis*)

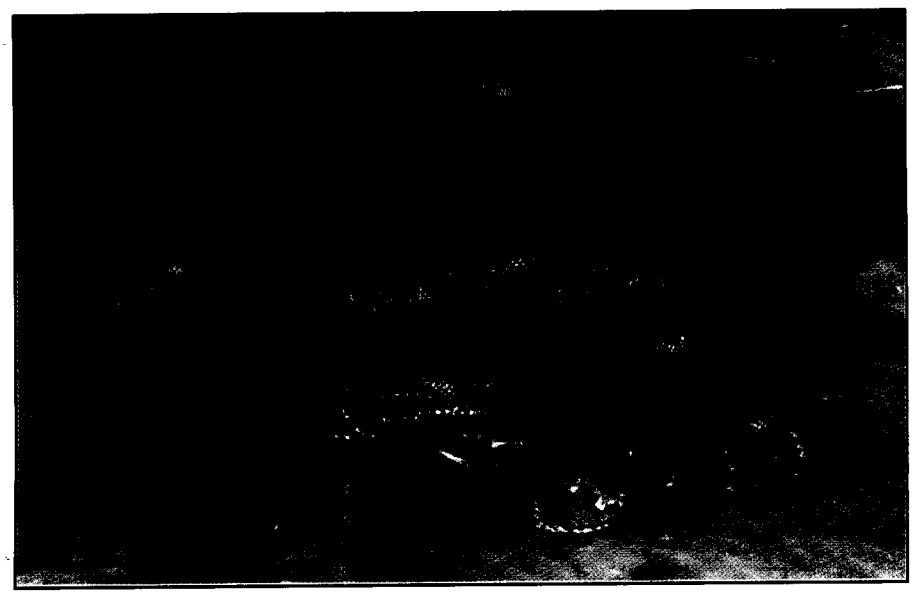

Fig.4 : Indian Python (*Python molurus*)

Park has bred over 170 animals since their acquisition and we are proud possessor of a healthy herd of 48 animals today, which is probably the biggest population of brow-antlered deer in any captive institution all over the world.

As far as zoo is concerned, its task is not only reproducing the endangered animals so as to increase their population but also to generate empathy in the hearts of the people so that they do not deliberately or unknowingly become a causative factor for their extinction. This seems to be a high set goal and zoos strive hard to attain it. The basic idea behind entrusting this responsibility to zoos is that this is the only place where people can see many of those animals which they would not have otherwise seen in the wild. Human nature is such that we take interest only in things and creatures of which we have some personal knowledge. Merely seeing an animal in picture or statue does not evoke as good a response as once the animal is seen and felt alive. The magnificent mane, the impressive gait and the thunderous roar of the lion have to be seen to be believed. No picture or statue of lion, however, real may be can transmit these experiences. If we see these lions often in zoo and experience birth and rearing of cubs we start feeling closer to these beasts and next time if we hear that these animals are endangered, we are definitely moved. Thus Kirchshofar (1968) has rightly said that a visit to zoo reveals to us the richness of wild heritage and through our curiosity, interest and affection, may engender a desire to partake of some of those riches.

Although live animals speak for themselves, but many visitors want to know more about animals at the zoo. The National Zoological Park tries to meet their curiosity in more than one way. The first and foremost amongst them are legible, well designed labels on the animal enclosures. These are made usually on a set pattern. There is a photograph of the animal alongwith its distribution on a map. Then its common name and scientific name in English and in local language are given. After that some interesting informations or facts are given about the species which helps in having a better understanding of the animal. On the foot line some facts like gestation period, longevity etc. are written. These labels help the visitor to see the animal and know the biological significance of its colour, shape and size etc. at the same time.

There are some professional groups who can't be satisfied merely by boards. For them, special conducted tours are organised in which the Zoo

Educator gives lectures in front of the animal enclosure. The advantage of this method is that a person uses almost all his senses to perceive information without taking his eyes off the animal. Of course, it is impossible to remember all informations provided in one visit to the zoo but a person tends to remember bits of these informations according to his own special interests and preferences.

