INDIRA GANDHI'S VISION ON WILDLIFE CONSERVATION : THE ZOO AS ONE SUCH INSTRUMENT

PROCEEDINGS OF THE SYMPOSIUM AND WORKSHOP ON "SCIENTIFIC MANAGEMENT AS AN INSTRUMENT FOR CONSERVATION OF WILDLIFE"

New Delhi, 29 - 31 October 1994

Central Zoo Authority
Ministry of Environment and Forests
Government of India

Cover photo Anonymous, from Memorial publication by
Indian Forest Service Association; other photographs by Shri Ashwini Arya

Edited, designed and produced by Zoo Outreach Organisation,
and printed at Vivega Offset Printers, Coimbatore

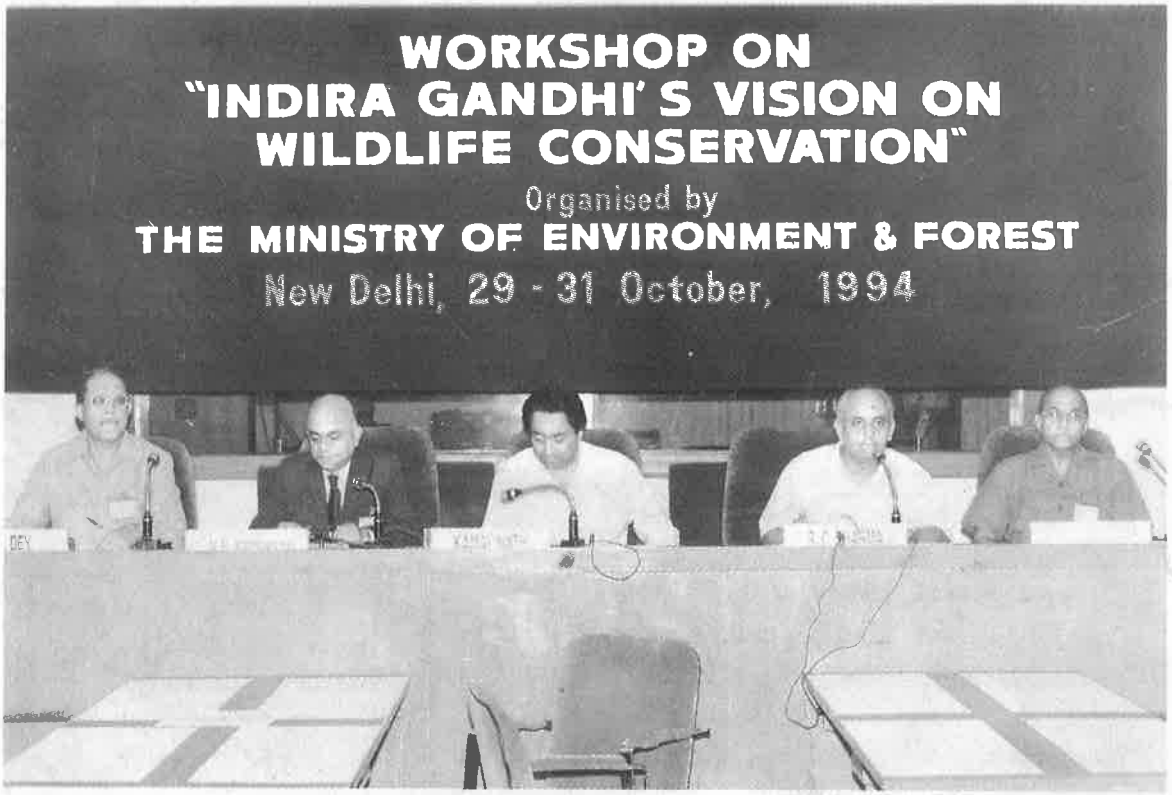
for

CENTRAL ZOO AUTHORITY

WORKSHOP ON
"SCIENTIFIC MANAGEMENT AS AN INSTRUMENT FOR CONSERVATION OF WILDLIFE"

CLOSING CEREMONY

Resume
Recommendations
Remarks



Closing function of Workshop on "Scientific Management as an Instrument for Conservation of Wildife"

PROCEEDINGS OF THE WORKSHOP ON "SCIENTIFIC MANAGEMENT AS AN INSTRUMENT FOR CONSERVATION OF WILDLIFE"

HELD ON THE OCCASION OF THE SYMPOSIUM TO HONOUR INDIRA GANDHI'S VISION ON WILDLIFE CONSERVATION, 29 - 31 OCTOBER 1994

CONTENTS

Preface -- S. C. Sharma
Executive Summary
Central Zoo Authority Logo
Agenda of Workshop
List of Participants

I. INAUGURAL FUNCTION

Welcome	**Sri S. C. Dey**
Opening address	**Sri Shivraj Patel**
Keynote address	**Sri Kamal Nath**
Vote of thanks	**Sri S. C. Sharma**

II. SCIENTIFIC SESSIONS

SCIENTIFIC SESSION - I
PLANNING AND DEVELOPMENT OF ZOOS FOR CONSERVATION OF ENDANGERED SPECIES OF WILD ANIMALS

First Plenary Session: Management of Zoos
Remarks of Chairman, Sri N. D. Bachketi

THE CHANGING ROLE OF ZOOS - A HISTORICAL PERSPECTIVE
Sri N. D. Bachkheti and Dr. J. H. Desai

EFFECTIVE UTILISATION OF RESOURCES AVAILABLE TO ZOOS FOR ACHIEVING CONSERVATION GOALS
Sri Pushp Kumar

ZOOS' ROLE AND APPROACH TO WILDLIFE CONSERVATION
Sri M. Kamal Naidu

BETTER HEALTH CARE FOR ZOO ANIMALS
Dr. L. N. Acharjyo

BETTER HEALTH CARE FOR ZOO ANIMALS; VETERINARY ASPECTS
Dr. D. S. Balain, and Dr. D. Swarup

Editor's Note : Papers which were circulated as part of the Briefing Book have been included in the Proceedings only in Abstract; papers which were not circulated previously -- or had been considerably revised -- have been published in full in this volume.

DIET SELECTION FOR ZOO ANIMALS
Dr. George Mahen

DIET SELECTION FOR ZOO ANIMALS
Dr. D. D. Manjramkar and Dr. S. Jayaraman

POPULATION CONTROL MEASURES FOR PROLIFICALLY BREEDING SPECIES
Dr. P. O. George

POPULATION CONTROL MEASURES IN ZOO ANIMALS
Dr. G.P. Talwar

SCIENTIFIC SESSION II
PLANNED BREEDING OF ENDANGERED SPECIES GENETICS

Second Plenary Session: Management of Zoos
Remarks of Chairman, Mr. A. K. Mukherjee

MANAGEMENT OFCAPTIVE POPULATIONS : AN OVERVIEW
Dr. A. K. Roy Choudhury, New Delhi

COORDINATION OF BREEDING PROGRAMME FOR ENDANGERED SPECIES,
Sri S. C. Sharma

ASSISTED REPRODUCTION IN ENDANGERED SPECIES
Dr. S. Shivaji

BREEDING BIOLOGY AND ASSISTED REPRODUCTION INCLUDING GENOME BANKING
Dr. Dharmeswar Das

TECHNOLOGIES FOR BREEDING BIOLOGY AND ASSISTED REPRODUCTION INCLUDING GENOME BANKING
Dr. M. C. Madan, Dr. S. K. Singla and Dr. R. S. Manik

ENSURING GENETIC PURITY OF ZOO ANIMALS
Dr. Lalji Singh

TECHNIQUES FOR DIFFERENTIATING PURE STRAINS AND HYBRID STRAINS, INCLUDING DNA-FINGER PRINTING
Dr. N. V. Giridhara

ENVIRONMENTAL ENRICHMENT IN ZOOS
Sri S. C. Sharma and Sri B. Chakraborty

ENVIRONMENTAL ENRICHMENT FOR RED PANDAS
Dr. Angela Glatston

ROLE OF ENVIRONMENTAL ENRICHMENT IN BETTER MANAGEMENT OF ZOOS
Sri R. Sunderaraju, Sri M. Jagannadha Rao and Sri A. Manimozhi

REINTRODUCTION OF CAPTIVE BRED ANIMALS IN THE WILD
Sri S. C. Dey

SCIENTIFIC SESSION - III
Developing Public Perceptions on Wildlife Conservation

Third Plenary Session: Management of Zoos
Remarks of Chairman, Sri R. Rajamani

EDUCATION AND INTERPRETATION IN THE INDIAN ZOO CONTEXT
Ms Sally Walker

THE ROLE OF "FRIENDS OF ZOOS" PROGRAMME
Ms Latha Thampi, Friends of the Zoo, Trivandrum

FRIENDS OF THE ZOO -- FROM A DIRECTOR'S PERSPECTIVE
Sri P. C. Mishra

PROVIDING GUIDE SERVICES FOR ZOO VISITORS
Sri S. K. Patnaik

"FRIENDS OF ZOOS" CREATING AWARENESS FOR WILDLIFE CONSERVATION.
Dr. (Sister) Doris D'Souza

EDUCATION AND INTERPRETATION IN ZOOS
Ms. Rajeshree Sharma

SESSION IV.
Working Group Sessions -- Reports

i. Planning and Management Group
ii. Planned Breeding and Related Problems Group
iii. Health Care Group
iv. Education Group
v. Reintroduction Group

SESSION V.
Practical Demonstration at National Zoological Park

SESSION VI.
Closing Ceremony

Closing remarks of Member Secretary, C.Z.A.
Reading of recommendations
Remarks of Scientific Community
Remarks of Secretary, MOEFWL
Remarks of Minister, MOEFWL and Chairman, C.Z.A.
Vote of thanks

Preface

Although the zoos have their origin as menageries, maintained for amusement and recreation of feudal lords, they have continued to evolve with the passage of time and today, they function as centres of conservation of biodiversity. To discharge the new role assigned to them, they have to take full advantage of the scientific knowledge and expertise in the fields of population biology, animal behaviour, animal nutrition, genetics, breeding biology, biotechnology and veterinary sciences. This cannot be achieved without close research on these aspects. However, the zoos in our country have so far been working in isolation with little interaction with the scientific world.

The workshop on " Indira Gandhi's Vision on Wildlife Conservation" was organised to bring the scientists and the managers on a common platform and deliberate the ways and means by which the expertise available in this country in fields related to zoo management can be utilised for effective and efficient management of wild animals in captivity. Smt. Indira Gandhi was quite keen to see that zoos contribute effectively in conservation of wildlife by augmenting the depleting populations of endangered species in wild through planned reintroduction programmes. It would be a befitting tribute to her if the collaborative efforts of the zoo managers and the scientific community can lead to successful captive breeding and reintroduction programme of the species which are on the verge of extinction.

S. C. Sharma, Member Secretary
Central Zoo Authority

Executive Summary

The Central Zoo Authority in collaboration with the Ministry of Environment and Forests, Government of India had organised a symposium entitled "Indira Gandhi's Vision on Wildlife Conservation : The Zoo as one such Instrument" and a Workshop on "Scientific Zoo Management as an Instrument for Conservation of Wildlife" at Vigyan Bhavan, New Delhi, October 29 - 31 October 1994. Participating in the symposium and working group discussions were 25 zoo directors, nearly 15 research institutions, 4 universities and a number of conservationists, educationists and animal welfare specialists.

After the Inaugural function, delegates gathered again for presentations in the following subject areas: Planning and Development of Zoos for Conservation of Endangered Species of Wild Animals; Planned Breeding of Endangered Species; and Developing Public Perceptions on Wildlife Conservation. Experts and enthusiasts from all over the country delivered papers on topics of interest in these subject areas.

The following day a Workshop on "Scientific Management as an Instrument for Conservation of Wildlife" was held consisting of the following small Working Groups : Planning and Management, Planned Breeding, Health Care, Education, and Reintroduction.

After drawing up recommendations in the Working Groups, these were discussed and revised by the Workshop in a Plenary session which specified conclusions about the direction in which the *ex situ* conservation in this country should move. A summary of the Recommendations of the Workshop follows:

Planning & Management:

1. Whereas keeping animals in zoos requires substantial resources in the form of land, water, energy and finance, the workshop recommended that any zoo should house only such species and only such numbers of animals of each species as are absolutely essential for achieving the stated objectives of the zoo. The workshop also recommended that strict population control measures be taken in respect of prolifically breeding common species.

2. Whereas it is crucial to provide all the animals displayed in a zoo adequate space and naturalistic fixtures so as to enable them to explore and display their natural behaviour, the workshop recommended that the enclosures for various species in the zoos should be of adequate size and simulate natural habitat as closely as possible.

3. For achieving the objectives stated above, every zoo should prepare a Master Plan for its development for a period of 20 years and a management plan for a period of 6 years.

Health Care:

4. Realizing the need for updating expertise on diagnostic methods and health management of animals kept in zoos, the workshop recommended that (a) the zoo veterinarians should remain in constant touch with Indian Veterinary Research Institute and other univerisites and colleges, where such studies are carried out, and utilize the facilities existing with these institutions for effective health care of zoo animals; and (b) workshops and seminars of zoo veterinarians should be organized every year under the aegis of IVRI and CZA.

5. The Workshop also recommended that for furtherance of aforesaid objective, every zoo should create a database regarding diagnosis of diseases in zoo animals and the treatment provided. This data should be shared with other zoos and the Central Zoo Authority on a regular basis.

6. Being concerned about the widespread incidence of tuberculosis in zoo animals, the workshop recommended that all the zoos should strictly comply with the guidelines issued by the Indian Veterinary Research Institute for diagnosis of tuberculosis in Cervids and Primates and take up effective measures to control the disease.

Education:

7. Whereas zoos have immense potential for creation of conservation awareness and thereby for mobilizing public support for conservation, the workshop recommended that zoos should plan their education programme to cater to the needs of all the sections of the visitors. Adequate budget provisions should be provided in relevant project for operating a zoo for implementation of these programmes.

8. Whereas zoo education is a very specialized subject, the workshop recommended that every zoo should have an adequate number of qualified and trained staff for conducting the zoo education programmes and where such staff exist, utilise them properly.

9. Whereas the non-governmental organizations and school children can pass on conservation message to the visitors very effectively, the workshop recommended that the zoos should take help of these organizations in supporting the zoo education programmes.

10. Whereas print media, television, radio, etc have immense potential in spreading the conservation message to the people at grass root level, the workshop recommended that zoos should endeavour to use the media for creation of conservation awareness effectively.

Planned Breeding:

11. Whereas the, role of *ex situ* breeding of endangered species by zoos has, over the years increased significantly, the workshop recommended that zoos should develop technical skills and know-how on population dynamics, breeding biology, conservation genetics, husbandry and upkeep of various species of wild animals.

12. Whereas carrying out breeding programmes requires significant infrastructure and resources, zoos must take up breeding programmes of species only for specific objectivies , *viz.* raising animals for display in zoos, maintaining gene pool reserves and raising stocks for reintroduction in the wild.

The Workshop also recommended that no breeding programme for raising stocks for release in the wild should be taken up without prior consultation with the Wildlife Wings of the State Governments.

13. Whereas the targeted number of animals to be raised under any planned breeding programme would depend upon specific objective for which breeding is being done, genetic and demographic objectives and the carrying capacity available with different zoos, the workshop recommended that no zoo should take up a planned breeding programme for any species without prior approval from the Central Zoo Authority.

14. Whereas it is crucial that the zoo populations, especially those raised for reintroduction in wild, are genetically and demographically viable, the workshop recommended that before taking up any programme for planned breeding of any species, the entire captive population, both within the country and outside the country, should be determined and a mechanism for exchange of animals to meet the requirements of breeding programme should be finalized. The workshop also recommended that to facilitate the process of exchange, State Governments may remove price tag on animals of various species required for planned breeding programmes.

15. Realizing that planned breeding of any species require extensve research inputs and technical expertise on population dynamics and husbandry of the species involved, the workshop recommended that programmes for scientific study through competent and committed scientific personnel be inbuilt in breeding programme for every species.

The Workshop also recommended that the zoos should support these programmes by contributing tissues of, or containing genetic material to the institutions entrusted with the responsibility of carrying out studies by the Central Zoo Authority.

However, no Institute shall transfer any tissue of genetic material to any agency outside the country without approval of the Central Zoo Authority. Relevant statutes, rules and regulations in this regard should be followed meticulously.

Reintroduction:

16. Realizing that *in situ* populations of the Great Indian bustard, Siberian crane, Black necked crane, Red panda, Musk deer, Western tragopan, Hangul, Swamp deer, Tibetan antelope and Snow leopard have declined considerably, the workshop recommended that the Central Zoo Authority and the zoos should start collecting information for implementing the breeding programme of these species successfully and develop such time bound projects in consultation with the Central Zoo Authority.

The workshop also recommended that Wildlife Wings of the State Governments should also start identifying suitable habitat for reintroduction of these species in the wild and acquiring necessary expertise for implementing the reintroduction programmes successfully.

