CSIR-CCMB

Central Zoo Authority
केन्द्रीय चिड़ियाघर प्राधिकरण

Workshop / Conference on

Reproduction and Welfare of Endangered Animals in Conservation Breeding

Organized by

CSIR - Centre for Cellular and Molecular Biology (CCMB)
Laboratory for the Conservation of Endangered Species (LaCONES), Hyderabad

&

Central Zoo Authority, New Delhi

January 28-30, 2015

Convener
Dr. G. Umapathy

Co-conveners
Dr. Ajay Gaur
Dr. Sandeep Goel

Conference / Workshop

on

Central Zoo Authority
केन्द्रीय चिड़ियाघर प्राधिकरण

"Reproduction and Welfare of Endangered Animals in Conservation Breeding"

January 28 - 30, 2015

Laboratory for the Conservation of Endangered Species (LaCONES)
CSIR-CCMB Annex I, Hyderabad

PROGRAMME

Day One (Wednesday) - January 28, 2015	
09:00 - 09:30	Registration
09:30 - 09:45	Welcome and Inaugural Address - Director, CSIR-CCMB
09:45 - 10:00	Inaugural Address - Member Secretary, CZA
10:00 - 10:15	Inaugural Address - Shri P.K. Sharma, Chief Wildlife Warden, Telangana
	Vote of thanks - Dr.Sandeep Goel
10:30 - 10:45	**Tea /Coffee Break**
SESSION - I	
10:45 - 11:30	**Keynote address - Prof. Mewa Singh,** University of Mysore **Title:** Perspectives for Conservation Breeding of Primates
11:30 - 12:00	**Dr. Sadanand Sontakke,** LaCONES **Title:** Reproductive Biotechnologies for Species Conservation
12:00 - 12:30	**Dr. Sambasiva Rao,** LaCONES **Title:** Cryoconservation of wild/endangered species: Developing cell lines and rescue and preservation of gametes (oocytes and spermatozoa) from dead animals.
12:30 - 13:00	**Dr. Sandeep Goel,** LaCONES **Title:** Testis Cryopreservation and Xenografting as an Aid to Conservation
13:00 - 14:00	**Lunch**
SESSION - II	
14:00 - 14:45	**Keynote address - Prof.P.B. Seshagiri,** Indian Institute of Science **Title:** Hormone Metabolites in Asian Elephants: Significance in the Assessment of Animals Reproductive and Stress Status
14:45 - 15:15	**Dr. G. Umapathy,** LaCONES **Title:** Conservation Physiology: Scope and Applications in Conservation of Endangered Animals

15:15 - 15:45	**Dr.N. Baskaran,** A.V.C. College **Title:** Captive Asian elephant population in three management systems in Tamil Nadu, their welfare and its implications for sustainability
15:45 - 16:00	**Tea / Coffee Break**
16:00 - 16:45	**Dr. Harish Shankar,** National Institute of Nutrition **Title:** Nutritional requirement for the production of quality animals
16:45 - 17:15	**Dr. Archana B. Siva,** CCMB **Title:** Ex-situ Conservation: The Microbiome Perspective
17:15 - 19:00	Poster session

Day Two (Thursday) - January 29, 2015	
SESSION - III	
09:30 - 10:15	**Keynote address - Dr. Goutam Narayan,** Ecosystems-India **Title:** Conservation Breeding Plays a Crucial Role in Recovery of Pygmy Hog
10:15 - 10:35	**Dr. Purnima Barman,** Aaranyak **Title:** Reproductive Biology of Endangered Greater Adjutant, *Leptoptilos dubius,* Gmelin 1789 in Assam, India
10:35 - 11:15	**Keynote address - Prof. P.C. Tyagi,** Wildlife Institute of India **Title:** Management of Endangered Species of Conservation Breeding Programme in India
11:15 - 11:30	**Tea/Coffee Break**
11:30 - 12:15	**Keynote address - Dr. Pradeep Malik,** Wildlife Institute of India **Title:**
12:15 - 12:45	**Dr. Ajay Gaur,** LaCONES **Title:** Molecular tools to ensure genetic health of endangered animals in conservation breeding
12:45 - 13:15	**Dr. Anuradha Reddy,** LaCONES **Title:** Deciphering tiger behaviour through genetic studies
13:15 - 14:15	**Lunch**
SESSION - IV	
14:15 - 17:00	Visit to the zoo and demonstration by Dr. Navin Kumar and Dr. Sadanand Sontakke
17:00 - 20:00	Visit to Golconda Fort

Day Three (Friday) - January 30, 2015	
SESSION - V	
09:30 - 10:15	**Keynote address - Dr. Vibhu Prakash,** Bombay Natural History Society **Title:** Role of Conservation Breeding in saving the three Critically Endangered Gyps species of Vultures in India from possible extinction
10:15 - 10:45	**Dr. Brij Kishor Gupta,** Central Zoo Authority **Title:** Designing & Enriching the Animals Exhibits for Animal Welfare and Conservation Breeding
10:45 - 11:05	**Mr. Mandar D. Kulkarni,** Vulture Conservation Breeding Centre **Title:** Molecular sexing: An important tool in managing captive populations of Gyps vultures in conservation breeding programme
11:05 - 11:20	**Tea/Coffee Break**
11:20 - 11:50	**Dr. Shailendra Singh,** Turtle Survival Alliance **Title:** Conservation Breeding and Head-starting of threatened Indian Freshwater Turtles
11:50 - 12:20	**Shri Sitendu Goswami,** Wildlife Institute of India **Title:** Effect of Enclosure Enrichment on Captive Animal Welfare
12:20 - 12:50	**Mr. Laxmi Narasimhan,** Wildlife Institute of India **Title:** Conservation breeding of the Western tragopan (*Tragopan melanocephalus*) in Himachal Pradesh
13:00 - 14:00	**Lunch**
SESSION - VI	
14:00 - 14:30	**Dr. Maroudam,** TANUVAS **Title:** Wild TB Sero-diagnosis- Specific point of care test kit
14:30 - 16:30	ISIS Talk **Title:** Two Hour ZIMS Medical Workshop
16:30 - 17:00	Feedback of participants
VALEDICTORY SESSION	
17:00 onwards	Review of Conference / Wokshop - **Dr.Ajay Gaur**
	Valedictory Address - **Shri A.V. Joseph, IFS, HoFF, A.P.**
	Distribution of certificates to participants
	Vote of thanks - **Dr.G.Umapathy**

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Workshop / Conference on

Reproduction and Welfare of Endangered Animals in Conservation Breeding

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Central Zoo Authority
केन्द्रीय चिड़ियाघर प्राधिकरण

Programme and Abstract Brochure

January 28 – 30, 2015

at

Laboratory for the Conservation of Endangered Species (LaCONES), CSIR-CCMB Annexe 1, Hyderabad