Reptiles are the most ill-treated animals, thanks to the myths attached to them. A snake-show is organised in the zoo to make people aware of the facts about reptiles, their importance in day-to-day life and their role in ecosystem. People are even allowed to touch the snake to help them to believe in whatever they listen. We also educate them about the first aid, that should be provided once a man gets bitten by a snake.

Zoo acts as a school for teachers too. We motivate pre-service and inservice teachers to come to zoo. Teachers are trained on how should they prepare their children for a visit to zoo. They are made to learn ways by which visit to zoo can become much more than just a fun trip for high school children. One of the main aims of holding teacher orientation training is that one teacher will educate hundreds of students about importance of wildlife.

Annual celebrations like wildlife week, animal welfare fortnight, zoo foundation day, world environment day, "van mahotasava" etc. at National Zoological Park also help in rejuvenating the spirit of wildlife conservation among masses During these celebrations different programmes are organised for people of all ages and interests. Special emphasis is given to children because they are the future custodians of wildlife.

These are the main strategies deployed to educate zoo visitors while visiting the zoo. From the above, the main steps leading to a successful conservation education programme can be given in the form of a model which is annexed.

To support this model we would like to present results of surveys conducted in National Zoological Park during 1987-88 (Naidu and Malhotra, 1988) and subsequently in 1997-98 (Sabina and Malhotra 1998) In these surveys besides many other aspects, aim of the visiting public and their inclination towards animals was studied. The results are as follows:

Attitude	1987-88(%)	1997-98(%)	Difference
Recreation	75.87	71.20	-4.67
Education	12.85	25.50	+12.65
No Specific purpose	11.28	3.30	-7.98

It is clear from above that during a gap of ten years we have been able to change attitudes of 12.65% people for education. In 1987-88, 75.87% people came for recreation whereas in 1997-98, this declined by 4.67% and became 71.2%. Similarly, in 1987-88, 11.28% people came to zoo just like that, without any special purpose but out of those 7.98% people changed their mind and sought education in zoo.

In 1997-98 survey, although only 25.5% people felt educationally inclined towards zoo whereas 57.40% visitors believed that zoo gives protection to endangered species and provides a chance to interact with nature. It is believed that in due course of time these 57.4% visitors will also start seeking education in zoo.

This indicates clearly that zoo is a powerful tool in imparting conservation education if used wisely, and we, the zoo-educators can change the minds of visiting public even without their being aware of this. The knowledge and appealing thus obtained makes visitors more responsible towards their fellow creatures and derives their inner self to conserve animals.

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BIOSECURITY

R. Hemanth Kumar

Biosecurity is defined as *"Embodies all the cumulative measures that can or should be taken to keep the diseases away (viruses, bacteria, fungi, protozoa, parasites), from a farm and to prevent the transmission of diseases (by humans, insects, rodents, and wild birds/animals) among the inmates of the infected farm and from an infected farm to the neighboring farms."*

The commonly occurring diseases among the wildlife are :

I. Bacterial Diseases :

- Anthrax- Caused by ***Bacillus anthracis*** and infects chital, gaur, hog-deer, sambar, leopard, primates, elephant, rhino, etc. The blood smear of infected animals shows short chains of rod with truncated ends.
- Clostridial infections- Caused by
  - i. *Clostridium perfringens* type D-enterotoxaemia in deer, sloth bear, etc.
  - ii. *Clostridium chauvoei*-black quarter in blackbuck,
  - iii. *Clostridium tetani*-tetanus in elephant, rhino etc.

In enterotoxaemia infections the affected animals show the symptoms of ballooned up intestine, congestion in other organs and black quarter affected animals show symptoms of gangrenous myositis.

- Leptospirosis- Seen in the animals like tiger, deer, elephant, lion, sambar, nilgai, blackbuck etc. The important symptoms are still-birth and abortion in the infected animals.
- Paratuberculosis- Caused by *Mycobacterium paratuberculosis* and infects spotted deer and swamp deer. The disease spreads from ingestion of food and water contaminated by faeces of infected animals. The main signs of the disease are diarrhoea and severe emaciation.

Director, Kanpur Zoological Park, Allan Forest, Kanpur-208002, Uttar Pradesh.