17. The workshop also noted that although the technique for breeding of Brow antlered deer has been perfected, genetic and demographic viability of the populations is not guaranteed. The Central Zoo Authority and the Wildlife Institute of India should find out ways and means of raising the required number of genetically sound individuals of Brow antlered deer in correct demographic configuration expeditiously.

18. Realizing that the methodology for reintroduction of ungulate population has been more or less perfected, the workshop recommended that suitable habitat for providing an alternative home for Brow antlered deer should be taken up on priority basis by the Wildlife Institute of India in consultation with State Governments of North Eastern States

The closing ceremony was honoured by the presence of Hon. Minister for Environment and Chairman of Central Zoo Authority, Shri Kamal Nath and Secretary for Environment, Shri M. N. Krishnan. Shri Kamal Nath and Shri M. N. Krishnan heard the combined recommendations as discussed by the Workshop as well as the closing remarks of the scientific community and the zoo directors. They made their own observations and comments, declaring the Workshop successfully conducted and closed.

Central Zoo Authority

The Central Zoo Authority Logo

Central Zoo Authority, recognizing the importance of having an appropriate symbol of its functions, and desiring to obtain a wide spectrum of creative ideas, called for logo designs from the general public giving wide publicity. It was requested that the design should depict the spirit of conservation of wildlife and the role of zoos in that regard. The responsibility of the Central Zoo Authority to ensure that animals are displayed under conditions that are congenial to their psychological and physical health was described in the logo design invitation for creating a proper philosophical atmosphere for creating a design.

Thousands of designs were submitted from all ages of people from all over the country. These designs were examined carefully and a few selected which served as inspiration for the final logo which was finalized by the Centre for Environmental Education, Ahmedabad.

The symbol is essentially the interlocking of hands which is suggestive of cooperation and inter-dependence. The black hand is made to look like a mammal and the white hand is made to look like a bird. Care was taken not to give particular identity to either the bird or the mammal which have been depicted only as animal forms.

The letter 'C' enclosing the mark may well be interpreted as the first letter of the Central Zoo Authority as well as the world "conservation" indicating the resolve of the CZA to conserve wildlife. Moreover the openness of the form is suggestive of getting away from the traditional bar-like enclosures.

Central Zoo Authority

WORKSHOP ON
"INDIRA GANDHI'S VISION ON WILDLIFE CONSERVATION : THE ZOO AS ONE SUCH INSTRUMENT"
29 - 31 October 1994

Agenda

SATURDAY, 29 October 1994
Hall No. 5, 2nd Floor, Vigyan Bhavan

0900 - 0945 REGISTRATION AT VIGYAN BHAVAN

1000 - 1040 INAUGURAL SESSION

1040 - 1100 COFFEE BREAK

1130 SCIENTIFIC SESSION - I -- Planning and Development
Hall No. 5, 2nd Floor, Vigyan Bhavan

Chairman: Sri N. D. Bachkheti

1. **Effective Utilisation of Resources Available to Zoos for Achieving Conservation Goals,**
   Sri Pushp Kumar. I.F.S., Ret'd, Former Director, Nehru Zool. Park

2. **Diet Selection for zoo animals**
   Dr. D. D. Majramkar, Inst. of Reproduction, Bombay
   Dr. George Mahen, Veterinary College, Trichur

3. **Role of Environmental Enrichment in Better Management of Zoos**
   a. Sri S. C. Sharma, Member Secretary, C.Z.A.,
   b. Sri M. Jagannadha Rao, Dy. Director, Arignar Anna Zoo, Madras

4. **Better Health Care for Zoo Animals**
   Dr. L. N. Acharjyo, M.V.Sc., Ret'd Veterinary Officer,
   Nandankanan Biological Park

1300 - 1400 LUNCH
Ground Floor, Vigyan Bhavan

1400 **SCIENTIFIC SESSION II -- Planned Breeding for Endangered Species and Reintroduction Programme**
Hall No. 5, 2nd Floor, Vigyan Bhavan

Chairman: Sri A. K. Mukherjee, I.F.S., Ret'd. I.G. Forests

1. **Planned Breeding of Endangered Species**
   Dr. A. K. Roy Choudhury, Retd. Scientist, Bose Institute, Calcutta

2. **Coordination of Breeding Programme for Endangered Species**
   Sri S. C. Sharma, Member Secretary, C.Z.A.

3. **Assisted Reproduction in Endangered Species**
   Dr. S. Shivaji, Scientist, C.C.M.B., Hyderabad
   Dr. Dharmeswar Das, Scientist, A.G.U., Gauhati

4. **Ensuring Genetic Purity of Animals**
   Dr. Lalji Singh, Scientist, C.C.M.B., Hyderabad
   Dr. N. V Giridharan, Scientist, N.I.N., Hyderabad
   Dr. Prabhakar Gupta, Scientist, Bose Institute, Calcutta

5. **Population Control Measures for Prolifically Breeding Species**
   Dr. P. O. George, Professor, Vety. College, Trichur
   Dr. G. P. Talwar, N.I.I., New Delhi

6. **Reintroduction of Captive Bred Stock in the Wild**
   Sri S. C. Dey, Addl. I.G., Wildlife, Ministry of Env. & Forests

1600 **SCIENTIFIC SESSION III -- Creating Conservation Awareness through Zoos, *Hall No. 5, 2nd Floor, Vigyan Bhavan***

Chairman: Sri R. Rajamani

1. **Education and Interpretation Programmes in Zoos**
   Ms. Sally Walker, Zoo Outreach Organisation, CBSG, India, Coimbatore
   Mrs. Rajeshree Sharma, Information/Education Officer, Assam State Zoo

2. **Role of "Friends of Zoos" Programme in Creating Public Awareness about Wildlife Conservation,**
   Sri B. A. Abhram, ZOOWATCH, Trivandrum

3. **Involvement of NGO's in Conservation Awareness Programme**
   Sri P. C. Mishra, Director, Sanjay Gandhi Biological Park, Patna

4. **Role of School and Colleges in Zoo Education Programme**
   Dr. (Sister) Doris D'Souza A.C., ECOTASK, Patna

5. **Providing Guide Services for Zoo Visitors**
   Sri S. K. Patnaik, I.F.S., Director, Nandankanan Biol. Park

SUNDAY, 30th October 1994
Annex, Vigyan Bhavan

0930 **GROUP DISCUSSIONS**

1. **Planning and Management Group -- Room # A**
   Group Coordinator : Sri Pushp Kumar and Dr. J. H. Desai, Retd. Director, National Zoo, New Delhi
   Rapporteur: Sri Mahinder Singh, Director, Lucknow Zoo

2. **Better Health Care for Animals Group -- Room # B**
   Group Coordinators : Dr. D. S. Balain Director I.V.R.I. and Dr. J. V. Cheeran, Professor, Vety. College, Trichur
   Rapporteur: Dr. Tuhin Chakraborty, Vety. Officer, Himalayan Zool Pk.

3. **Planned Breeding of Endangered Species including Identification Genetic Purity, Assisted Reproduction & Genome Banking Group -- Room # C**
   Group Coordinators: Dr. Lahiri Choudhury and Sri B. C. Choudhery
   Rapporteur: Sri Bipul Chakrabarty, Scientist, C.Z.A.

4. **Education Awareness Group -- Room # 4**
   Group Coordinator: Ms Sally Walker and M. K. Mishra, Former Director, Van Vihar National Park, Bhopal
   Rapporteur: Mrs. Rajashree Sharma

5. **Reintroduction of Captive Bred Stocks in the Wild -- Room # 5**
   Group Coordinator: Sri S. C. Dey
   Rapporteurs : Sri S. Chug, Dy. Director, WL, Ministry of Env. and Forests / Sri Sanjay Molur, Pgm. Officer, ZOO/CBSG, India

1300 - 1400 **LUNCH -- National Zoological Park**

1400 **PRACTICAL DEMONSTRATION ON REPRODUCTIVE CONTROL, NATIONAL ZOOLOGICAL PARK, NEW DELHI**
Group Coordinator : Dr. B. M. Arora (IVRI, Izzatnagar); Demonstrations by Dr. Jacob Cheeran, Dr. Sunil Chabra, Dr. Anil Suri, Dr. P. O. George

MONDAY, 31st October 1994

0930 **Presentation of group reports and finalisation of recommendations**

1300-1400 **Lunch**

1400 **VALIDICTORY SESSION**

INDIRA GANDHI'S VISION OF WILDLIFE CONSERVATION : THE ZOO AS ONE SUCH INSTRUMENT,
Central Zoo Authority -- 29 - 31 October 1994

Participant List

Acharjyo L. N., Dr.
M-71 Housing R/Board Colony
Baramunda, Bhubaneswar 751 003

Alexander, Bijoy
ZOO WATCH
Trivandrum

Ali Khan, Mir Gauhar.,Dr.
19-2-81/3/B Khaja Pahadi
Mir alam Tank Road, Hyderabad

Arora, B. M., Dr.
Director, Wildlife Section
IVRI, Izzatnagar
Bareilly, U.P.

Bachkhetti, N. D.
Ret'd. Director, N.Z.P.
85 Vasant Vihar II
Dehra Dun, U.P.

Bagga, Shikha Ms.,
Education Officer
National Zoological Park
New Delhi

Bahuguna, N. C.,
Director
P.N. Himalaya Zool. Park
Darjeeling

Balain, D. S., Dr.
Director
Indian Vety. Research Institute
Izzatnagar, Bareilly (U.P.)

Bharat, Jethva D.
Dept. of Zoology
Gujarat University, Ahmedabad

Bhatia C. L., Shri.
143 Udai Park
New Delhi

Bonal, B. S., Director
Assam State Zoo
Guwahati, Assam

Borathakur, T., Dr.
Vety. Officer., Assam State Zoo
Guwahati, Assam

Chabra, Sunil., Dr.
National Inst. of Immunology
New Delhi

Chakraborty, Bipul
Central Zoo Authority
New Delhi

Chakraborty, Tuhin., Dr.
Vety. Officer, Padmaja Naidu Himalayan Zool. Park
Darjeeling

Cheeran, J. V., Dr.
Professor
College of Vety. & Animal Sciences
Mannuthy, Kerala - 680 561

Chellam, Ravi Dr.
Scientist
Wildlife Institute of India
Dehra Dun, U.P.

Choudhury, B. C.
Scientist, S. E.
Wildife Institute of India
Dehra Dun, U.P.

Chowdhury, Lahiri, D. K.
45, Suhasiri Ganguli Sarani
Calcutta 700 025

Chugh, Suresh
Dy. Director (WL)
Min. Env. & Forests
New Delhi

Das, A. K., Director
Alipore Zoological Garden
Calcutta, West Bengal

Das, Dharmeshwar., Dr.
College of Veterinary Sciences
Assam Agricultural University
Guwahati, Assam

Desai J. H., Dr
Addl.Director
Wildlife Institute of India
Dehra Dun, U.P.

Desai, D. C.
Dy. Municipal Commissioner
VJB Udyan Zoo, Bombay

Dey, S. C.,
Addl. I. G. Forest (WL)
Ministry of Environment & Forests, New Delhi.

Dogra, A. K., Director
M. C. Zoological Park
Chatbir, Chandigarh

D'Souza, Doris (Sister)., Dr.
ECO TASK
Patna

Dutt, A. K., Director
Kanpur Zoological Park
Kanpur

George, P. O., Dr., Prof. & Head
Dept. of Surgery, College of Vety. & Animal Sciences,
Mannuthy, Kerala 680 561

Ghosh, Arin, Director
Project Tiger, Bikaner House
Min. of Env. & Forests
New Delhi

Ghildial, M. C.
Chief Wildlife Warden
Lucknow, U.P.

Girdharan, N. V., Dr.
National Institute of Nutrition
Hyderabad

Glatston, Angela, Dr.
Rotterdam Zoo
Netherlands

Gorhe, Vinay, Dr., Dy. Supdt.
Peshwa Park Zoo
Pune

Gupta, Prabhakar, Dr.
Bose Institute
Calcutta

Haque, M. A., Dr., Director
Environment
Min. of Env. & Forests
New Delhi

Jadeja, Vijayraj, Curator
Sayaji Bagh Zoo
Baroda

Jain, M. S., Director
Tata Steel Zool. Park
Jamshedpur

Ramakrishna, T.
Chief Wildlife Warden
Govt. of Andhra Pradesh

Kumar, V. V., Gen. Manager (P & A), Nagarjuna Fertilizer & Chemical Ltd, Kakinada, Hyderabad

Kumar, Pushp
Zoo Consultant
8-3-833/97 Kamlapuri
Hyderabad 500 873

Madan, M. L., Dr.
National Dairy Research Institute
Karnal

Majrumkar, D. D., Dr.
Institute of Research in
Reproduction
Bombay

Malik, Iqbal, Dr.
540 Hawa Singh Block
Khel Gaon, Hause Khas,
New Delhi

Mathew, George ., Dr.
Dept. of Animal Nutrition
College of Vety. & Animal
Sciences
Mannuthi, Trichur

Mishra, M. K.
Addl. Director, Indian Institute of
Forest Management
Bhopal, M.P.

Mishra, P. C.
Sanjay Gandhi Biol. Park
Patna, Bihar

Mishra, S. K.
Executive (Horticulture)
Steel Authority of India, Rourkela

Mitra, Deepak
Calcutta Snake Park
Calcutta

Modi, S. K.
Kamla Nehru Prani Sangrahalaya
Indore, M.P.

Molur, Sanjay
Zoo Outreach Organisation
Peelamedu, Coimbatore 641 004

Mukherjee A. K.
Ex-IGF, Min. of Env & Forests
New Delhi

Kamal Naidu
General Manager
Forest Dept. Corporation
Hyderabad

Naidu S. S.
Blue Jay, No.25 West Street
Kilpauk Garden Colony
Madras 600 010

Nainan T., Curator
National Zoological Park
New Delhi

Pandey, Mamta, Dr.
Centre for Environment Education
Ahmedabad

Pasricha, Sheila, Ms.
E-4, Palm Springs, 104,
Cuffe Parade
Colaba, Bombay 400 005

Patnaik, S. K.
Director
Nandankanan Biol. Park
Bhubneswar

Pringu, P.
Director
Itanagar Zoological Park
Itanagar

Pawar, Rajeev
School of Studies in Zoology
Jiwaji University, Gwalior

Rai, Usha
Journalist
Indian Express
Bahadur Shah Zafar Marg, New
Delhi

Rajamani, R.
Ex-Secretary (E&F)
8-2-585/A/1 Road No 9
Banjara Hills, Hyderabad

Rao, Jagannadha
Arignar Anna Zool. Park
Vandalur, Madras

Raval, P. P.
Geer Foundation
Gandhi Nagar, Gujarat

Roychoudhury, A. K., Dr.
1/5a Prince Golam Md. Road
Calcutta 700 026

Rishi, Vinod
Addl. Director (WL)
Ministry of Env. & Forests

Sahu, R. K., Dr., Dy. Supdt.
Kamla Nehru Zool. Garden
Ahmedabad

Sahai, R.M.N.
Addl. Director (WL)
Min. of Env. & Forests
New Delhi

Salam, M. A., Dr.
Office Incharge
Jawahar Lal Nehru Biol. Park
Bokaro Steel City, Bokaro

Sahu, S., Dr.
Maitri Bagh Zoo
Bhilai Steel Plant, Bhilai

Shankar, Ravi
Secretary
Animal Welfare Board of India
Madras

Sharma, R. C.
Chief Wildlife Warden
Bhopal, M.P.

Sharma, S. C.
Member Secretary
Central Zoo Authority
New Delhi

Sharma, Rajshree
Edn. Officer
Assam State Zoo
Guwahati, Assam

Sharma, Shruti
Director
Kota Zoo, Kota, Rajasthan

Shastri, Kamala Shri.
Director
Beauty Without Cruelty
New Delhi

Sheshamani, Geeta
Vice President
Friendicos Seca
271 & 273 Under Defence Colony
Flyover Market, New Delhi

Shivaji, S., Dr.
Centre for Cellular & Molecular Biol.
Hyderabad

Singh, Brijendra
28 Sunder Nagar
New Delhi

Singh, Mohinder, Director
Prince of Wales Zool. Garden Trust
Lucknow, U.P.