ABSTRACTS OF SPEAKERS

Perspectives for Conservation Breeding of Primates

Mewa Singh and Werner Kaumanns

Ramanna Fellow, and Life-Long Distinguished Professor
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A large number of primate species have been maintained under human care, and several of these have been brought under 'Conservation Breeding Programs' due to their threatened status in the wild and in captivity. Over the years, the keeping conditions have improved and management practices have become more appropriate. Still, it appears that most of the primate species under captivity may not reach the intended targets to serve as 'reserves' and models for their wild conspecifics. Viability of the populations seems to be low. Zoo community actually discuss this situation under viability crisis. To demonstrate the problems, we analyze the population development in 25 species of primates, ranging from prosimians to apes, under European Endangered Species Breeding Program (EEP) for the period 1990 to 2002. Except for a few species including some lemurs, lion-tailed macaques and Western lowland gorillas, the development in populations has not been satisfactory. We also analyze, in more depth, the conservation breeding program on lion-tailed macaques under Species Survival Plan (SSP), EEP and in India. The initially growing population under SSP shrank towards a non-viable status possibly due to certain management decisions. Population has considerably increased under EEP but the breeding problems still remain. Efforts have been made to establish Indian breeding program for the species but both management practices and breeding success still need much improvement. We emphasize that the conventional perspective with heavy emphasis on genetic management may not actually produce the intended results as several fitness related key traits are not considered. The key assumption in biology is that the unit of selection is the whole phenotype including behavioural aspects and not the genotype alone. Based on Carroll & Fox (2008), we therefore propose that a phenotype-oriented management may produce better breeding conditions and result in better reproductive output. We specifically discuss the importance of considering life-history traits such as the group size and composition, socialization process, inter-group encounters etc. They reflect adaptations which are critical for the survival of population and evolved in response to recurrent environmental problems.

Reproductive Biotechnologies for Species Conservation

Sadanand D. Sontakke

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Maintaining a healthy and viable population of an endangered species could be best achieved by habitat preservation (*in situ*). *In situ* conservation strategies enable wildlife populations to be maintained in their adaptive environments. However, many times, these efforts remain ineffective in propagating small populations and also for maintaining adequate genetic diversity. The alternative conservation approach could be to use reproductive biotechnologies such as estrous induction, gamete and tissue preservation, artificial insemination, *in vitro* fertilization, embryo transfer and cloning in *ex situ* that aim at establishing a viable population in captivity. These technologies have great potential in conservation biology that allow more offspring to be obtained from selected parents to ensure maximum genetic diversity and importantly, it reduces the risk of transfer of valuable endangered animals from one zoo to another. However, unlike domestic animals, current reproductive technologies have not yet been optimized for many endangered species because of species-specificity and paucity of knowledge on basic reproductive physiology and anatomy of wildlife species. Nonetheless, over the years, satisfactory progress has been made by the scientists in generating baseline information related to reproductive processes in many wildlife species, and also a few technologies have been successful in a few species including elephant and rhinoceros. My talk briefs about different reproductive techniques that can be applied effectively for conservation programs in endangered wildlife species. Further attempts being made at LaCONES-CCMB to use these technologies for Indian endangered species as newer dimension to wildlife conservation in India will be discussed.

Cryoconservation of wild/endangered species: Developing cell lines and rescue and preservation of gametes (oocytes and spermatozoa) from dead animals

B. Sambasiva Rao

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Cryoconservation is the collection and freezing of semen, ova, embryos or tissues for potential future use in breeding or regenerating animals. In any species recovery programs, natural reproduction would be the preferred method to increase the size of the declining population. When natural breeding is ineffective due to fertility failure associated with inbreeding depression, reproductive technologies such as artificial insemination, superovulation, and embryo transfer have been used to increase the endangered/wildlife population. Lack of basic knowledge about reproductive functions of concerned species is one of the major concerns to use ARTs for wild/endangered species. The ability to rescue and cryopreservation of gametes immediately after the death of wild/endangered species is the one of the promising approach to build basic knowledge of gametes for development of ARTs in concerned species. In addition, in vitro maturation and fertilization of these cryopreserved oocytes would allow one to develop embryos to reproduce the species by embryo transfer. A genome resource bank of cryopreserved oocytes, spermatozoa, embryos or cell lines may allow the recovery of wild/endangered species even after extinction by using the existing reproductive technologies. Thus cryopreservation of cell lines, tissues, oocytes and spermatozoa of endangered animals could serve as a bio-resource for resurrection animals in future.

Testis Cryopreservation and Xenografting as an Aid to Conservation

Sandeep Goel

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Testis cryopreservation can aid in preservation of germplasm of male animals that die before sexual maturity. This is especially of significance for germplasm preservation of valuable, rare and endangered animals whose dwindling population is affected by high neonatal/juvenile mortality because of diseases and poor management practices. Cryopreservation of immature testis in conjunction with testis tissue xenografting provides a powerful approach for the study of spermatogenesis mechanism, therapy of infertility and conservation of domestic and endangered species. Cryopreservation of testis tissue is challenging owing to its structure and presence of different cell types that differ in size and membrane permeability. Our laboratory current focus is to develop protocols for efficient cryopreservation of ungulate testis. Currently about 150 species of ungulates are under some degree of threat according to IUCN Red List of Threatened Species.

Our group has developed an uncontrolled slow freezing (USF) protocol for cryopreservation immature testicular tissues which, does not require expensive computer-assisted freezing equipment that are usually not available in field or in most laboratories/zoos/conservation parks of developing countries. Combinations of dimethyl sulfoxide (DMSO) and fetal bovine serum (FBS) were evaluated for efficient preservation of germ, germ-stem and somatic cells in the testis, without addition of any additional sugar, polyether or any other additives. Our results reveled that a suitable combination of DMSO and FBS can effectively cryopreserve immature testicular tissues that can be used for production of fertilization competent haploid gametes.

Hormone Metabolites in Asian Elephants: Significance in the Assessment of Animals' Reproductive and Stress Status

Polani Seshagiri, Raman Sukumar, Ratna Ghosal and Sanjeeta Pokharel

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Hormones are key biological regulators governing reproductive and stress status of mammals. In this regard, measurements of gonadal and adrenal hormones become important and it is increasingly recognized that these measurements help in strategic management of reproductive and stress status of captive and free-ranging animals, including Asian elephants. Because free-ranging Asian elephants blood sampling is not always possible, their fecal samples act as precious material for the estimation of hormone metabolites which could reflect animals' reproductive or stress status. Non-invasive methods to assess fecal hormone metabolites contents gained great significance in wildlife endocrinology as well as in conservation biology. We standardized suitable ELISAs for the estimation of fecal metabolites of progesterone, testosterone and glucocorticoids in Asian elephants. Using their profiles, we have been able to assess reproductive and stress status observed in captive and free-ranging Asian elephants. Implications of these study outcomes will be presented in my lecture. (Support: IISc, MoEF).

Conservation Physiology: Scope and Applications in Conservation of Endangered Animals

Govindhaswamy Umapathy

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Conservation physiology (endocrine studies that can contribute conservation), the newly recognized discipline draws on a wide range of existing research areas, including theoretical, diagnostic and management studies by enhancing the survival and reproduction of threatened animals. Accurate information about the reproductive biology and health is necessary for the effective management of animals in captivity and in wild. Reproductive parameters such as estrous cycle length, the length of gestation, the length of lactational an ovulation, sex determination, and age at the onset of puberty all were assessed using reproductive hormones (estrogen and progesterone in female and testosterone in male) in the blood. But repeated blood sampling, which is possible in domesticated animals and human beings, is not permissible in wild animals, resulting development of non-invasive method for hormone assay using fecal / urine samples. There have been several reports available on hormone monitoring in wild animals using fecal samples, which helped wildlife managers for better management and conservation of endangered animals in captivity and wild. Recently, physiological stress of wild and captive animals has also been studied using non-invasive method. Advantage and use of non-invasive hormone assessment in reproduction and stress level of wild animals would be discussed in detail.