- Pasteurellosis - Caused by *Pasteurella multocida*, *P. haemolytica* in sambar, nilgai, spotted deer, blackbuck, hippo, lion, tiger, wolf etc. causing congestion in the internal organs, haemorrhage, consolidation in lungs etc.
- Plague - Caused by *Yersinia pestis* in baboon, rhesus monkey etc. The diseased animals show the symptoms like fever, dullness, early prostration etc.
- Spaphylococcosis - Caused by *Staphylococcus aureus* in tiger, lion, rhino and zebra, causing arthritis and enteritis in them.
- Salmonellosis - Occurs in zoos due to the poor management of the animals; and is frequently seen in sambar, blackbuck, jackal, leopard, chimp, rhino etc. characterized by the symptoms like diarrhoea, dysentery etc.
- Tuberculosis - Caused by *Mycobacterium tuberculosis* in rhino, non-human primates, giraffe, barking deer, hog-deer, thamin deer, spotted deer, sambar, nilgai, blackbuck, elephant, lion, tiger, leopard, bear, python, crocodile etc infecting lungs, intestine and viscera of these animals. The main route of infection is through respiratory tract.
- Shigellosis - Occurs in lion, tiger, primates etc. The infected animals show symptoms like pyrexia, dysentery, etc.. The disease is characterized by severe congestion in intestine.

II. Viral Diseases :

- African horse sickness - Commonly occurs in horse, zebra, monkeys etc.. The disease spreads through culicoides bites and from infected domestic equines.
- Rabies - Occurs in tiger, brown bear, lion, civet cats, jackal, leopard, rhino etc.. The disease spreads mainly among the inmates of the zoo through the stray animals like dogs etc..

- Foot-and-mouth disease - Caused by 'O' Asia-1 strain in Artiodactylas. The source of infection among the animals of zoo can be contaminated grasses brought from the infected areas (outside the zoo)
- Rinderpest - Seen among nilgai, sambar, chital etc. The natural infection among the wild ruminants is mostly air-borne and by ingesting contaminated food. The infected animals show symptoms like diarrhoeic faeces containing blood. Oral and nasal mucosae-hemorrhages, abomasal mucosa, caecal and colonic mucosae and mesenteric lymph nodes are also swollen and congested.
- Canine distemper - Caused by RNA paramyxovirus
- Infectious hepatitis - (jaundice)
- Infectious feline enteritis - Occurs in the felidae with symptoms like pasty to watery diarrhoea and rapid emaciation and dehydration.

III Mycotic Diseases :

a. Intestinal candidiasis-in sambar, blackbuck.
b. Nercotic dermatomycoses- in gharial
c. Dermatomycoses -in chital, tiger, lion, hyena etc.
d. Aflatoxicosis - Caused due to contaminated food in bear and deer. The kidneys become pale in colour, grayish white nodules can be seen on liver of infested animals.

IV Helminthic Diseases :

Trematodiasis- Fasciolosis, Paragonimosis, Schistosomosis, Paramphistomosis etc.

Cestodiasis - Taeniasis, Dipylidiosis, Echinococcosis, Diphyllobothriosis, etc.

Nematodiasis - Ascariasis, Oxyuriasis, Capillariasis, etc.

V Protozoan Diseases :

Trypnasomosis, Plasmodiasis, Toxoplasmosis, Sarcocystosis, Coccidiosis, Babesiosis, Entamoebiasis, Trichomoniasis, Leishmaniasis, etc.

The main sources of infection in zoological parks are -

- Humans -- Hands, hair, clothing, footwear etc.
- Contaminated equipment (includes the food distribution vans, utensill etc.),
- Domestic and wild animals,
- Improperly disposed carcasses,
- Contaminated food,
- Backyard flock like rodents, free ranging birds like pea fowls etc.
- Infected Premises.
- Migratory birds etc.

Risk Reduction Techniques

After having discussed about the various diseases, their causative organisms and the main sources of infection, the following measures are to be incorporated into the daily management of a zoological collection to minimize the risk of introduction of exotic animal disease or any other disease emergency caused due to the spread of diseases among the resident populations.

