WORKSHOP ON HEALTH AND MANAGEMENT OF ZOO ANIMALS FOR ZOO VETERINARIANS

28th to 30th October, 1999

ORGANISED BY --

College of Veterinary Science

Assam Agricultural University

Khanapara, Guwahati - 781 022

Assam

SPONSORED BY --

Central Zoo Authority

Ministry of Environment & Forests,
Bikaner House, Shahjahan Road, New Delhi - 110 011

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PROCEEDINGS OF THE WORKSHOP ON HEALTH AND MANAGEMENT OF ZOO ANIMALS FOR ZOO VETERINARIANS HELD AT COLLEGE OF VETERINARY SCIENCE, ASSAM AGRICULTURAL UNIVERSITY, KHANAPARA, GUWAHATI - 781 022

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GOVERNMENT OF INDIA
MINISTRY OF ENVIRONMENT & FORESTS
PARYAVARAN BHAVAN, C.G.O. COMPLEX
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FOREWORD

The main objective of a zoo is to complement and strengthen the national efforts in conservation of the rich bio-diversity of the country. This objective can be achieved only if we have the requisite technical competence in *ex-situ* animal management. Though there has been considerable progress in the field of health care and zoo medicine, most of the zoo vets are still relying on symptomatic treatment based on individual experience. Data base on diagnostic methods and health care is lacking. We have not been able to formulate veterinary care protocols for various groups of wild animals as yet.

The workshop on "Health and Management of Zoo Animals for Zoo Veterinarians" held at College of Veterinary Science, Assam Agricultural University, Guwahati is second in the series of workshops for zoo veterinarians organised under the aegis of CZA. Such workshop are organised with the objective of capacity building of zoo vets in carrying out systematic prevention and control of zoonotic diseases. The topics covered during this workshop ranged from disease management in wild animals to application of modern techniques like PCR for diagnosis of diseases. The participants were also exposed to tranquilization and restraint of animals particularly the elephants in 'Musth'. Marking of animals by transponders was also demonstrated.

There is a need for greater cooperation and networking between the zoos and veterinary institutions for two way flow of knowledge in veterinary care and disease management of wild animals. Recognizing the need for closer cooperation with the zoo, the Veterinary Council of India has now made one week internship at a zoo mandatory for veterinary graduates for their registration. The zoo veterinarians should take advantage of this new opportunities available to them to develop a systematic prophylaxis, diagnosis and treatment regime for zoo animals.

The scientific approach of the veterinary colleges and research institutions should be tempered with the practical experience of zoo veterinarian for devising veterinary protocols for different species of wild animals.

The proceedings of this workshop would provide the zoo veterinarians appropriate direction and orientation for improving health care and disease diagnosis and treatment of zoo animals.

Sd/-

S. C. SHARMA

Addl. Inspector General of Forest (Wildlife)

Date : 07-04-2000

केन्द्रीय चिड़ियाघर प्राधिकरण
Central Zoo Authority
(STATUTORY BODY UNDER THE MINISTRY OF ENVIRONMENT & FORESTS, GOVT. OF INDIA)

P.R. SINHA
MEMBER SECRETARY

MESSAGE

The importance of wild animals as an inseparable part of the environment is very well appreciated. It has been realized that health care and disease management of wildlife is an essential and specialized branch of veterinary science and due attention has to be paid to this important aspect in the direction of conservation of wildlife.

The zoos offer an opportunity to the veterinarians for study and research in the field of wildlife disease management. The knowledge available with the various institutions has to be amalgamated, so that it can be utilized by individual veterinarians for the benefit of wildlife.

I sincerely hope that the present workshop which includes practical sessions and methodologies which could be used for curtailing and preventing the animals losses due to disease and management associated factors will help to develop new approaches to formulate better management of zoo animals.

I wish the workshop all success.

(P. R SINHA)

Bikaner House, Annexe - IV, Shahjahan Road,
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ACKNOWLEDGMENT

This workshop has been possible because the fund was made available by the Central Zoo Authority of India. We are grateful to Mr. P. R. Sinha, member Secretary of CZA for extending his support and for efficiently conducting the inaugural session .

Mr. S. C. Sharma, presently Addl. Inspector General (Wildlife) was instrumental in making this workshop happen. It was Mr. Sharma who mooted the idea of organising the workshop here, and accordingly set the process rolling during his tenure as CZA's member secretary. We sincerely thank Mr. Sharma for his initiative and for choosing our institution for the workshop. Further, we are very much grateful to him for his presence in the plenary session of the workshop.

We are highly oblized to our Hon'ble Vice-chancellor, Professor A. N. Mukhapadhyaya for granting permission for holding this workshop here in this campus. His presence in the workshop not only inspires us in our venture but also brings to fore his innate character of encouraging others to achieve more.

We thank all the resource persons and the participating zoo veterinarians for their contribution and deliberation in the workshop.

We also thank all the members of the organising committee, sub-committees, all the teachers, students, officers and employees of the university for their help and co-operation in organising the workshop with grand success.

Dharmeswar Das
Chairman, Organising Committee
W. H. M. Z. A. Z. V.

Apurba Chakraborty
ORGANISING SECRETARY
W. H. M. Z. A. Z. V.

NATIONAL WORKSHOP ON HEALTH & MANAGEMENT OF ZOO ANIMALS
COLLEGE OF VETERINARY SCIENCE, 28TH TO 30TH OCTOBER 1999

TECHNIAL SESSION PROGRAMME

Session - I
Nutritional Requirement of Zoo Animals and Effects of Deficiency

Time : 11.30AM-1.30PM, Date : 28th October 1999
Paper by : i) Dr.B.M. Arora, Head, Epidemiology Divn.,IVRI
ii) Dr. N.C. Nath, Professor, Dept. of Physiology & Biochemistry, CVSc, AAU
Chairman : Dr. B.K. Konwar, Prof & Head, Dept. of Animal Nutrition,CVSc,AAU
Rapporteur : Dr. H.F. Ahmed, Assoc. Prof., Dept. of Animal Nutrition, CVSc,AAU

Session - II(a)
RestraintTechniques and Constraints

Time : 2.30 PM - 4.30 PM, Date : 28 October 1999
Paper by : i) Dr.Pradeep Kr. Malik wildlife Institute of India, Dehra Dun
ii) Dr K.K. Sarma, Associate Professor, Dept Surgery, CVSc, AAU
Chairman : Dr. S.C. Pathak, Professor, Dept. of Surgery, CVSc, AAU
Rapporteur : Dr.Nasser Ahmed, Wildlife Health Coordinator, CVSc, AAU

Session - II(b)
Demonstration of Chemical Immobilization, Sterilization, and Pinioning
at Assam State Zoo

Time : 6.30 AM - 12.00 Noon, Date : 29 October 1999
Demonstration by : i) Dr.Pradeep Kr. Malik wildlife Institute of India, Dehra Dun
ii) Dr. K. K. Sarma, Associate Professor, Dept. of Surgery, CVSc, AAU
iii) Dr. Bijoy Dutta, Assistant Professor, Dept. of Surgery, CVSc, AAU

Session -III
Health Care of Zoo Animals : Prevention & Control of Diseases.

Time : 2.30 PM - 4.30 PM Date : 29 October 1999
Paper by : i) Dr. L.N.Acharjyo, Retd. Veterinary Officer, Nandan Kanan Zoo,Bhubaneswar
ii) Mr. Pushp Kumar, Consultant, CZA
iii) Dr. A. Chakraborty, Professor, Dept. of Pathology, CVSc, AAU
Chairman : Dr. G.K. Baruah, Prof. & Head, Dept. of Pathology, CVSc, AAU
Rapporteur : Dr. A. Mukit, Director of Clinics, CVSc, AAU

Session - IV

Approach to Clinical & Laboratory Diagnosis

Time	: 5.00 PM-7.00 PM	Date : 29 October 1999
Paper by	: i) Dr. H. Rahman, Assoc. Professor, CVSc, AAU ii) Dr. D. K. Sarma, Virologist, AICRP on FMD, CVSc, AAU iii) Dr. J. Goswami, Professor, Dept. of Physiology, CVSc, AAU	
Chairman	: Dr. B.M. Arora, Head, Epidemiology Divn, IVRI	
Rapporteur	: Dr. T. Rahman, Professor, Dept of Pathology, CVSc, AAU	

Session - V

Care, Management and Sexing of Reptiles

at Assam State Zoo

Time	: 6.00AM -8.00 AM	Date : 30 October 1999,
Demonstration by	: Mr. B.C. Choudhury, Wildlife Institute of India, Dehradun	

Session -VI

Population Management & Husbandry

Time	: 9.00 AM 11.00 AM	Date : 30 October 1999
Paper by	: i) Ms. Sally Walker, Zoo Outreach Organization, Coimbatore ii) Dr. Goutam Narayan, Project Manager Pigmy Hog Conservation Programme	
Chairman	: Dr. Dharmeswar Das, Dean FVSc, AAU	
Rapporteur	: Dr. Saidul Islam, Assoc. Professor, Dept of Parasitology, CVSc, AAU	

Session - VII

Inbreeding, Genome Banking, and Assisted Resprodution

Time	: 11.15 AM -1.15PM	Date : 30 October 1999
Paper by	: i) Dr. Dharmeswar Das, Dean, FVSc, AAU ii) Dr. B. C. Sarma, Professor, Dept. of Physiology, CVSc, AAU Dr. B.C. Deka, Professor, Dept of Gynaecology, CVSc, AAU	
Chairman	: Dr. A.B. Sarkar, Director of Research (Veterinary), AAU	
Rapporteur	: Dr. P. Chakraborty, Assoc. Professor, Dept. of Physiology CVSc, AAU	

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College of Veterinary Science
28-30 October, 1999

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National Workshop on Health & Management of Zoo Animals for Zoo Veterinarians
College of Veterinary Science
28th - 30th October, 1999

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WORKSHOP ON HEALTH AND MANAGEMENT OF ZOO ANIMALS FOR ZOO VETERINARIANS

Inauguration of the Workshop

Resource persons and Delegates attending the workshop

CONTENTS

HEALTH CARE OF ZOO ANIMALS - PREVENTION AND CONTROL OF DISEASES

DR. L.N. ACHARJYO
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Housing board colony
Baramunda
Bhubaneswar,-751003,

It is a well known fact that to meet the increasing needs of the growing human population coupled with their greed, more and more forest areas were deforested depriving the wildlife of their food and shelter, resulting in the rapid decline of their population in the wild. To save them from further depletion, several measures are now being taken for their conservation. The modern zoos are playing an important role in the conservation movement of wildlife through captive breeding, rehabilitation of species in the wild, creation of awarness about wildlife, education, scientific research and ofcourse recreation. The zoo animals are to be in their optimum health to achieve these objectives.

Maintenance of good animal health is one of the difficult tasks of any zoo. Still more difficult problem is efficient and prompt diagnosis, restraint and treatment once they fall sick. Inadequate knowledge about the ecology , biology, physiology, psychology, anatomy and behaviour of such a wide spectrum of wild animals increases the problems of a zoo veterinarian who is supposed to attend a variety of animals and birds from the biggest land animal like elephant to the smallest bird like munia, reptiles and even fishes.

The sick zoo animals are difficult to manage and therapeutic measures adopted for individual sick animals may not always yield the expected results. Therefore, more emphasis has to be given on prevention and control of diseases among zoo animals. The scope for prevention and control of diseases in a zoo covers the period from the time of entry of animal into the zoo premises till its final disposition.

The effective preventive health measures involves a comprehensive package of good management practices such as housing, feeding, sanitation, day to day management and measures for control of diseases. Inadequate and improper implementation of the above practices adversely affects the health of the animals resulting in sickness or death etc. These behavioural abnormalities and physiological stress are likely to increase susceptibility to diseases and may affect their breeding. Therefore the enclosure environment has to be suitably enriched to meet the physical, physiological, biological and behavioural requirements of the species under display.

The enclosure must ensure safe work procedures for the zoo workers and the animal should not suffer from stress due to maintenance routine.

The impact of improper housing on disease conditions among zoo animals can be eliminated or minimized by providing suitable housing facilities.

FEEDING : The free-living wild animals have the freedom to gather and eat their choicest food items from nature whereas the zoo animals are dependant upon the food supplied to them. The selection of diet for these animals depend upon their feeding behaviour and nutritional requirement. They may be carnivorous, herbivorous, omnivorous, frugivorous, insectivorous etc. The digestive system varies considerably in different species as per their food habits and nutritional requirements. If the food does not suit them, it is likely to cause digestive and nutritional disorder.

It is well known that the quality, quantity and kind of food has a direct bearing on health of the species and so the food selected should be as close to the natural diet of the species as in the wild depending upon their feeding behaviour. The food provided should be adequate, fresh, hygienic, palatable, nutritious and meet the physiological needs of the animals. Hygienic storage, timely distribution and daily examination of all items of food specially the perishable articles must be ensured before feeding to minimise the incidence of food related health hazards. The animals in the zoo have to be fed on the optimum but not on the minimum scale.

Animals and birds like rodents and parrots have tooth /beak adopted for hard diet of definite abrasive effect and so if the food is too soft in consistency, they may have excessive growth of tooth/beak due to insufficient abrasion. Similarly if the food is too hard, the animals may not be able to consume their required quantity. In birds of prey and some other animals like *Varanus* (lizards) the pellet, a peculiar product of metabolism consisting of undigested hair, feathers, bones, chitin, etc. are expelled from the mouth. They are essential for their good health and so they must be given similar sort of hairy, feathered and chitinous food. Ruminants like deer and non-ruminants like elephants with functional caecum are fed with large amount of roughages to keep the gastrointestinal tract efficient and healthy. Lack of roughage may lead to constipation and telescoping of the intestines. Feeding of big cats with only carcass meat without liver, lungs, adrenals, bones, etc. may cause avitaminosis A and mineral deficiency.

Many animals like deer, antelopes

etc. are fed in groups needing sufficient feeding space whereas big cats like tiger, panther etc. are fed individually, otherwise they fight among themselves causing injuries and the young and weak ones are deprived of their due share of food. Many species of snakes specially the baby pythons have to be fed individually or simultaneously as otherwise two snakes seize the opposite ends of the same prey and as they approach one another, one engulfs the other.

Presentation of food to the zoo animals is as important as the quality and quantity of food. For example the flamingoes are adopted to strain food particles out of water only as they are unable to take dry food. Some animals like giraffe can not take the required quantity of food unless the food is placed at appropriate height.

The health and mortality of zoo animals are also influenced by accidental intake of foreign bodies such as nails, wires, glass, plastics, rubber, etc. which are occasionally found in the offered diet or enclosure. Special precautions are to be taken from ingestion of toxic paints, poisonous pesticides and insecticides used for pest control programme.

Clean water from protected water supply system may be ensured daily for all zoo animals for prevention of water borne health problems.