Captive Asian elephant population in three management systems in Tamil Nadu, their welfare and its implications for sustainability

Varadharajan Vanitha[1&2], Krishnamoorthy Thiyagesan[1] and **Nagarajan Baskaran[1]**

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The captive Asian elephants, despite having a long history in captivity, globally suffering with wide range of welfare problems. There is no comprehensive data on various management practices of captive elephants and their influence on the elephant welfare. This study was carried out between 2003 and 2009 to document the population, reproduction and management of captive elephants in three systems–Private elephants, Hindu Temple and Forest Department– in Tamil Nadu, Southern India.

The captive elephant populations: Based on an extensive survey, the study estimated 135 elephants managed during 2003-06 together under private (42 elephants), temple (41 elephants) and forest department (50 elephants). Data on age class composition revealed that adult segments (75%) outweighed the other age-classes (25%) in all the three systems indicating an aged population trend. Sex ratio of the population was biased towards females in private (male to female 1:10) and temple establishments (1:21), but male biased in the forest department (1:0.5) with adult males constituting 50% of the total population. There was no breeding in private and temple populations. While in forest department population, fecundity has dropped (0.065/adult female/year) over the past 10 years (1996-2005) compared to an earlier (1969-1989) estimate (0.155/adult female/ year). Mean mortality estimated together for the three systems was higher (3.9%) than reported earlier (1.9%). Given the aging population trends, with no breeding and fewer chances of additions from the forest department due to ban on elephant sale, captive populations in private establishments and temples may not survive in the long run. Sustainability appears rather remote for population of the forest department system with a male bias, increase in mortality and a decrease in fecundity.

Assessment on health condition revealed that the proportion of elephants with poor health condition was highest in the private facility (24%) followed by temples (16%) and lowest in the forest department (6%). Mean monthly salary per *mahout* was lowest in the temple management (Rs. 2177), moderate in the private (Rs. 2693) and highest in the Forest Department (Rs. 4849). The study suggests various measures to improve the welfare and sustainability of elephants in these systems.

Nutritional requirement for the production of quality animals

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Good experimental outcome is dependent on the quality of animals employed, which in turn based on the genetic quality, health status of the animals and nutrients supplemented to them during growth and development. The nutritional requirement of an animal is based on the positive balance to the particular nutrient, which can be assessed clinically and biochemically. Nutrient composition in the diet may influence growth, diseases and tumor occurrence, the life span as well as responses to new chemical entities. The causes that contribute to mortality of animals in long-term studies, which could be influenced by diet includes nephropathy in males, mammary tumors in females and anterior pituitary tumors in both sexes of most strains of laboratory animals. Deficiencies or imbalance of nutrients can influence the animal metabolism and may result in false and misleading data being generated. The stock diets prepared from natural ingredients will contain adequate amounts of the essential nutrients and give reproducible results. Purified diets usage may result in metabolic aberrations due to deficient, borderline or highly excessive presence of one or more nutrients involved. All feeds either natural or purified should have ingredients like Carbohydrate, Protein, Fat, Fibre, Minerals and Vitamins. The lack of quality natural ingredients and micronutrients in the diet result in deleterious effects on the quality of animals, their reproductive performance, litter size would be discussed.

Ex-situ Conservation: The Microbiome Perspective

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For several threatened species, captive breeding may be the sole option for survival. One of the resultants of an effective captive breeding program is successful 'reintroduction" of captive animals into the wild. Maintenance of species in captivity requires stringent monitoring of animal health/disease, behavior, fertility; during captivity and prior to reintroduction, so as to ensure successful outcomes. In recent times, Microbiome [also called the "second genome"] has emerged as a major determinant of health and disease. Microbiome is the collective expression of genomes of all microbial species present inside the living organism, like bacteria, virus, fungus, protozoa and helminths. The advancement in DNA sequencing technologies has facilitated microbiome studies greatly. Promising studies are carried out in humans and it is timely and pertinent that this "Omic" approach be utilized in captive breeding programs in India. Variables seen during captive breeding viz. change in diet, environment, stress (due to human interaction) etc., are known to correlate well with changing microbiomes; thereby substantiating microbiome studies in these captive species. Such microbiome studies would aid in assessing and maintaining "fitness traits" in captive animals before their release. As rightly put forth, -"Successful management of species in captivity may well require managing their microbiomes".

Conservation breeding plays a crucial role in recovery of Pygmy Hog

Goutam Narayan

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A species which was once feared extinct, the pygmy hog (*Porcula salvania*) is on the path of recovery due to the efforts of a well coordinated and broad based conservation project despite stiff challenges. One of the world's most threatened mammals the 'Critically Endangered' pygmy hog was originally distributed in the narrow belt of plains alluvial grasslands south of the Himalayas from Uttar Pradesh and Nepal to North Bengal and Assam. By mid-1990s it had completely disappeared from all locations except Manas Tiger Reserve in Assam where just a few hundred of them survived. None of the attempts to breed it in captivity following its rediscovery in 1971 succeed and no captive pygmy hogs survived when the Pygmy Hog Conservation Programme (PHCP) was launched.

Conservation breeding of the species under PHCP started with just six wild pygmy hogs captured from Manas in 1996. Despite the small number of founders the captive stock multiplied rapidly under a well designed and superbly executed initiative and PHCP soon became one of the most successful breeding projects for an endangered species. Since 2008, this captive population has become a reliable source for reintroduction efforts for the species in restored and better protected habitats. So far PHCP has released 85 captive-bred hogs in 18 social breeding groups in two PAs of Assam in the last seven years while maintaining about 60 hogs in captivity, which is the sole captive population of the species in the world. Plans are afoot to release more animals in a third PA in 2015.

The presentation will outline the salient features of captive management of pygmy hogs including minor details that has contributed to its success. Other aspects of the programme from capture in the wild, pre-release protocols for soft release, their release in selected reintroduction sites and monitoring of the released hogs will also be discussed. Lessons learnt from the project can be used for conservation breeding of other endangered species.