Singh, Lalji, Dr.
Centre for Cellular & Molecular Biology
Hyderabad

Singh, Gurmeet
Chief WL Warden
Government of Punjab
Chandigarh

Singh, D. M., Director
National Zoological Park
New Delhi

Singh, Dinesh
Bhagwan Birsa Biological Park
Ranchi

Singh, R. K., Director
Bikaner Zoo
Bikaner

Somasundaram, S.,
Department of Zoology
Madras University

Talwar, G. P., Dr., Director
National Institute of Immunology
New Delhi

Tripathi, L. M.
Indira Gandhi Park Zoo & Deer Park. Rourkela Steel Plant,
Rourkela

Verma, R. N.
Maitri Bagh Zoo
Bhilai Steel Plant, Bhilai

Walker, Sally, Secretary,
Zoo Outreach Organisation
PB No 1683 Bharati Colony
Peelamedu, Coimbatore 641 004

WORKSHOP ON
"SCIENTIFIC MANAGMENT AS AN INSTRUMENT FOR CONSERVATION OF WILDLIFE"

INAUGURAL ADDRESSES

Lighting the lamp at the Inaugural function of the Workshop on Indira Gandhi's Vision on Wildlife Conservation"

Welcome Address

S. C. Dey, Addl. I.G., Wildlife
Ministry of Environment and Forests, Government of India

It is my privilege to welcome this gathering to the Inaugural Session of the Workshop "Indira Gandhi's Vision on Wildlife Conservation, organised to observe the Tenth year of martyrdom of the late Smt. Indira Gandhi, our former Prime Minister of India.

In the Workshop, we have especially chosen as the theme for this year: "The Zoo as One Such Instrument".

Smt. Indira Gandhi-ji's vision on conservation of biological resources is respected all over the world. More than 20 years ago in the Conference on Human Environment in Stockholm, Smt. Indira Gandhi was the only Head of the State who participated in Conferences and gave it a proper direction and thrust. The perception on which most of the countries of the world are deliberating today was visualized by her at that time. Twenty years later in 1992, at the Earth Summit at Rio, her vision of conservation of wildlife and of the wild resources for the betterment of mankind was realized perhaps by most of the Heads of State of all the major countries of the world.

As the Chairperson of the Indian Board for Wildlife, in the 15th meeting of the I.B.W.L., which was held on 1st October 1982, she initiated the idea of a National Wildlife Action Plan, which contained a Twelve-point programme to conserve the wildlife of our country. This Action Plan also laid emphasis on ex-situ breeding of rare and endangered species of wildlife and their reintroduction in suitable wild habitats.

A good environmental sense has been one of the fundamental features of India's ethics, culture and tradition. This tradition taught us to respect Nature as a necessity for human welfare, and it is this teaching which imbibed Indians in the ancient times to pay respect to all forms of life -- man, other animals and plant. This was reflected in the wisdom of sages and the sciences, that unless these components are all kept in a proper form, it will be difficult to have a better life for human beings, because these components are all interlinked and interdependent, and the deterioration of one leads to the deterioration of others, leading in turn to the erosion of land forms and other living assets which are ultimately responsible for the continuation and welfare of mankind itself.

While a great deal of progress has been made in India in respect of *in situ* conservation of wildlife particularly in setting up of the protected area network and their planned management, very little progress has been made in the field of ex situ conservation of wildlife. In the present era when the wildlife habitats are under severe pressure from the human growth and demands, the importance of *ex-situ* conservation programme is increasing day by day. During recent years the Ministry of Environment has organised a large number of workshops and seminars on *in situ* conservation of wildlife but unfortunately *ex situ* conservation has always remained a neglected area.

However, the Biodiversity Convention as per article 9 has identified ex-situ conservation as one of the instruments of conservation. I feel that at least with respect to some of the endangered species like Great Indian bustard, Siberian crane, Musk deer and Sangai, the number of which in the wild has come to such a low level that we will not be able to save these species unless the wild populations are augmented through planned breeding and rentroduction of such species in the wild. We have some experience in the case of Siberian crane where a few captive birds brought from USA and Rusia are at present free flying in Bharatpur.

I am grateful to the Prime Minister's Office for allowing us to hold this workshop on the occasion of the 10th year of the death anniversary of our late Smt Indira Gandhi and also to the Minister of Environment for choosing the special topic "Zoo a One Such Instrument". I am thankful to you, Sir, for reminding us that this is an item which perhaps we have not addressed with sufficient importance in the past.

We are thankful to you, Speaker, Sir, that you have spared your valuable time to inaugurate this workshop to set the ball rolling. I am sure the deliberations of the Workshop will focus the relevance of the subject that it deserves today. I, once again, welcome all distinguished participants and delegates to this Workshop. I am sure tht you will make the Workshop meaningful and encourage us in detailed deliberations in the Plenary as well as in Working Groups. Thank you all.

Opening Address

Sri Shivaraj Patil
Speaker

Sri Kamal Nathji and other dignitaries on the dias, Ladies and Gentlemen, I am indeed very happy to be with all of you here this morning. At the outset I would like to thank Sri Kamal Nath for asking me to inaugurate this symposium cum workshop which I am told is the first of its kind. I feel that organising a symposium on Wildlife Conservation as part of the observance of the 10th anniversary of Srimati Indiraji's Gandhi's martydom has a great signficiance of its own. Indiraji, as we all know, was a great lover of nature. She knew that a symbiotic relationship exists in nature among its various forms of life. She once said that we humans are dependent on the animals and on the vegetable kingdom for our survival. A threat to any species of plant and animal life is therefore a threat to man himself. She rightly observed that by protecting wildlife we not only express our concern for various forms of life but for man himself.

As Chairperson of the Indian Board of Wildlife, Smt. Indiraji had launched a National Wildlife Action Plan in which several conservation strategies were finalised. Smt. Indira Gandhi was always conscious of the need for maintaining sustainable use of natural resources for the country's development. It was to her credit that protection and improvement of the natural environment became one of the fundamental duties of the citizens of the Constitution of India. The Wildlife (Protection) Act also came into being during her time. The Project Tiger, the Rhino Reintroduction Project, the Crocodile Breeding project and a number of such other projects were introduced with her blessings for the conservation of declining species.

It was again her initiative in 1976 that made India a party to the International Convention on International Trade in Endangered Species (CITES) of wild fauna and flora. Indiraji was also equally concerned about the need for forest conservation in the country. As she herself once said, and I quote "The narrow outlook of the accountant must give way to the wider vision of the recreational, educational, and ecological value of totally undisturbed area of wilderness. Is it beyond our political will and administrative ingenuity to set aside about one or two percent of our forest in our pristine glory for this purpose. A country which cares for the future must take good care of its forest."

In our country we are endowed with rich varieties of plant and animal life. The different geographical regions in the country present us with their unique types of flora and faunal assemblage. This is something we have to take pride in, but it is equally a matter of deep concern when we see that much of this living natural resources have become either endangered or extinct or are becoming depleted. When we observe nature we see that certain forms of life have become extinct in course of evolution. This process however, is very slow, often involving millions of years. What is of real concern is the human factor which has accelerated the process of depletion or extinction beyond all proportion. The human

pursuit of food, fuel, fodder and -- above all -- material development has already destabilized the balance in nature. It is indeed a matter of satisfaction when we see that in the recent past the global community has become particularly concerned about the need of promotion and preservation of natural environment.

In our country also the government has initiated steps in that direction in a much more vigorous manner. The Indian Board for Wildlife has been monitoring strategies for conservation of wildlife in India. Various national parks, sanctuaries and zoological gardens are functioning well all over the country. There have, of course, been satisfactoy results as a consequence of various governmental measures. Yet the fact remains that much more needs to be accomplished. As one knows how sound and well-rounded and well-founded a policy of the government may be, nothing can succeed, unless the actual cooperation of the people is aroused towards the cause of wildlife protection. And at the turn of the 20th century people -- perhaps with the idea that wildlife was inexhaustable -- took pride in boasting about the number of trophies they had secured through hunting. Even in the present days one would not be surprised to have in some sections a similar opinion when it is felt that spending on conservation is an unnecessary exercise when the country is struggling for economic self-reliance. People's outlook, attitude therefore needs to be changed; otherwise no enduring result in the direction of wildlife conservation can come about.

While speaking of wildlife conservation, the wildlife community finds that scientific management of zoos can indeed be a very effective means of implementation of wildlife conservation. In India we have more than 350 zoos, yet many of them are small centres of recreation, rather than contributing towards conservation of wildlife. With the decline of various species of wildlife, the role of zoos in the present context takes on more importance as centres of conservation. They need also to perform an educative role in the rural people to make them aware of the role and importance of animals in the life cycle of nature. All the zoos in our country have made significant contributions in conservation and rehabilitation of wildlife, but much more thrust is required for them to be conservation-oriented. While we have some well-designed and efficiently run institutions, we have to provide congenial conditions to the multifarious functions they are expected to perform. With the establishment of the Central Zoo Authority in the country, a major step has been taken in the direction of evolving measures towards far more effective management.

So we have a thesis, . . . we have an anthesis, . . . and we shall have a synthisis. I am sure your deliberations will throw up new ideas and these ideas could be adopted by the government and, if passed, they would be acted upon and implemented also.

It is very difficult for a layperson like me to speak to a group of scientists and experts in the field. What I have said is very preliminary but what you will say will be very important, scientific and pragmatic also. If it is pragmatic I have no doubt Mr. Kamal Nath and his Ministry will accept your suggestions and act on them. It is not necessary for me to say anything more than this. With these words I declare your seminar cum workshop open. I wish your deliberations all success.

Inaugural Address

Sri Kamal Nath,
Hon. Minister for Environment and Forests

Hon. and respected Speaker Shivraj Patil, Members of the Central Zoo Authority, Members of the Zoo community, ladies and gentlemen:

We are gathered here today to honour the memory of one of India's greatest daughters. Ten years ago, with the mingling of her blood with it's soil, Indira Gandhi became one with the country she loved so deeply. A decade has passed since her tragic martyrdom, but Indiraji's vision to guide and inspire us in much of our work is still very much with us.

Indiraji's achievements, even the major ones are too numerous to be listed. In her sixteen years as Prime Minister, she touched upon every aspect of national life and left her imprint upon whatever she touched. She engineered the abolition of privy purses, back nationalisation, the xxxxxxx Hatao campaign, her stupendous victory in the war to liberate Bangladesh, and then her magnanimity in the Shimla agreement. The nuclear explosion at Pokharnan, self-sufficiency in food grains and the IRDP and NREP programmes are among the achievements that come to mind readily. Along with these I would also categorise her abiding love for nature which she translated into concrete action in terms of forest legislation and wildlife conservation programmes.

Twenty-two years ago, when the Stockholm Conference on Environment was organised, Indira-ji demonstrated the courage and conviction of a true statesman by attending it, although she was the only Head of Government to be doing so. Her charismatic presence put the spotlight on environment internationally, and nationally it was also brought to centre stage. Twenty years after these events we had the Earth Summit at Rio, which was attended by not one or two or twenty or thirty Heads of Government and State, but one hundred and forty Heads of State. I had the good fortune of leading the Indian delegation to the non-Summit portion of the Earth Summit at Rio. There were only a few people there, who were at that conference in Stockholm which Mrs. Gandhi had attended twenty years earlier. Some of them spoke of her and the tremendous role she played in Stockholm. That conference which was held when environment was not a buzz word like it is today. Indiraji's presence there added stature to it and from then onwards, the perception of environment took on a new importance.

I remember Mr. Morris Strong at the Earth Summit in Rio, who had been at Stockholm as Secretary-General in 1972, spoke of her. He said that there would have been no Earth Summit in Rio, perhaps, if Mrs. Gandhi had not been there in 1972 in Stockholm. It was she along with the leaders of the delegation of the other countries who finalised the basic document which led to the Rio Summit.

It was under Mrs. Indira Gandhi's leadership that the Wildlife (Protection) Act was enacted. In 1977, the subject of forest was brought on the concurrent list of the

Constitution, thus paving the way for the Forest Conservation Act in 1980, an act made possible by the vision and determination of Indira Gandhi. I recalled very vividly the debates we had over this and whether this would achieve the desired results. Mrs. Gandhi once remarked to me that she hated going to the hills now because almost all the hills were nearly denuded. The contrast between these naked hills and the lush forests of her earlier visits. I think it was her foresight that today, when we talk of a treaty on forest, when we talk on commissions on forest, when we talk on concepts such as sustainable development, if we are only to see what was discussed in her meetings much what she has said in the 70's is being taken up by the world at large today. Even the world community had not fully realised the implications of carbon sinks or biodiversity to the extent of the farsighted vision of Indira Gandhi. The Forest Conservation Act of 1980 is quite stringent and till today has not been replicated anywhere in the world. It has succeeded in stalling the massive downslide in forest cover in India.

In 1980, also Indiraji herself assumed the Chairmanship of the Indian Board for Wildlife, giving it the requisite stature and clout In 1973, she had already launched the Project Tiger preserving this majestic animal not merely for its majesty but rather as an embodiment of its entire habitat.

We talk of the ecosystem and we talk of the habitat and the most complete ecosystem in that habitat. At a time when lumbering was still legal, Indiraji had said and I quote: "Forestry practices designed to squeeze the last rupee of our jungles must be radically reoriented " Please mark the words "reoriented", thus giving an indication about her future policy. Challenging the prevalent wisdom of politicians and the bureaucracy alike she asked "Is it beyond our political will and administrative ingenuity to set aside a portion of our forest in its pristine glory for the purpose of wildlife conservation?" It shows how clear Indiraji was in her mind, that conservation and wildlife required effective legislation, and as such she did not hesitate to have these laws enacted and implemented even when it was not considered a "populace measure.

At the same time, she was not a blinkered fanatic or environmentalist who saw things only in isolation. Immersed as she was in the rich cultural heritage of India, she saw things in perspective. I would like to quote her again when she said that "Indian tradition teaches us that all forms of life, human, animal and plant are so closely interlinked that disturbance of one leads to disturbance and imbalance in the other. At the same time, in our anxiety to conserve the environment, let us not contribute to the denigration of human beings. People can be expected to live in peace with nature and themselves only if they are assured of food, water, shelter and work. Let not the burden or cost of conservation fall on the poorest." This is what she said then.

I think when we read this statement, it appears it is a statement which emerged from Rio, but that is not so. Indiraji said this fifteen years before Rio was even thought of. So all these statements form part, not only of a national perspective, but also how the world looks into environment and development. That is how to word "sustainable development" has emerged.

Indiraji's concept of wildlife conservation included scientific zoo management with its *ex situ* emphasis parallel to the *in situ* emphasis for the wild. The National Wildlife Action Plan passed by her in 1982 specifically placed upon zoo the duty to take up the planned captive breeding of endangered species in such a manner that these animals could be returned to suitable wild habitats from time to time. Project Tiger was one of the more glamourous of the conservation schemes. Equally successful was the one to save the three crocodile species and to rehabilitate them, to the extent of an embarassement of riches when they were on the brink of extinction.

Zoos have a dual purpose, the first being to spread knowledge and awareness of wildlife, and through the means of visual entertainment to create empathy in human beings for animals. The second is the captive breeding aspect. Both these topics are of equal imporntnce and it is this which gives the distinctive characteristic to scientific zoo management. I have no hesitation in saying that, unfortunately, the vast majority of our zoos fulfill neither purposes. A few manage to achieve the first, that is of visual entertainment, however a great deal more needs to be done on the question of scientific captive breeding. I am convinced that if a zoo concentrates on developing its scientific base, even the visual entertainment aspect would become upgraded automatically.

One cannot forget that the natural habitat of the animals is the jungle. The zoo, however, beautiful, is still a prison. We have therefore to establish more and more advanced and novel concepts of zoos. Safari parks are one such concept which could be the halfway mark between the traditional zoo and wildlife sanctuary. Unfortunately in our country the concept of safari parks has become perverted out of recognition. I prefer to believe that this is only because of the astonishing ignorance of some people rather than deliberate negligence. I am a strong votary of the new type of zoo of which a safari park could form an integral part, but this will require adequate thought and planning. We have selected some guidelines for how a genuine safari park could be established and circulated these as a basis for discussion. I would suggest at first we attempt such a project for a large number of herbivorous species rather than opt for carnivorous species right in the beginning. If a safari park would include the physical barriers seperating them from the wild, it would also be possible also to introduce certain exotic herbivores to make the park more interesting and educative

The setting up of the Central Zoo Authority two years ago was a milestone in zoo management in India. The Central Zoo Authority is not intended to take over the zoos or to do "back-seat driving" as it were. It is intended to establish the minimum technical standards that zoos must maintain if they are to function, e.g., to coordinate the activities of zoos among themselves as well as the foreign zoos, to help them with technical guidance they need to upgrade and improve, and also to be a channel of financial sustainence to the extent possible.

I do not claim that ther Central Zoo Authority is doing everything it ought to be doing, but a start has been made and we certainly are trying. It will take some time -- as it happens with any new structure which is formed -- before it develops into what it is intended to do.

I am very happy that the Central Zoo Authority has now set the tone and has gone about the setting up a pattern which in future will insure that the Central Zoo Authority will play a very crucial role.