SANITATION : General sanitation and hygiene of the animal enclosures and surrounding areas, zoo veterinary hospital, quarantine, isolation ward, post-mortem room and all places constantly in use by visitors are of utmost importance for prevention of diseases and for good health of zoo animals. The excreta and food refuses of animals and all sorts of solid and liquid wastes generated inside the zoo premises can act as reservoir and breeding ground for the disease causing microbes, parasites and disease causing vectors. Therefore, due importance should be given for daily cleaning, quick disposal of wastes and disinfection of the enclosures and surrounding areas. The utensils, feed and water troughs shall have to be cleaned, disinfected and rinsed before serving food and water.

Periodical operations to prevent the spread of mosquitoes, flies, snails, rodents, crows, stray dogs etc. have to be carried out to prevent the spread of diseases among zoo animals. In case of any outbreak special drive for general sanitation and hygiene has to be carried out along with other effective disease control measures.

DAY TO DAY MANAGEMENT : Incidence of management linked health hazards/mortality can be substantially reduced with efficient and effective day to day management. Majority of death in zoos are noticed within a month or so of their arrival/births. Hence special care during this period is of utmost importance.

The ill-effects of inbreeding like still-births, congenital anomalies, early mortality, abortions, infertility etc. can be minimised or prevented by planned breeding programme. Any disturbance during pregnancy may result in abortion, pre-mature birth or still-birth. Losses due to cannibalism in young ones can be prevented by separating the pregnant mothers specially in carnivores from rest of the animals.

Losses or injuries resulting from infighting during times of mating and feeding, due to incompatibility of breeding pairs/ groups and capture operations can be reduced or stopped by sound management practices as required for different species. Before introduction of a new animal into the enclosure of resident animals, they should be kept side by side with a visual barrier so that they get acquainted with each other as sudden introduction invariably results in fighting causing grevious injuries or death. Overcrowding in enclosure should be avoided.

Stress conditions play a great role in health and disease during routine management practice such as cleaning, capture, crating, transportation, shifting and during the period of settling down of the newly arrived animals. So all efforts should be made to lessen the stress in zoo animals.

CONTEROL OF DISEASES : The wild animals in captivity like their domestic counterparts, suffer from various diseases. But the detection of illness, diagnosis, restraint, treatment and post-operative care of sick zoo animals are more difficult than that of domestic animals. Since informations on wildlife diseases are scanty and scattered, all attempts have to be made for preventing or lessening the occurrence of diseases in the zoo. Many wild animals have their domestic counterparts which has to be taken into account along with their habits, behaviour, age, body weight and size while managing the disease problems. The following procedures are usually adopted for effective disease control programme in zoos.

Quarantine - Any newly procured wild animal for a zoo can be a potential source of pathogenic organisms/parasites to the healthy inhabitants of that zoo. Therefore, all newly received animals are kept in quarantine which is now mandatory as per the Zoo Rules, atleast for a period of 30 days.

Isolation ward : Isolation ward to house and treat the animals suffering from infectious diseases has to be there away from quarantine, zoo Veterinary Hospital and animal display areas.

Vaccination : Usually all the wild cats are given feline enteritis vaccine once a year. The other vaccines which are in use against diseases among zoo animals are foot-and-mouth disease, rinderpest, haemorrhagic septicanemia, anthrax, canine distemper and Ranikhet disease, but these have not been in use on a regular basis because of some inherrent difficulties.

Zoo Veterinary Hospital : Each zoo must have properly equipped Veterinary Hospital with facilities for restraining and handling of sick animals and diagnosis of diseases.

Post-mortem room and carcass disposal facilities : A zoo should have a post-mortem room with proper equipments for conducting post-mortem examination of all dead animals. This should be away from animal enclosures, quarantine, isolation ward and zoo Veterinary Hospital. The carcasses after necropsy have to be buried deep with lime in a specified grave yard or burnt in an incinerator to prevent the spread of infection.

Health Monitoring - Health monitoring of zoo animals is a complex subject which requires keen day to day observation. The animal keepers/caretakers have to be trained for detection of illness and abnormal behaviour at the initial stage and on principles of preventive medicine including the basics of nutrition and environmental sanitation so that they will be in a position to detect the illness in animals easily on time. Then they can report to be concerned authorities. An investigation can be carried out immediately to detect the cause of sickness and appropriate action can be taken either by improving the management practices or through suitable therapeutic measures or both. Regular periodical examination of faecal samples of all animals has to be carried out to detect any endoparasitic infestation before they can exhibit the clinical signs.

The combined and coordinated efforts of all concerned with the upkeep, management and disease control programme will go a long way in keeping the zoo animals free from diseases and in sound health.

HOUSING AND HEALTH CARE OF ZOO ANIMALS

PUSHP KUMAR
Former Director Nehru Zoological Park, Hyderabad
& former Member, Central Zoo Authority.

1. Introduction :

About 40 years back there were still good populations of wild animals in India. Though the need and necessity for protection of wild life had been recognised, yet the conservation movement was yet to gain momentum. The objectives of zoos was not conservation. Zoos still had access to wild animals of their choice. Trade in wild animals was still a feasible proposition. As a corollary not enough attention was paid to health care of zoo animals, since perhaps they could be replaced if they were lost. Consequently lesser attention was paid to how they were kept and housed in most zoos. Usually animals were kept in small barred cages arranged serially with smooth floors and a few play equipment's. These cages housed miserable looking beasts with a bored look !

In 1973 a report on the management of zoos in India was prepared and published by the G. O. I. It listed about 44 zoos in the country and made observation on the need for better health care of animals in zoos. It highlighted the role of zoos in the country. Conservation was listed as the foremost role. This was the first time that zoos were brought under the umbrella of wild life conservation. This was echoed by the World Zoo Conservation strategy in 1992. A number of zoos abroad declared themselves as conservation centres. Within the country the Wildlife Protection Act of 1972 was amended to include zoos and to set up the Central Zoo Authority. The aim of zoos was laid down as conservation of wild life.

However some "Wild lifers" did not take kindly to zoos and their role since the care and upkeep of animals in zoos did not show any uptrend. Zoos were termed as a "drain on wildlife resources" and were sought to be banished from conservation goals. This came about because perhaps, inspite of the Wildlife Protection Act many zoos continued to acquire animals which may have depleted wildlife resources in the wild especially the endangered ones. Due to loss of wild animals in the zoos, perhaps some zoos had to resort to this method to avoid showing empty cages to visitors ! Soon it was realised that animals no longer could be obtained from the wild since the wild populations had depleted to almost a point of no return. With this awareness zoos realised that it was necessary to 1) make animals survive by better management method and 2) take up controlled breeding of animals so that at least the population in enclosures could be maintained by fresh recruitment or by exchang ! Health care of zoo animals began to take on a new urgency and meaning.

An impetus was given to zoo animal's health care with the inclusion of veterinary care in the enunciation of the functions of Zoos, viz. Housing, upkeep and veterinary care in chapter IV of the WLP Act. This was further elaborated in recognition of zoo rules where in certain norms were laid down for health care which are to be observed and complied with by each zoo. The CZA has also extended assistance to several zoos in this regard.

2. Improvement of health care :

Health care of Zoo animals involves betterment of various factors in zoo management which affect the wild animals which are housed their in. The main factors may be summarised as here under.

i) Housing : It is to be realised that once an animal enters a zoo enclosure, it usually has to spend most of the balance period of its life in the confines of its enclosure. Yet, most zoos do not pay much attention to this important fact. The housing designs are usually made by an architect (who is not a biologist) and depends mostly on visual impact to promote his drawings or it is some times in the hands of engineers who seldom have any idea of the requirements of zoo animals.

ii) Husbandry : The upkeep of zoo animals involving a) proper handling b) proper nutrition c) proper prophylactic measures etc.,

iii) Better Medication :

3. Effect of housing :

As mentioned above housing of zoo animals many a time has a significant impact on the long term health and well being of zoo animals especially mammals. They are mostly the product of the limited experience of architects or engineers. Enclosure designs have to take care of the needs of three main stake holders, viz. a) The animals b) The keepers and c) Visitors. Among these a) and b) are of vital importance since the zoo by definition has to keep live and healthy animals in order to meet the goals of conservation.

4. Factors for better housing :

The main factors involved in ensuring proper housing are -

i) Site Conditions : Badly drained, rocky or marshy sites will be unsuitable for keeping many animals since over a period of time it would be difficult to avoid built up of adverse accumulated load of parasites.

ii) Soil : Besides the above, soil types also play an important part in ensuring health of zoo animals, for example unsuitable ones would be, clayey soils which will not only pose problems of parasitic load but also create problems for feet especially for ungulates like chinkara, nilgai etc. Sandy soil would be unsuitable for similar reasons besides the problem of overgrown hooves for the horned and hoofed animals. Such soils would also be difficult to clean properly every day.

iii) Drainage : If the drainage of the enclosure is poor due to any reason as mentioned above it is likely to encourage build up of infections and accumulation of water puddles which can form a health hazard besides creating unaesthetic conditions.

iv) Water Supply : Proper water supply both quantitatively as well as quantitatively has to be made available to the animals. Impure water is likely to create health problems for the animals. Provision has to made in the enclosures to provide hygienic water to the animals in proper drinking ponds and pools which would not be contaminable by ground conditions or by the animals

v) Protection from weather conditions : Provision will also have to be made for providing suitable shelters to the animals from extremes of the weather conditions i.e. from sun and rain. At the same time these could be blended aesthetically with the landscaping of the enclosure. They should be easy to access for the animals and for keeping them clean. Usually in naturalistic enclosures use of artificial rocks and boulders could be made as part of the landscape.

5. Animal Enclosures :

The enclosure for housing animals usually consists of i) Animals House ii) Open Yard iii) Kraal

i) Animal House : This usually consists of a number of feeding/cubicles of species specific sizes (laid down for a number of species in the zoo recognition rules). The cubicles are interconnected through doors and one or more accesses to the out side enclosure as well as the kraal. The cubicles are usually made of iron rods fitted in angle iron frames. The angle iron frames usually retain refuse in between the bars and the angle frames. These species which are usually difficult to clean become repositories of infections. The cubicle floor usually gets pitted due to action of urine etc., which again become sources of infection. The floor material has to be chosen according to the species that are proposed to be housed. If very smooth surfaced material is used like e.g. ceramic tiles adequate footing is not available to the animal. If it is too rough, it will be not only injurious to the animals but can also retain some of the refuse. Besides other factors, the use of suitable paints for the iron grills has to be kept in mind since the iron work is not only corroded but also they are often licked by the animals and the paints could prove to be poisonous.

ii) Open yard or enclosure : The enclosure in which animals spend most of the time indulging in their natural or modified behaviour, also get exercise as well is of prime importance, for not only their physical but also psychological well being. The trend in zoos today is to keep animals in their simulated natural habitat. As against old concept of keeping them in bare cages with smooth floors. Though the smooth floor is perhaps more hygienic from the points of view of easy cleaning and maintenance. The naturalistic enclosures with simulated trees, plants, water, pools, moats and so on could harbor more sources of infection and unhygienic water supply. Yet, in keeping of animals and presenting them in natural habitat, the occurrence of sources of infection has to be taken into account while managing the health care of the animals housed their in.

The use of water to fill up pools and wet moats become a major source of concern of health care. The problems of wet moats could be solved by the use of dry moats to a large extent and secondarily by the use of treated water with recirculation facilities. However, these also pose number of problems. This problem to a great extent could be taken care of by taking prophylactic measures to prevent infections.

Lots of discussion has been done into arriving on the size enclosures, however this will depend on the species being kept and the land available. In general it can be said animals like elephants should be kept in a large area in small numbers. Some gregarious species like chital could be kept is an comparatively smaller area etc., however if too many animals are kept in small area, the chances of injury and infection increase manifold.

6. Conclusion :

From the fore going brief account it can be concluded that proper housing and attention to the various factors involved could go a long way in ensuring better health care for zoo animals. In order to meet conservation goals it is essential to ensure good health and there by increase not only the life of the animal in the zoo but also to enhance its breeding potential. However it appears that the principle which should be followed in the provision of better health care for zoo animals should be "*Prevention is better than cure*". If this principle is followed many of the problems of management of zoo animals may be solved.

COLLECTION PLANNING, POPULATION MANAGEMENT, REINTRODUCTION AND ANIMAL WELFARE - VETERINARY CONSIDERATION

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Collection planning and population management - in terms of population control and species management - has been practiced by modern zoos around the world for only a short time. Even in the United States zoos, which pioneered the use of systematic collection plans, until, relatively recently, awards were given by their Association for breeding ***more*** numbers of animals. Breeding was once considered the best thing a zoo could do and the more the better, regardless of whether the animals were required for any purpose or not. It was presumed, perhaps, in the matter of endangered species that breeding them was equivalent to conservation, a spurious belief which is held only by the most backward zoo persons today. Even many laymen know better today ; even my parents know this - from television programmes like Discovery - not from me !

More than two decades ago William Conway wrote a seminal article for the International Zoo Yearbook in which he introduced the startling concept that if zoos wanted to be relevant to conservation they should consider how many and what kind of species required conservation breeding. They should then make a systematic plan of exchanging animals of different genetic make up and age so that captive populations could be bred with a maximum of genetic diversity and demorgraphic security. Conway did some figuring of "zoo space", meaning the area a zoo can devote to breeding, which indicated that all the zoos in the world together could not provide space for even a small percentage of species that were endangered even THEN. Population biologist specializing in zoo problems came up with computer program which could tell zoos how to breed a relatively small number of animals and preserve as much as 90% genetic diversity for even 100 years. Dr. Ulie Seal had begun the first systematic zoo animal record system in late 1970s (the International Species Information System) which ultimately has been adopted by all modern zoos. He also developed the systematic breeding program– for Siberian Tigers, which became the basis of the Species Survival Plan of the American Zoo Association, the prototype for similar cooperative zoo breeding plans in UK, Europe, and Australia. These regional plans are now linked to ISIS and to a computer program called REGASP from Australia which helps zoos plan their collections.

A key element of the success of these collaborative breeding programs is that zoos agree to cooperate and collaborate to avoid inbreeding or overbreeding of any threatened species. Zoos figure out how many "spaces" they have to spare for a particular taxon and agree to "hold" that number on behalf of the Plan. In return they "get" animals - without a fee or trade. The agreement includes several components of management, health, exhibition, behaviour, care, welfare, etc. but the point to be emphasized is that the zoos agree NOT to breed the animals or exchange or sell them without permission from the Species Coordinator and other members of the SSP program. Zoos avoid breeding animals by various means - separation of sexes, sterilization, implants, drugs. The point is that zoos in many countries today are successful in controlling over-population - it is not considered a problem anymore. In two decades they have gone from getting prizes from breeding many animals to routinely controlling breeding for conservation.

Collection plans can be regional, national or individual for a particular zoo. Species Survival Plans or breeding programs have to involve several zoos exchanging animals to maximise their genetic potential. Whole books can be written about collection planning and population management. The point here is that IF zoos plan their collections and manage their populations, they can avoid surplus animals (both common and genetically over-represented) which take up valuable space and resources......from captive breeding, at least.