(A) Management of resident animal collection

The level of biosecurity and record keeping will significantly reduce the risk of acquiring an exotic animal disease by the resident population of the zoo, for it the zoo veterinarian and his support staff must follow the following :-

- All animals should be individually identified.
- Daily observation by animal care staff of each animal for clinical signs of disease and method of reporting abnormalities helps in early veterinary investigation.
- The zoo veterinarian as a part of the disease surveillance in zoos must follow the practice of performing complete necropsies on every animal that dies within the zoo and should maintain a record of it.
- Another important element in disease surveillance in zoos is the use of molecular diagnostics to identify and characterize novel agents responsible for disease outbreak. For this purpose the samples

obtained from the dead animals must be sent to the labs for detailed investigation.

- The proper use of disease risk assessment procedures and proper communication of risks, is essential in navigating the complex realm of disease outbreak response and biosecurity in zoos, so the zoo veterinarian should work in this direction.
- Periodical inspection of the food sources (slaughter houses, areas where the grasses are grown etc.) must be given top priority

(B) Management of animal acquisitions and dispositions

In addition to the sound management of animal collections in zoos implementation of the following management strategies will significantly reduce the risk of an emergency disease outbreak, maximize early detection and assist in control measures.

- All newly acquired animals must be identified at all times and detailed records kept.
- Treatment records of newly acquired animals may also be procured, as this will facilitate "trace-back" investigations.
- The veterinarian and the curator should have a current inventory along with origination/source of all imported animals held by the institution and updated on an annual basis.
- The veterinarian should analyze the cause of death of any quarantined or imported animal (after detailed postmortem examination and detailed histopathological tests) as soon as possible after the postmortem examination.
- Disposal of the carcass should be performed to minimize potential transmission of pathogens to humans, other animals within the zoo.
- During quarantine, access to animals should be limited to the essential staff only (veterinary and designated animal care staff only).
- Waste material from animals in quarantine should be treated in a

manner that limits access by all other fauna (including free-ranging animals/ birds).

- Biological specimens from animals in quarantine should be handled, transported and stored under conditions that will minimize the potential transmission of pathogens while preserving the integrity of the sample for diagnostic testing.
- There may be a need to consider the spatial requirements (distance) between animals in quarantine and those that have been cleared.

Different Sections of the Zoo and their Role in the Control of Diseases

1. Veterinary Section

Veterinary services should have emergency disease preparedness plans. The veterinarian should be familiar with the relevant aspects of the zoo animal handling and management practices so as to enable more informed decisions if an exotic animal disease is suspected. The veterinarian should be aware of different diseases and procedures for dealing with the suspected cases. The veterinary health program should be designed so that there is a reasonable chance of detecting disease if at all it is present. The veterinarian should impart basic training to staff in procedures to minimize the spread of disease

2. Zoo Staff

The main objective of training is to prepare zoo staff for an emergency disease, including training for specific individual roles and information about recognition of clinical signs of different commonly occurring diseases. Emphasis should be placed on the need for staff to report promptly if any abnormalities in animals under their care are observed. Animal care staff should be instructed to report animals with suspicious signs to the veterinary staff immediately.

Other Important Aspects in Biosecurity of Zoological Parks

1) Early Detection of Disease

Zoo should be well positioned to detect a disease early, since each animal is visually inspected daily. The use of pre shipment examination and certification

surrounding animal movements between zoos provide an additional opportunity for disease detection.

2) Regular Sampling

Regular sampling of animals for a range of diseases by faecal, urine, or blood analyses is part of each institution's routine preventive health program.

Apart from the collection of routine samples, the zoo authorities should periodically collect samples that may include serological and other testing for diseases of concern and banking of those samples. Banked samples will help in a more thorough epidemiological assessment of disease in the collection.

In the event of a suspected disease, serum may assist the diagnosis and evaluation of exposure of animals to different diseases.

3) Laboratory Submission

Zoo veterinarians should submit appropriate samples to the laboratory for diagnosis.