We all know of the sorry state of the zoos in our country -- with institutions t which go in the name of zoos and in the garb of zoos and that is not all of it. So the Central Zoo Authorty which has been started, is now performing very well. It has gone through its initial teething problems. It is now involved in setting up various structures, but I am confident with the kind of dedication and involvement that is the vision of what CZA has to do, we are on the right track. I also must say that, after all, you are the people who will implement the policy guidelines developed by the CZA. The zoo directors who are here, they are on the field and finally it rests and vests upon you to really convert the zoos from what they are, into what they should be. Without your understading and genuine acceptance of it, CZA would remain a dead letter.

Indiraji was concerned about the integration of technical and advanced practices of resource managment to achieve objectives. When our Prime Minister asked me to organise a special function to mark the death anniversary of Indiraji's martyrdom, I thought a CZA function of this sort would be ideal. Not only because of the wildlife conservation elements but also because it exemplifies Indiraji's vision of infusion of technology and resource management practices into the business of government. The workshop is the first major conference of the CZA. it brings together the zoo directors, research institutions, ngo's experts from various fields and Chief Wildlife Wardens who are the real decision-makers to deliberate on relevant issues. I trust that these deliberations spread over three days and including practical demonstrations will be marked by definite knowledge finalising practical strategies which will be adopted in an achievable time frame.

I would not only like to thank the speaker, Hon. Mr. Shivraj Patilji, but I would like to emphasize his inspiration in this. Shivraj Patilji is dedicated to conservation and brings a lot to a conference. He has been a source of encouragement and inspiration not only as a speaker of the Lok Sabha as the Chairman when I made my maiden speech. Shivraj Patilji who is present here as an inspiration and encouragement to all of you who come from all parts of the country. This reflects I think his personal dedication and commitment to this important task before us. Thank you all.

Vote of Thanks

Sri S.C. Sharma

Member Secretary, Central Zoo Authority

Hon. Speaker, Sri Kamal Nath, senior officials, friends of zoo community, scientific community, all over the world the animal lovers and the zoo managers are at war. First I thought that only our zoos are in bad condition but all over the world the zoos and animal lovers are at odds. With perception and vision, Mr. Kamal Nath when he formed the Central Zoo Authority, gave adequate representation to the animal lovers. It also goes to credit of Mr. Rajamani for assigning a new role -- of animal welfare -- to the zoos also.

So the process of synthesis has already been started by our Honorable Minister, and by the Secretary Sri Rajamani. Sir, we owe it to you that during your tenure this amendment which brought the Central Zoo Authority was created.

When the Central Zoo Authority was being created, most of the Parliamentarians were very much worried, and they said that this is also going to be one of the routine organizations in the country. Then our Minister of Environment and Forest had assured the House, that he will not allow this Central Zoo Authority to become a routine organization. And this is why he himself -- in spite of his busy schedule -- chose to be the Chairman of the Central Zoo Authority. He has been the guiding force for the CZA. He has been giving proper direction and thrust. I find myself short of words to express my thanks and gratitude to the Minister. Not only me, all the members of the Central Zoo Authority are with me in expressing our gratitude for the guidance that he has given. Sri Ranjamaniji, Sri Mukherjee-saab, Sri Dey-saab -- they have been the main guiding force. I am particularly grateful to Mr. Dey that he hs been taking interest in day to day affairs of the CZA.

The zoo community is a very dedicated community, but they are silent workers. Their problem is they are short of resources; there is less of exposure; they are not allowed to have a look at things. Therefore their vision is not so broad as it should be. I can tell you, Sir, there are some Directors in this country who do not have the powers to issue cheques. Somebody else in their administrative system issues the cheques. There are some zoo directors who have the power to issue a cheque for only Rs. 5000 or less. So with that kind of administrative set up, it is very difficult for the zoo directors to implement ideas.

People at large and our political masters don't realise that keeping of live animals is a very specialised job. How much of advances have taken place in medical sciences, but we are not much aware of the animal welfare. So everywhere -- in every nook and corner of this country -- you want to have a zoo, whether there are resources or not.

Generally it happens that in some initial enthusiasm an officer establishes a zoo. He goes and the system fails. Now there are few states that do not have money to feed their animals. They want to close the zoos and deer parks and now we are in a fix. Now, what should we do about these animals because they are not fit to be released in the wild, and

we don't have money to feed them in captivity. This is a very difficult situation.

For my friends in the zoo community I have a word to say. Gone are the days when we could afford to be secretive and competitive. Today the cooperation is going to be our main tool. If you don't take help from the scientific community, you don't plan things scientifically, then we may say on paper that we are conserving wildlife, nobody is going to believe it. We want to see in practice that we have rehabilitated one species. This will give us a credibility. So let the zoo directors decide if we can just conserve and reintroduce five species -- that will be a very good thing for the zoo directors because then the whole country will start believing that we can do conservation.

I know we have two masters. On one hand there are the dumb denizens, the animals, and on the other hand the masters are the visitors. They always ask us that bring some new and exotic animal, a skyline ropeway, this, that... Now it needs a strong commitment on the part of the zoo director to resist those forces and insure that interests of the animals are kept intact. We all should resist an ill-planned zoo that is being developed in any part of the country.

Through you Sir, Mr. Speaker and the Environment Minister, for the Forests we would like this message to go to our political bosses that they should not insist on creating deer parks or zoos in every nook and corner of the country unless sustainable amount of money is guaranteed for those animals.

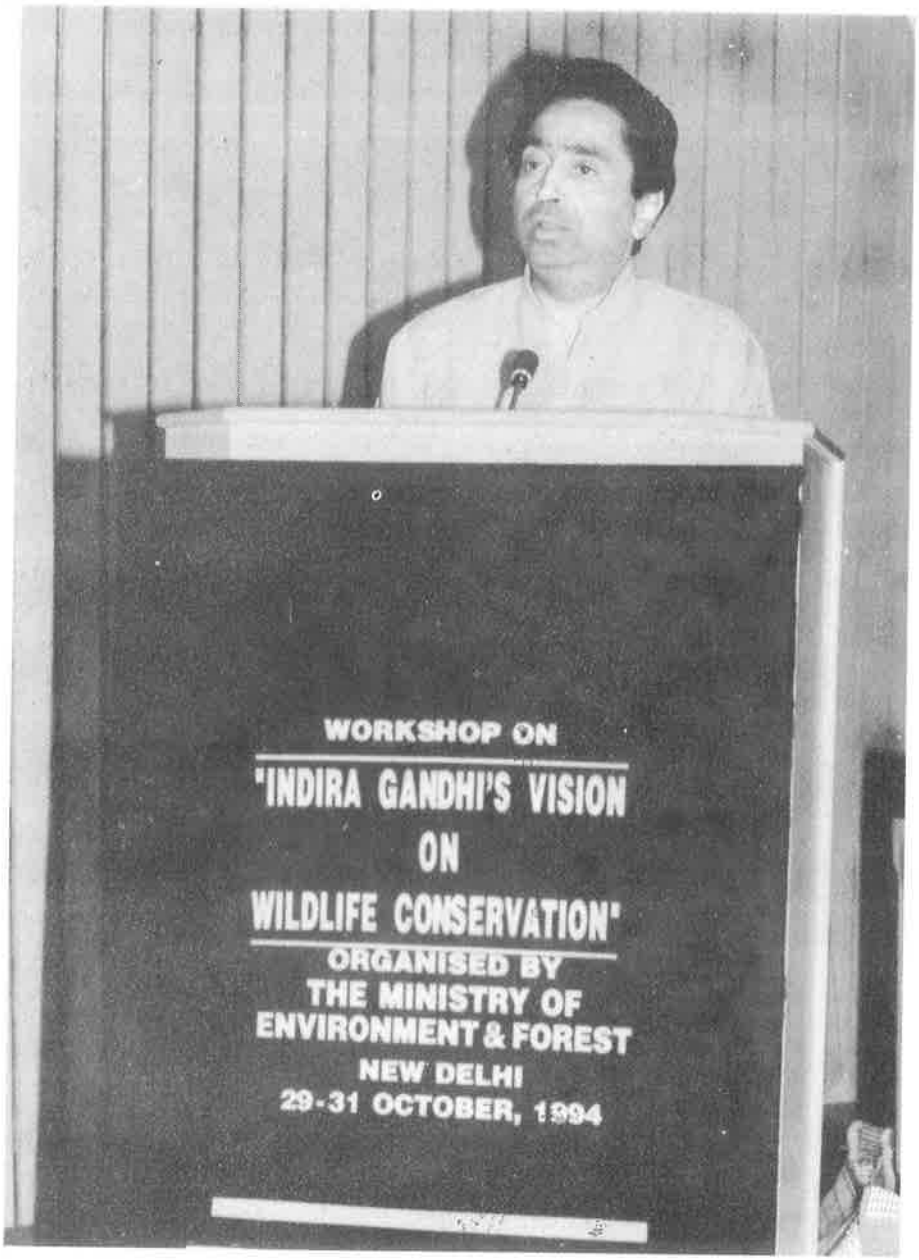
With that, I would like to thank you all who have given time. I will be failing in my duties if I don't make a special mention of the hard work of the members of the C.Z.A. have been doing in evaluation and assessment of the zoos. Now we know which direction to go; only we need blessings of Hon. Minister of Environment and Forests and the Government of India.

With that I again express my thanks to the Minister of Environment and Forests, Shivraj Patil-ji, and all of you for having graced this occasion and given us encouragement to think in a plain manner on the development of the zoos. Thank you very much.

WORKSHOP ON
"SCIENTIFIC MANAGEMENT AS AN INSTRUMENT FOR CONSERVATION OF WILDLIFE"

SCIENTIFIC SESSION - I

Planning and Development of Zoos for Conservation of Endangered Species of Wild Animals



Hon. Minister for Environment and Forests,
Sri Kamal Nathji, is Chairman of the Central Zoo Authority

FIRST PLENARY SESSION : MANAGEMENT OF ZOOS

Remarks of Chairman, N. D. Bachketi

Thank you for asking me to chair this session. This is a unique occasion and a very important occasion for the zoo people and scientists involved in zoo upkeep. This morning we had a lot of information given to us regarding the stage at which we are in the development and improvement of zoos.

Such an assembly like this where all the zoo directors and scientists have come, and we would be talking about various problems that face us was not held earlier.

I am sure that the result of our discussions will be useful to the zoo managers and to the policy makers, because we zoo people have suffered quite a lot on account of non-understanding by people. Everybody coming to the zoo goes around and it is rarely that they have good remarks. They only say, "Oh, the lions were there but they did not have enough food." Or, "the space was not enough", or whatever other bad points they see or they can think of. Such comments are disheartening to the zoo managers. It is only recently that people have started talking about the problems of zoos, and people are also appreciating the difficulties we have.

Mostly the difficult part comes in the form of less resources for individual zoos. In some zoos probably we don't have enough funds for feeding animals. This is not for every zoo, but many zoos, which get less attention or sympathy from superior officers do suffer from such things. We hope that in the near future, this sort of problem will cease to exist. The Wildlife Act also had made provision for zoos but more directly in the amendments act of two years ago, the Central Zoo Authority has come into existence.

One of the things which necessitated the formation of the Zoo Authority was proliferation of a number of zoos in the country. Any person, every officer, or maybe foresters, the irrigation department people or any people who are dealing with some land, or research stations even, decided to keep a few animals and call it a zoo. They may have charged entrance fee, or probably not, so with the result that they did not have resources and the interest declined in a few years. The people who started these zoos were interested and the animals were fairly well looked-after, at least well-fed in that time, but after the person got transferred, the animals did not have even proper food. So this sort of thing went on and therefore it was considered necessary that there should be a Zoo Policy of the Government of India.

The Zoo Policy probably was not declared as such but it was under consideration and that actually led to the idea that we should have a Central Zoo Authority with necessary powers, distribution of advice, and technical knowledge and coordination. So that has come into

existence and for some years it is working. People are approaching the Zoo Authority for necessary help which I hope will be acted upon.

The subject for today's workshop is Indiraji's vision on Conservation with particular reference to zoos. In the Inaugural function many people related the dramatic achievements of Mrs. Indira Gandhi in environment and wildlife conservation. I will just tell one incident to show to what extent she was concerned and very careful about wild animals.
Once when she came there was a full grown tiger with whom our Curator was very friendly. That tigress had the name of Rosy and she used to climb the Curator from the side so that her mouth was almost at the same height as his. She used to come and put her two front legs on his shoulders. That was a nice thing to see and the other people who were in the zoo area also appreciated it very much. We happened to mention that the name of the tigress was "Rosy" and then when we said that, Indiraji quietly said "Roses have thorns also." A great deal was communicated in that small statement -- she wanted that the keepers and others should not try to be so friendly. That was a warning to us that it should not be done, so we took an example from that.

So this way in a very mild way, she used to love the animals and instruct us in a very subtle but effective manner. I would like now to call on our speakers to instruct us in their own effective manner.

THE CHANGING ROLE OF ZOOS - A HISTORICAL PERSPECTIVE

N. D. Bachkheti and Dr. J. H. Desai

Though there is evidence of animals kept by the Egyptian rulers as long back as 2500 BC, the first animal collection maintained as a zoo dates back to about 2000 BC in China as the "Garden of Intelligence" established by Emperor Wen Wang. In the fourteenth century, rulers kept a variety of wild animals. Animal collections were kept by great rulers in the renaissance period.

The oldest existing zoo, Schonbrun, Austria, was built in 1759. The principal royalties established zoos for royal entertainment and as symbols of status and power. An all important event was the establishment of London Zoological Society in 1826. Barless, moated enclosures were initiated in 1907 by Carl Hagenbeck. The concept was rapidly adopted in the later zoos. Few decades later, the objectives of zoo management also included captive breeding of the rare and endangered species and conservation, education and research.

In India the first zoo to be set up was the private collection of a variety of birds at the Marble Palace Zoo Calcutta in 1854. The Madras zoo was set up in 1855. Several other zoos were established by enthusiasts, mainly the rulers. The zoo movement got an impetus after independence when the Central and the State Governments took up the establishment of several large zoos. Even some public and private sector undertakings established zoos, though smaller.

Realising the importance of zoos the Government of India set up a Zoo Expert Committee in 1973 which laid clearly the objectives and means to achieve these. A Central Zoo Authority of India was established in 1992.

Captive breeding of endangered species has become an important function of the zoos. Artificial insemination and embryo transfer have been successfully adopted in the respect and are bound to play an important role in future.

UTILISATION OF RESOURCES BY ZOOS

Pushp Kumar, I.F.S., Retd.
Hyderabad

INTRODUCTION:

The cause of conservation of our natural resources received a tremendous boost with the publication of the World Conservation Strategy by the I.U.C.N. in 1980. It was launched in India by the then Prime Minister Smt. Indira Gandhi on 6th March 1980, who began her speech with these words:

"The interest in conservation is not a sentimental one but the rediscovery of a truth well known to our ancient sages. The Indian tradition teaches us that all forms of life in humans animals and plants are so clearly interlinked that disturbance in one gives rise to imbalance in the others".

This concern for all forms of life and their conservation is crystallised in the strategy which lays down three main aims of achieving living resource conservation *viz.*,

a) Maintenance of essential ecological processes and life support systems
b) Preservation of genetic diversity and
c) ensuring sustainable utilisation of species and eco-systems.

The strategy recognised the role of zoos, though to a limited extent in the preservation of genetic resources. The strategy further mentions the role of zoos in creating awareness among various classes in the conservation of endangered species etc. Thus zoos which were hitherto considered by the public as well as the authorities to be mere places of recreation and entertainment were assigned a higher role.

The strategy's aims were further carried forward and elaborated in the sequel "Caring for the earth".

Another event of importance has been the publication and adoption of the Zoo Conservation strategy in 1992 which squarely lays down the main aim of zoos to be conservation of natural resources. This is of particular significance to the zoos of the world and lays down the means of achieving this goal of conservation. As a result zoos in the world are orienting themselves to this role spelt out for them. The New York Zoo has changed its policy as well as its name as 'New York Wild Animals Conservation Centre. The London Zoo (the oldest organised Zoo) has even styled itself with the time "Conservation in Action".

This new found concern of the western zoos was not new to the zoo world in India. As far back as 1973, i.e. about 20 years prior to the publication of the Zoo Conservation Strategy, the Experts Committee set up by the Government of India, to study the management of Zoos in India and to make recommendation for their improvements had drawn attention to the depletion of wildlife and other living resources and laid down the role of zoos in India. The main aims were Conservation, Education and Research and it made a number of

recommendations among which was setting up a central agency for zoos. However, unfortunately no effective action was taken by zoos to implement and improve their establishments. In fact most of the zoos even lost sight of the role of zoos that was defined in the report and even the report itself! This has lead to a decline in the quality of development and obscuring of the aims and objectives of zoos. However, a new zoo that is proposed to be set up has changed its name from a Zoological Park to a Biosphere Reserve Conservation Centre in the hope of infusing a new dimension in the same old Zoo concept!