Surplus animals from other sources :

Surplus wild animals are one of the most problematic issues of zoos today. Even zoos that have planned their collections and control their own populations sometimes become saddled with animals from other collections, from confiscations, rescues, etc. In western countries, some zoos solve the problem by euthanising the animals. Recently a very good zoo in the USA was forced to take in some animals (big cats) from a substandard rescue centre which could not pass USDA (US Department of Agriculture) standards and had to be confiscated. The zoo put up a message on the Zoo Biology Email that these animals were surplus; they had no space for them and they would be euthanised if no one wanted them. While not a popular option with anyone, it is considered a legitimate management tool. It is regularly practised in the Scandinavian countries's zoos which have managed to convince the press that it is a sensible solution to a management problem.

In India, zoos are literally swamped with such animals, mostly from confiscations - circus confiscations, closed travelling zoo or non-recognised zoo confiscations, animal laboratory confiscations, trade confiscations, performing animal confiscations etc. Many animals which have developed bad habits of man eating, cattle lifting, crop destruction or terrorising cities (such as troops of city monkeys) also land up in zoos. Indian zoos don't have collection plans but even if they did, they might be forced still to take these animals due to politics and welfare and religious sentiment. However, IF Indian zoos DID have collection plans, they could have legitimate reason to refuse such animals. If Indian zoos had collection plans, they would not be generating surplus of their own which makes them vulnerable to complaints from the animal welfare lobby.

Surplus animals from confiscations and "rescues" can be very destructive to a zoo - in terms of space, systematic planning, use of financial and human resources, and even disease. If the animals come from another zoo, trade, pet owners, performers, etc., the possibility of disease looms large. Surplus animals of this type pose another threat however which is even more insidious and that is when zoos decide the best way to manage populations is to release them to the wild !

Bad releases of captive animals to the wild - veterinary implications

Dr. James Kirkwood, Director of the Universities Federation for Animal Welfare and formerly a Veterinarian at London Zoo, speaks of the destructive aspects of wrongful releases stating that such releases, either for conservation or for welfare, can be harmful to both released animals as well as animals in the area of release. These possibilities must be assessed, prevention measures put in place and outbreak of disease controlled should something go wrong.

The subject of "risk assessment" for any releases is now being discussed in forums all over the world due to the many accidents and long term ill effects of putting captive animals into wild areas. Veterinerians should be consulted both by biologists and welfare persons to insure that the risks to both individual and resident populations of wildlife are minimised.

Bad things that can happen (risks) with releases (both conservation and welfare)

1. Stress related health risks (from capture, temporary captivity in a new environment, transport, etc.)
2. Infectious disease accidentally introduced both to the same species and other species, such as domestic animals)
3. Infectious diseases picked up by introduced animals from another area which have little or no immunity in the new site.
4. Non-infectious diseases as a result of travel and temporary captivity (nutritional, trauma, stress) or new elements in the new environment (toxins from poisonous plants perhaps).
5. Accidents - captive animals which have

not grown up in a forest environment may not be expert in avoiding hazards which wild animals do instinctively (snakebite, falling branches! Even, predators, etc.).

6. Aggression between conspecifics with different behavioural patterns and levels of "confidence".

Risks numbered 1-4 are well documented by wildlife veterinary doctors and biologists. Accidents are not as well documented but there are examples in Indian experience in the last few decades. Manipur Brow-antlered deer which were released into Jaldapara in the 1970's did not survive long. The speculations of cause of death were snake bite and falling branches. Speculation is the key word here because there was no consistent monitoring of these animals after release. More recently, 14 barasingha were released into the same park and all died almost immediately. Monitoring was not necessary in this case as there were witnesses to the Minister opening the crate and turning the frightened animals out with no preparation and perhaps many human beings and equipment observing !

Aggression between conspecifics from different populations and ways of life has not received much attention. Again, there is an example in India, about two years ago, a captive born rhino was taken to Dudhwa National Park and kept in a krall prior to release. A wild male rhino broke into the krall and seriously injured the newcomer. In all these cases, there was insufficient preparation and clearly insufficient ability to anticipate such contingencies. Contingency planning as a skill need a better coverage in India. Animal behaviour studies also needs to be planned so that such possibilities between conspecifics might be considered and prepared for.

On this subject, the practice of translocating city monkeys to wild areas or releasing laboratory primates into wild areas in India needs very careful review. This is being done not just by animal welfare advocates but by forest officers, wildlife managers and zoos also. No monitoring has been done to speak of except by welfare advocates who may have a very different perspective than a wildlife biologist or veterinarian or genuine behavioural scientist.

Translocating city monkeys is done on a relatively large scale yet we have no idea what the effect of these releases brings about. These monkeys, having survived by eating off streets, from garbage dumps and from the kitchens of unlucky residents, could well have any number of zoonoses yet it is probably very rare for them to be tested before translocation. Also these city monkeys are aggressive and street wise. It would seem that, primates being what they are (human-like) that the behavioural anomalies between city and forest monkeys could be very damaging to the forest monkeys. The city monkeys could over-run a territory, attack resident populations of monkeys, infiltrate a group and introduce bad habits. This is speculation but not unreasonable – until monitoring is done and behaviour is studied we just won't know the fate of either released or resident animals following such an action.

The recent release of laboratory monkeys into the wild was a particularly atrocious action of the welfare community. The failure of the Forest Department of Andhra Pradesh, the Wildlife Institute of India and local college zoology department to follow this up is a lost opportunity. Monkeys kept in small laboratory cages and released to the wild are likely to have come to a very painful and shocking end. However, those of us who believe that is may be the case are helpless to convince anyone without data. Documentation of these incidents would provide ammunition to insure that such releases did not take place in future or that a preparation phase was included. Although, it must be admitted, the experience of Sangai in Jaldapara did not deter the authorities either in Delhi or in West Bengal from approving the release of 14 barasingha, with disastrous results.

Adverse effects Politics and Publicity on Wildlife and Zoo management

The politicization and publicity of almost every action taken (or not taken) by any official or organization regardless of scale has led to a climate of carelessness on the one hand and terror on the other. Officials are so anxious to please or impress superior official and the superior officers are so anxious to please politicians that projects are dreamed up and conducted with more thought to the photo op than the real result. A careless attitude towards zoo and wildlife projects, from construction to breeding to research to conservation (often very questionable conservation) in order to please a reigning Minister has resulted in hundreds of deer parks and zoos being constructed (dutifully named after Hon. Someone), even sanctuaries and national parks as well as a myriad of mistakes in legislation, project preparation and actions. These careless actions, lacking both experience and rational thought, bring a bad name to the subject of zoo, wildlife and welfare and does untold damage to individual animals, species and habitats. Terror of reprisal often leads to obstruction of future action renders the lessons which might be learned from mistakes as non-existent. Following any "incident" that goes awry, there is a refusal of all related projects and suggestions - many of them genuine and systematic - for months or may be years. As a result, many of the same mistakes are made over and over again without scientific study. In a few years, when a Minister gets a bright idea, past mistakes will not be remembered (or if they are brought up, they are ignored).

Veterinary doctors in zoos suffer very much from this plague of politics and press. Fear works against progress. Many veterinarians have been refused permission to use tranquillizer guns or to knock down animals for fear of an accident. Instead of preventing accidents, it produces more of them because when a crisis comes and the vet is under stress he is given a possibly instrument and allowed to use his rusty skills. Thus, in India, tranquilization is not practiced except in emergencies in zoos and consequently we have very few animals which have been given proper health screening at birth, marking devices, or systematic and complete check ups. In western countries and increasingly in other parts of Asia, all levels of zoo personnel - even zookeepers - - know how to use tranquillization equipment and routinely tranquillize animals for the ease of management. This brings us back to collection planning because collection planning and captive population management absolutely requires marking of animals for permanent and easy identification.

Zoo and wildlife managers, including veterinarians, should work in tandem. Zoos in India are lagging behind the rest of the world in many, many important aspects which impact their ability to be conservation relevant. Zoo and wildlife management for conservation cannot be separated into isolated fragments - all aspects must work together. Without collection planning and a rational and protective attitudes towards zoos as scientific institutions, conservation goals for strengthening or saving small populations in the wild never will be achieved. Without systematic monitoring and study of both conservation and welfare releases much damage can be done to both released and resident populations of wildlife. Conservation and welfare efforts, then, may yield only more suffering than solutions.

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INBREEDING, ASSISTED REPRODUCTION AND GENOME BANKING IN ZOO AND WILD ANIMALS

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Different theories on continuity of life had been put forward by different scientist from time to time. Those are Preformationism, Epigenesis, Pangenesis and Germ plasm theory. Out of all these theories the Germ plasm theory given by Wismann could explain the basic principles of continuity of life. According to this theory zygote is produced out of the fertilization of ovum produced by female by the spermatozoon of male. The zygote develop in to foetus and then to adult individual which after attaining maturity produces gametes for production of the subsequent generation. The sex ratio male and female offsprings is 1:1.

Types of mating and Inbreeding :

There are different types of mating to produce offsprings for subsequent generations. These are Genetic, phenotypic assortative mating and Genetic, phenotypic disassortative mating. Based on different types of relationship between the parents the matings are further classified as Inbreeding, Outbreeding/ Outcrossing, Species hybridization etc. Inbreeding is the mating between related individuals. When there is one or more ancestors of the individuals are common, they are known as related individuals.

Inbreeding can be measured by Inbreeding Co-efficient, which is the probability that two alleles in and individual are identical alleles. The co-efficient of inbreeding measures a particular way of being homozygous. The value for the offspring of first cousins means that 1/16 of the time a gene-any gene-is expected to have alleles identical by descent. Alternatively, it means that on the average, $1/16^{th}$ of all genes have, identical alleles. Inbreeding increases homozygosity. It effects fertility, causes congenital malformations and various forms of physical and mental illness. It causes mortality within a given time periods and causes miscarriages, still births and even mental deaths. In a small population or small isolates, the individuals are likely to be inbred even if the individuals are random bred. Thus in zoo animals or wild animal where the isolates or populations are small, even if mating is random within the group, the observed level of inbreeding may be higher or lower than the random amount if mates tend to be more related or less related then average traits.

Inbreeding in a population depends on the Effective Population size which is a number of individual which actively participate in the reproductive process. Estimate of the effective population number for actual population depends on unequal number of male and females, fluctuation in population size, Non-Poisson (non-binomial) variance in distribution of offspring, overlapping of generations, heritability of fertility etc.

In order to conserve the gene pool in animal, particularly in wild and zoo animals, attention must be given to the founder population. When taken from the wild population for future breeding the larger the founder population is the better. The effective population with 20-30 number can be a suitable population size under ideal breeding scheme to preserve 90 percent of genetic diversity for 200 years provided a genetically and demographically viable population is built. Besides, the gene pool can be conserved provided there is production of equal number offspring from each founder pair, sex-ratio is maintained at 1:1, longer generation interval is maintained then normal and inbreeding is avoided by rotations of males. Reduction in reproductive performance of wild animal results due to reduction in population size (inbreeding), reduction in size of breeding grounds and inbreeding depression.

The correlation of genetic variation and reproduction parameters in the population of lions are shown in Table 2 as per data completed from O'Bixien (1984) and Wildt *et al.* (1987)

Prevention of Reduced Reproduction Performance :

In order to prevent reduction in reproduction performance prevention of degradation of environment and breeding grounds and prevention of reduction of forest cover is needed. Besides, adoption of assisted reproduction help tremendously in that direction. In wild or zoo animals inbreeding can be avoided by adoption of DNA fingerprinting in order to choose the mates for breeding.

Assisted Reproduction :

Intervention of mankind to improve the fertility status and reproductive performance of the organism is known as the Assisted Reproduction. Assisted Reproduction starts from merely involving and bringing together of the mating pair when both male and female exhibit signs of mating behaviour to more complex semen collection to *in vitro* fertilization and embryo transfer (ET). Success of assisted reproduction is measured by the number of live births obtained in the animals.

The benefits of assisted reproduction technologies are - it overcomes the fertility and behavioural handicaps in animals, stimulate reproduction in genetically important individuals, facilitates exchange of genetic material between *ex-situ* populations and between *in-situ* and *ex-situ* populations, enable rapid population growth, enable preservation of genetic diversity and provide insurance against genetic loss, disease and unnatural selection and facilitate more effective use of limited space in zoos. The different methods of assisted reproduction involves semen collection, semen cryopreservation, semen evaluation, artificial insemination (AI), intrauterine insemination (IUI), *in-vitro* fertilization (IVF), embryo transfer (ET), gamete intrafallopian transfer (GIFT), zygote intrafallopian transfer (ZIFT) etc. The benefits of A.I. are - it assists in control of genetic diversity, animal of different locations can be bred easily without transfer of the animal, sprem can be used even after death of the donor and sprem can be used from earlier generation. Besides these, A.I. enables animals with non inherited physical or behavioural abnormalities to breed, helps to prevent spread of disease and reduce number of males to be kept for breeding purpose. Similarly, the IUI which is also relatively simple method of AR eliminate inbreeding depression by ensuring reproduction between incompatible partners, eliminate risk of animal transport and increases chance of gene mixing. There are reports of successful use of AR in many wild and zoo animals like clouded leopard, penguins, condors, elds deer etc. Use of ETT further increased the reproduction and breeding status of zoo animals which can be now routinely used after standardizing the technology as per need of a particular station.

Conservation and Genome Banking :

In-situ preservation is the maintenance of live population in their adaptive environment or as close to it as practically as possible. *Ex-situ* conservation means storage. This involves preservation as animal of a sample of a breed/species in a situation removed from its normal production environment or habitat and for the collection and cryopreservation of resources in the form of living sperm, ova, embryos or tissues, which can be used to regenerate animals.

Genome banking of animals includes cryogenic storage of semen, ova, embryos and tissue for further production of the animals which can be accomplished after thawing of cryopreserved material and transfer to the receipients. By micro manipulation of embryos, one can produce twins and hemi-embryos out of which one copy can be grown and the other copy can be preserved in Gene Bank.