Reproductive biology of endangered Greater Adjutant, *Leptoptilos dubius,* Gmelin 1789 in Assam, India

Purnima Devi Barman and DK Sharma

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The breeding biology of endangered Greater Adjutant *Leptoptilos dubius* was investigated from August 2009 to December 2014 in Dadara-Pasariya-Singimari (13 ' 13.47 " N or 26.2204083 N and 91° 38 ' 03.03 " E or 91.6341750 E) village, Kamrup District (25°46'-26°49'N and 90°48'- 91°50'E) where more than 50% of the species' global population exist. We recorded 95 nests in 2009-10; 90 nests in 2010-11; 114 nests in 2011-12; 152 nests in 2012-13, and nests 128 in 2013-14 and 155 nests in 2014-2015. This is the largest nesting colony of the species. Breeding season of *L. dubius* spans from late August to early April. Nesting colonies are very few within Protected Areas in India. It forms nesting colonies in tall trees in thickly populated village in Assam. The bird prefers tall trees of *Alstonia scolaris*, *Anthrocephalus cadamba*, *Artocarpus heterophylus*, *Pithecellobium monadelphum* and *Bombax ceiba* for nesting. We recorded up to 10 nests in one *Artocarpus lakoosha* tree in 2010. In Assam, breeding plumage of the birds appears during the onset of monsoon in July. They start congregating at community feeding sites in July. In August they start moving to breeding locations. Soon after they start pairing and select nesting trees. Several pairs select the same nesting tree and occupy specific branches of the same tree. At the same time nest building commenced. Both sexes participate in the nest building activity.. The clutch size varies from one to four eggs although hatching success in clutches with four eggs is poor. In 2014 we recorded four clutches of four eggs with successful hatchings. The incubation period ranges from 30 to 35 days. The fledgling period varies from 138 days to 145 days. We recorded chick mortality of 46.5% in 2011-12, 50.9%2012-2013 and 41.9% in 2013-2014, due to chick falling off the nest. During the study period, the chicks that fell off the nest were rescued and successfully released after hand raising them at Assam State Zoo. Post release monitoring reveals successful integration with the other storks. Investigation was also carried out in guts contents of dead juveniles. Blades, nails, and some unusual foods were found in the stomach which is alarming for the population. EDAX and SEM of egg shells were done to investigate the elemental status of eggshells. Results show high presence of mercury, lead and arsenic in the egg shells. Conservation breeding is required to save the species from extinction in near future.

Management of Endangered Species for Conservation Breeding Programme in India

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The Central Zoo Authority (CZA) was established in the year 1992 to oversee the functioning and management of zoo, and to provide technical support to facilitate the development of zoos in the country. One of the flagship programme of CZA is the conservation breeding of endangered species facing the risk of local extinction in the near future. The Central Zoo Authority has prioritized 26 species for which coordinated conservation breeding should be initiated by zoos located within the geographical range of the species. The coordinating zoos and participating zoos have been identified and the programme has been initiated for 23 species.

In spite of clear guidelines of CZA on how endangered species have to be raised for conservation breeding, the programme is festered with various impediments. First, the inability to acquire adequate founders that are genetically, and behaviourally healthy for conservation breeding and subsequent release in the wild. Second, the off exhibit housing of species should incorporate naturalistic ecosystem-based design, where the species can display its range of behavioural repertoire without showing any signs of human imprinting. Third, the breeding plans have to be determined through a scientific regimen involving study of studbook data on pedigree and mean kinship and ascertaining levels of heterozygosity for long term viability of the captive population. Fourth, scientific animal husbandry and health protocols have to be developed for breeding the species and its eventual release in the wild. Fifth, capacity building and skill-development of the personnel managing the centre is a prerequisite for the success of this plan. Finally, the sharing of information for developing linkages between in-*situ* and ex-*situ* programmes is crucial. The one plan approach for species management comprising of an in-*situ* meta-population management plan with multiple regional ex-*situ* population including global population, if any should be considered.

Molecular tools to ensure genetic health of endangered animals in conservation breeding

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The wild populations worldwide are experiencing continuous decline as a result of variety of factors like habitat loss, predation, climate change, hunting and loss of genetic diversity. Therefore, species conservation is one of the major issues that need immediate attention globally. Conservation Breeding or *Ex-situ* conservation holds the hope and potential of protecting endangered species, when *in-situ* conservation fails. Genetic management of captive populations is essential to ensure genetic diversity. Conservation breeding paves the way for systematic identification of genetically healthy founders and their use in controlled breeding programs for raising populations suitable for future reintroduction in to the wild. Central Zoo Authority of India identified 23 species which are endangered and need immediate conservation efforts and initiated conservation breeding programs for various species at different zoos.

Molecular genetic markers are a promising tool for conservation breeding programs. Molecular techniques are used for the analysis of mitochondrial as well as nuclear genes to check the genetic variation, in identifying genetically healthy individuals at population level, species level and other taxonomic levels. These are also used to detect paternity, similarity, relatedness and structure between captive populations. As a part of CZA's conservation breeding program, molecular studies to ensure genetic health are being carried out at LaCONES on several species such as mouse deer, snow leopards, rhinos, clouded leopards, red panda, pheasants etc.

Deciphering tiger behaviour through genetic studies

Anuradha Reddy

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Mate selection and partitioning of reproduction among individuals are largely unexplored phenomena in solitary and secretive carnivores. This is true even for a large-bodied species like the tiger (Panthera tigris). Behavioural studies on wild tiger populations are prohibitive due to their secretiveness and the difficult terrains they inhabit. Also tigers disperse over long distances very rapidly making them difficult subjects to monitor continuously over extended periods of time. An individual's movements are extremely important for fitness, reproductive success, genetic diversity and gene exchange among populations. We largely use molecular genetic analyses of non-invasively collected samples to understand philopatry, sex-biased dispersal and mate selection in wild tiger populations. Our studies will help understand tiger movement and have important implications for better management of habitats and interconnecting forest corridors. Further our studies will also help in streamlining future reintroduction programs.

Role of Conservation Breeding in saving the three Critically Endangered Gyps species of Vultures in India from possible extinction

Vibhu Prakash

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The Gyps species of vultures are obligate scavengers and never ever kill. They are nature's most efficient scavengers and are known to finish the carcass of a full grown cattle in a matter of minutes. The three resident Gyps species of vultures, Oriental White-backed Vulture *Gyps bengalensis*, Long-billed Vulture *Gyps indicus* and Slender-billed Vulture *Gyps tenuirostris* were very common in India till a couple of decades ago but their populations crashed in mid nineties and by the year 2007, 99% population of the three species had declined since 1990. A veterinary non-steroidal anti-inflammatory drug, diclofenac was found responsible for the crash in vulture populations. Vultures get exposed to diclofenac when they feed on carcass of an animal which died within 72 hours of the administration of the drug. The drug is extremely toxic to vultures and causes renal failure. The ban on the veterinary diclofenac and the initiation of conservation breeding were the two important recommendations of South Asia Vulture Recovery Plan prepared in 2004 and the Vulture Action plan of Government of India 2006. The diclofenac as a veterinary drug was banned by Government of India in 2006.

The first conservation breeding centre was established in 2004 and subsequently seven more centres were established by 2008. The Vulture Conservation Breeding Programme is a coordinated effort of Central Zoo Authority. The Pinjore centre is the coordinating zoo for the programme. The major objective of the programme is to house 25 pairs of each of the species in six different centres and release 600 pairs of each of the three species in wild within 10 years of the beginning of release programme. Over 400 vultures are housed in various centres. The Central Zoo Authority has developed a manual for Vulture Conservation Breeding Programme which is being followed by all the centres for husbandry and care and design of the aviaries. All the three species have bred in the centres and over 100 nestlings have hatched at these centres. Double clutching technique has been successfully experimented to augment the productivity in these slow breeding and long living species.