Aims and Objectives of Zoos :- As stated earlier the role of zoos was already defined two decades back i.e., in 1973 itself. The accent then was on Conservation, Education and Research with concession at the time to other aspects and notions then prevailing. It also reflects the relative status of wildlife then. The Wildlife Protection Act passed in 1972 did not recognise zoos as instructions for conservation and hardly any significant mention is made of the same in the Act. Zoos were considered by the wildlife purists as institutions at best to be tolerated if not shut down. They were thought to have no relevance to the conservation movement. The position up till now has been the same though there has been some easing in this attitude of late with the setting up of the Central Zoo Authority.

With the amendment of the Wildlife Protection Act, 1991 a fresh dimension has appeared. The act vide section 318 H clearly lays down that the primary objective of zoos in this country should be conservation. Thus zoos have a firm direction and objective to follow. This is aptly so as it reflects the state of the natural environment today. There has been a decline in our natural resources be they the forests or wild animal life in general. In such a scenario zoos have to have conservation as their objectives, as against looking on them as facilities to provide entertainment to the people. It has to be remembered that there are other and more effective methods to provide entertainment. It is also not the business of zoos to keep animals for the mere entertainment of people. There is also a needless conflict in the minds of those who feel education is of primary importance. It is important but one has to consider whether it is for its own sake or for a degree or if not, education for what? The answer is evident education in zoos has to be for conservation. similarly the aim of all resources use is the well being of the wild animals, which once again would mean for conservation of wild animals. Thus it is of utmost importance at this time to be very clear about our objectives and aims. It is also of paramount importance to remember that zoos are unique institutions which are visited by people mainly for the live animals kept therein. Thus the main aim and objective of zoos is conservation, which could be through a) Breeding of endangered species for (i) Survival (ii) Eventual re-introduction into former habitats.
b) Conservation Education (c) Research for the better management of *ex situ* population as well as contribution to the better management of *in situ* population.

Resources available to Zoos :- With foregoing account of the aims and objects one may take stock of the various resources available to zoos, for subserving the cause of conservation. The main resources can be summarised as follows :

1) Wild animals **2) Human** **3) Financial**

1) Wild animals :- It is perhaps a truism to state that there can be no zoos without animals (though one has heard arguments to the contrary.) The definition in the Wildlife Act is also very specific in defining zoos as "institutions where wild animals are kept for public exhibition". It cannot be over emphasised that wild animals are the core of zoos. They make zoos unique unlike eg. museums, botanical gardens, hospitals, jails, etc. Because of these, zoos have management problems which are peculiar to themselves. Because of the wild animals large number of people visit them. It is therefore essential that at all times a sizeable population of animals is to be maintained. Two decades back wild animals were freely availlable from the forests around us. In fact instructions were issued to forest authorities to capture in one case, tiger cubs for the local zoo even if they had to shoot the mother in the process! There was flourishing trade in captured animals for supply to zoos and one could get animals one wanted. Today with the excessive deforestation and lack of habitat, the wild animals in general have registered a decline. It is no longer possible to obtain freely captured animals from dealers. If at all, some are available, they might be clandestinely obtained. Number of instances have been noticed where the source of the animals is not clearly mentioned in acquisition registers of some zoos ! The lesson one learns is that if zoos are to maintain their collections, they should no longer look to the wild to "replenish" their stocks. In the conservation scenario now prevalent it would be immoral to take any animal from the wild. There may be some exceptional cases where to meet specific requirements a zoo may want to have a particular animal especially when none were available from *ex situ* stocks. The only source available to the zoos would be stock bred in their own or other zoos obtained through controlled breeding i.e., breeding animals when there is a need, observing all technical parameters. An example of such a case is that of cheetah in foreign zoos where it is stated that they can breed them when required for supply to other zoos (In India) and not till then! Breeding programmes have been drawn up by the Central Zoo Authority and one hopes that in time zoos will be able to have viable optional populations of endangered species. Till then zoos will have to look after their stock well through better housing and upkeep so that their animal populations are not depleted. Another method (perhaps more desirable) could be for zoos to reduce the number of species kept with them, specialising only in some of them, especially endangered species. In this way more species and natural exhibit could be maintained instead of large number of species housed in rows of dingy cages. This will be far more important from the conservation point of view and much more appealing to the public. This will also gain their sympathy for the wild animal and further their cause.

2) Human Resources :- Zoos throughout the world are visited annually by over 600 million people. In India it is estimated that over 30 million people visit zoos. This gives zoos the opportunity to put across in a suitable way not only biological and ecological facts about animals but also the conservation message. Use of this resource is by and large negligible. Debate does go on the semantics of zoo education, yet hardly any significant effort is made to stimulate interest in the viewers mind towards the plight of the animal and the causes which are responsible for the same. As a result vast majority of the people simply "go through the zoo", looking at the strange forms and their antic. No doubt the problems of putting across the message are many. In what language should this be done? Often boards are done up in english where the vast majority (except the elite and the foreigners) do not

understand the language. Many messages are on grandiose hoardings which do not evince much interest except the zoo personnel. Another aspect is as to how much matter and material be passed on? What proportion of this is absorbed or retained by the viewer? Should we use gimmicks like T.Vs, computers, tape recorders, raised signboards, flapboards, etc.? Should we have cultural or ethnic exhibits like tribal villages (e.g. Bomas of Africa) or Fossil exhibits or human skeletons etc., to create an atmosphere? Should we have class rooms putting into enclosures to enable the learners to see animals first outside a glass window? In this cultural deluge is there not the danger of the main subject i.e., the animal and its cause being drowned? What message can be conveyed to the common viewer? If a simple and proper message is focused on the wild animal and the need for its conservation could be conveyed, this resource could be of great potential in serving the cause of conservation. For this it is necessary to remember that zoo education *per se* is not an end but a means.

3) Financial Resources :- Zoos are usually, short of funds both for recurring (maintenance) as well as for non-recurring works. Since 80% of the zoos in India are Government owned, they follow a budgetory system where funds are allocated annually and lapse the same year! However for staff salaries funds are assured for the regular employees. Elaborate or costly structures to house animals under controlled climate are not required. They are required if exotic tropical plants and animals are to be housed in temperate climates and conditions. In India with a tropical climate one has to choose what is best required and suited in as natural and as habitat stimulating enclosures as possible, at much less cost of setting up and maintenance, utilising the less costly, biological park concept. But definitely not in cages which are symbols of a bygone era, however well planted and done up they may be. The use of glass in enclosures has its advantages and dis-advantages in India, though it is extensively used in Western Zoos often with telling effect. Since at present it is very costly and required sites are unavailable, it has to be thought off after due consideration as it often introduces artificialness. It would perhaps be enough if we would house animals in large open enclosures with available vegetation, rocks, water, etc., as would be found in nature. The focus would then be on the animal and not on the enclosure itself. This would also be less costly to set up and to maintain.

The upkeep of animals includes the cleaning up, sanitation and the nutrition of the animals housed. This is of great importance for maintaining the stock position as well as the health of the animals themselves. If both housing and upkeep are well-taken care-of it is possible to avoid costly veterinary care and costlier hospitals and equipments. Mention may be made here of the veterinary hospital recently set up in Brookfield Zoo at a cost of 40 million dollars! Though it is very important to have adequate veterinary facilities, it is very difficult to decide how much and how far. The incidence of disease the climate (it snows for 4 months in Brookfield) etc., should be guiding factors. An important aspect is the housing of animals in large natural enclosures, as in the biological park concept in this country which could reduce disease and pathogen build up and consequently mortality. In some zoos it is 40%!

The highest allocation of recurring expenditure to a zoo in India is Rs. 180.00 lakhs per annum of which nearly Rs. 100.00 lakhs are required for staff salaries. Compared with some modest western zoos (eg. Atlanta Zoo spends 9 million dollars per annum) this does not appear to be

very high! Even for non-recurring works the allocations are meagre. Often the earning by the zoo are not available to the zoo for any work. In any case these are also not high.

In the above circumstances it is neccessary for the zoo to use the available finances judiciously and purposefully. The first priority should be the animals housed. Specifically these should be as laid down in the Act ensuring proper housing and upkeep of the animals housed. Housing or enclosures have to meet the biological requirements of the animals housed. They should be as open and as large as possible and present the animal housed as well as the visiting people as natural a habitat as possible. In western zoos naturalness has gone to such an extent that plants and even rocks of the habitat are simulated in large halls where the temperature and the humidity, etc., are controlled to as near a level as is found in the animals habitat, to permit the vegetation to grow, and the animal to have comfortable conditions. Examples of such western extravaganzas are to be found in the Tropical World of Chicago Zoo, Jungle World of New York Zoo, etc. This sort of exhibits which cost 7 to 9 million dollars are highly acclaimed and popular. But to the discering eye they often appear garrish and highly artificially contrived. Their maintenance itself is highly energy consuming and costly. Since financial resources are limited it is essential for zoos to prioritise and consider what exactly they should do with the available ones to further the aim of conservation. A few instances illustrate this dilemma, (which often occurs due to political considerations).

a) A zoo requires funds to put up a compound wall round its periphery as there is intrusion of stray dogs and people. It has no funds to improve the water supply and drainage of enclosures.

It sets up an aerial rope way costing nearly Rs. 1.00 Crore.

b) A zoo has no funds for setting up a chainlink fence to keep out people and pests like dogs etc., It has no funds to improve the veterinary hospital or the animal houses and enclosures of animals. It sets up an aquarium costing nearly Rs. 50.00 lakhs.

c) A zoo maintains 58 lions obtaining meat for them from 200 Kms. away, spending nearly Rs. 40.00 lakhs per annum. Another has 28 tigers for which 6 moated enclosures are constructed. Another zoo has cages and cages, but has 1500 budgrigars !

d) An aquarium is proposed amidst a shisham forest in a zoo which does not have facilities for keeping reptiles.

e) Zoos construct guest houses for the public when the animals facilities require upgrading.

f) Zoos set up children's park with swings, slides, etc., when proper enclosures are yet to be set up. It has to be remembered that in none of the above instances in any way enhance either the aim or cause of conservation. On the other hand they divert scarce funds to unrelated activity, take up valuable space, place a strain on the already thin staff and maintenance facilities, and finally send a wrong kind of message regarding the purpose of zoos.

Planned approach for Zoos : Most zoos that have come up in the past were adjuncts of gardens and had the objective of providing entertainment to the visiting public. Thus we still have these relict zoos even now with rows on rows of cages. Little or no attempt is made at modernisation in a planned manner. Many zoos have large populations of some species and are complacent that they are breeding animals and get publicity accordingly. Usually these animals are Lions, tigers, panthers, cheetal, nilgai, sambar, black buck etc. Zoos to serve the conservation requirements would have to change in a planned way. Some of the points that required to be considered are :

1) Master Planning : - Some zoos have layout plans and guide maps. There is no theme nor are objects well defined. Since the primary objectives of zoos is conservation, the planning must take this into account. Conservation exhibits highlighting the areas and species under threat can be chosen eg: Nilgiris, Sahyadris, Aravallis, Himalayan eco-system, Coastal eco-system wetlands, etc., and presented. In general plans should provide for fewer species and large nature simulating and open enclosures. The enclosures should be suitable for the species housed. They should be for optimum population of animals, so that enclosure values like plants are maintained, otherwise there is likelihood of parle ground not only being exposed but also leading to erosion problems. Large and natural enclosures permit vegetation to grow if the number of animals is kept small. They are also environmentally rich and biologically satisfying for the needs of the animals. All these would depend on the master planning. The master plan also helps in developing a zoo in future, according to a policy independent of the vagaries of politics and whims of the bosses.

2) Management Plan : - None of the zoos at present have a cogent management plan. No proper records are kept. As a result there is change in management practices with the change in management. A management plan by nature would lay down not only the maintenance, sanitation, and hygiene procedures for the zoo among others, but would also provide a policy for breeding animals and their upkeep. The present day over breeding of some species which is at best a result of captive breeding as against controlled or planned breeding, which should be brought under check and scarce funds and space diverted for the really deserving ones. Animals now being kept for popular appeal like rabbits, guinea pigs, etc., could give way to those having a conservation value.

CONCLUSION : It is evident from the foregoing that zoos in India require a major re-orientation in outlook, presentation and implementation. This has to be by law as per the Wildlife Protection Act. Since animal stocks can no longer be replenished from the wild (nor is it ethical to do so), it is necessary that zoos address themselves to better upkeep of the animal populations in their possession and look upon them as a part of the national if not global effort to conserve the diminishing natural resources. This could be done to a large extent through controlled breeding of animals and by husbanding all available resources to subserve the primary goal of conservation. Then only zoos could rightfully play their role in the conservation of natural resources.

REFERENCES

1. The World Conservation Strategy, IUCN, 1980.
2. Indian Wildlife (Protection) Act, Ministry of Agriculture, Government of India, 1972
3. Management of Zoos in India, Ministry of Agriculture, Government of India, 1972
4. World Zoo Conservation Strategy, I.U.D.Z.G., C.B.S.G, 1993.

ZOOS ROLE AND APPROACH TO WILDLIFE CONSERVATION

M. Kamal Naidu, I.F.S.
Special Secretary (Forests), Govt. of A.P

From mid-ninteenth century, the concept of zoo as a centre for endangered species was first mooted by Samuel P. Langley, then Secretary of the Smithsonian Institute, while inaugurating the National Zoo at Washington in 1889 when he called it "a home and a city of refuge for the vanishing races of the Continent". This was followed by a revolution in zoo designing in Europe when in 1907 Carl Hagenbeck, using reinforced concrete and architectural skills created artificial rocks and mountains in zoo exhibits by doing away with bars in cages and by using moats, thus giving the animals an opportunity for more freedom of movement. This gave rise to a new philosophy of zoo exhibits called "Immersion concept". This was in true keeping with the thoughts of Albert Schweitzer who stated "It is only when persons become concerned about animal life that they truly become human beings".

Concern for Wildlife Conservation, and the role of zoos therein came with the establishment of IUCN in 1948 and was concretised in 1964 at the symposium in London entitled "Zoos and Conservation". This symposium changed the prioritization of the role and values of Zoos to Conservation and Education mainly, thereby making research and recreation as secondary. In India we never lagged behind this appreciation. IBWL was set up in 1952 and it recommended setting up of modern zoos based on Hagenbeck concepts in 1954. This resulted in the National Zoo at Delhi in 1956 and Nehru Zoo at Hyderabad in 1959. In 1973 the IBWL constituted an "Expert committee on Zoo Management" to study and recommend actions to be taken for better zoo planning , development and management, with reoriented objectives as Conservation, Educational, Research and lastly Recreation.

Keeping in view the main theme of this Workshop, I may state that there had been no clear-cut wild life policy in our country before 1980, though a separate Wildlife Act came into force in 1972. It was Late Prime Minister, Smt. Indira Gandhi, as the Chair-person of the XV meeting of the IBWL who outlined a 12-point programme for Wildlife management, wherein items 3, 5, 7, 8, & 12 were relevant to zoos. Later in November, 1983 a 'National Wildlife Action Plan" based on the 12 points programme was formally released. This plan had items 4, 5, 6, 7 and 10 very relevant to zoos. It is as part of this Action Plan that the existing Wildlife Act of 1972 came to be drastically revised. The Zoo Authority of India was constituted, a Zoo Policy was formulated and a Zoo Act and Rules there-under framed for the proper upkeep and management of zoos, with authority to check and implement decisions. Thus Zoo keeping got a firm footing in India.

Zoos have played a relevant part and have been instrumental in conservation of birds and mammals in the past. In 1909 Beebe and Crandall reported that 82 species of wild birds bred at least once in American zoos and private aviaries. In 1965 Jarvis reported that 585 species bred in zoos, of which 20 were rare ones. In 1975 it was reported that over 820 species and

subspecies bred throughout the world representing 22 out of 27 orders and included 32 species / sub-species regarded as rare or endangered by IUCN Red Data Book.

Pender & Barkhams (1978) analysed the data from volume 4-17 of IZYB (1962 -1975) and summarised their findings thus :

IUCN Category	Species listed	Spp. exhibited	Number Bred	Number studied
E	132	82	53	24
V	64	53	41	20
R	56	27	13	2
O	7	5	4	3
I	15	8	4	1
X	x	54	46	11
Total	274	229	161	61

X These species were not then listed by IUCN.

Ratcliffe of Philadelphia Zoo reported that mortality decreased from 18.8% for mammals and 20.7% for birds during the period 1916-35 to 11% and 13.9% respectively for the period 1936-55 owing to improved diet and management techniques and was further reduced to 7-10% in the eighties.

U.S. Seal and others analysed the composition of animals in captivity for 108 zoo collections, involving 18072 mammals as representing:

17 out of 19 orders .. (89%)
76 out of 123 families .. (62%)
263 out of 986 genera .. (27%)
533 out of 2986 species .. (13%)

Out of the 17 orders, primates, carnivores and artidactyles accounted for 80% of all specimens, 85.5% births and 79.5% deaths while marsupials, rodentias, and perissodactyla accounted for 3.7 % , 5.9% and 4.0% respectively, and the balance are accounted for by other orders.