The programme of genome banking now needs research on characterization, selection, collection, processing, culture and cryopreservation of sperm cells, embryos and embryonic cells of different species of animals, mapping of genome etc. Besides, there is also a need to develop the germ plasm policies, develop Central Repository to fulfil both short and long term objectives of the programme designed for providing storage space for semen, embryos, oocytes, sperm cells, cell lines and

TABLE : 1 EFFECT OF INBREEDING DERESSION ON CHEETAH*

Characteristics	Cheetah*	Cat
Sperm count/ml (x 10^6)	14.5+/-1.8	147+/-39.5
Abnormal sperm (%)	71+/-0.9	29.1+/-3.7
Infant mortality (%)	29.1	<10
Vulnerability to infection (%)	60	5
Genetic variation (average heterozygosity)	0.013	0.082

* Data compiled from Wildt *et al.* (1983) and O'Brein *et al.* (1985)

TABLE : 2 CORRELATION OF GENETIC VARIATION AND REPRODUCTIVE PARAMETERS IN THREE POPULATIONS*

Parameters	Serengeti, Tanzania	Ngorongoro Crater, Tanzania	Gir Forest, India
Heterozygosity (%)			
Allozyme	3.1	1.5	0.0
MHC RELP	21.8	8.0	0.0
DNA fingerprinting	48.1	43.5	2.8
Reproductive Measure			
Sperm count (x 10^6)	34.4+/-12.8	25.8+/-11.01	3.3+/-2.8
Sperm abnormality (%)	24.8+/-4.0	50.5+/-6.8	66.2+/-3.6
Motile sperm per Ejaculate (x 10^6)	228.5+/-65.5	236.0+/-93.0	45.3+/-9.9
Testosterone (mg/ml)	1.3 - 1.7	0.5 - 0.6	0.1 - 0.3

* Data compiled from O'Brein (1984) and Wildt *et al.* (1987)

DNA from designated genetic covering a wide range of animal species, and also to develop animal germ plasm database, DNA sequencing or mapping on relevant animal genomes.

Bridging research gaps in wild and zoo animals in different areas, collaboration on animal availability for the purpose, financial support for R & D programme, training of personnels, increasing image of research, awareness within the zoo community about research in wild animals are some of the basic issues needs to be redressed.

Conclusions :

It is obvious that Assisted Reproduction methods have been applied to wild animals only in a limited way because of the inherent difficulties involved in handling of the animal and standardizing techniques which many a time have to be done in the wild under very difficult conditions. However, considering the dwindling population of wild animals, AR methods need to be standardized before it is too late and preferably before inbreeding depression sets in. Further, AR techniques for wild animal would logistically be more difficult but with the cooperation of various experts and with both national and international efforts AR methods could significantly improve the breeding status of endangered animals.

The challenges ahead of zoo veterinarians and animal scientists now lies in identifying the areas of inbreeding depression, AR and genome banking for research and evolving and adopting suitable technologies related to those in order to conserve the precious genetic materials of wild animals of the world.

REINTRODUCTION - PRINCIPLES AND PROTOCOL, PIGMYHOG CONSERVATION PROGRAMME - A CASE STUDY

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Conservation Breeding

A captive propagation programme to save any species from extinction is called conservation breeding. Since the species is a basic unit of biological diversity in any ecosystem, it is important to save the endangered ones from extinction to conserve the biodiversity of the ecosystem. As is well known, biodiversity conservation is essential for long term survival of all species on the earth.

The World Conservation Union (IUCN) considers the conservation breeding programmes as integral part of biodiversity conservation. In its 1987 Policy Statement on Captive Breeding it has recognised the following:

Habitat protection is not sufficient for maintenance of biological diversity.

Establishment of self-sustaining captive population and other supportive intervention will be needed to avoid the loss of many species – especially those at high risk in greatly reduced, highly fragmented and disturbed habitats.

Captive breeding programmes need establishing before species are reduced to low numbers – to be coordinated internationally according to sound scientific principles.

The view of captive breeding programmes must be re-establishment of viable populations in the wild.

EXTINCTION

Extinction is the complete disappearance of all individuals of a species. Absence of a recorded species from a defined area is often called local extinction but the word 'extinct' is used only if a species disappears completely from earth. It is often difficult to state unequivocally that a species is no longer present in an area since some may persist unrecorded despite intensive efforts to locate them. Generally, when a species is not located for several decades it is considered extinct.

Extinction is a natural phenomenon and has always been part of evolution process. The fossil records show that since life originated about four billion years ago the vast majority of species that have existed are now extinct. For every living species perhaps a thousand have disappeared from the face of earth. However, natural extinction is an extremely slow and gradual process and is quite different from accelerated rate of extinction in recent human history. Although there are difficulties in documenting extinctions of the past, most recent extinctions have been linked with European expansion in the 15th and 16th century. The generalised pattern that emerges from an analysis of the recorded 484 extinctions since 1600 AD is that most (75%) of the extinctions have been on islands.

Process of extinction

Two broad processes are believed to affect the dynamics of populations, and cause extinction:

Deterministic processes (or cause and effect relationships) e.g. direct human intervention such as deforestation.

Stochastic processes (chance or random events), which may act independently or influence variation in deterministic processes. Four types of stochastic processes can be distinguished (Shaffer 1987):

Demographic uncertainty - this is only a hazard for relatively small populations (numbering tens or hundreds of individuals).

Environmental uncertainty - due to unpredictable changes in weather, food supply, disease and the populations of competitors, predators or parasites.

Natural catastrophes - floods, fires or droughts.

Genetic uncertainty - random changes in genetic make-up, to which several factors contribute.

The magnitude of the effects of all the above processes depend on the size and degree of the genetic connectedness of populations.

Factors causing extinction

Diamond (1984, 1989) termed the following four causes of decline of species as 'the evil quartet':

i) Overkill

ii) Habitat destruction and fragmentation

iii) Impact of introduced species

iv) Chains of extinction

i) Overkill: Hunting at a rate above maximum sustained yield results in overkill. The most susceptible species are those with low intrinsic rates of increase (e.g. large mammals such as elephants, rhinos and whales) because their limited ability to recover quickly.

ii) Habitat destruction and fragmentation: The habitats are modified, degraded, completely eliminated, but more commonly they are fragmented. Fragmentation is common throughout the world. A large tracts is converted into smaller pieces and the land-use is changed. This creates discontinuous patches of the original habitat. The modified land-use expands and becomes a continuous stretch reducing the original habitat to 'islands' where the vulnerability of species increases disproportionately.

iii) Impact of introduced species: Some exotic species intentionally or unintentionally introduced by people have exterminated native species by competing with them, preying upon them, or destroying their habitat. Atkinson (1989) has demonstrated that 22 species of reptiles and amphibians have disappeared from the world due to introduced animals; in New Zealand alone, 9 species of reptiles and amphibians and 23 bird species have become extinct in the last 1000 years through introductions.

iv) Chains of extinction: The extinction of one species may cause demise of other; this is known as secondary extinction. Examples of predators and scavengers dying out after extinction of their food species are common.

Vulnerability of species to extinction

There is considerable evidence that the number of species in an isolated habitat (e.g. 'island') will decrease over time. At least nine life history traits have been proposed as factors determining the sensitivity of a species to fragmentation (Karr 1991, Laurance 1991):

Rarity: Rarer species are likely to suffer more due to habitat fragmentation compared to commoner ones as fewer individuals of a rare species are likely to occur in the fragments.

Dispersal ability: Animals capable of migrating between fragments or between 'mainland' areas and the 'islands' (fragments) are able to mitigate the effects of small population size. Good dispersers are therefore less prone to extinction in fragmented habitats.

Degree of specialisation: Ecological specialists often exploit resources which are patchily distributed in space and time, and therefore tend to be rare. They are also vulnerable to successional changes in fragments and collapse of co-evolved mutualism and food webs.

Niche location: Species adapted to, or able to tolerate, conditions at interface between different types of habitats may be less affected by fragmentation than specialists. For example, forest edge species may actually benefit from fragmentation of a large forest.

Population variability: Species with relatively stable population are less vulnerable than species with pronounced population fluctuations, since they are less likely to decline below some critical threshold from which they may not be able to recover.

Trophic status: Animals at higher trophic levels are less abundant therefore more prone to extinction because of rarity.

Adult survival rate: Species with naturally low adult survival rate are more likely to become extinct.

Longevity: Long-lived animals are less vulnerable to extinction than short-lived ones.

Intrinsic rate of population increase:

Populations which can expand rapidly are more likely to recover after habitat fragmentation and population decline.

REHABILITATION THROUGH CONSERVATION BREEDING

Over 3,000 vertebrate species and subspecies will require a captive propagation programme within the next 50 years (Seal 1991). This estimate is based on available data and often very little is known about the status of wildlife. For example, even among the relatively well studied groups like birds definite information is available for no more than 30% of the total 8,500 species. About 1,000 bird species are considered threatened or endangered while just 1,000 - 1,500 are considered secure. Information on the status of remaining 6,000 is insufficient to make any judgement.

Captive propagation activities are still in early stages of development. All are experimental and learning by trial and error is usually the norm. The need to manage captive populations require cooperation and collaboration among institutions. This must be based on better standards of record keeping and pooling of genetic and demographic data for scientific analysis and husbandry. The Conservation (originally Captive) Breeding Specialist Group (CBSG) was organised by the IUCN Species Survival Commission (SSC) to fill this need through the formation of a multi-disciplinary group to advise, monitor and catalyse captive breeding programmes across the world.

Selecting species for captive breeding

Ideally, all species in need of urgent attention may be considered for captive breeding. But any such attempt is likely to be affected by limitations imposed by shortage of funds, space, professionals as well as unsuitability of the species for captive propagation. However, prioritising efforts by triage approach (sorting according to degree of urgency) organises guidelines and actions for effective conservation strategies. Such strategies require the selection of priority species which may be classified in relation to the different types of assistance needed (or a combination of these) to survive:

species needing habitat protection

species requiring captive breeding

species that can be helped by translocation

species for which an education campaign is the greatest need

species which can be effectively protected through legislation

Assessing conservation status of a species

Until recently the conservation professionals, legislators as well as lay public relied upon the IUCN Red Data Book which categorised different threatened species with a view of highlighting their extinction risk.

IUCN Red Data Book categories:

Extinct: Species not definitely located.

Endangered: Taxa in danger of extinction if pressures continue.

Vulnerable: Taxa believed likely to move into 'Endangered' category in near future if pressures continue.

Rare: Taxa with small world populations that are not at present 'Endangered' or 'Vulnerable'.

Indeterminate: Taxa for which there is not enough information.

The Mace-Lande Categorisation System

On geological time scale all species are doomed to extinction, so simple terms in the Red Data Book such as "in danger of extinction" are rather meaningless. The probability of extinction expressed in a finite time scale, e.g. 100 years, is much more realistic. The inherent subjectivity in the Red Data Book categories resulted in differences in quality and quantity of information needed to support the assessments. Consequently, Mace and Lande (1991) devised a system for assessing extinction threat based on meaningful time scales. This system provides quantitative criteria in terms of population size, distribution, trends and stochasticity.

Critical: 50% probability of extinction within 5 years or 2 generations, whichever is longer.

Endangered: 20% probability of extinction within 20 years or 10 generations, whichever is longer.

Vulnerable: 10% probability of extinction within 100 years.

Definitions for the above categories (including Extinct and Safe) are based on the theory of extinction times for single populations. Since events beyond 100 years in future are hard to foresee, the meaningful time scales in years or generations also helps in organising conservation efforts rationally. The process of calculating extinction probabilities and risks required to assign a category to any species is discussed in detail in the above paper and other publications of Mace and Lande.

CAMPs, TAGs, GCAPs, PHVAs

Even when considerable information is available there may be substantial uncertainties in the extinction risk obtained from population models containing parameters (e.g. catastrophes, inbreeding, chance demographic fluctuations etc.) that are difficult to estimate accurately. To rationalise decisions based on information obtained for each taxa CBSG has developed Conservation Action and Management Plans (CAMPs) and Taxon Advisory Groups (TAGs) to provide strategic guidance on intensive conservation for threatened taxa. Their ultimate goal is to promote the creation of viable populations.

CAMPs assess the degree of threat for every taxon within the broad taxonomic groups (e.g. order, family) by assigning each taxon a category (Critical, Endangered, Vulnerable or Safe) using the Mace-Lande system. So far the CAMPs for various taxa have proposed following intensive actions:

Captive Breeding

Intensive in situ Management

Conservation Related Research

Population and Habitat Viability Analyses (PHVAs)

Of the 22 groups reviewed to date by the CAMPs, captive breeding has been suggested for 1,192 of the total 3,314 species in the groups (Seal et al. 1993). Asian hornbills and cranes are the groups with highest number of species recommended for captive breeding. Recommendation like these form the foundation for development of Global Captive Action Plans (GCAPs).

RULES FOR BREEDING WILD ANIMALS IN CAPTIVITY

The following rules are vital in breeding wild animals in captivity:

Familiarisation with reproductive behaviour patterns for providing appropriate accommodation.

Thoughtful selection of breeding stock and careful keeping of records and marking of animals to avoid inbreeding.

Pairing and grouping by adequate selection of individuals, recognition of secondary sexual characters, sexing of monomorphic species and understanding the importance of pair compatibility.

Seasonality and, if necessary, artificial control of breeding cycles.

Best possible diet for breeding females and young for proper development and growth.

Judicious use of methods of restraining and restriction of ranging if they interfere with breeding performance.

Close monitoring of infertility frequency, development abnormalities and birth or hatching problems for taking appropriate actions.

If required, use of artificial rearing methods such as double clutching (clutch extension), incubation, fostering, artificial insemination and embryo transfer or manipulation to maximise reproductive output.

A compromise between adequate management, hygiene and levels of disturbance to reduce stress in captive animals.

Establishment of multiple colonies by splitting the captive population to reduce the risk of disease or some other disasters.

Control of the reproductive rate to prevent unwanted growth in the captive population by using direct methods (e.g. separation) or through contraception (e.g. drugs, implants or surgery).

Reintroduction

A Keystone Species may determine the ability of a large number of other species to persist in a community. Protecting keystone species is a priority conservation effort, because if one is lost, numerous others may disappear with it. For example, many tropical plants support 10-30 highly specialised insect species which are lost whenever any of these plants become extinct (Raven,1976).

The IUCN/SSC Reintroduction Specialist Group has issued guidelines for reintroduction projects (IUCN 1998), which require that the principal aim of any such project should be establishment of a viable and free-ranging wild population of a species or subspecies, which has become globally or locally extinct, or extirpated, in the wild. It should be reintroduced within the species' former natural habitat and range and should require minimal long-term management. The objectives may include: enhancement of long-term survival of the species; re-establishment of a keystone species (in ecological and cultural sense); maintenance / restoration of biodiversity; to provide long-term economic benefits to the local / national economy, to promote conservation awareness; or a combination of these.

DEFINITIONS

Reintroduction: An attempt to establish a species in an area which was once part of its historical range, but from which it has been extirpated or become extinct (re-establishment is synonymous, but implies that the reintroduction has been successful).

Introduction: Deliberate or unintentional move to introduce a species to an area or habitat outside its recorded distribution range.

Conservation or Benign Introductions: An attempt to establish a species, for the purpose of conservation, outside its recorded distribution but within an appropriate habitat and eco-geographical area (this is a feasible conservation tool only when there is no remaining area left within a species' known historic range).

Re-enforcement / Supplementation / Restocking: Addition of individuals to an existing population of conspecifics.

Translocation: Deliberate or mediated movement of wild individuals to and existing population of conspecifics.

Planning and implementing a reintroduction programme

Tudge (1991) asserts that conservation and reintroduction should be the final goal of any captive breeding programme. The philosophy of maintaining a "living museums" in form of zoos is clearly becoming out of fashion as more and more zoos are calling themselves conservation centres for threatened and endangered species.