4) Routine Screening of Deaths

In accordance with Central Zoo Authority (CZA) guidelines, all animals that die in a zoo should receive a complete necropsy. This provides a check on the disease status of the zoo's animal collection. If lesions consistent with vesicular disease are present, appropriate samples for additional diagnostic testing should be collected (i.e. affected tissue, tissue fluid, serum if possible).

5) Zoo Design

To reduce the risk of transmission of disease among the inmates of the zoo

- Exotic animals and the free ranging animals should not have any direct contact with the zoo animals.
- An effective pest (including rats) management program is implemented and maintained.
- Exhibit and holding facilities should be free from the contamination of adjacent areas by waste materials and / or drainage.

6) Work Practices and Staff Hygiene

The following routine practices should be followed in the zoo for reducing the chances of disease transmission.

- Measures to be taken for the periodical health check up of zoo staff so that they will not act as carriers of zoonotic diseases.
- Work clothes, including footwear, should be dedicated and worn only at work.
- Contact between animals kept at home and zoo animals should not occur. This includes indirect contact via footwear, equipment and clothes as stated above. Hand washing before and after work is an additional risk mitigation technique that should be made mandatory.
- It is very important to follow-up on any suspect signs of clinical illness.

7) Disposal System

The possibility that a serious disease could occur in a zoo, particularly among the herbivorous mammals, underlines the need for strategically located disposal facilities. Burial or incinerations are possible options for carcass disposal. In addition to it composting/ burning is a better option for the disposal of waste materials.

Any disposal procedure that necessitates the transportation of carcasses from inside the infected premises to a distant location (with in the zoo) increases the risk of spread of disease and requires special measure.

All procedures for carcass disposal should comply with CZA guidelines. These procedures should provide adequate biosecurity measures and traceable disposition of carcasses to prevent transmission of pathogens.

Disposal of faeces is another consideration. In a mammalian disease emergency, faeces, bedding, and used hay should be burnt or buried on-site. Non-infective faecal material, i.e. from non-infested animals may be composted. Faecal waste from recently acquired animals still in quarantine should be kept separate or sterilized before disposal.

Care must be routinely exercised to ensure all food (living or dead) brought into the zoo (to feed zoo animals) should originate only from safer sources. It requires periodical checking of fodder cultivation areas and being in touch with the local veterinarians of those areas, for ensuring that diseases should not enter the zoo through the feed. Similar care also should be taken while procuring meat and poultry from different sources.

8) Creation of High Security Isolation Area

a) Isolation premises for small animals

Isolation premises for small species must be indoors and bird, vermin and insect-proof. Such premises should also have no wind currents; efficient waste collection and disposal; and dedicated utensils, instruments and clothing. Isolation areas should meet requirements for quarantine facilities as outlined in the CZA guidelines.

b) Isolation premises for large animals

Large animal isolation premises must be in a part of the property that has as wide a buffer zone as possible from other stock or have solid walls that prevent aerosol transmission. The enclosures must also have footbaths; dedicated utensils, instruments and clothing and be tended by staff that will not have further contact with any other animals that day.

9) Vaccination

Periodical vaccination of all zoo animals should be considered even if an outbreak of disease is not imminent. Due to the individual value of rare or endangered species, vaccination should be done early, if the threat of an outbreak is imminent.

10) Public Relations and Education

In the event of an emergency disease, a zoological institution will be the target of intense media interest. In preparation for the event of an emergency disease outbreak, every institution should formulate a plan for handling public relations. Someone should be designated as the zoo media officer. In the event

of an outbreak, the media officer should be advised immediately and be kept with up-to-date informations periodically.

Media and public relations activities relating to a zoological institution should ensure:

- Rapid and effective information flow and media operations in the event of an emergency disease affecting or threatening to affect a zoo;
- An up-to-date, constant flow of accurate information to staff within the affected premises,

Part of the media officer's responsibility is ensuring the cooperation of zoo staff by keeping them fully informed about animal management decisions and animal health status. Technical information regarding the situation should be explained in layman's terms and should be prepared in advance. Signs, graphics and brochures should be used to communicate actions being taken to prevent and minimize the impact of diseases to the public and zoo personnel.