In 1983 ISIS computer records showed that out of 58,830 registered animals in captivity, 38,256 were born in captivity.

These data convinces one of the positive role played by zoos in conservation contrary to the belief that zoos consume a lot of animals from the wild. Actually statistics of world trade in animals has shown that only 1% is for zoos and the rest are for other purposes like food,

clothing, experiments, etc. May be, had the zoos taken such a serious approach to conservation as now spelt out in the "World Zoo Conservation Strategy" document of IUDZG released on 13th December, 1993 to act locally and think globally", we would not have lost the quagga, Indian cheetah, Passenger Pigeon, etc. We now have hopes to save the Mauritius kestrel and pigeon, Great Indian bustard, Jerdon's Courser, etc. like we have been able to save the Sangai, Indian lion, Wild ass, and Indian rhino.. Today there are many species whose natural habitat is degraded and destroyed, and the only hope for their survival are the zoos and similar facilities.

The zoo approaches to conservation of wildlife would be through captive breeding, education and research, while recreation will not be ruled out as it has its own subtle way of getting love and respect for the captive animals.

We tend, especially so in India to strongly de-emphasize the role of recreation unlike in Western countries where the concept "Customer is King" approach is adopted. These are too extreme steps. In the Indian approach ultimately the general upkeep of zoo declines and management gets boring. In western approach so much emphasis is given to people and revenue that the attention to animal is on a lower profile and often the exhibit design takes top priority. However, visitors are important. To capture their attention is more essential to increase their frequency of visits is still more so, especially if we have the goal of conservation; where we need to communicate this message to them.

Visitors' surveys conducted in Hyderabad and Delhi zoos in 1980 and 1987 respectively, has shown that 70-75% of the visitors come to the zoo for recreation, and only 10-15% for an educational experience. This has been the same trend in western zoos as reported by Joslin (1983) when he said that zoos attract more visitors than all major sports events put together. We also know that historically zoos are the most popular cultural institutions and the survey shows that 50-70% of visitors are adults and constitute a broad-based socio-economic strata of society. It is also been reported that around the world in more than 800 zoos over 350 million visitors are attracted by them.

Therefore zoos have a vast scope of impressing a very large segment of the human population to convey the message of conservation. Joslin therefore desired that we "turn strangers into visitors, visitors into participants, and participants into believers". William Conway remarked "we learn something of permanent value while having fun". Jones & Jones quipped "the best education is recreational and the best recreation is educational". Therefore recreation should be intimately linked to education.

Now the question arises as to how do we entertain the visitors? how do we fascinate them? How do we rouse their curiosity? so that the people are receptive to our conservation message. What are the conditions necessary for creating an optimal learning environment?

To answer the last question first, learning occurs best when 1) a persons interest has been roused; 2) their expectations are high; and 3) they are mentally challenged.

People learn best when they are actively involved and experience something first-hand and by using as many senses as possible. It is a known fact that "people retain little of what they hear, some of what they read, half of what they see, and a great deal of what they do". Therefore a zoo is an excellent school where one could see, read, hear and also participate. Therefore an excellent place where we can communicate our message of conservation, through multi-faceted programmes, utilising wide ranging methods of inter-woven communication techniques.

The visitors can be entertained, fascinated and their curiosity roused through exhibit desings which not only thrill, but also educate about the many facets of the animals and their intricate relationship with man and his environment, and finally the visitor could leave the zoo with a feeling of respect for the animals and their intrinsic values. Such designing of the exhibit, the display and the appropriate message content are the major challenges facing us today.

The exhibit design should rely on illusions to 1) attract the visitor's attention, and 2) instill a memorable impression, 3) promote an enjoyable experience, and 4) convey a clear educational message.

These could be achieved by 1) Simulating the animal's habitat 2) Focusing on the animal's outstanding physical features by various optical illusions, and 3) emphasing their ecological relationship.

The exhibits should create an initial memorable impression and a visual involvement, so as to influence the perceptual expression of the visitors in all his remaining encounters. This could be achieved by exhibits being imaginative, innovative and creative with a sense of movement, mystery and exploration, to be not only enjoyable, but also inspire and stimulate an emotional and intellectual response beyond the sensational and perceptual level, to reinforce and contribute to a total learning experience. The exhibit should carry an educational message which is in harmony with it, to satisfy the expectations and needs of the visitor.

Finally, I would like to conclude with the observation of Robinson (1985) Director, National Zoo, Washington "A good zoo exhibit must be people oriented. It must entertain, inform, educate. It must provide for all people, allow for positive interaction, provide for surprises and new ways to see animals and plants and all the zoo visitors to view animals without distraction, and to be safe for him".

BETTER HEALTH CARE FOR ZOO ANIMALS

Dr. L. N. Acharjyo, Retd. Vety Officer
Nandankanan Zoo, Bhubaneswar

Abstract

Health of animals and birds in zoos is directly or indirectly dependent on several factors such as housing, feeding, sanitation and disease management. Therefore, a constant effort has to be made to improve upon these management practices to prevent or lessen the occurrence of diseases among zoo animals and to keep them in perfect health.

This paper deals in brief the impact of different requirements of housing, feeding, sanitation and disease management practices on health of zoo animals and various remedial measures to overcome such problems.

BETTER HEALTH CARE FOR ZOO ANIMALS: VETERINARY ASPECTS

D. S. Balain and D. Swarup
Indian Veterinary Research Institute
Izatnagar 243 122 (UP)

ABSTRACT

Zoo animals differ from domestic animals, as well as from their free living counterparts in several aspects. In spite of possessing wild traits unfavourable for domestication, they depend for their feeding, breeding, health care and very living upon man which is in a way comparable to domestic animals. Zoo animals represent a collection of animals from different biomes and are commonly prone to a broad array of infectious and non-infectious diseases, besides suffering from the ill effects of inbreeding and congenital disorders. Health care forms a very important and significant aspect of management for zoo animals and therefore calls for all possible care and attention through all possible veterinary approaches.

Management of the diseases and proper health care of zoo animals revolves mainly upon the cardinal principle of 'prevention is better than cure'. Application of strict quarantine measures, proper sanitation, optimum nutrition and feeding, proper caging or confinement facilities, routine surveillance and prophylactic medication, specific diagnosis, effective treatment, and proper disinfection and disposal of dead animals facilitate the maintenance of normal health status of wild animals being kept under confined conditions.

Also planning of their mating would help in avoidance of ill effects of inbreeding and congenitalities. Special efforts are needed to minimize stresses and strains while capturing and restraining the animals. Proximity and any presence of harmful and toxic materials in zoo environment need to be taken note of, and it is especially so while applying drug preparations consisting of toxic chemicals like pesticides. Close observance and monitoring and proper surveillance of the health of all types of zoo animals along with proper following of vaccination and diagnostic schedules should form important part of any good zoo management. In essence, a collective approach on the part of veterinarian and management personnel is important for ensuring better care of animal health in the zoos.

Man has relied heavily on animals for evolutionary and cultural developments. In the beginning, man was a hunter by nature. Nearly half a million years ago *Homo erectus,* the remote ancestors of modern man killed large mammals with spears and ate the flesh of their quarry. It was in the period of 9000 BC to 6000 BC that some docile wild animals possessing traits conducive for domestication were brought under human control as livestock or companion animals. Many other animals with inherent characters, distinct from domestication, could not be domesticated and roamed wild. But they too have fascinated man for centuries to be either hunted as 'game animals' or captured for recreation. Zoos and parks are the places where the captured wild animals are kept. These places are not merely the means of human recreation, but are the treasure house of natural resources displaying a wide spectrum of natural collection of wild fauna from

different biomes. Zoos are also an important institution for educating people on various aspects of animal ethology. Zoos also now are instrumental in conservation, management and breeding of rare and endangered species. "So zoos -- good zoos -- are good for human beings and good for our fellow creatures".

Animals in zoos differ from their wild counterparts in several ways. They are under a sort of physical and psychological restraint and depend on man for feeding, breeding and medical care, and for their very well being. Moreover, ecologists are in general agreement that there are fewer deaths from diseases among wild population than among captive animals, except at times when population numbers become excessive. Therefore wildlife in zoo requires better attention to their health problems as domestic species of animals.

Diseases in Zoo Animals:

Zoo animals are subject to different categories of diseases caused by a broad array of infectious and non-infectious agents including bacteria, viruses, fungi, rickettsia, protozoa, helminths, poisons, physiological, nutritional, and congenital degenerative factors. (1) effects of inbreeding and congenital types of disorders are also quite common. While the impact of infectious agents on wild animals has been recognised since long: non-infectious diseases have received due attention for the past about two decades, particularly with the advent of environmental pollution and increased interest in capturing, transporting, and accommodating wild animals. Environmental pollution and accidental ingestion of toxic chemicals are the main causes of poisoning, whereas post-capture complications and compression of populations into small areas are manifested by capture myopathy, shock, stress and high incidence of infectious diseases. Congenital anomalies, infertility and other forms of inbreeding depression are also more likely to occur in small isolated populations of animals in Zoos. Some selected diseases of Zoo animals are summarised in Tables 1 and 2 and would require attention on the part of zoo vets in order to formulate better health care programmes.

Zoo Animal Diseases and Human Health :

Zoo animals may serve as reservoirs or as vectors of many pathogens that ultimately affect humans. Several deadly diseases like rabies, tuberculosis, Kyasanur forest disease (KFD), hydatidosis, leptospirosis, etc. prevalent in zoo animals are communicable to man. More than 230 species or subspecies of wild rodents, besides other wild life are associated with natural infections of sylvatic plague caused by the same pathogen (i.e. *Yersinia pestis*) as bubonic, pneumonic or septicaemic plague in humans. Some of the important zoonotic diseases which can be spread from zoo animals to livestock and man, and vice-versa are listed in Table 3.

Management of Zoo Animal Health:

Health management programmes for zoo animals are aimed mainly at preventing occurrence of diseases and malnutrition, besides provisions to minimise stress and physical injuries. These can be achieved by effective implementation of preventive measures, provisions for nutritive food, prompt and accurate diagnosis and effective treatment of prevailing disease problems.

(A) Preventive measures: Various disease conditions of zoo animals are sometimes not manifested apparently until quite advanced. In such stages, the therapeutic approaches may not achieve desired results. Moreover, capture and restraint, required to perform diagnosis and treatment, are usually accompanied by considerable hazard adding to the stress of animals. It is therefore, essential to practice effective preventive programmes as an integral part of management of wild feline to administer FPL vaccine at least once a year as booster. Although zoo animals rarely require rabies vaccination but in case it is desirable (mostly carnivores) a killed vaccine should be used because vaccine induced rabies has been noticed in certain species of zoo carnivores. Elephants are susceptible to a number of diseases such as tetanus, elephant pox, rabies, anthrax, pasteurella and clostridia for which vaccines are available. An annual vaccination should be done against tetanus and trivalent and quardrivalent clostridium. Other vaccinations are rarely used. Adult elephants can be given two to three times the recommended doses for the adult horse or bovine. Anaphylaxis is a potential complication to repeated vaccination, so elephants should be watched closely for one hour after vaccination and epinephrine be kept ready for intravenous administration, should anaphylaxis develop.

Examination of faeces for parasites should be repeated every four to six months and where significant parasitisms are found, deworming be taken up. Broad spectrum anthelmintics recommended for domestic species can be used for this purpose at prescribed doses of 5-10 mg/kg body weight.

(B) Diagnostic Approaches: Although early detection of disease symptoms is an important principle in any medical programme, it is often difficult to determine if a wild animal is ill. As compared to their free living wild counterparts it is easier to monitor health of captive wild animals. However, overt clinical signs in zoo animals may not be noticed so frequently until near death. Daily rapport is therefore necessary between veterinary staff and animal keepers. Being in close contact, keepers can detect subtle abnormalities in animals they attend. The ailing animal should be captured carefully for detailed investigation and treatment. Baseline data *viz* temperature, pulse, respiration and blood biochemistry values can reflect the health status of animal and substitute clinical diagnosis. Materials should also be collected for microbiological and pathological examinations from live and dead animals. Fresh stool samples should be collected in 5-10g formaline for parasitological examination. Sufficient exudate or scabs and crusts from exudeate in 70g alcohol and deep skin scrapings in 5% formalin need to be collected for mites. Same materials as for domestic species may be collected for diagnosis of poisoning.

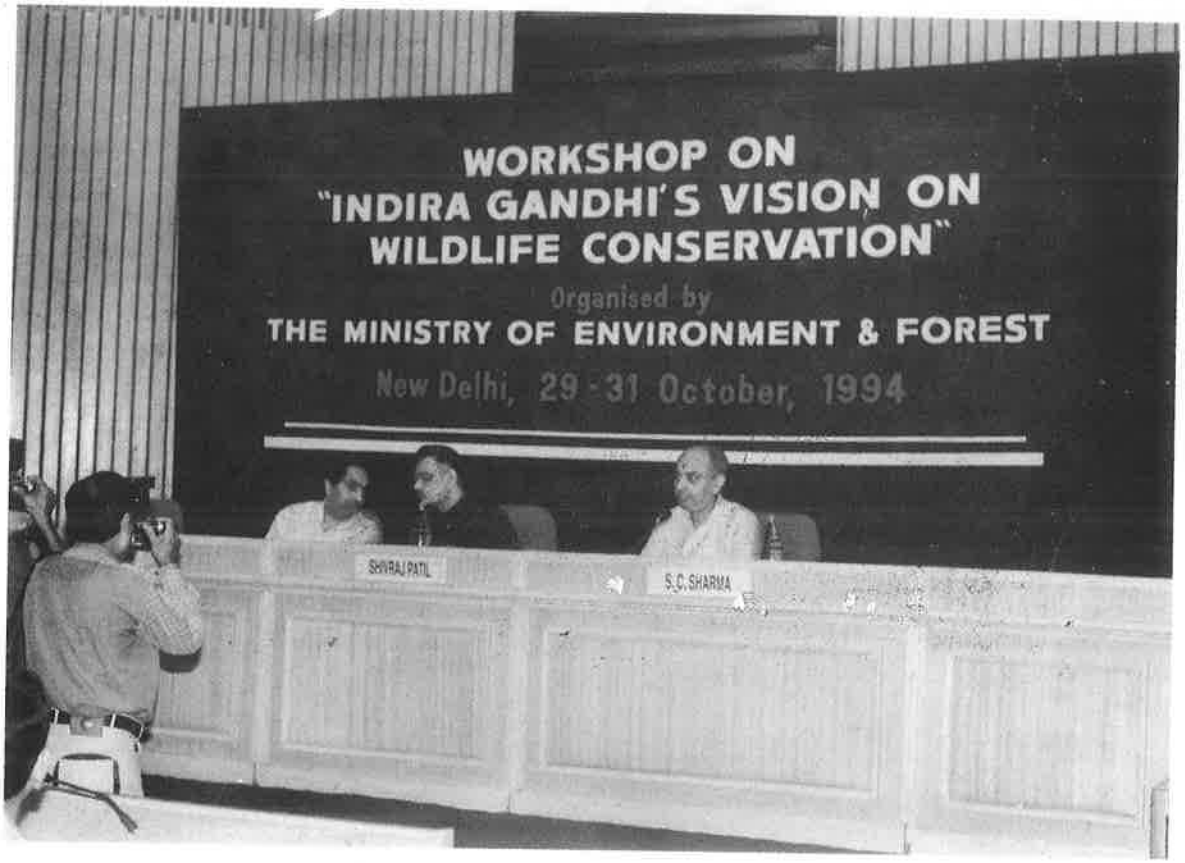
Tuberculosis which is one of the most important diseases in zoo animals, particularly in primates and artiodactyls in India. According to a recent survey conducted by Assam Science Society, tuberculosis has claimed the lives of more than 1,700 animals in the Assam Zoo in the last decade. Pulmonary tuberculosis was the major cause of death of sambar deer and giraffe. The disease can be diagnosed by clinical signs, X-ray, tuberculin testing and finding of tuberculosis lesions on PM. In primates intradermal injection of 0.1 ml old tuberculin or PPD is given in upper eyelid or into the skin of abdomen. The animal is observed daily for 3 successive days with a positive reaction varying from a slight reddening of the lid, through progressive degree of oedema, to complete closure of lids with purulent discharge and even localized necrosis. A test usually increases in severity over the 72 hr and may persist upto 96

INDIRA GANDHI'S VISION ON WILDLIFE CONSERVATION : THE ZOO AS ONE SUCH INSTRUMENT

WORKSHOP ON
"SCIENTIFIC MANAGEMENT AS AN INSTRUMENT FOR CONSERVATION OF WILDLIFE"

New Delhi
29 - 31 October 1994

Central Zoo Authority
Ministry of Environment and Forests
Government of India



Workshop on Indira Gandhi's Vision on Wildlife Conservation

WORKSHOP ON
"SCIENTIFIC MANAGEMENT AS AN INSTRUMENT FOR CONSERVATION OF WILDLIFE"

SCIENTIFIC SESSION II

Planned Breeding of Endangered Species

hr. Use of old tuberculin (2500 TU) is recommended, as it has been shown to be more sensitive than PPD. Single intradermal test, as described in cattle, can be practiced in artiodactyls. A diffuse swelling of more than 10 mm at 72 hr may be read as positive. Any animal that has shown positive reaction or two consecutive suspected reactions to tuberculin should be isolated and considered tuberculous.