Two of the most common recommendations made in the IUCN/SSC Action Plans are the management and establishment of protected areas (Stuart 1991). In fact, in most cases habitat protection is seen as the key to species survival. This is because most threatened species have declined to low levels primarily because of destruction and alteration of their habitat. Unless large scale ecological restoration is first carried out reintroduction is unlikely to be a useful conservation tool.

It is important to note that most species recommended for reintroduction in the SSC Action Plans have suffered from pressures on the species per se and not at the habitat level (Stuart 1991). For examples, the animals which disappeared or declined in number as a result of killing by human beings for food, fur, trophy, medicinal products or because they were dangerous or harmful to human interests, those which were over-exploited by the pet trade, or were naturally vulnerable to disease and natural disasters due to their originally small and fragmented populations are most likely to benefit from reintroduction programmes as their habitat are still suitable and plentiful.

Any reintroduction project requires careful planning and implementation. Approval of relevant government agencies and coordination with national and international conservation organisations, formation of multidisciplinary team (government representatives, NGOs, funding bodies, universities and veterinary institutes, zoos / botanic gardens / other conservation breeding projects, knowledgeable individuals etc.) with suitable expertise for all phases of the programme, are some of the pre-requisites. The IUCN guidelines recommend the following approach:

PRE-PROJECT ACTIVITIES

BIOLOGICAL REQUIREMENTS

Feasibility studies and background research: An assessment of taxonomic status of the individuals to be reintroduced is necessary to find out if these are of the same subspecies / race as those which were extirpated. Investigations of historical information on the loss and fate of the extirpated individuals is important. Detailed studies of the status and biology of any existing population is required to determine the species' critical needs. Moreover, any other species which may have filled the void created by disappearance of the target species from the ecosystem should also be studied for success of the project. A PHVA too will be very helpful.

Research into previous reintroductions: Information from other reintroduction attempts of same or similar species and contacts with experienced individuals will help in developing a protocol for a reintroduction project.

Choice and evaluation of reintroduction site: The site should have a suitable habitat and assured long-term protection. Identification and elimination / reduction of previous causes of decline may include: habitat restoration, protection from hunting / collection, safety from disease, introduced species, and competition with domestic livestock, in all seasons.

Availability of suitable release stock: A captive stock that is well managed, both demographically and genetically according to principals of conservation biology, may be used for reintroductions. But reintroductions should not be carried out merely because surplus individuals in captive stocks exist. On the other hand, removal of individuals from the captive stock or a wild population should not endanger the captive or the donor populations. All imported individuals should undergo thorough veterinary tests and, if necessary, quarantine procedures both before and after shipment.

Release of captive stock: Most mammals and birds rely on individual experience and learning for survival. Therefore, captive individuals should be given the opportunity to acquire necessary information for survival in the wild, either in their captive environment or through erection of temporarily fenced / delimited areas within their former natural habitat. Care should be taken while releasing potentially dangerous animals as they might be a danger to local inhabitants and livestock.

SOCIO-ECONOMIC REQUIREMENTS

Reintroductions are generally long-term projects that require commitment of long-term financial and political support. An assessment of socio-economic impacts on humans and attitudes of local people is necessary (especially if the cause of decline included human factors) and the programme will succeed only if it is understood, accepted and supported by local communities.

POST-RELEASE ACTIVITY

Post-release monitoring using suitable methods (e.g. marking, telemetry, indirect evidence)

Demographic, ecological and behavioural studies of released stock

Record and investigation of mortality

Interventions (e.g. supplementary feeding, veterinary / horticultural aid), when necessary

Development of proper habitat protection or restoration procedure

Public relation activities

Publication of scientific and popular literature

Evaluation of cost-effectiveness and success of various techniques

Revision, rescheduling or discontinuation of the programme, when necessary

Success criteria

Griffith et al. (1989) found that several factors were associated with success of translocation or reintroduction:

Better habitat quality ensured greater success.

Reintroductions into the core of the species' historical range were more successful.

Herbivores were more likely to succeed than carnivores or omnivores.

Threatened, endangered or sensitive species were less successful.

Scarcity of competitors was beneficial.

Early breeders with large clutches/litters were better off than late breeders with small clutches/litters.

Wild caught animals fared better than captive reared ones.

Even among wild caught species those with source population of higher density and those with their source population showing an increasing trend were more successful.

Successful reintroductions released more individuals than unsuccessful ones.

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Pigmy Hog Conservation Programme

The Pigmy Hog (Sus salvanius) is the smallest and the rarest wild suid in the world. Today, it is at the brink of extinction, as only a few isolated and small populations survive in the wild. In the past, it was found in the tall, wet grasslands in the area south of Himalayan foothills from Uttar Pradesh to Assam, through Nepal terai and Bengal duars.

Present Distribution

Currently, however, it is restricted to a few pockets along Assam's border with Bhutan and Arunachal Pradesh. In fact, the only viable population of the species exists in the Manas Tiger Reserve and nowhere else in the world. The World Conservation Union (IUCN) has accorded the highest priority rating (Status Category 6 - Critically Endangered) to the species putting it among the most endangered of all mammals. It is also listed in the Schedule i of the Indian Wildlife (Protection) Act, 1972.

Distinctive Characters

Pigmy hog measures about 65 cm (25 inches) in length and 25 cm (10 inches) in height and weighs 8 to 9 kg. Females are a little smaller and the newborn babies weigh only 150 to 200 g. A vestigial tail (2.5 cm or 1 inch in adults) and only three pairs of mammae distinguishes it from the wild boar (Sus scrofa) which, despite being 10 to 20 times larger, often gets confused with pigmy hogs. The pigmy hog is locally called Nol Gahori or Takuri Borah in Assamese, Oma Takuri in Boro, and Sano Banel in Nepali.

Threats and Importance

The main threats to survival of pigmy hog are loss and degradation of habitat due to human settlements, agricultural encroachments, flood control schemes, and improper management. Some management practices, such as planting of trees in the grasslands and indiscriminate use of fire to create openings and to promote fresh growth of grass, have caused extensive damage to the habitats the authorities intend to protect.

The survival of pigmy hogs is closely linked to the existence of the tall, wet grasslands of the region which, besides being a highly threatened habitat itself, is also crucial for survival of a number endangered species such as the one-horned rhinoceros *(Rhinoceros unicornis)*, tiger *(Panthera tigris)*, swamp deer *(Cervus duvauceli)*, wild buffalo *(Bubalus bubalis)*, hispid hare *(Caprolagus hispidus)*, Bengal florican *(Eupodotis bengalensis)* and Assam roofed turtle *(Kachuga sylhetensis)*. The pigmy hog is one of the most useful indicators of current wildlife management practices in these habitats as it has disappeared from grassland which still support some other species. It is therefore important to understand why it is disappearing faster than other less sensitive species and take remedial actions if we wish to preserve the original habitats in their pristine state and with optimal diversity. This will eventually benefit all species of these threatened habitats. Preserving these important habitats, which are one of the richest in the Indian subcontinent in terms of their biodiversity, will also help in maintaining long term ecological and economic well being of the region.

CONSERVATION ACTION PLAN

It is therefore essential to formulate a properly structured action plan to save the species from extinction. This includes:

conservation breeding of the species with aims to reintroduce them to selected sites from where they have disappeared as well as an insurance against the possible early extinction of the species in the wild;

upgrading the (legal as well as actual) protection status of the above sites;

field research to plan ideal management practices for maintenance of optimal diversity of these habitats and mechanism to implement the recommendations of such studies;

reintroduction of viable number of pigmy hogs for their long term survival in the wild, monitoring the reintroduced populations; and

monitoring and modifying management practices to promote survival of all original inhabitants of such habitats.

THE ONGOING PROGRAMME

The Pigmy Hog Conservation Programme (PHCP) is a broad-based research and conservation programme which aims to fulfil at least some of the above requirements. This important recovery programme for the 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, formerly Jersey Wildlife Preservation Trust), the Forest Department, Government of Assam, and the Ministry of Environment and Forests, Government of India. The DWCT is the main financial sponsor for the 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 organisations (e.g. Harper Collins) is helping in continuation of the Programme.

It must be expressly mentioned that the only aim of this collaborative programme is conservation of the pigmy hogs and other endangered species of tall grasslands of the region through field research, captive breeding and reintroductions after adequate restoration of degraded former habitats. The project has absolutely no commercial interest. The above Agreement stipulates that ownership of all pigmy hogs bred in captivity would lie with the Government of Assam, till perpetuity. Translocation and reintroduction of any such animal is possible only with mutual consent of the agencies involved.

CONSERVATION BREEDING

One of the main objectives of the Programme is to establish a well structured conservation breeding project for pigmy hogs as an insurance against the possible early extinction of the species in the wild and as a source of animals for reintroductions projects. In 1996, six wild hogs were caught from Manas National Park and transferred to a custom built research and breeding centre built 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.

INCREASE IN CAPTIVE POPULATION

The six hogs settled down well in Basistha and 3 adult females, which were pregnant from wild, produced healthy litters in

1996. All but one of the 13 young (7 males, 6 females) were reared.

Seven more litters were born in 1997 and 24 (15.9) young were reared. However seven adult/sub-adult hogs died, six of them due to a mixed bacterial-fungal infection which was effectively controlled with local and international help. Nonetheless, the hog population almost doubled in 1997 from 18 to 35, which constituted a 580% increase in 21 months period.

In the 1998 breeding season, five captive sows farrowed at Basistha adding 22 (11.11) more hogs to the population. In 1999, 11 (7.4) young from five normal litters were reared despite several babies dying of piglet diarrhoea. Currently, 59 hogs (30 males and 29 females) are present at the Research and Breeding Centre and this represents almost ten fold increase in the captive population in about three-and-a-half years - a massive increase by any standard. This unanticipated and rapid increase in the captive population had created a accommodation problems, but extension enclosures and a quarantine facility have been constructed with funds provided by the Assam Valley Wildlife Society.

Like any other modern captive breeding programme, it is necessary to carry out DNA studies to determine relatedness among the wild caught and the wild sired individuals to maximize the genetic heterozygosity in captive population for its long term survival. Besides genetic studies, introduction of a few more wild animals into the captive population may also be required for the same reason.

A second breeding centre is being planned in collaboration with the Assam Valley Wildlife Society, which will, preferably, be located close to one of the reintroduction sites. Since the animals at Basistha Centre are the only captive pigmy hogs in the world, the second breeding centre will also be an insurance against any catastrophe at the present location.

FIELD SURVEYS AND FUTURE PLANS

In addition to the concluded first phase of radio-tracking studies in Manas, a wide ranging survey of known and suspected sites of pigmy hog distribution has been carried out. Grassland ecology studies are being planned in collaboration with University of East Anglia, Norwich (U.K.), Gauhati University, Guwahati and Bombay Natural History Society, Mumbai, to provide grassland management guidelines for conservation of natural floral and faunal diversity of the grassland habitats. Formation of a local governing body consisting Indian experts has also been proposed for management of the Programme.

Surveys to locate possible reintroduction sites have begun as the rapidly increasing captive population will necessitate an early transfer of some of these pigmy hog back to where they belonged.

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CHEMICAL IMMOBILIZATION OF WILD ANIMALS

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Wild animals, whether free ranging or captive in the Zoos, need to be handled for various reasons. For rendering treatment including surgery, various scientific studies, translocation to manage overpopulation or inbreeding depression, collection of samples or ectoparasites, rescue operation, biotelemetry to study the migration pattern are only to mention a few reasons for which a wild animal needs to be immobilized.

The primitive men of some of the countries like Congo and the Amazon basin used arrows and spears dipped in some crude preparations of paralysing drugs derived from plant sources to immobilize wild animals for subsequent killing for meat. In the recent part (less than 50 years ago), it was a convention to capture wild animals by trapping techniques like use of nets or a bait, whenever need arose for capturing them. But these techniques were very expensive, unpredictable and generally resulted in the death or injury (fracture) of the animals. The trapped animals were scared, struggled violently, and suffered from capture myopathy, which resulted in immediate shock or long term physiological disturbance. As the Veterinary-medical Science made inroads into the wildlife conservation programme, these crude conventional methods have falled into disuse. Technology has developed to inject safe and reversible stupifying drugs from a distance and has become a mainstay of modern wildlife and zoo medicine. The skillful and safe handling of the dangerous or hyperexcitable animals, which is the daily routine of the present day wildlife vet was only a distant dream until the remote injection techniques were developed in conjunction with the safer injectable anaesthetics.

Scientifically designed first projectile dart was reported in 1958. The early "Cap-chur" dart system was field tested in Africa in 1960. The entire operation of chemical immobilization of wild animals involves several components. The most important of them being the target animals, operators, drug delivery systems, drugs, equipments, facilities and site of the operation.

Very good knowledge about the biology of the animal, its response to the drugs, dart, physical abilities and limitations are all important to have. Depending upon the skin thickness, availability of heavy muscles, presence of trunk etc. will dictate the darting site. There is great variations in response of different species to drugs, e.g. 400 mg of xylazine makes a huge elephant unconscious, whereas 1500 mg of the same drug can't affect a rhinoceros, or 500 mg can't make a sambar asleep. 5 mg of Etorphine immobilizes a rhino but only ends-up in exciting a big cat. When darted, a rhino will run away towards the swamp but a tiger in every likelihood try to bite your neck. Then the animals' high olfactory, auditory or poor visual capabilities are all important things to have good knowledge about. The type of the target animal will also dictate the choice of the delivery system. The heavy metal dart of the Dist-Inject System may end-up inside the abdominal cavity of an antelope, or the smaller (3 ml) or light weight dart of the Tele-inject system may easily get diverted by the tip of a hanging creeper, a strong wind and that ever restive trunk of the elephant may pull it out and smash.

Only a qualified vet, expert in the field is authorized to apply drugs in animals (Veterinary Council of India Regulations, 1992). As the mainstay of this procedure is the use of drugs, a vet expert in the field of animal anaesthesiology should be heading the darting operation. But handling anaesthesia inside the operation theatre and in a free ranging condition greatly differs. The target animals are elusive, ferocious and no pre-anaesthetic patient evaluation is possible in the wild. Therefore, besides having expertise over the drugs, he must also have good knowledge about the 'jungle craft' and behavioural response of the target animals. The drugs used in the wild animals immobilization are highly potent and accidental human exposure is dangerous. Therefore, in the operations, at least two experts should be there in the team, so that in case of one of them getting poisoned, the other can help. In the darting operations, expert snippers often come in handy. However, the darting force should be headed by a high ranking and knowledgable wildlife official, which makes the resource mobilization and the liaison effective.