Biosecurity Measures to be adopted in case of disease outbreak among Animals in Zoological Park

- The zoo veterinarian should prepare a list of all the potentially susceptible animals within the zoo divided into high and low-risk groups. The high-risk group should consist of animals that have proven to be highly susceptible to diseases for example to FMD (i.e. hoofstock); the low-risk group should consist of non high-risk animals that have been either naturally or experimentally infected.
- A schedule of regular surveillance for the presence of diseases should be developed for both low and high-risk groups. The methods and frequency should be appropriate for the species involved.
- Instructions should then be given to staff, such as keepers, to carry out these surveillance procedures and report the results to the veterinary officer. It may be desirable to withdraw any high-risk or high value susceptible species from public display while restrictions are in place.

- Proper training to the staff for the recognition of clinical signs and prompt reporting of any unusual signs in zoo animals.
- Organizing and prioritizing staff duties and movements, with high-risk animals being dealt with last.
- All movements of susceptible species within and into the zoo should cease.
- Any highly endangered or valuable susceptible species should be immediately moved to the most secure facilities available within the zoo and kept there in isolation from all other susceptible species.
- Facilities for routine disinfection are required for all people and vehicles (including feed trucks etc.) coming into contact with zoo grounds or animal areas.
- Decontamination/disinfection of zoo vehicles and other equipment;
- Food brought into the zoo should only be sourced from outside the surveillance and infected areas; if not feasible, special arrangements should be made to lessen the incidences of contamination.
- Toys purchased for enrichment will be disinfected before giving to the animals.
- All dead animals are to be burnt after proper necropsy and after the collection of various tissues for histo-pathological examinations.
- **Outside contractors, consultants and visitors**
  a. Work or visits delayed or cancelled if possible.
  b. "Back gate" control point where all non-employees are queried about their recent contact with diseased animal. Protocol in place to clean mud off muddy vehicles and disinfect tyres of high-risk vehicles.
  c. Disinfect footwear and supply outerwear to cover street clothes.
  d. Trash and recyclable pickup vehicles must not carry meat or other agriculture operations prior to servicing the zoo. Whenever possible, reposition trash and recyclable goods containers to facilitate offsite pickup.

- Tracing of all equipment and materials that have been used in handling and transporting the diseased animals should be carried out. Where there is any uncertainty as to whether it may have been in contact with the infectious agent, then it must be immediately decontaminated, along with sites where it has been held and people who have handled it.
- **Staff and uniforms**
  - Staff should be advised to keep direct contact between susceptible species and people to a minimum.
  - They should also pay particular attention to hygiene in food preparation; it may be desirable to have a separate area for food preparation during the outbreak.
- **Staff education**
  - Biosecurity lecture/questions and answers are given to employees working in animal areas. Open presentation for all interested employees.
  - Letter to employees living in or near quarantine zones explaining precautions that they should take to minimize the chance of bringing exotic disease micro-organisms inadvertently into zoo premises.
  - Staff working with susceptible animals should shower, change clothes or undergo personal disinfection before and after handling the infected animals
- **Dealing with feral animals and other vectors**
  - Immediate action should be taken to control any vermin or feral animals that could spread the disease agents. This may include rodents, wild birds and a variety of other wildlife.
  - For the control of insects which act as vectors for various diseases, may be killed by using techniques like fumigation and by spraying insecticides in the stranded water.
  - Attention should be paid to the security of boundary fencing and enclosures to prevent the entry of animal vectors.

- A general clean up of all buildings and enclosures should occur with removal of any accumulated garbage/unused equipment.

- **Dealing with organic waste**
  - Particular attention should be paid to removal of any accumulated organic material that may either harbour microorganisms or act as insect or vector breeding grounds.

- **Public outreach**
  - Install signs in front of all enclosures explaining the need to close the enclosure whenever required to protect the collection from exposure to diseases.
  - Provide a letter to neighbours of the zoo notifying them of the disease and the quarantine and our concern for their animals and our animal collection.

- **Additional Measures to Consider**
  - Separate work areas with biosecurity measures (facility and protocols) where possible.
  - Use disposable facemasks for people working in close contact with infected animals. Change masks when moving from one enclosure to another.
  - Use a transfer station outside the facility for delivery of feed for animals. If feed trucks must enter the premises, clean and disinfect the wheels and wheel wells before allowing entry to the facilities. Do not allow the driver to disembark.
  - When possible, footwear should have smooth or minimum tread for more effective cleaning and sanitizing.