(C). Post-mortem records and interpretations: Post-mortem examination is an important veterinary aspect for establishing disease diagnosis in zoo animals where overt clinical signs of illness are less frequently visible. For example, evaluation of nutritional status is often difficult in wild animals. However, a thorough PM examination of an emaciated animal can help in confirming malnutrition on the basis of pathomorphological changes in fat depots, bones, and other internal organs. The procedures for necropsy in zoo animals can be adopted from the techniques used for closely related domestic species. A close screening of tissue reaction identified as lesions need to be done while conducting necropsy. There are many diseases where pathogenic lessions are present in the internal organs. The striking lessions occur in alimentary tract in rinderpest (striped appearance of colonic mucosa), in heart (tiger heart) and mouth in FMD, in lungsin pneumoni tuberculosis, and in visceral organs (extensive haemorrhages) in haemorrhagic diseases.

Knowledge of normal anatomical structures of organs is of immense help in interpreting the necropsy findings. For example, a normal lung is pink in colour with spongy texture. An animal died of pneumonia will reveal red, purple or grey areas in lungs with firm texture. If the pneumonia is older than 10 days, there may be firm adhesion of lung with rib cages requiring knife to cut apart to remove the lungs from thoracic cavity. Presence of worms in pneumonic lungs indicate lungworm infestation. Animals with tuberculous and mycotic pneumonia are usually in poor conditions.

For histopathological examination pieces of liver, stomach, small intestine, spleen, heart, lung, kidney, brain, etc. should be collected in 10% formalin in addition to those tissues having gross lesions. For cultural examination, tissues should be placed in a sterile petridish or wide mouth jar. If there is to be a delay of an hour or more in culturing, these specimen should be refrigerated. Tissues that can not be taken aseptically should be removed as a large chunk and labelled 'non-sterile' so the specimen can be seared before culturing. Impression smears of organs for Giemsa and gram stains are most beneficial when possible. Parasites recovered from necropsies should be placed in saline until they can be fixed. Most parasitologists do not like to receive nematodes in formalin. However, follow the procedures directed by the parasitologist identifying the specimen.

In cases when chemical analysis is indicated, fresh specimen should be frozen immediately for the submission to laboratory. Heparinized whole blood (10ml), and/or 10 g. (multiple pieces) each of kidney, liver, brain, muscles in ice packed wide mouth bottle should be submitted for analysis of toxic heavy metals. About 50 ml stomach/rumen content is also submitted for diagnosis of poisoning. Special considerations are required while sending specimen for chemical analysis. Do not use any preservative. If a preservative has been used, separate sample of the same should

be submitted alongwith the specimen. For cyanide, forage should be sent together with liver and muscle in 1% Mercuric chloride. Whole blood under mineral oil for ammonia and urea, and bones and urine for fluoride need to be submitted to the laboratory with proper labelling and details.

(D). Therapeutic Approaches: Treatment of zoo animals required considerable experience and expertise. When an animal is diagnosed ill it should be restrained cautiously with minimum stress and given treatment specific to the condition. Full knowledge of the possible consequencies is necessary when a decision is taken to treat animal against a communicable disease such as tuberculosis. It has been observed that tuberculous primates may continue to shed pathogen following initiation of isoniazid therapy and they can never become free from the disease. PAS @ 40-60 mg/kg and streptomycine, and Rifampin or other anti tuberculosis. However, these drugs are of little value in treating avian or atypical mycobacteria, unless they are used in effective combination. Treatment approaches for other infectious diseases remain the same as adopted for domestic mammals. However, efficacy may be variable.

Non infectious conditions such as shock, stress, capture myopathy (CM), poisoning, nutritional deficiencies, etc. deserve immediate therapeutic attention. Shock can be treated with administration of isotonic balanced electrolyte soultion. Ringer's lactate is the fluid of choice. Addition of 2.5% dextrose in half strength in Ringer's lactate is a better shock therapy. Antibiotics are added to prevent secondary bacterial infection. Anesthetic agent, narcotics, and tranquilizers should never be given to animals in shock. Treatment of CM consists of intravenous infusion of sodium biocarbonate dissolved in physiological saline @ 32g/100 kg b.wt. this solution is also useful in the treatment of shock. It should be administered over a period of 5-10 min. Specific antidotes as prescribed for man and domestic animals can be used for counteracting poisoning in zoo animals.

(E) Sanitation and Disinfection: Althought these are managemental measures, zoo veterinarians are frequently called upon to recommend suitable cleansing and disinfectant agents. They are also responsible to recommend proper disposal of carcasses and disinfection procedures to be adopted following outbreak of infections.

No single disinfectant is ideal for all situations. Phenolics, chlorine compounds, (Sod. hypochlorite 5.25% soln), iodophors, formaldehyde (10%) and caustic soda (2% soln) can be used as bacteriocidal, viricidal and fungicidal to disinfect zoo animal premises. Carcasses of dead animal may serve as the source of infectious diseases. These should be disposed of promptly and properly so as to preclude access to them by other exhibit animals or vermin (rats, mice, insects, birds, etc.). Together with carcass, disposal of the bedding and food stuff also needs to be done in a manner so as to preclude their contact with or accessibility with other animals.

(F) Modern Veterinary Facilities: A well equipped Veterinary polyclinic with modern infrastructures is the most essential component of zoo animal health management. The polyclinic must have basic facilities for animals restraint, treatment, surgery and radiology in addition

to clinico-pathology, microbiology, and immuno-diagnostic laboratories. Nets and squeeze cages are important tools for animal restraint. These are available in different sizes and shapes and must be available with a zoo hospital. There must be satisfactory techniques and appliances for drug delivery to zoo animals. Modern chemical restraint requires equipments capable of projecting a syringe from some distance and discharging contents upon impact. There are short-ranged pistols and long-range rifles available for this purpose and a zoo hospital must have these alongwith necessary syringes and darts. An acid-base analysing unit, coulter cell counter, spectrophotometer, endoscopes, ECG, and immunodiagnostic kits and antigens for common infectious diseases form the integral part of a clinicopathology laboratory. A radiographic unit with a mobile x-ray machine (50mA), and a 300-500 mA x-ray machine with fluoroscopy unit and a diagnositc ultra-sound assembly is necessary to facilitate disease diagnosis. A fully equipped operation theatre with facilities of positive pressure ventillation and administration of inhalant anaesthetics is an essential component of modern zoo veterinary hospital. Provisions of suitable enclosures for different species of animals are also required for effective post-surgical and post-treatment care.

In conclusion, better health care of zoo animals is principally based on preventive medicine which needs support from many people, animal caretakers, laboratory personnel, security people, managers, etc. besides veterinarians. Public education for certain prohibitive zoo rules (no public feeding, teasing, etc.) is also an important part of total zoo animal health care programme. Nevertheless much depends upon skill, experience, and expertise of zoo veterinarian to provide in the form of effective preventive and therapeutic measures in order to achieve the ultimate goal of better health care for zoo animals. The Indian Veterinary Research Institute, a premier institute of Veterinary Science, can play a valuable role in achieving this objective. The Institute has a Centre for Wildlife conservation, Management and Disease Surveillance which also provides consultancy services pertaining to disease management in captive and free wild life. There are also laboratories for diagnosis of various infectious diseases and poisonings. The services of these laboratories can be utilized by the zoo veterinarians for establising disease diagnosis and management.

Table - 1: Selected infectious diseases of zoo animals.

Common name (Synonyms)	Causative pathogen	Principal Hosts	Characteristic signs
Tuberculosis (mycobacterial infection)	*Mycobacterium bovis* *M. tuberculosis* & *M. avium*	Almost all artiodactyls (Deer, antelopes, mouse deer, llama, wild sheep, giraffe, etc), Carnivores (cat, bear, binturongs, leopard, red panda), non-human primates (monkeys, langurs, baboon), elephant rhinoceros, etc.	cough, dyspnoea, emaciation roughened hair coat, enlarged spleen and liver (in primates) and hard palpable lymph node (in artiodactyls).
John's disease (paratuberculosis, chronic enteritis)	*M. paratuberculosis*	Deer, bighorn sheep, antelope, mountain goats, camels, etc.	Chronic persisting diarrhoea, emaciation, rough hair coat.
Pasteurellosis (H.S., Shipping fever, swine plaque snuffles in rabbits	*Pasteurella multocida*	Axis deer, gazelle, greater kudu, nilgai, sable antelope mink, bison, tiger, etc.	Generalized haemorrhagic sept caemia, pneumonia, meningitis, arthritis. Subcutaneous abscess in snuffles.
Brucellosis (abortion disease)	*Brucella spp.*	Mammals specially ungulates	Lameness from infected joints, scrotal enlargement in mates, uterine thickening and oedema in pregnant females, aborted foetus, stunted or weakened calves.
Distemper	Virus of Carre belonging to *Morbillivirus* group	Wolf, jackal, dogs coyote, foxes, hyena, mink, ferret, raccoon, civet, etc.	Generalized infection, hyper-keratosis, CNS disturbances, or any combination of these,
F.M.D. (Apthous fever, hoof and mouth disease)	*Picornavirus*	All cloven hoofed arti-dactyls.	Erosive vesicles on tongue, mouth and on feet.
Feline panleukopenia (feline distemper) virus	Filterable DNA	Mammals belonging to family Felidae	Enteritis and depression in haemopoietic centres with marked decrease in leukocytes in peripheral circulation.
Anaplasmosis (Gall sickness)	*Anaplasma marginale*	Domestic and wild ruminants including cattle, buffalo, blesbok, deer, antelopes, bison, etc.	Usually asymptomatic but may cause anaemia and icterus.
Trypanosomiasis (Surra)	*Trypanosoma evansi*	Camel, horse, elephant, cat, tapir, capybara, deer, etc.	Oedema, emaciation, anaemia, intermittent fever and enlarged lymphnodes.
Helminthiasis (Parasitism)	Helminthic parasites	All captive mammals and birds.	General weakness, anaemia roughened hair, diarrhoea

contd....

Common name (Synonyms)	Causative pathogen	Principal hosts	Characteristic signs
Anthrax (Splenic fever, malignant pustule charbon	*Bacillus anthracis*	Mammals, specially artiodactyls, carnivores, elephant, hippopotamus, etc.	Sudden onset and death with exudation of tarry blood from body orifices, enlargement of of the subscutaneous and sub-serous tissues.
Leptospirosis	*Leptospira* spp.	Mammals special carnivores, rats, deer, antelopes, swamp deer	Vaque. Anorexia, weakness, anaemia haemoglobinuria, (in deer), vomitting and haematuria (dogs)
Rabies	Rhabdo RNA virus	All warm blooded animals	Behavioural changes- anorexia, apprehension, nervousness, apathy followed by aggression, drooling of saliva, restlessness, excitement, biting at indefinite objects. difficulty in swallowing, pratysis death.
Rinderpest (Cattle plague pestis bovina)	Morbilli virus of Paramyxoviridae family.	All cloven hoofed artiodactyls	Fever, erosive stomatitis and gastroenteritis. Death.

Table -2: Some non-infectious disease of zoo animals.

Disease entity	Aetiology/ predisposing factor(s)	Commonly affected species	Characteristic signs
Lead poisnoning (plumbism)	Lead in environment in form of contaminated feed and water Accidental ingestion of lead bearing materials.	All animals, specially waterfowl, non-human primates and equines.	Anaemia, behavioural changes incoordination, excessive salivation (in acute), cephalic oedema (in birds)
Pesticide poisoning	DDT, organophosphorous compounds, carbamates etc. Accidental or pollution of environment. Absorption of chemical after topical application, dipping or spraying.	All animals and birds	Onset of signs such as muscle tremors, apprehension or salivation
Captive myopathy (overstraining disease, stress myopathy, polymyopathy, etc.)	Uncertain	Most common in recently trapped animals, particularly ungulates.	Depression, muscular stiffness, incoordination, paralysis metabolic acidosis, myoglobinuria and death.

contd.....

Table -2: Some non-infectious disease of zoo animals. (contd.,)

Disease entity	Aetiology/ predisposing factor(s)	Commonly affected species	Characteristic signs
Shock	Variable	Recently captured animals	Increased heart and respiratory rates, reduction or absence of pulse rate, pale mucus membranes, decreased body temp., dialated pupils, muscular weakness, mental depression and decreased urine output.
Malnutrition	Deficiency of gross energy and nutrients,	All mammals & birds	Variable, depending upong the type of deficiency.
Metabolic bone disease (osteoporosis, rickets, simian bone disease, osteogenesis imperfecta, cag paralysis, paper bone disease, Paget's disease etc.)	Prolonged deficiencies of calcium and vitamin D or improper ratio of Ca and P		Lameness, reluctance to move, bones and joints painful, anorexia, poor mastication.

Table 3 : Important zoonoses prevalent in zoo animals.

Bacterial	Viral	Mycotic & Rickettsial	Parasitic
Tuberculosis	Rabies	Aspergillosis	Toxoplasmosis
Plague	Kyasanur Forest disease	Histoplasmosis Kala Azar)	Leishmaniasis (Oriental Sore,
Leptospirosis	Louping- II)	Nocardiosis	Amoebiasis
Listeriosis	Simian-Herpesvirus	Rocky Mountain-spotted fever	Simian Malaria
Salmonellosis	Monkey pox	Q-fever	Hydatidosis
Tularemia	Measles	Rickettsial Pox	Taeniasis
Anthrax (Splenic fever)	Cowpox		Hookworm
Brucellosis (Malta fever, undulant fever Mediterranean fever)			Ascariasis
Pseudotuberculosis			Sarcoptic mange (Scabies)

DIET SELECTION OF ZOO ANIMALS

Dr. George Mahen

Abstract

Feeding strategies on zoos are naturalistic, traditional and substitution. Food commonly eaten in the wild, feeds constantly used and found good and substituting natural food with their equivalents form the respective basis.

In India, the zoos still follow the first two methods which are time tested and proven good. The zoos abroad have formulated diets that are based on scientific data on the domestic species and their wild counterpart. The precise nutritional requirement of all domestic animals are established and ready to feed compounded rations are commercially available. It is required to examine how best we can modify the existing system further to suit the requirements and habits of the animals. A ready mix feed is, however, much easier to handle and feed and more nourishing.

This paper summarises the dietary requirements of different groups of zoo animals including Carnivores (felidae, canids), ruminants, primates, avians, and including quantity and type of food needed.

DIET SELECTION FOR ZOO ANIMALS

Dr. D. D. Manjramkar & Dr. S. Jayaraman
Institute For Research in Reproduction (ICMR),
J.M.Street, Parel, Bombay 400 012, INDIA.

Abstract

Nature has a great variety of flora and fauna which almost balances all the requirements of the creatures living in it, whereas in zoos, it is almost impracticable to provide feed to zoo animals that eats exactly the same as in the wild. Apart from this, different animals have different food habits, different foraging behaviour in the wild which offers ample choice for their own selection of food but whereas in zoos, they have to depend upon the diet which is offered. This may perhaps affect their maintenance as well as production. Therefore, a knowledge of feeding preference and nutritive requirements becomes important in planning for diet selection. In zoos, where the animals are kept in captivity or in semi-natural environment, attempts should be made to translate the needs of the animals by feeding concentrated rations which supply all the essential ingredients. It is therefore essential to acquire a thorough knowledge of all feedstuffs, combined with an understanding of the physiological requirements of the animals and provide mixed diets composed of many ingredients which supplement one another. While planning an appropriate diet and feeding schedule, the palatability, bulk requirement, specific and special needs during maintenance, sickness, pregnancy, lactation and growth should also be taken care of.

To meet all the requirements in a nutshell as well as to bear the financial burden for maintenance of zoo animals, steps towards gradual substitution to the natural diet and efficient use of agricultural by-products including slaughter house by-products are necessary.

DIET SELECTION FOR ZOO ANIMALS

D. D. MANJRAMKAR
Institute for Research in Reproduction
(ICMR), J. M. Street, Parel, Bombay.

A feeding system in a zoo should aim primarily at fulfilling the animals physiological needs. Nutrition plays an important role in zoo husbandry and a sound diet is a significant protection against disease and debility. The problem of feeding a wide variety of captive species is to recognise how they deviate from the common patterns that are familiar to us. In doing so a knowledge of the foods they eat under natural circumstances is essential.

According to Morris (1975) zoo diet has three approaches
1. Traditional
2. Naturalistic
3. Substitutional approaches.