Different drug delivery systems are now available with advantages and disadvantages and the choice depends on the target animals, volume of drug to be delivered, terrain and individual choice. The remote injection is made in two phases; first the syringe is projected using the power of gun powder, compressed air/CO_2 or even by blowing by mouth. After the syringe stucks into the target muscle, the second phase of the process is completed by releasing the energy built-in the syringe. This may be either compressed spring, compressed gas (butane) or gun powder (syringe charge) which burst on the impact or released due to dislodging of the cuff blocking the opening on the specially designed fenestrated needle.

The properties of ideal immobilizing drugs are wide safety margin, suitable for many species, readily soluble in water, potent but non-irritant, retain essential body functions and vital reflexes, reversible with antagonist, titrable etc. Some of the commonly used drugs are narcotics (Etorpine, fentanyl), H_2 adrenoceptor agonists (Xylazine, Meditomidine, Detomidine, Romifidine), Dissociative anaesthetics (Ketamine, Phencyclidine, Tiletamine), phenothiazine derivatives (Promazine Acepromazine), Buterophenone derivatives (Haloperidol, Droperidol), Benzodiazepines (Zolazepam) etc. Drugs of yester years like muscle relaxants (Gallamine, d-tubocurarive) are not used any more. The compatible ones of these drugs are combined judiciously to reduce the chances of toxicities or increase the margin of safety, induce rapid immobilization or regulate the sleeping time as the situation might demand.

Depending upon the operation, a host of extra equipments are required to enhance the success rate, safety of personnel and safety of the animal darted. Equipments and supplies like safety rifle, portable climbing ladder, knife, rope and chain, blanket, water, blind fold etc. are always required. Wild buffalo, rhinoceros are best approached on monitor elephants. Rogue elephants in plain grass lands can be safely approached from helicopters. Musth elephants can be safely darted from atop of a tree or from a boat if it is near a river. Other supports like the monitoring equipments (thermometer, ECG, pulse oximeter and Stethoscope), emergency surgical kit, water, resuscitation apparatus, should be readily available. Portable Walkie talkie sets are also very useful in the field operations.

Some important considerations of the capture operations are :-

1. Safety of personnel and that of the target animal.
2. Adherence to correct approach and darting protocol.
3. Species, body weight, age, sex and temperament of the animal.
4. Terrain and climate, availability of light etc.
5. Signs of drug effect and correct positioning of the animal, monitoring of vital functions and appropriate remedial measures.
6. Complications like A-V block, cardiac fibrillation, tachycardia, bradycardia, hypoxia, anoxia, hypoventilation, decrease O_2 or increase CO_2 tension of blood, hypothermia, hyperthermia, haemorrhage, fracture, bloat, capture myopathy are all to be recognized and properly attended to.
7. Attention to be paid for post reversal sedation and measures taken to protect the animal from predators, drowning and rolling down a cliff.

Artificial Insemination and Cryopreservation of Germ Plasm as a means of Assisted Reproduction in Zoo Animals

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Artificial Insemination has been most widely used as a means of scientific breeding for improving the genetic potentialities of offsprings in domestic animals. During the first few decades, insemination was done using semen preserved at liquid state in a refrigerator. With the development of technology for cryopreservation of semen in the year, 1949, (Polge *et al.*, 1949), the frozen semen has gradually replaced the chilled liquid semen for artificial insemination in domestic animals. Application of artificial insemination in breeding of zoo animals is very limited and not so easy unlike domestic animals. In certain circumstances artificial insemination has to be used as a means of assisted reproduction in zoo animals. Generally, the necessity of A.I. in breeding of zoo animals is felt in the following situations.

i) Group consisting of individuals of same sex and of closely related animals.

ii) Males may be too old to reproduce or infertile.

iii) In behavioural incompatibility.

iv) In those species which don't breed well in captivity.

v) For preserving rare and endangered animal species.

vi) To maintain genetic diversity in Zoo animals.

Advantages of A.I. :

Although there are certain limitations in application of A.I. technique in zoo animals, it has many advantages. It is the most practical and first choice of veterinarian whenever assisted reproduction is needed. The advantages of A.I.are as follows :

i) Male and female animals can be in the same or in different Zoos.

ii) Sperm can be used after the death of the male.

iii) Sperm obtained from earlier generations can also be used.

iv) A.I. permits animals with non-inherited physical or behavioural abnormalities to breed.

v) It prevents spread of diseases as there is no direct contact of male and female animals in A.I.

vi) The member of male kept may be reduced which can be an advantage in certain species where the social structure of the species does not permit more than one adult male in a group.

vii) It permits control and maintenance of genetic diversity.

viii) It enables choice of potential sperm donor.

Factors controlling success of A.I. :-

The conception rate following A.I. in zoo animals depends on several factors, the most important of which are :

i) Ability to deposit semen at proper site in the female reproductive tract at a suitable time so that the conception rate is optimum.

ii) A good quality semen which in turn depends on proper semen collection and handling technique, semen preservation and test for semen quality.

Site and time of semen deposition and technique of A.I. :

There are certain practical difficulties in A.I. of zoo animals. The information on reproduction which are very much important for obtaining satisfactory conception rate are correct site of semen deposition, time of A.I. in relation to onset of heat, detection of heat, control of ovulation, effect of sedation at the time of A.I. on timing of ovulation, and minimum number of sperm required for obtaining satisfactory conception rate. But these information in different species of zoo animals are very scarce. From the knowledge of working with cattle, buffalo, pig, sheep and goat, it can be assumed that, wide species to species differences exist in physiological parameters of reproduction. The current state of knowledge in zoo animals reproduction is based on studies conducted only on a limited number of animals. So the applicability of these basic information has got certain limitation.

Various methods of A.I. applied in zoo animals are intra peritoneal, intra vaginal, intra cervical and intra uterine. Sedation of female at the time of A.I. is needed. While devising appropriate method of A.I., species differences in anatomy of reproductive tract in depositing semen in the cervix or uterus is to be taken into consideration.

Technique of semen collection :-

Different techniques may be used for collection of semen from zoo animlas depending on the species and situations. Most of the techniques can be used only occasionally. A technique that can be used on routine basis without affecting the life and health of the animals is to be found out for each species of Zoo animal to make possible wide application of A.I. in zoo animal breeding. A few techniques of semen collection are mentioned here under.

i) Postmortem recovery :- This can be done in any species. Sperm retains motility for several hours after the death of the animals. It is not possible to take up routine. A.I relying on occasional death of animal.

ii) Microaspiration of sperm from epididymis:- This technique can not be used as a routine method for obtaining sperm.

iii) Artificial Vagina Method :- Natural ejaculate can be obtained. But male needs training which is a difficult task to overcome owing to natural aversion of zoo animals to man. Gould *et al.*, (1993) reported collection of semen from chimpanzee using A.V.

iv) Masturbation/Digital manipulation :- This technique may be used only in certain animals like chimpanzee, monkey etc. (Seuanez, 1980; Hiyaoka and Cho, 1990). Animals are to be trained, which is difficult.

v) Vaginal washing/Vaginal aspiration :- For both methods, females are to be caught soon after copulation for collection of sperm from vagina. Semen is contaminated with the vaginal secretions and cells which are detrimental for preservation of sperm.

vi) Electroejaculation :- This method of semen collection by means of rectal probe is used most widely in Zoo animals. The advantage of this method is that the animal does not require training, The animal must be anaesthetised. In case of electroejaculation the secretions of accessory sex glands are more which affect adversely during preservation. Hence, sperm may be separated from seminal plasma for preservation. Sometimes urine may contaminate the semen.

Electroejaculation using penile probe is not very popular. In this case, male can not be sedated. It may cause lesions in the penis.

Test of semen quality :- Tests for ascertaining semen quality are generally based on criteria used for domestic animlas *viz.*, sperm motility, concentration, live sperm, sperm morphology etc., but the relevance of such measurements in certain Zoo animals is uncertain. The recent technique of sperm motility estimation i.e. computerised sperm motility analysis permits assessment of various sperm movements objectively (Mathur *et al.*, 1986)

This may give better information on fertilizing ability of sperm. The normal semen characteristics including sperm abnormalities in different zoo animals need to be found out. While assaying sperm quality we must remember that seasonal changes in ejaculate are common is some species of zoo animals. Poor semen quality in a particular ejaculate may be due to seasonal variation in testicular function. Wide variations in sperm biometrics were reported by Ahmed *et al.*, (1991) in a few species of zoo animals.

Preservation of semen :- Preservation of sperm for a long period without loosing its fertilizing ability is essential to have maximum benefit of A.I.as a means of assisted reproduction in zoo animals. Although a few attempts are made (Kraemer and Cruz, 1969, Cho *et al.*, 1975, Graham, *et al.*, 1978, Holt *et al.*, 1994,), successful preservation of semen of different zoo animals is not yet reported. Preservation of semen for a short duration of 3 to 5 days in chilled liquid state may not serve the purpose as A.I. is used as a means of assisted reproduction unlike that in domestic animals where it is used in most cases as sole means of breeding. Successful cryopreservation of semen of different species of zoo animals if made possible, would help in solving the breeding problems in zoo animals. Based on the knowledge of freezing semen of domestic animals, it can be said that several factors like type of semen extender, rate of extension, cryoprotectant and its concentration, rate of cooling, period of equilibration, rate of freezing, thawing temperature and method of thawing etc. would affect the success of cryopreservation in zoo animals. In every step species differences exist. It is therefore necessary to conduct systematic research work to standardize the methods of cryopreservation of semen of zoo animals.

Cryopreservation of germ plasm :- Research works carried out over the past five decades have established that several species specific factors determine the success of cryopreservation of germ plasm *viz.*, sperm, oocytes and embryos. There are wide species to species variations in resistance of sperm to cold shock and to harmful effect of cryoprotectant glycerol. Generally two methods are used for cryopreservation of germ plasm. These are (i) conventional and (ii) vitrification methods.

Conventional method : During freezing and subsequent thawing of sperm, death occurs mainly due to internal ice crystal formation, increased solute concentration (both extra and intra cellular) and the interaction of these two physical factors. Cryoprotectant *viz.*, glycerol, DMSO etc. is used to protect sperm from freezing damage. Glycerol protects sperm from freezing damage through a salt buffering mechanism (Lovelock, 1953). Glycerol is used to modulate the colligative properties of water by lowering its freezing point. In conventional method of freezing, glycerol is considered to be better cryoprotectant. However, it is toxic to spermatozoa specially at higher temperature, although its toxic effect varies between species. It is therefore, necessary to find out the optimum concentration of glycerol in freezing medium and the temperature of its addition for each species. Pregnancy results of frozen embryos suggests that glycerol is also a satisfactory cryprotectant for cryopreservation of embryos of domestic animals.

Vitrification Method : Highly concentrated aquous solutions of cryoprotectants often failed to crystalize even when cooled to very low temperature. Instead they become viscous that they could pass from the liquid state to a non-structural solid state, called a glass, leading to the process of solidification, called vitrification. In this technique, cells are immersed in such a high concentration of cryoprotectants that ice crystal formation is prevented during cooling.

Success of the technique is critically dependend upon factors like cryoprotectant toxicity and the development of methods which minimise osmotic injury during addition and removal of cryoprotectant. Vitrification of spermatozoa has so far been unsuccessful but it has been used for successful cryopreservation of mouse, cattle, sheep, rabbit, rat and cat embryos. Successful vitrification of oocyte was also reported (Balasubramanian *et al.* 1991; Taha and Schellender, 1992).

Conclusion :

1. Artificial insemination using cryopreserved sperm provides the best available choice of assisted reproductive technologies in zoo animal at present.
2. Development of species specific cryopreservation technique for semen is essential.
3. Species specific information on basic reproductive physiology has to be obtained to harvest maximum benefit of A.I.
4. Embryo cryopreservation may be of value in near future in restricted number of species.

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RADIOIMMUNOASSAY (RIA) OF HORMONE - PRINCIPLE AND PROCEDURE

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Principles :

The principles of radioimmunoassay (RIA) is very simple. The assay is based on the competition of labelled (radio active) and unlabelled antigen/hormone for fixed binding sites on the antibody molecules. As a result of this competition, the amount of radioactive antigen/hormone that can bind to the antibody is related inversely to the concentration on unlabelled antigen/hormone (standard or unknown) present in the reaction.

This may be represented as follows :

Ag AgAb - (1)
(free antigen/hormone)
+ Ab -------------
Ag* Ag*Ab - (2)
(tagged antigen/hormone)
(1) & (2) Corresponding Antigen-antibody complexes.

The aforesaid reaction is carried out by incubating fixed quantity of antibody (Ab) with a mixture containing a fixed quantity of labelled antigen/hormone (Ag*) and varying concentration of unlabelled hormone/antigen (Ag). Free antigen/hormone (Ag and Ag* are separated from the antibody bound antigen/hormone, AgAb and Ag*Ab) and the radioactivity of either the 'bound' of 'free' fraction is counted. A standard curve relating the antigen/hormone concentration and bound radioactivity is plotted . The antigen/hormone concentration of an unknown sample is determined from this graph.

Procedure :

The essential requirement of RIA are-

1. Standard : Sample of pure antigen/hormone of unknown potency.
2. Radiolabelled antigen/hormone.
3. Specific antibody.
4. Method for separating the antigen/hormone- antibody complex from the free antigen/hormone.

1. Standard : Standard hormone/antigen plays a crucial role in RIA because unknown sample is quantified by comparing its response to that of the standard. Hence it is essential to select an identical antigen/hormone as standard to that of unknown.

2. Radiolabelled antigen/hormone : This reagent of RIA has many synonymous term such as tracer, labelled antigen/hormone, tagged antigen/hormone etc. It is highly purified analyte to which has been attached a radioactive atom. The radioactive atom commonly used to label antigen/hormone are tritium (H^3), cobalt 60 (Co-6o), Na^{24}, Na^{22}, I^{121} and I^{125} etc.

It is to be noted that the labelled antigen/ hormone must be identical to the antibodies that bind strongly to the antigen/hormone being measured in terms of its affinity towards the antibody.

3. Specific antibody : Antibodies belong to the class of serum proteins known as immunoglobulins. Antibodies that bind strongly to the antigen/hormone are naturally have a strong affinity for the antigen and such antibodies result in highly sensitive RIA's.

4. Separation procedure : Separation procedure of RIA comes after antigen/hormone and antibody reaction. By this procedure antigen-antibody complex is separated from free antigen/hormone so that the radioactivity of either fraction can be counted. The separation technique may be classified into three general categories.

They are -

a) Absorption method : Here free antigen/hormone is adsorbed onto adsorbent like dextran chareol.

b) Precipitation method : Here only bound fraction is separated. Precipitated of antigen-antibody complex may be of two types-

i) Non-specific precipitation.

ii) Specific precipitation.

Non-specific precipitation of antigen-antibody complex is done by reagents like ammonium sulphate, alcohol or polyethylene glycol etc.

In the specific precipitation method a sound antibody directed against the primary antigen-antibody complex.

c) Solid phase method : This method consists of the primary or second antibody either bound to solids like cellulose, sephadex, plastic or ploysterene tubes etc. In the separation step, the solid phase containig the bound fraction is separated and counted.