Biosecurity Measures to be Adopted in case of Disease Outbreak Among Birds in Zoological Parks

1. Cease movement of birds into and out of collections including transfers between zoo facilities.

2. Discontinue public contact with zoo birds.
3. Collection birds shouldn't go off premises for any purpose.
4. Discontinue the use of poultry as food items (processed eggs exception). (In Kanpur zoo we are feeding poultry to some animals)
5. Eliminate all bulk poultry feed brought onto premises.
6. Laboratory samples from collection birds will no longer be sent to laboratories outside the quarantine area (waiver for select laboratories can be requested.)
7. Remove collection birds from public-access areas of open ponds.
8. Provide informational signs at the entrance to all bird areas identifying them as such and notice of precautions in place.
9. Bird toys purchased for enrichment will be disinfected before giving to birds.
10. Transport cages, feed trays and any equipment used with birds must be cleaned and disinfected after each use and where possible should be restricted for use within a specific group of birds.
11. Handling dead birds
    a. Dead birds will be double bagged and delivered to the necropsy room.
    b. If 5 or more birds die in one day, the duty veterinarian and pathologists confer and assess risk.
12. Use standard disinfectant for footbaths, vehicle disinfection, etc.
13. Outside contractors, consultants and visitors
    a. Work or visits delayed or cancelled if possible.
    b. Visitor queried on recent poultry or other bird contact.
    c. "Back gate" control point where all non-employees are queried about recent bird contact. Protocol in place to clean mud off muddy vehicles and disinfect tyres of high-risk vehicles.

d. Disinfect footwear and supply outerwear to cover street clothes.

e. Trash and recyclable pickup vehicles must not service poultry or other agriculture operations prior to servicing the zoo. Whenever possible, reposition trash and recyclable goods containers to facilitate offsite pickup.

14. Remove free-roaming peafowl and guinea fowl from zoo grounds.

15. Footwear

a. Work shoes worn while in bird areas must stay at work.

b. All footwear cleaned and disinfected on entry or exit to bird areas.

c. Footbath hygiene and management stressed. Footbaths changed daily or more frequently if soiled.

16. Uniforms

a. Employees entering bird areas must wear uniforms.

b. Uniforms stay on property. Uniforms include any surface clothing.

17. Staff education

a. Biosecurity lecture/questions and answers are given to employees working in bird areas.

b. Open presentation for all interested employees.

c. Letter to employees living in or near quarantine zones explaining precautions that they should take to minimize the chance of bringing exotic disease micro-organisms inadvertently onto zoo premises.

18. Public outreach

a. Install signs in front of all walk-through aviaries explaining the need to close the aviaries to protect the bird collection from exposure to diseases.

b. Provide a letter to neighbours of the zoo notifying them of the disease and the quarantine and our concern for their birds and our bird collection.

Additional Measures to Consider

19. Separate bird work areas with biosecurity measures (facility and protocols) where possible.

20. Discourage employee visits to any other bird or bird product facilities (e.g., egg processing plants, chicken fights, neighbours who have birds, etc.). Attempt to stop any unnecessary contact of employees with birds.

21. Use disposable facemasks for people working in close contact with birds. Change masks when moving from one bird area to another.

22. Use a transfer station outside the facility for delivery of feed for birds. If feed trucks must enter the premises, clean and disinfect the wheels and wheel wells before allowing entry to the facilities. Do not allow the driver to disembark.

23. When possible, footwear should have smooth or minimum tread for more effective cleaning and sanitizing.

To Sum Up

- Biosecurity is a team effort and a shared responsibility.
- Biosecurity should be an ongoing process and must be followed at all times.
- Each step should be carried out judiciously and effectively to reduce disease contamination.
- Optimum biosecurity measures need to be developed and implemented to help both disease prevention and control.
- The mark of a good biosecurity programme is
  - To maximize the health of the flock.
  - To minimize the risk of disease spread.

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