Designing & Enriching the Animals Exhibits for Animal Welfare and Conservation Breeding

Brij Kishor Gupta

Evaluation & Monitoring Officer & Member, Expert Group on Zoo Designing
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At the beginning of the twenty-first century, zoo exhibit design around the world is in developmental phase that includes thematic display of ecological niches, simulation of animal's natural habitats, and the creation of mixed species exhibits. Today the quality of a zoo is no longer measured by the number of species it contains, but rather by the quality of its exhibits which meets the requirement of animal, visitors and management , its educational programs, and its research and conservation activities. Over the past 10 years zoo exhibit design in India has undergone a metamorphosis which has resulted in a significant improvement in the quality of animal care at the major zoos.

It is high time that while designing the animals exhibits, animal welfare, enrichment to be incorporated systematically into the husbandry programmes of all zoos. Scientific inputs from the biologist working *in situ* and *ex situ* should be taken into the consideration while designing or renovating the animal exhibits. Enrichment has recently been defined as "a dynamic process which structures and changes animal environments in a way that provides behavioral choices to animals and draws out their species-appropriate behavior and abilities, enhancing their animal welfare. There is a need to carry out the detailed systematic studies utilizing large sample sizes are needed to test and refine hypotheses in order to ensure that species survival and enrichment activities continue to be effective tool for the welfare in the future. Future Zoos should be created in a manner with landscape immersion, where animals are seen in open and naturalistic setting with hidden barriers. Animal exhibits should meet the physical, mental, biological, behavioural and psychological requirements of the animals housed.

Key Words: Designing, Environmental Enrichment, Animal Welfare, Captive Animals

Molecular sexing: An important tool in managing captive populations of *Gyps* vultures in conservation breeding programme

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Out of the nine vulture species recorded in the Indian subcontinent, populations of three resident *Gyps* species namely Oriental White-backed Vulture *Gyps bengalensis*, Long-billed Vulture *Gyps indicus* and Slender-billed Vulture *Gyps tenuirostris* have declined by over 99% since 1990s and now considered critically endangered. The major cause of decline in these populations was found to be the veterinary use of non-steroidal anti-inflammatory drug (NSAID) diclofenac, which when used in treatment of livestock enters the food chain of vultures. Conservation Breeding Programme has been taken up for all the three species as the last ditch effort to save the species from possible extinction. Indian *Gyps* vultures are not sexually dimorphic and sex identification based on morphological characters is not possible; but sexing of individuals is important in a Conservation Breeding Programme for optimizing breeding. Hence, the applicability of polymerase chain reaction (PCR) based methods (molecular sexing methods) for sex identification was assessed. This study reports successful application of *W*-specific PCR combined with *ZW*-common PCR for sex identification in all the three Indian *Gyps* vultures. In total, sex identification of 64 vultures including 16 Oriental White-backed, 30 Long-billed and 18 Slender-billed was carried out using the reported method. A homosexual (all male) pair of Oriental White-backed was identified during the study. The pair was separated and the birds were kept in different aviaries to maximize the breeding. One of them paired up with a female and bred successfully. Thus, the reported molecular sexing method can prove to be a useful tool in management of vulture populations in Conservation Breeding Centres by helping maximize the breeding.

Conservation Breeding and Head-starting of threatened Indian Freshwater Turtles

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Conservation breeding is a means to save species from extinction (CBSG, 2014). As per the recommendation s of two national level workshops held in 2005 and 2010- TSA has been attempting to recover severely threatened riverine turtles through protection of nests and nesting sites, head starting and captive breeding. Post-release monitoring is being conducted to track such recovery efforts. Proactive efforts over the past decade primarily attempted to address conservation needs of the Red-crowned Roofed Turtle, *Batagur kachuga*, Three-striped Roofed Turtle, *Batagur dhongoka*, Northern River Terrapin, *Batagur baska*, Crowned River Turtle, *Hardella thurjii*, Black softshell Turtle, *Nilssonia nigricans* and the Indian Narrow-headed Softshell Turtle, *Chitra indica*. These initiatives have been primarily conducted along the *Ganges* and *Brahamaputra* river basins. Founders were acquired from illegal trade or from government or private collection/s and exchanges. Semi-natural incubation programs have been conducted for *B kachuga* to protect hundreds of nests and prime nesting beaches. Thousands of juvenile *B. kachuga* have also been reared and released under the aegis of our headstarting initiative. Post-release monitoring of headstarts using acoustic telemetry indicates a minimum survival rate of 70 percent. Another notable success is the recovery of *B. baska* from 11 (6.4.1) to over 156 individuals over three years (2012-2014) within the Sunderban Tiger Reserve. Initial challenges in rearing hatchling *C.indica and N. nigricans* in concrete pools have been overcome with husbandry improvements. Over the years we have refined our *ex-situ* efforts through information collected from *in-situ* populations. This communication provides an overview of methods employed in enclosure design, developing assurance colonies, nest protection and incubation, on-site head-starting efforts, captive husbandry, habitat evaluation, reintroduction/supplementation and post-release monitoring along with the concomitant successes and limitations.

Effect of Enclosure Enrichment on Captive Animal Welfare

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Captivity imposes limitations on the movement and expression of instinctive behaviours for most species. A restrictive captive environment can jeopardize the health of welfare of captive animals earmarked for conservation breeding. A study was conducted by the Wildlife Institute of India to evaluate the existing housing and enrichment conditions of 40 extant species from diverse taxa. The study aimed to better understand the effects of housing conditions on the welfare of captive animals. A preliminary study was carried out to assess the existing housing and enrichment conditions for all 40 species included in the purview of the research initiative. An enclosure complexity scoring mechanism was used to rate enclosures based on their species-appropriateness; and behaviour studies were also conducted to assess the welfare status of the animals in the enclosures. Based on the results of evaluation study, gaps in the enclosure housing and enrichment practices were identified. Subsequently, an enrichment exercise was implemented for representative species that aimed to ameliorate the deleterious effects of impoverished housing and enrichment practices in a few zoos.

The results of the enrichment study clearly indicates that enclosure enrichment and species-specific enclosure features improve welfare conditions for captive animals from a diverse assemblage of taxa. Animals housed in a complex environment show more activity, have better social coherence, and better cognitive abilities. Animals housed in the conservation breeding centers should have the freedom of choice to express most of the species-typical behaviour repertoire. A good enclosure design, species appropriate management practices and enrichments can improve the welfare status of captive animals. Therefore, there is an urgent need to review and refurbish the existing housing and enrichment conditions at the conservation breeding centers to meet the mandates of conservation breeding initiative.

Conservation breeding of the Western tragopan (*Tragopan melanocephalus*) in Himachal Pradesh

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The Western tragopan *Tragopan melanocephalus* is a threatened montane pheasant endemic to the north – Western Himalaya. A small population of the species is maintained in a captive breeding centre located at Sarahan, Himachal Pradesh, India. In 2007, a conservation breeding program for the species was started here. Due to low breeding success at the centre, in 2011, the Himachal Pradesh Forest Department initiated an applied research project with the Wildlife Institute of India to develop a better husbandry and management system. The improved keeping system and its effects in the first three years of its implementation are described. The key features of the improved keeping system included larger aviaries, a diet with a large proportion of fresh vegetative matter and undisturbed housing under natural climatic conditions. These changes facilitated the expression of natural breeding behaviours. This resulted in better egg quality, species – typical nesting behaviour, natural incubation by all the females and natural rearing of all the chicks. The present stock size at Sarahan is comprised of 31 individuals (16 males and 15 females) including six wild-born founders. An average of six births per year has been recorded, reaching the maximum capacity of the captive centre this year. The study contributed to husbandry know – how and demonstrated that natural breeding is possibly an easy and efficient method in conservation breeding programs. To further improve the breeding potential of the stock, a master – plan is being prepared. Management options proposed for the captive population to address these issues include (a) further expansion accompanied by population sub-division, (b) establishment of a new pairing system, (d) training the managers, and (e) behavioural and husbandry research. This study has implications for captive breeding and management of this species and can serve as a model for other ongoing pheasant breeding programs in India.