The reagents for RIA are supplied by the manufacturer in kit form and the user has to reconstitute these reagents as described in the assay protocol .

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- INTRODUCTION -

Mammals are born at widely different stages of development and it is presumed that their nutriitive requirements depend on their physiological maturity. Therefore, milk of a given species is best adopted to the nutrition of the young of that species. It is thus tempting to speculate that the nutritive requirements of the young have exerted an importance selective force in the evolution of the composition of milk. Nutritive requirements of sucklings at various stages of developments are not very well defined and thus precise correlation of nutritive requirements with milk composition is not possible at present. Furthermore, the nutritional adequacy of milk for young depends not only on composition but also on quantity produced.

There seems to be no general correlation between physiological maturity at birth and milk composition. As for example, in the Logomorpha - the young of Oryctolagus are extremely altricial, those of Lepus very precocious and those of Sylvilagus intermediate. However, as may be seen the concentrations and proportions of the principal nutrients are similar in milks of the three genera. Another interesting example in the case of artiodactyls and perissodactyls whose youngs are born at similar stages of rather advanced physiological maturity. Such families as equidae and bovidae occupy similar ecological niches. Never the less their milk differ greatly in composition, milks of perissodactyls resembles that of primates whose youngs are rather altricial.

Nutrient content in the milk depend on nursing habit of the species also. Species nursing on a demand basis tend to produce milk with lower concentration of nutrients than those of that nurse their young infrequently. There are different types of nursing habits - (i) Species nursing on demand includes mersupials, primates, perissodactyls and some artiodactyls (ii) Those nursing on schedules basis includes logomorphs, rodents, carnivores and many artiodactyls (iii) Those occasionally arctic aquatic animals.

Milk Composition :

Milk is a complex secretory fluid containing lipids in emulsion, proteins in colloidal dispersion and various organic and inorganic constituents in aqueous solution. The major constituents include water, lipids,

MILK COMPOSITION

Typical composition of mammals milk

Water (Dry matter)

Lipids (Milk fat)
- Triglycerides
- Mono and diglycerides
- Phospolipids
- Free fatty acids
- Sterols

Proteins
- Casein (α, β, γ)
- Whey protein
  - α lact albumin
  - β lactoglobulin
  - Serum albumin
  - Immunoglobulin
  - Enzymes
  - Lactoferrin

Carbohydrates (sugar)
- Lactose
- Monosaccharides
- Oligosaccharides
- Protein- bound
- Lipid -bound

Minerals (ash)
- Calcium
- Phosphorous
- Sodium
- Pottasium
- Magnesium
- Chloride
- Trace minerals

Miscellaneous
- Vitamins
- Non protein nitrogen
- Citrate

proteins, sugars and minerals. Each of these categories may be further divided into more detailed components. Inter specific differences occurs not only in the relative proportions of the major nutrient categories, but also in the extent to which species components such as phospholipids, minor when proteins and oilgosacharides contribute.

- COLLECTION OF DATA -

Reliable information on the composition and quantity of milk secreted by diverse mammalian species in control to any evaluation of lactation strategies. A more restricted but more reliable data base is needed both for comparative purpose and for use in formulation of artificial milk for neonatal mammals.

Small numbers of samples, inattention to lactation stage, potential sampling bias, inappropriate analytical procedures and/or methodological difficulties plague many studies of lactation in non-domestic species.

Lactation Stage :

In every species examined to date, milk composition varies accordingly to lactation stage, but the direction and degree of change appears to differ among species of diverse taxonomic groups. Three stages of lactation are :- (i) the initial or colostral secretion produced in the first hours or days postpartum, referred sometimes as early lactation milk ; (ii) mid-lactation milk serected at about peak lactation, sometimes referred to as mature milk ; (iii) late-lactation milk produced in the more or less prolonged period of declining yields as the young are weaned to solid foods. In some species composition appears rather stable for a long period both before and after peak production ; in these species the mid-lactation period may be considered correspondingly long. In other species milk composition undergoes marked change rather soon after the lactation peak so that mid-lactation comprises but a small part of the total. Among studied primated, carnivores, perissodactyls and artiodactyls colostrum is typically high in total solids and proteins while low in sugar ; fat levels may be high, low or unchanges relative to mature milk. Rodents and the domestic rabbit, on the other hand, appear to secrete colostrum elevated in fat content, rather then in protein content. Late lactation trends are even more diverse. Fat content rises in late lactation in domestic rabbit, most rodents, some carnivores, elephants, giraffes and ruminants, but it falls in some seals, pigs and perhaps horses. Rising fat content is accompanied by increasing protein and declining sugar levels in many species, but fat and protein appear to change in opposite directions in a few (e.g. mink and pig).

Sampling bias :

Fat is the main source of error in milk sampling due to unequal distribution of milk fat in mammary contents in many species. A pronounced rise in the fat content of successive portion of milk removed during milking has been indicated for cows, sheep, water buffalo, eland, moose, bactrian camels, horses and humans. Thus incomplete mammary evaluation during milk collection may yield samples atypically low in fat.

Ideally milk sampling should replicate normal suckling behaviour, both in the interval allowed for milk to accumulate before sampling and in the amount of milk removed at milking. The suckling behaviour of only a few species in known in any detail, however. Inter suckling intervals differ substantially among species.

Certain precuation can help to minimize sampling bias. Mothers can be separated from their young for a period of time so as to minimize the influence of residual milk remaining after the last suckling. Prolonged separation is to be avoided to prevent mamory involuation.

Efforts should be made to evacuate the mammary gland as completely as posible. Administration of exogenous oxytocin immediately before milking can be practised. Unfortunately the use of unphysiological does of oxytocin may influence milk composition.

Difficulties in obtaining milk samples have inspired various alternatives to manual collection, but error may be introduced there by. Alternative methods are vaccum-assisted device, wild animals sometimes shot for milk collection, mammary incision and milk samples collected from the stomachs of recently suckled young. But these alternative methods have advantages and disadvantages as well

- ANALYTICAL PROCEDURE -

A variety of analytical procedures has been employed in the determination of the major constitutions of mammalian milks ; yet the results of all methods are not equivalent.

Water content generally determined by gavemetric method, protein is usually reported as total nitrogen (determined by kjeldahl procedures) time 6:38, sugar is generally determined by reduction method, fat is by Gerber method.

- SELECTION OF DATA -

No study can be considered completely free of interacting effects of lactation stage, sampling bias and analytical procedure in case of mammalian milks. The best that can be done to accept the data which has minimum sampling bias. A compliled reports from various sources in milk compositions of different species is presented in table 1.

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Table 1:

The composition of mammalian milk at mid-lactation

Species	No. of samples (%)	Dry matter (%)	Fat (%)	Protein (%)	Sugar (%)	Ash
MARSUPIALIA						
Brush-tailed possum *Trichosurus vulpecula*	46	24.5	6.1	9.2	3.2	1.6
Tammar wallaby *Macropus eugeni*	18	23.5	-	5.5	12.5	-
Red kangaroo *Macropus rufus*	16	22.8	4.9	6.7	9.8	1.4
INSECTIVORA						
White-toothed shrew *Crocidura russula*	21	51.2	31.9	9.7	-	2.6
PRIMATES						
Lemurs *Lemur spp.*	5	-	2.3	1.9	6.7	0.3
Talapoin monkey *Cercopithecus talapoin*	4	12.3	3.0	2.1	7.2	0.3
Baboons *Papio spp.*	11	14.0	4.6	1.5	7.7	0.3
Human *Homo sapiens*	1160	12.4	4.1	0.8	6.8	0.2
LAGOMORPHA						
European brown hare *Lepus capensis*	30	32.2	14.8	10.3	1.6	-
Rabbit *Oryctolagus cuniculus*	56	31.2	15.2	10.3	1.8	1.8
E. cottontail rabbit *Sylvilagus floridanus*	4	35.2	14.4	15.8	2.7	2.1
RODENTIA						
Europeon beaver *Castor fiber*	14	34.1	19.0	11.2	1.7	1.1
Golden hamster *Mesocricetus auratus*	6	22.6	4.9	9.4	4.9	1.4
Brown rat *Rattus norvegicus*	3-18	22.1	8.8	8.1	3.8	1.2
House mouse *Mus musculus*	5	29.3	13.1	9.0	3.0	1.5
Guinea-pig *Cavia porcellus*	10	17.5	5.7	6.3	4.8	0.8

Chinchilla *Chinchilla lanigera*	60	-	11.2	7.3	1.7	1.0
CARNIVORA						
Arctic fox *Alopex lagopus*	100	28.6	13.5	11.1	3.0	1.0
Dog (domestic) *Canis lupus*	25	22.7	9.5	7.5	3.8	1.1
Racoon dog *Nyctereutes procyonoides*	22	18.6	3.4	7.8	-	1.1
Red fox *Vulpes vulpes*	3	18.1	5.8	6.7	4.6	0.9
Brown bear *Ursus arctos*	5	33.6	18.5	8.5	2.3	1.5
Striped skunk *Mephitis mephitis*	5	30.6	13.8	9.9	3.0	-
Mink *Mustela vison*	20	21.7	7.3	5.6	4.5	1.0
Cat (domestic) *Felis silvestris*	15	-	10.8	10.6	3.7	1.0
Northern fur seal *Callorhinus ursinus*	3	61.0	49.4	10.2	0.1	0.5
California sea-lion *Zalophus californianus*	18	41.0	30.7	8.6	0.3	-
Weddell seal *Leptonychotes weddelli*	8	57.2	42.1	15.8	1.0	-
Harp seal *Phoca groenlandica*	3	51.7	42.2	8.7	0.1	0.7
Northern elephant seal *Mirounga angustirotris*	20	64.4	48.8	7.6	0.3	-
Southern elephant seal *Mirounga leonina*	3	48.8	39.0	9.0	-	-
PROBOSCIDEA						
Asian elephant *Elephas maximus*	3	17.7	7.3	4.5	5.2	0.6
African elephant *Loxodonta africana*	6	17.3	5.0	4.0	5.3	0.7
PERISSODACTYLA						
Ass *Equus asinus*	9	8.5	0.6	1.4	6.1	0.4
Horse *Equus caballus*	25	10.5	1.3	1.9	6.9	0.4
Black rhinoceros *Diceros bicornis*	11	8.8	0.2	1.4	6.6	0.3
Indian Rhinoceros *Rhinoceros Unicornis*	1	9.8	1.4	1.4	7.6	-

ARTIODACTYLA						
Pig *Sus scrofa*	302	20.1	8.3	5.6	5.0	0.9
Bactrian camel *Camelus bactrianus*	30	15.2	4.3	4.3	-	0.9
Moose *Alces alces*	15	21.5	10.0	8.4	3.0	1.5
N. American elk *Cervus elaphus nelsoni*	28	19.0	6.7	5.7	4.2	1.3
Red deer *Cervus elaphus scoticus*	6	21.1	8.5	7.1	4.5	1.4
Black-tailed deer *Odocoileus hemionus*	12	-	12.6	7.2	4.8	1.4
White-tailed deer *Odocoileus virginianus*	4	22.5	7.7	8.2	4.6	1.5
Reindeer *Rangifer tarandus*	6	26.3	10.9	9.5	3.4	1.3
Giraffe *Giraffa camelopardalis*	3	14.5	4.8	4.0	4.9	0.8
Gayal *Bos frontalis*	4	20	7	6.3	5.2	-
Cow *Bos taurus*	2000	12.4	3.7	3.2	4.6	0.7
Water buffalo *Bubalis bubalis*	42	16.8	6.5	4.3	4.9	0.8
Goat *Capra hircus*	120	12.0	3.8	2.9	4.7	0.8
Ibex *Capra ibex*	24	23.3	12.4	5.7	4.4	1.2
Dorcas gazelle *Gazella dorcus*	16	24.1	8.8	8.8	5.7	1.1
Tahr *Hemitragus jemlahicus*	9	-	7.9	5.4	3.1	-
Rocky mountain goat *Oreamnos americanus*	11	21.3	8.1	6.4	4.3	0.9
Sheep *Ovis aries*	20	18.2	7.3	4.1	5.0	0.8
Dall Sheep *Ovis dalli*	4	22.9	9.5	7.2	5.3	0.9
Eland *Taurotragus oryx*	11	21.9	9.9	6.3	4.4	1.1

MORTALITY IN DIFFERENT SPECIES OF ANIMALS OF ASSAM STATE ZOO, GUWAHATI.

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A systematic study of etiopathology of mortality of different species of animals of Assam state zoo was undertaken.

Altogether carcasses of 214 herbivores, 85 non-human primates were necropsied and diagnosis was made on the basis of history, gross and histopathological examination, microbiological, parasitological and chemical analysis of the tissue when warranted. The cause of death of the animals are presented species wise as follows :

Causes of Mortality in Different Species of Animals

Sl. No.	Species	Cause of death	Number. of deaths
1.	Spotted deer (*Axis axis*)	Tuberculosis	10
		Bacterial pneumonia	2
		Viral pneumonia	2
		Colibacillosis	1
		Traumatic injury	11
		Capture myopathy	4
		Metritis and peritonitis	1
		Bloat	1
		Fascioliasis and amphistomiasis	1
		Total	**33**
2.	Barking deer (*Muntiacus muntjak*)	Tuberculosis	8
		Bacterial pneumonia	3
		Zygomycotic pneumonia	1
		Aspiratory pneumonia	1
		Colibacillosis	2
		Traumatic injury	14
		Capture myopathy	4
		Shock	1
		Agalactia	2

		Complication of injury		3
		Decomposed and undiagnosed		2
			Total	**41**
3.	Sambar (*Cervus unicolor*)	Tuberculosis		8
		Bacterial pneumonia		4
		Zygomycotic pneumonia		1
		Necrobacillosis		1
		Candidiasis		1
		Traumatic injury		5
		Dystokia		1
		Agalactia		2
		Complication of injury		18
		undiagnosed		1
			Total	**42**
4.	Hog - deer (*Axis porcinus*)	Tuberculosis		6
		Bacterial pneumonia		1
		Traumatic injury		2
		Agalactia		1
		Complication of injury		1
			Total	**11**
5.	Thamin deer (*Cervus eldi eldi*)	Traumatic injury (killed by predators)		2
			Total	**02**
6.	White fallow deer (*Dama dama*)	Bacterial pneumonia		1
		Bloat		1
		metritis and peritonitis		1
			Total	**03**
7.	Mouse deer (*Tragulus meminna*)	Bloat		1
		Colibacillosis		1
		Capture myopathy		4
			Total	**06**
8.	Nilgai (*Beselaphus tragocamelus*)	Bacterial pneumonia		2
		Bloat		1
		Colibacillosis		2
		Traumatic injury		6
		Complication of injury		2
		Cirrhosis		1
		Hernia		1
		Intussusception & volvulus		2
			Total	**17**