Wild TB Sero-diagnosis- Specific point of care test kit

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Tuberculosis due to *Mycobacterium tuberculosis* complex (MTC) in captive and free ranging wild animals is an important disease and not studied in detail globally. The problems associated with practicing routine skin testing using crude Protein Purified Derivative (PPD) and gold standard culture testing in wild animals had driven the quest for discovery of rapid point of care (POC) TB diagnostics. The lack of TB diagnostics for most of wild species and the absence of an effective vaccine make it currently impossible to contain and control TB. Thus the Rapid POC is serology based which are rapid, economical and well suited for wild life TB control and prevalence studies. Wild animals are variably exposed to environmental non-pathogenic mycobacterium species which have high degree of cross reacting antibodies. Therefore there is a need for highly specific rapid POC diagnostic kit to identify pathogenic TB. Thus the present invention of POC rapid diagnostic kit was developed using defined TB specific fusion proteins of Early Secretory Antigenic Target (ESAT)-6 and Culture Filtrate Protein (CFP)-10 and two PPDs (bovine and avian PPD) of Mycobacteria. This improved POC sero diagnostics facilities the detection of antibodies to pathogenic as well as non pathogenic mycobacteria. Thus in the present study Rapid POC for TB diagnostics developed using novel combination of pathogenic TB specific defined antigens and two PPDs of pathogenic mycobacteria and non pathogenic TB respectively. The developed POC rapid kit tested for its performance in sloth bear samples (n=76), elephants samples (n=15), cervidae samples (n=13), big cats (n=17) and others (n=5). The developed Rapid POC for TB diagnostics was validated in OIE World TB reference lab AHVLA, UK using their reference sera samples. The results indicated that the kit had 94% sensitivity and 92% specificity.

Keywords: Rapid test; POC; Wild TB diagnostics; Tuberculosis; WildTB alert™ kit

ZIMS For Medical by ISIS

CCMB Centre for Cellular & Molecular Biology

TWO HOUR ZIMS MEDICAL WORKSHOP

In managing conservation programs for ex-situ population, entering data in a standardized and sharable format has a multiplier effect on the important work being carried out with these managed species. When agreeing to create digital records you are agreeing to additional efforts, this make the effectivity of the data collection with regard to the success of your conservation programs an imperative. One way to guarantee your digital records will enhance your program's relevance is to follow the best practices and data formatting that has been agreed upon by the worlds largest international consensus organization in the field, such as the WAZA recommended ZIMS platform.

This workshop provides a targeted look at the features of ZIMS Medical that most directly relate to the reproductive health of intensively managed populations. We begin by discussing the overall feature set in brief. A full training on the program can last up to five days, this workshop, therefore, is a very high-level overview of the capabilities of this system used by more than 911 member zoos, aquariums and conservation organizations in over 85 countries.

Specific features demonstrated in this workshop include: contraception clinical notes, the issuing of chemical contraceptives via prescription records, integrated agenda for scheduling activities for a future date, laboratory sampling and testing records and finally the diagnostic framework used for discrete data entry and recall of verified diagnoses. Additional features that support the medical records system, but that fall under the prevue of the animal husbandry domain, are also touched on. In particular: clinical and husbandry note collaboration and the weight management feature which permits comparison of your individual weights with those of the global ZIMS database.

Reproduction and welfare of endangered animals in conservation breeding

1ST HOUR

- 10 MIN: INTRODUCTION AND ENSURE PARTICIPANTS CAN ACCESS INTERNET AND LEARNZIMS.ISIS.ORG
- 15 MIN: ZIMS MEDICAL – DESIGN OVERVIEW: **DASHBOARD, SEARCH, DICTIONARY, INVENTORY, RECORD TYPES**
- 15 MIN: CLINICAL NOTES – MAINSTAY OF MEDICAL RECORDS: **CONTRACEPTION NOTES**
- 15 MIN: QUICK PRESCRIPTION – CHEMICAL CONTRACEPTION: **ISSUE PRESCRIPTION**
- 5 MIN: CONTRACEPTION STATUS – UPDATE ANIMAL HUSBANDRY NOTES: **HUSBANDRY AND MEDICAL COLLABORATION**

2ND HOUR

- 5 MIN: ZIMS CALENDAR – CENTRALIZED EFFORT PLANNING: **SCHEDULE IMPLANT REMOVAL**
- 30 MIN: ANESTHESIA | SAMPLES | TESTS – DURING PROCEDURE BLOOD SAMPLE TAKEN: **PROGESTERONE LEVELS TESTED**
- 15 MIN: WEIGHT COMPARISON – GRAPH ANIMAL WEIGHTS: **VISUALIZE LATE PREGNANCY GAINS**
- 10 MIN: CLINICAL DIAGNOSIS – AFTER ULTRASOUND (CLINICAL NOTE): **MAKING FORMAL DIAGNOSIS SUPPORTS REPORTING**

PRACTICE ACCESS TO ZIMS MEDICAL:
Using username/password provided log-in to http://learnzims.isis.org/
Additional training documentation available: http://training.isis.org/library/

ABSTRACTS OF POSTER PRESENTATIONS

Captive Breeding of King Cobra (*Ophiophagus hannah*)

Dr. Dilip Falgunan

Pilikula Biological Park, Mangalore, Karnataka

Pilikula is a well known zoo in the country to breed some of endangered mammals, reptiles and birds of Western Ghats region Conservation breeding of King Cobra in Pilikula Biological Park is funded by Central Zoo Authority, New Delhi.

A spacious and scientifically enriched off-display enclosure is constructed for the breeding of King Cobras. The enclosures in enriched with bamboo grooves, ponds, water sprayers for artificial rain, hiding places, hot and cool spots, natural tree growths and dead wood etc. Natural substrate like soil, leaves and grass were provided to simulate natural habitat of King Cobras in Western Ghats region.

The temperature ranging from 26°c - 30°C. and the humidity between 70 – 90% are maintained in the breeding facility. For the breeding programme four females and six males were selected. The selected snakes were implanted with microchips for identification. Mating behaviour was observed in the month of January to march. After successful mating female snakes were separated. The snakes started to build the nest of bamboo leaves and laid eggs in the month of june and 50% of the eggs were collected and incubated artificially under controlled environment and 50% were left for natural incubation. Incubation period was found to be 80-85 days. 60% hatching rate was observed for eggs kept under natural incubation and 100% hatching was achieved in artificial incubation under controlled environment. The hatchlings were kept in glass tanks and were hand fed till they showed interest to feed by their own. At eight months of age the young ones were successfully released to the selected regions of Western Ghats.

Dr. Jacob Alexander

Museums & Zoos, Thiruvananthapuram, Kerala

Zoological Gardens, Thiruvananthapuram was established in 1857. Situated at the heart of Thiruvananthapuram city, the zoo occupies an area of 55 acres. The goal of the zoo, in mid 1900s changed from recreation to conservation of wildlife, and part of this endeavour culminated in the traditional iron- bar cages being replaced with more naturalistic enclosures for most species. Apart from the eighty odd species formally housed at the zoo, including Bengal tigers, a Greater One Horned Rhino and Nilgiri lagur, the area is home to many avian, Piscean and mammalian species. The flora population hosted at the zoo is also of a wide variety. The latest additions to the zoo include six green anacondas and a white tiger. The zoo also functions as a breeding centre for lion tailed macaques. Rainwater harvesting is another commendable achievement that this establishment may boast about. Vermicomposting is done for a large quantity of manure produced. The goals of the zoo include conservation, breeding, research and education on wildlife.

The daily backstage activities at the zoo include maintenance of enclosures, feeding the animals, prevention and treatment of illness and injury (as and when required). The zoo hospital has a team of well trained, dedicated individuals who are instrumental in keeping the animals healthy. The hospital is well- equipped with all the best medications, a state- of- the – art operation theatre, imaging techniques such as radiography and ultrasonography, darting equipment and telepathology unit. A makeshift nursery is present, complete with a setter and hatcher for eggs. The zoo also provides a good learning environment for students of various life sciences.

Successful breeding of Indian wolf (*Canis lupus pallipes*) in Jaipur zoo

Dr Arvind Mathur

Jaipur Zoo, Rajasthan

A control breeding programme becomes a necessity when essential habitat critical to species long term survival is lost or degraded. Most wild populations become endangered because a portion of their habitat is modified .One of the most important contributions of captive wild animal breeding is that it could generate public awareness and concern about conservation of wildlife.Indian wolf, a member of the family *Canidae* is an important canid that is maintained at the zoo. Expansion of agricultural activities in to marginal areas including open plains, resulted in the loss of habitat and geographical range of wolves has drastically reduced. The greatest threat to the Indian wolf survival is persecution by poison, and habitat loss due to intensive agriculture, development and industry. Jaipur zoo is among few zoos of India where successful breeding program of wolfs is going on in captivity.

Points For Successful Wolf Breeding: Keep compatible male and female together prior to breeding season. During breeding season, no person other than the keeper should be allowed inside the enclosure. The concerned keeper should be advised not to go very often near the whelping den so as to minimize disturbance. Twice feeding is required to the mother after she whelps. The diet should consist of minimum buffalo meat of 2 kg along with chicken 1 kg. As the pups grow and become less dependent on the mother, small pieces of boneless chicken may be provided. Handling of pups should be avoided as much as possible for at least 6 months. If needed concerned keeper may be advised to handle the pups for physical examination in the presence of Veterinarian. The pups can be weaned at the age of 6 months to promote further breeding by the mother.

Measures to Prevent Inbreeding In Wolves: To prevent inbreeding in wolves following measures are suggested:

- To introduce new gene pool -- Inter exchange of wolf between different Zoos of India, so that wolf of improved genepool could be maintained.
- Maintaing of complete genetic database of all the individuals in jaipur Zoo by implanting " Microchipping" of all the individuals

Conservation & Breeding Activities in Nainital Zoo

Dr. Yogesh Bharadwaj

Bharat Ratna Pandit Gobind Ballabh Pant High Altitude Zoo, Nainital

The Nainital zoo is actively carrying out conservation and breeding activities of various animals and specifically pheasants. The zoo has developed its Veterinary & breeding facilities for this major objective. Some of the important animals being bred at the zoo include Tibetan Wolf, Snow Leopard, Red Panda, Blue Sheep, Cheer and Kalij Pheasant.

The zoo is also actively involved in Wildlife rescue operations both in the Himalayas and the tarai landscape and has a fully functional wildlife rescue post care facility. The zoo is specifically equipped for breeding birds, pheasants.

Some of the facilities available at the Zoo are...

- Separate breeding facility which is away from the display enclosure for providing isolation & peaceful atmosphere.
- For avoiding inbreeding, the zoo changes the breeding pairs as and when wild/new blood becomes available either by exchange or rarely by rescued animals that are not suitable for release into the wild.
- Proper healthcare including, periodical deworming & diet supplementation with vitamins & minerals are provided during breeding season.
- In pheasants, brooding is done by natural means by brooders & artificial incubators.
- A technical Health Advisory Committee has been constituted which includes experts from I.V.R.I.Bareilly & College of Veterinary Medicine & Animal Sciences. This committee visits the zoo regularly for providing necessary inputs on the health and welfare of the animals.

Haematological and Immunoglobulin profile of spotted Deer (Axis axis)

N. K. Nighot[1], R. V. Jadhav[2], and C.S. Mote[3]

Rajiv Gandhi Zoological Park, Pune, Maharashtra

As per guidelines given by Central Zoo Authority and also for effective resource management, every zoo needs to be managed with population of highly prolific breeding species like deer. Hence, due to excess number of spotted deers (*Axis axis*), it was decided to release few animals in the free range area by opting permission from concerned department. After following the IUCN guidelines for releasing animals in the wild, 15 spotted deer (7 male and 8 female) were selected with apparently clinical healthy status without any history of illness for last 2 months. Before releasing, hematological examination and serological screening for tuberculosis was performed. All animals were sedated using a combination of Xylazine and Ketamine (each @ 2.5 mg/kg BW) by darting. Blood was collected in sterile vaccutainers from jugular vein. All 15 animals screened for faecal parasite and blood parasite were found negative. In wild animals, conventional method of screening of tuberculosis, i.e. Intra dermal PPD test showed no sense as it increases chances of casualty and duration of animal under sedation. So ELISA for anti tuberculosis for IgG, IgM and IgA was preferred.

The hemoglobin values ranged from 9.00 to 15.00 gm/dl with mean value of (11.96±0.63 gm/dl). Hematocrit value varied from 24.4 to 52 % (35.47±3.23 %). White blood cell count ranged from 4,250 to 12,000 $x10^3/\mu l$ (8436.67±837.19$x10^3/\mu l$). Red blood cell count ranged between 6.25 to 12.2x 10^6 / µl (8.89±0.606$x10^6/\mu l$). Mean Corpuscular Volume (MCV) of RBCs ranged from 25.7 to 32.2 fl (28.538±0.693 fl), while MCH varied from 10.1 to 11.9 pg (10.975 ± 0.245 pg). The MCHC showed mean value 38.588±0.462 gm/ dl (36.8 – 40.6 gm/dl). Total platelet count varied from 1.35 to 2.64$x10^3/\mu l$ (2.17±0.187$x10^3/\mu l$). Among the differential count of WBCs, Neutrophilic count ranged from 26 to 83 % (46.73±5.22%), while the Lymphocytic count ranged from 10 to 70 % (35.14±3.35 %). Monocyte and Eosinophil count showed the mean values of 1.46±0.61 % and 1.33±0.52 %, respectively. These mean values reported were in accordance with ISIS (www.isis.org). The anti-tuberculosis screening of animals was analyzed by ELISA for immunoglobulin (IgG, IgM and IgA) and is presented as optical density ratio (OD Ratio). IgG value ranged from 0.49 to 0.8 with a mean of 0.5173±0.102. IgM value showed mean 0.578±0.030 with a range of 0.44 to 0.7 while IgA value ranged from 0.48 to 0.81 with a mean of 0.661±0.03. These immunological values were below the normal range, indicative of no active, recent and chronic infection of tuberculosis. So these values of hematological and immunological screening for tuberculosis would be helpful for base line data of said animals.