9.	Blackbuck *(Antilope cervicapra)*	Bacterial pneumonia		1
		Pseudotuberculosis		1
		Tuberculosis		7
		Intestinal candidiasis		1
		Complication of injury		1
		Agalactia		1
			Total	**12**
10.	Serow *(Capricornis sumatraensis)*	Bacterial pneumonia		3
		Colibacillosis		2
		Traumatic injury		1
		Agalactia		3
		Haemonchosis		1
		Cestodiasis		1
		Traumatic reticulopericarditis		1
			Total	**12**
11.	Ladakhi goat *(Capra ibex)*	Haemonchosis and hydatid cyst		1
		Cestodiasis		1
		Still birth		1
			Total	**03**
12.	Mithun *(Bos frontails)*	Tuberculosis		1
		Fascioliasis and amphistomiasis		1
		Agalactia		1
		Still birth		1
			Total	**04**
13.	Water bufflalo *(Bubalus bubalis)*	Fascioliasis and amphistomiasis		1
			Total	**01**
14.	Giraffe *(Giraffa camelopardalis)*	Tuberculosis		2
		Bloat		1
		Paracute death		1
		Senility with accompanied lesions		1
			Total	**05**
15.	Hippopotamus *(Hippopotamus amphibius)*	Traumatic injury		1
		Still birth		2
			Total	**03**

16.	Rhinoceros *(Rhinoceros unicornis)*	Colibacillosis	2
		Capture myopathy	2
		Complication of injury	4
		Agalactia	1
		Still birth	1
		Senility with accompanied lesions	2
		Total	**12**
17.	Zebra *(Equus zebra)*	Botryomycosis	1
		Traumatic injury	1
		Organophosphorous Poisoning	1
		Senility accompanied with associated lesions	1
		Total	**04**
18.	Elephant *(Elephant maximus)*	Colibacillosis	1
		Intussusception	1
		Complication of injury	1
		Total	**03**
19.	Gibbon *(Hylobates hoblock)*	Pneumonia	5
		Enteritis	9
		Tuberculosis	2
		Stress	1
		Neonatal mortality	1
		Total	**18**
20.	Golden langur *(Presbytis geet)*	Pneumonia	4
		Enteritis	2
		Tuberculosis	5
		Traumatic injury	1
		Mycotic infection	3
		Gastric dilatation	1
		Neonatal mortality	3
		Stress	1
		Total	**20**
21.	Capped langur *(Presbytis pileatus)*	Pneumonia	1
		Enteritis	1
		Tuberculosis	1
		Traumatic injury	4
		Adenocarcinoma	1
		Neonatal mortality	1
		Dystocia	1
		Total	**10**

22.	Common langur *(Presbytis entellus)*	Pneumonia Bronchogenic Carcinoma Gastric ulcer		1 1 1
			Total	**03**
23.	Nilgiri langur *(Presbytis johnil)*	Tuberculosis mycotic infection		1 1
			Total	**02**
24.	Phayres leaf monkey *(Presbytis phayrei)*	Gastric ulcer Poisoning		1 1
			Total	**02**
25.	Bonnet monkey *(Macaca silenus)*	Senility		1
			Total	**01**
26.	Lion-tailed monkey *(Macaca silenus)*	Tuberculosis Senility		1 1
			Total	**02**
27.	Assamese macaca *(Macaca assamese)*	Pneumonia Tuberculosis Traumatic injury Neonatal mortality		1 1 3 2
			Total	**07**
28.	Slow loris *(Nycti cebus coucang)*	Pneumonia Enteritis Traumatic injury Gastric ulcer Stress		9 2 2 1 6
			Total	**20**

The works on carnivores and birds are in progress.

PCR IN DISEASE DIAGNOSIS

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Polymerase chain reaction (PCR) is an *in vitro* method for enzymatic synthesis of specific DNA sequences using two oligonucleotide primers that hybridise to opposite strands and flank the region of interest of target DNA.

PCR consists of repetitive cycles of DNA denaturation through melting at elevated temperature to convert double-stranded to single-stranded DNA, annealing of oligonucleotide primers to the target DNA, and extension of the DNA by nucleotide addition from the primers by the action of DNA polymerease. The target region for amplification is defined by unique oligonucleotide primers that flank a DNA segment. The oligonecleotide primers are designed to hybridize to regions of DNA that flank a desired target gene sequence, annealing to complementary strands of the target sequence. The primers are then extended accross the target sequence by using a heat-stable DNA polymerase (frequently Tag DNA polymerase, a thermostable and thermoactive enzyme from Thermus aquaticus) in the presence of free deoxynucleoside triphosphates (dNTPs), resulting in a doubled replication of the starting target material. By repeating the three stage process many times, a nearly exponential increase in the amount of target DNA results. The product of each PCR cycle is complementary to and capable of binding the primers, and so the amount of DNA is potentially doubled in each successive cycle.

Numerous modifications of standard PCR procedures have been developed. Among the ones most relevant to diagnostic application are nested PCR, Reverse transcriptase PCR (RT-PCR), multiplex PCR and quantitative PCR.

PCR is useful for rapid detection of pathagens, especially those whose *in vitro* cultivation is difficult or not possible. It can be applied to fixed tissues (frozen or formalin fixed) reducing the potential danger involved with live virulent pathogons. Diagnosis can be made in hours rather than days as required by some other methods. Multiplex PCR permits simultaneous screening of multiple pathogens. It also permits detection of virulence factors.

RESOLUTION & RECOMMENDATIONS FROM THE WORKSHOP ON HEALTH AND MANAGEMENT OF ZOO ANIMALS FOR ZOO VETERINARIAN 28TH - 30TH OCTOBER, 1999

1.0. Nutritional Requirement of Zoo Animals and Effects of Deficiency

1.1. Feeds supplied to the different animals in zoos be analysed for chemical composition from time to time and ration be prepared as per nutritional requirement of various categories of animals. For this purpose, the zoo authorities should establish a liaison with the animal nutrition departments of the local veterinary colleges/institutes.

1.2. The normal blood profile be studied for the different species of zoo animals which are important from the nutritional point of view.

1.3. Proper methodology for measurement of body weight and body surface of different species of animals, especially the native species be worked out to facilitate computation of diets.

1.4. Milk from different mammalian zoo animals as well as from cows and buffaloes need to be analysed for detrmination of comparative chemical composition of milk to formulate suitable milk substitute diets for the orphaned neonates.

1.5. Feeding standards for important species like elephant, tiger, leopard, rhinoceros etc. be established with the help of nutritionists from local veterinary colleges /institutes.

1.6. In all the zoos, specific guidelines for proper quality control and storage of various supplied foods be indicated.

1.7. Proper studies of the more prevalent diseases due to nutritional disorders be carried out with the help of expert nutritionists from veterinary colleges/ institutes. For the purpose, zoos should regularly supply the relevant samples as and when problem arises.

1.8. An independent course on Wildlife Nutrition be developed and included in the course curriculum of Animal Nutrition of B.V.Sc. & A.H. programme. Veterinary Council of India (VCI) be moved for the purpose to review the existing course.

1.9. State zoos be made available for practical orientations of undergraduates as well as intern veterinary students for imparting the knowledge of feeding habits of zoo animals and birds.

1.10. The Central Zoo Authority (CZA) should bring out a compilation on dietary management of all kinds of zoo animals and birds to provide it to each teaching institute and zoological parks of the country at the earliest.

1.11. Scientific methods of zoo nutrition be practiced in all zoos.

2.0. Restraint Techniques and Constraints

2.1. Training of mahout be conducted for early identifying of signs of musth to take appropriate preventive measures.

2.2. Appropriate training of zoo vets in chemical restraint techniques be organized from time to time by CZA.

2.3. Collection of samples be made for development of biological value standards at every chemical restraint opportunity and development of such collection facilities in zoos.

2.4. Standardization of doses be studied on immobilizing drugs for native species.

3.0. Health Care of Zoo Animals – Prevention & Control of Diseases

3.1. Vaccination schedule for captive animals be explored and general guidelines be evolved.

3.2. Vaccination of zoo staff connected with the management & treatment of zoo animals be made against Rabies.

3.3. Improved management practices and continuous monitoring of various diseases be undertaken.

3.4. Veterinarians working in the zoos be always consulted/associated in policy making process regarding planning and management of zoo animals.

3.5. Carrying of plastic bags by the visitors be strictly prohibited and zoo authority should provide disposal facility at the time of entry of visitors.

3.6. Traumatic injuries to the wild & zoo animals be guarded to minimize the loss. Adequate care be taken to prevent zoonotic and other infectious diseases in zoo animals.

3.7. Every veterinary hospital in the zoo should have at least two veterinarians to look after the animals.

3.8. *In situ* promotion and continuity of zoo veterinarians in zoos be ensured. The numbers of zoo veterinarians depending upon the category of zoo should be increased.

4.0. Approach to Clinical and Laboratory Diagnosis

4.1. For quick diagnosis, regional laboratories on disease investigation be strengthened.

4.2. Appointment of qualified technician for clinical investigation of zoo materials be made in each zoo.

5.0. Care, Management and Sexing of Reptiles

5.1. Demonstration session. No recommendations made

6.0. Population Management & Husbandry

6.1. Zoo and wildlife vets should work closely with researchers to monitor any release of captive wildlife into the wild (and even "wild" city living animals translocated to wild), for both health and welfare problems caused by either released or resident animals.

6.2. Zoo veterinarians should conduct research on the negative effects of crowding, of handling confiscated animals, and like subjects so that zoo managers will have herd data to use as ammunition to refuse further dumping of extraneous animals on a zoo.

6.3. Zoo veterinarians should use their legal power to euthanize sickly animals with courage and conviction.

6.4. Standard protocols for systematic release is available here and there which requires thorough study, monitoring and execution. CZA in collaboration with vets should take appropriate measures in strengthening the procedures.

6.5. It is necessary to build up a database of disease & cure of local endangered species whether in wild or in captivity.

6.6. The need for veterinary interventions in relation to the need for behavioural security of the animals be emphasized.

6.7. Up-to date veterinary medical assistance be accommodated into any conservation-breeding programme. They should also incorporate veterinary breeding & genetics experts into the project, in addition to other veterinary health officers.

7.0. In-breeding, Assisted Reproduction and Genome Banking

7.1. Establishment of frozen semen & embryo bank at national level for different species of zoo animals be initiated.

7.2. Information on basic reproductive physiology of different species of zoo animals be obtained through research works.

7.3. Collaborative efforts on research among zoos and Veterinary Colleges are recommended in the area of inbreeding, assisted reproduction and genome banking.

7.4. Efforts be made to cryopreserve germplasm of endangered species of zoo animals and *in vitro* fertilization.

7.5. National database on zoo animals be created.

7.6. Assessment of the level of inbreeding in different species of animals in zoo be made regularly.

7.7. Inter transfer of zoo animals be undertaken to increase genetic variability.

Additional General Recommendations:

(i). Veterinarians always be made an integral part of any conservation-breeding programme from its inception till its accomplishment.

(ii). Department of Wild Life Sciences be established in each and every Veterinary College of India providing adequate facilities for study, training, research and such other related matters. The VCI be moved for the purpose without delay.

WORKSHOP ON HEALTH AND MANAGEMENT OF ZOO ANIMALS FOR ZOO VETERINARIANS

Practical on Reptiles in progress

Plenary session of the workshop

INDIAN WILDLIFE HEALTH COOPERATIVE(IWHC) is a country-wide programme initiated jointly by **Wildlife Institute of India,** Dehra Dun, and the **Fish & Wildlife Service** of the U.S.A.

The primary objectives of the programme are :

* Extend veterinary care service to State Forest Departments
* Publishe a **Field Manual** for Forest officers on identification of diseases in wild animals and disease management techniques.
* Offer training to officer of Forest Departments on wildlife health issues.
* Research to understand the impact of diseases on wildlife conservation.

Started in 1995 the IWHC programme operates through five veterinary colleges located in five different regions of the country, with WII acting as the coordinating body. These veterinary colleges were carefully selected for their technical competency and their strtegic location to significant protected areas. At each of these veterinary colleges a Regional Centre of the IWHC has been opened, headed by a faculty member designated as **Wildife Health Coordinator(WHC).** To enhance their technical competence, the WHCs participated in :

* Wildlife Institute of India's 9-month Diploma Course in Wildlife Management.
* 3-month Study Tour to Wildlife Health facilities in the U.S.A.

To enable the WHCs to offer veterinary care service to the forest Dept., all the IWHC Regional Centres have been provided with field vehicles and tranquilizing equipment.

The contact address of the Indian and the U.S. Coordinators of the programme are :

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WEBSITES FOR ZOO AND WILDLIFE VETS

SOME GENERAL SITES - GOOD ONES

General Information

AZA Bear TAG - http://www.bearbiology.com
AZA Canid TAG - http://members.xoom.com/mthor/dogs/
AZA Antelope TAG - http://members.xoom.com/mthor/antelpe/
AZA North American Fauna Interest Group - http://members.xoom.com/mthor/nafig/
Asiatic Lion Information Centre - http://wkweb4.cableinet.co.uk/alic/
Big Cats Online - http://dialspace.dial.pipex.com/agarman/
Cheetah Conservation Project - http://www.cheetah.org
The Cheetah's Workshop -http://www.bigcats.com/
Class Mammalia - http://www.oit.itd.umich.edu/biol108/chordata/mammalia.shtm
Conservation Breeding Specialist Group - http://www.cbsg.org
Electronic Zoo - NetVet Veterinary Resources - http://netvet.wustl.edu/cats.htm
Endangered Species Homepage - http://www.fws.gov/~r9endspp/endspp.html
Hornocker Wildlife Institute - http://www.uidaho.edu/rsrch/hwi/index.html
International Snow Leopard Trust - http://www.serv.net.islt/home2.html
ISIS - http://www.worldzoo.org
IUCN Cat Specialist Group - http://lynx.ulo.no/catfolk
IUCN Taipir Specialist Group - http://www.tapirback.com/tapirgal/iucn-ssc/tsg/
IUCN/Species Survival Commmission - http://www.iucn.org/themes/ssc/index.html
Mammal Species of the World - http://www.nmnh.si.edu/msw/
Tiger Information Centre - http://www.5tigers.org/
World Conservation Monitoring center - http://www.wcmc.org.uk/
ZooNet - All About Zoos - http://mindspring.com/~zoonet

Organizations

AAZK: American Association of Zookeeper's Homepage - http://aazk.epower.net
African wildlife - http://www.africanwildlife.org
AZA Homepage: American Zoo and Aquarium Association - http://www.aza.org/
Defenders of Wildlife - http://www.defenders.org
Exotic Feline Breeding Compound - http://www.cathouse-fcc.org
Florida Panther Society - http://atlantic.net/~oldfla/panther/panther/html
ISIS: International Species Information System - http://www.worldzoo.org
Oklahama City Zoo - http://www.okczoo.org
San Diego Natural History Museum - http://sdnhm.org
Tigris - http://web.inter.NL.net/users/tiger
The Wildlife Society - http://www.wildlife.org
Wild About Cats - http://www.wildaboutcats.org