Conservation of Endangered Indian narrow-headed Softshell Turtle *Chitra indica* (Gray 1830)

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In 2008, a conservation program was initiated to protect endangered *Chitra* species through *in situ* nest protection and head-starting in Ganges river basin. To increase hatchlings' survival, a total of 53 nests (6678 eggs) were protected through six river-side hatcheries. Out of the recorded 88% of hatching success, 10% neonates were head-started under natural conditions (to alter the high mortality in captivity during winter). Since 2012, through intensive captive management a total of 42 juveniles of *C. indica* are currently being successfully reared in captivity for the first time in the world. Future steps will involve a continued effort to rear these head-started cohorts to viable breeding individuals and supplement wild populations through further head-starting, and create satellite populations in rivers with historic distribution through reintroduction programs. This communication details significant findings on the captive management of endangered *Chitra* species for its conservation under the species recovery program.

A Study on Reproductive Behavior of Nicobar Long-Tailed Macaque (*Macaca fascicularis umbrosa*) in Nicobar Islands, India

Arijit Pal

Salim Ali Centre for Ornithology and Natural History, Tamil Nadu

The Nicobar long-tailed macaque (*Macaca fascicularisumbrosa*) is one of the ten subspecies of widely distributed south-east Asian long-tailed macaque (*Macaca fascicularis*).This sub-species has been categorized as 'Vulnerable' in IUCN 'Redlist' (2011) and 'Schedule-I' of the Indian Wildlife Protection Act (Anonymous, 1972) due to its restricted distribution and susceptibility of habitat to natural calamities. This subspecies has isolated from other subspecies about four million years ago and till now is sustaining. Population of them is restricted within three small tropical islands of Nicobar Island group *viz.* Great Nicobar, Little Nicobar and Katchal, where monsoon is longer and receives high rainfall, and with tropical rain forest. This unique habitat characteristics and environmental parameters influence on many of the behavioral strategies of the species. My study aims to understand sexual and related behavioral information of this macaque to understand its reproductive behavior.

M. f. umbrosa is non-seasonal breeder with a birth peak in dry season (November-April). Females' represented their receptive phase with various degrees of ano-genital organ and tail root swelling but no sex skin reddening. Like other non-seasonal despotic society here also mate monopolization by dominant males and inter-sexual competition is very high. Within males aggressive interaction events were frequently recorded which shows strong mate competition. Males' mate guarding strategy which consists of a series of courtship behavior was commonly recorded behavior of dominant males to avoid mate competition. Choosey females were engaged in mating interference which also shows highly intra-sexual competition in this sub-species. In this macaque society male influx and bluff mating leads inter-troop encounter up to lethal stages. In this highly intra and inter-sexual competitive society both sexes evolved strategies and counter strategies to optimize their inclusive fitness. Females'acquired various avoiding and group defense counter strategies to compete with males' sexual coercion strategies. After a successful takeover event females showed opportunistic receptiveness, pseudo-swelling and abortion (Bruce effect) behavior which as well as increase their fitness and decrease aggressive approach from new dominant male towards them. Post conception mating and mating with outer group males were recorded, which may help females to prevent infanticide through paternity confusion. In the other way, males were also seeking receptive females in outer group through bluff mating and intertroop encounter to increase their paternity concentration. The study in progress, has been documenting those behavioral strategies and counter-strategies of Nicobar long-tailed macaque which has been helping this subspecies to sustain in this small restricted region.

Is captive breeding a sign of good captive wildlife welfare?

Dr. Nirupama Jaisingh

Bannerghatta Biological Park, Bangalore

Bannerghatta Biological Park is one among the few places in our country where wilderness is preserved so close to a big city.Bannerghatta Biological Park has got its unique identity of situating inside a Bannerghatta National Park and the specialty of holding large, natural looking safari enclosures for the tigers, lions and herbivores.

This is a study about tiger conservation breeding in captivity. The current inventory of Bengal tigers (*Panthera tigris tigris*), after successful captive conservation breeding has gone up to 40 numbers. The reproductive season seen in zoo is almost all around the year and for the past seven years there was at least a cub born at the park. In this tiger conservation breeding study at Bannerghatta Biological Park, eight female tigresses were considered as parent stock and their seasonal breeding patterns were recorded for seven consecutive years from 2007 to 2014. Only 2 of the 8 females reproduced twice during the 7 years of the study. The average age at first reproduction was 3 to 4 years with gestation period ranging from 98 to 110 days.Thirty cubs were born during this study period and most of the birth is seen during the month of February and August. The captive born tigress also has a good mothering ability and the survival rate of cubs (<12 months) was 85 to 90 %. This retrospective study deals with the successful tiger breeding in captivity and we can say the years following the millennium was a much more success in this concern without a level of inbreeding.

This study indicates that tiger populations in the captivity can grow rapidly if the habitat provides adequate protection, reduce the stress level which will enhance the animals overall physical and psychological well-being, which will in turn increase the success of captive breeding.

Captive Breeding Potential of Lion-Tailed Macaques in Indian Zoos

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Laboratory for the Conservation of Endangered Species (LaCONES)
CSIR-CCMB

The lion-tailed macaque (LTM) is one of the most endangered primates in the world. It is estimated that only about 4000 individuals survive in the wild and the population is decreasing. The major threats to its survival are habitat fragmentation and its consequences like loss of genetic diversity. Compared to other macaques, LTM populations have a low growth rate, which would result in a relatively slow recovery following a demographic crash. These warrant the maintenance of a healthy captive population as a source of reproductively fit and genetically diverse individuals.

We studied captive LTMs of 4 zoos (Chennai, Mysore, Thiruvananthapuram and Hyderabad) with the objective of evaluating individual macaques for potential use in future breeding programs. We collected blood samples from 23 lion-tailed macaques and genotyped the individuals using a set of 11 microsatellite markers to assess the genetic diversity of the captive LTM population in India and to estimate the genetic heterozygosities. We also looked at their mitochondrial DNA sequences to ascertain their phylogeographical affiliations. In addition to this, we collected fecal samples at regular intervals from individuals in Mysore and Hyderabad zoos in order to assess their reproductive fitness through fecal steroid analysis.

The results indicate that LTMs in Chennai zoo have lower allelic diversity than those in Mysore and T'puram which are mostly wild-caught or confiscated. Furthermore, it was found that there are two distinct groups of LTM in the wild and that Mysore and T'puram zoos have individuals belonging to both these groups. It is recommended that LTMs belonging to these two groups be managed as separate breeding units to avoid outbreeding and facilitate easy reintroduction into the wild if and when required. Since expertise and genetic diversity are distributed unequally among these zoos, there must be a coordinated effort with an aim to maintain the best possible captive pool of LTMs, keeping in mind possible future reintroductions.