1. In traditional approach feeding instruction and diets were inexact and variable. While some were nutritionally inadequate, others were less so. Their adequacy was judged on the basis of observation and experience.

2. The naturalistic approach is found on the principle that as far as possible zoo feeds should be similar to those present in the species natural habitat which includes quality and quantity of what the animal eats. But this is very impracticable in zoos due to uncertain availability of natural foods, labour, storage and difficult to assess the nutritional composition of the total diet.

3. In the substitutional approach the contribution by Ratcliffe and Wackernagal (1966) brought a major reform in the feeding of zoo animals. The diets consists basic formulae to include foods which provide proteins, fats, carbohydrates, vitamins and minerals in the correct proportions.

The ingredients may or may not be natural to the species concerned and for this reason they have become known as "substitute diets".

DIET SELECTION

When we think of diet selection, it should be so formulated to suit the majority of the animals in the zoos classed under herbivores, omnivores and carnivores. It is therefore necessary to have a thorough knowledge of all feed stuffs combined with an understanding of the physiological requirements of all the animals and provide mixed diets composed of many ingredients which supplement one another.

While planning for the diet selection one should think over the following points as suggested by Morris (1975).

1. Nutritional requirements and food preferences.
2. Choice of ingredients.
3. Acceptability
4. Formulation and feeding trials.
5. Evaluation.

1. NUTRITIONAL REQUIREMENT AND FOOD PREFERENCE :

Specific nutritional data for most of the wild species are limited and sometimes non-existent. To determine their nutritive requirements and food preferences can be done by assuming that the needs of a wild animal are similar to those of its closely allied domesticated relative, e.g. the sheep and cow can be taken as representative of all ruminating animals. The horse of the non-ruminating herbivores like rhinoceros and monogastric herbivore the anatomy of the digestive system is similar to that of equines. Domestic cat can be taken as representative for the wild felidae like wise chicken for birds.

When we plan to formulate a diet it should fulfill the nutritive requirements which obviously be related to the physiological state of animal and different considerably for adult maintenance growth, work, pregnancy and lactation.

For an elephant, a minimum level of 5% crude protein inplant material is needed for maintenance. For tusk growth 1.7 g/day of calcium is needed (R. sukumar 1985). McCallagh (1969) calcutated that a 1000 kg. male elephant needs 8-9 gm. of calcium per day. A 3000 kg. pregnant or lactating cow elephant may require 60 g calcium/day. Benedict (1936) and Olivers (1978) calcutated a net sodium deficit of 5 g/day for Captive Asian Elephant and 11 g/day for wild elephants. Therefore it has been suggested that an elephant requires 75-100 gm. sodium/day.

Regarding the nutritive requirements Patricia (1968) correlated the deficiences and vitamin and mineral requirements of domestic felidae with that of wild felidae. The requirement for the fat soluble vitamin A is remarkably specific in case of cats as they cannot synthesize vitamine A. Thus all natural supplies of vitamin A must be obtained from the prey. Body fat and muscle are virtually devoid of vitamin A whereas large amounts are found in liver and smaller quantities in lungs, adrenals and kidneys. It is therefore apparent that cat fed exclusively on carcass meat without liver or vitamin A supplement will inevitably suffer from deficiency.

When muscle meat or heart is given to animals the total amount of calcium provided is very small. It is therefore not surprising that growing kittens and cubs fed exclusively on meat suffer severely from calcium deficiency. A nutrient requirement thus may be defined as the quantity of a nutrient or of energy which must be supplied in the diet to meet the net requirements.

2. CHOICE OF INGREDIENTS :

The ingredients which are thought to be included in diet should be available in sufficient quantity and assurance to get future supplies. The different feed ingredients have been assigned to eight main classes.

i) Dried forages or dried roughages e.g. hay, straw fodder and other products with more than 18% crude fibre, hulls or shells.

ii) Pasture, forages fed green including all forage feeds.

iii) Silages (maize, legume and grass)

iv) energy feeds - cereal grains, milling by products less than 20% crude protein.

v) Protein supplement - this may be of mammals, avian, marine, milk and plant origin and contains more than 20% crude protein.

vi) Mineral supplement

vii) Vitamin supplement

viii) Additives - which contains antibiotics, flavourants, hormones, medicants.

3. ACCEPTABILITY :

Acceptability is a major factor in the choice of any ingredients. When an animal is introduced to a new food, whether at birth/hatching, during weaning or at any other stage of development or on removal to a strange environment, the first essential property of that food is that it should be acceptable.

Odour and taste are the principle components. Texture which includes particle size, hardness, elasticity, viscosity and resistance to shear can be crucial. Colour relatively seems to be unimportant for most mammals but may influence primates and many birds. It is less well known that canids will readily accept foods of high sucrose content while felids not.

4. FORMULATION AND FEEDING TRIALS :

Once the animals nutritional needs and dietary preferences have been established, the most appropriate ingredients that determine the finished diet is formulated by combining suitable acceptable foods in proportions which produce the desired nutritional composition.

After formulation, the diet is subjected to a series of feeding trials during which the animals feeding habits are carefully observed. The diet must be a practical work and factors such as ease of handling, storage and manhour requirements should all be evaluated at this time.

5. EVALUATION :

A diet can only properly be judged nutritionally adequate if it is fed to the intended species during all phases of the life cycle. Parameters to assess its overall adequacy are :

i) Food intake
ii) Faecal examination
iii) Biological efficacy.

i) Food intake – A careful record of intake is a standard procedure and provides an estimate of the calorific needs of individual species to maintain normal body weight (assuming digestibility is constant).

ii) Faeces -- The character of the faeces is a good index of the digestibility of the diet. A note should be made of various ingredients affecting faecal consistency and also the ease with which faeces can be removed.

iii) Biological efficacy – This refers to the animals physiological performance and is judged by observation of its external condition, maintenance of body weight in the adult and fulfilment of normal growth patterns in the young. The ability of a diet to support normal reproduction is the most critical test of nutritional adequacy. However, reproduction is also influenced by factors such as social and environment other than nutrition Nevertheless, there are reasonable grounds to assume that when the normal reproduction occurs the diet can be said to be nutritionally satisfactory.

FACTORS IMPORTANT IN FORMULATING A DIET

A. ENERGY. The energy needs of animals and birds are not related in a simple way to body weight but are related roughly to the surface area of the body and in term to the rate at which heat is lost from the body. Thus the larger the animal the smaller is its surface area in relation to its weight and vice versa and so the turnover of energy decreases as weight increases. It means the smaller the animal the more concentrated food it tends to eat in terms of energy yield and the more frequently it needs to eat.

One of the major factors affecting food intake is its concentration of energy; generally speaking, the higher the energy content, the lower the intake. It is now well established that the requirements for certain nutrients are influenced by the concentration of energy in the diet. All animals require a source of energy, aminoacids (from protein) minerals and vitamins.

B. PROTEIN. Proteins from different sources do not have the same value in providing aminoacids for tissue repair and synthesis. Most vegetable proteins differ in certain essential aminoacids that are less abundant than in animal proteins. For this reason vegetable protein is needed in larger quantities than animal proteins for growth and maintenance.

The needs for protein differ between species and in practice 10-20% protein in the diet is adequate for adult herbivores while domestic cats need about 21% protein mixed food. Animals that are lactating need proportionately more protein for energy than non-lactating animals if they are not to lose weight, this also applies to pregnancy during its later stages when fetal growth is rapid, and to egg-laying birds. The young growing animal needs higher protein levels than adults in order to provide for tissue synthesis.

SUBSTITUTION TO THE NATURAL DIET

An approach towards the substituion to the natural diet is based upon that "all animals need the same groups nutrients (i.e. proteins, carbohydrates, fats, minerals, and vitamins) in

similar proportion". As mentioned earlier, Wackernael at the Basel Zoo studied for about 10 years on the different modifications of the substitutional diet. Moreover most of the subtitutional mixtures are concentrates and must be supplemented in order to supply bulk requirements.

1) DIET FOR HERBIVORES.

Ruminants and pseudoruminants are treated as herbivores, such as the elephant, rhinoceros, all equine animals, hippopotamus. In the table given it is clear that one third of the diet formula is made up of oats and barley as the concentrate rations. But oats and barley do not offer more than 10 or 11% of crude protein. This is overcome by addition of mainly soyabean and groundnut oil meal. A fairly high amount of minerals and vitamins are also added.

2) DIET FOR OMNIVORES.

This diet is suggested for apes, monkeys, bears, pigs, most of the rodents, the flying fox and the sloth. In addition the apes are given milk and an occasional egg and the monkeys are also given some meat. The bears are given fat meat or fish. (Table is enclosed).

3) DIET FOR CARNIVORES.

Muscle meat is hard and by itself is not balanced nutritionally as it is deficient in calcium and oil soluble vitamins. All carnivores therefore should be given a supplement of protein minerals and vitamins concentrate. Pigeons, rabbits, rats and mice are given to balance the feeding and provide interest. The supplement has proved to be pallatable and adheres well to the pieces of meat. It was found suitable for a variety of other animals from flying fox to tortoise. It can also be dusted on chopped fish for storks and herons. (See table enclosed).

4) DIET FOR INSECTIVOROUS BIRDS.

The basic food is provided as a moist, friable mixture and is supplemented with seeds and grain in the case of grain eaters. For birds which require meat the basic feed is enriched with minced meat (as in comivores diet). In case of larger carnivorous birds, e.g. hornbills, freshly killed wild mice can be provided. This ration has proved its value both for mainteance and reproduction as well as most useful in the rearing of ducks, geese, fowls, cranes and ostriches.

A birds feed is not complete if it is entirely lacking in carotenoids. Most of the yellow, orange and red colours in birds feathers are carotenoids. In the birds body these may be transformed but are not synthesised; they must therefore be provided in the feed. Synthetic carotenoids like carophyll red and carophyll yellow are also used.

CONCLUSION

1) Diet should be formulated wisely based on nutrititive and overcome deficiencies as well avoidance of exessive nutrients. Captive rhinoceros are frequenty subjected to laminitis and as in the case of equines, this can often be related to high levels of protein in diet.

2) It is easier to introduce formulated diet at a young age as animals food preference is to a great extent determined by the kind of food on which it was weaned.

3) Incorporation of slaughter house byproducts such as offals, cattle head, pork head, hide trimmings, bone scrape (which is higher in calcium and phosphorus)

4) Agricultural by-products such as

i) Mill by-products : Bran, wheat bran, grain screanings, malt sprouts, rice polishing (10.15% proteins) can be used.

ii) Molasses : used as source of energy, appetiser, good binder, reduces dustiness, can be used as ration.

iii) Roots & tubers : e.g. potatoes, cassava, sweat potatoes can be used.

5) Culturing of mealworms in zoos itself: Since mealworms are readily eatne by many insectivores, they provide a very convenient food source.

6) Breeding of prey animals such as mice, rats, rabbits, chicks to maintain interest of zoo animals can be undertaken.

7) Interaction with other institutional laboratories to carry out periodic analysis of food should be set up.

8) Sharing of experience and suggestions monitoring diet adequacy should be done.

9) Efficient use of locally available all season food ingredients.

10) As animals tissue are becoming more costly and to sustain financial burden, less expensive and more abundant vegetable protein sources such as soyabean meal and other legumes will probably be used in even greater quantities as a basis for diets.

However, improved nutrition is only one of many factors collectively responsible for the higher standards of health and breeding of animals.

REFERENCES

A. T. Phillipson : Principles of zoo animals feeding : introduction, Int. Z.Yb. 16:1-3.

CASR Vaneysinga : The dietory requirement of lions, tigers and jaguars when kept outdoors during winter months3. Int., Z. Yb. (9) 164-168.

D. M. Jones : The Husbandry & Vet. Care of captive rhinoceroses. Int. Z. Yb. (19)

E. Yong & J. Oelof Se: Management & nutrition of 20 newly captured young African elephants in the Kruger National Park Int., Z. Yb. (9).

G. C. Banerjee: A textbook of Animal Husbandry, 7th ed.

Keith F. Cline: Diets for siberian tigers at Detroit Zoo Int., Z. Yb. (9) : 166-167.

K. K. Gurang : Heart of the Jungle 1983, Ist ed.

Lee S. Crandall : The management of wild animals in captivity (1974, 5th ed.)

L. G. Chubb & A. D. Walker : Principles and practice in foumulating manufactured foods in the UK Int. Z. Yb. (16): 3-13.

Mark & Moris, JR : Prepared diets for zoo animals in the USA. Int. Z. Yb. (16): 13-17.

Niels Bowling, D. H. Hill et al. : Hand rearing of an African elephant : Int. Z. Yb. (5).

R. D. Martin, et al : Culturing mealworms as food for animals in captivity. Int. Z. Yb. (16): 63-69.

Patricia P. Scott (1968) : The special features of nutrition of cats with observations on wild felidae nutrition in the London Zoo Symposia Zoological Society, London No. 21, 21 -36.

R. Sukumar: The Asian elephant (1989-1st ed.)

Wackarnagel (1968) : Substitution & prefabricated diet for zoo animals. Symp. Zool. Soc. London No. 21, 1-12.

COMPOSITION OF DIET FOR CARNIVOROUS ANIMALS

Supplement mixture	**%**
Sources of animal protein:	
Skimmed milk powder, Peruvian	
fish meal, herring meal, meat meal	40+/-4
Sources of plant protein:	
sugar cane yeast, brewer's yeast,	
distiller's solubles	40+/-4
Fat of animal and plant origin :	
Soya bean oil, beef tallow	5+/-2
Minerals :	
Limestone, bone meal, salt	15+/-3
Premixtures :	
Trace elements, vitamins	

Composition	**%**
Crude protein	28-31
Crude fibre	max 1.5
Crude fat	5-7
TDN	min. 23
Calcium	4.5-5.2
Phosphorus	1.5-2.2
Salt	1.5-1.8

Vitmins per kg feed	
A	90,000-110,000 iu
B1	55-70 mg
B2	60-80 mg
B6	40-60 mg
B12	400-1500 mm
C	800-1200 mg
D3	7,500-9,000 mg
E	1,000-1,200 mg
K	30-35 mg
Biotin	2,000-4,000 mg
Folic acid	25-40 mg
Pantothenic acid	350 - 450 mg
Nicotinic acid	250-320 mg
Choline	3,000 - 3,500mg
p-Aminobenzoic acid	100-200 mg
Inositol	3,000 - 4,000 mg

Santoquin (antioxydant) min. 150 mg.

Trace Elements	**per kg feed**
Iron	300 - 400 mg
Iodine	10 - 14 mg
Cobalt	6-10 mg
Manganese	220-250 mg
Magnesium	1,000-1,300 mg
Zinc	250-320 mg
Copper	120-140 mg

USE : Raw meat (minced meat) 93 %
Supplement 7 %

COMPOSITION OF DIET FOR HERBIVOROUS ANIMALS

Contents	**(%)**
Ground Oats	15.0
Ground barley	20.0
Ground grain sorghum	8.0
Ground wheat	10.0
Soya bean oil meal	10.0
Groundnut oil meal	8.0
Linseed meal	3.0
Lucerne meal	10.0
Wheat bran	5.0
Potato flakes	2.0
Pomace	3.0
Liquorice powder	1.0
Ground calcium carbonate	1.0
Bone meal	2.0
Salt	0.9
Trace element and vit. mix	0.9

Composition (%)	
Crude protein ea	18.0
Crude fat	2.5
Crude fibre	7.0
Calcium	1.2
Phosphorus	0.6
Total digestible nutrients	62.9

Trace elements added per kg of feed (mg)	
Fe	20.0
Mn	10.0
Cu	5.0
I	4.0
Co	0.4
Zn	10.0

Vitamins added per kg of feed	
A	12000 i.u.
D_3	2000 i.u.
E	60.0 mg
C	100.0 mg
B_1	2.5 mg
B_2	10.0 mg
B_6	1.25 mg
Pantothenie acid	12.5 mgt
Nicotinic acid	25.0 mg
Choline	500.0 mg
Folic acid	0.075 mg
B_{12}	25.0 Ug.

COMPOSITION OF DIET FOR OMNIVOROUS ANIMALS

Basic Mixture	%
Cereal products	
Corn, rice, wheat bran, wheat oat flakes, barley flakes, corn starch	50+/-5
Other sources of energy:	
Soya bean oil, sugar	8+/-2
Sources of plant protein:	
Groundnut oil meal, soya bean oil meal, yeast, distillers' solubles	25+/-4
Sources of animal protein:	
Skimmed milk powder, casein	12+/-3
Minerals :	
Calcium Phosphate, caicium carbonate, salt, benotonite	3+/-1
Premixtures :	
Vitamins, trace elements, amino acids	2

Composition	%
Crude protein	21-24
Crude fibre	2-4
Crude fat	6.5-9
TDN	80-84
Calcium	0.8-1.1
Phospherus	1.0-1.4
Salt	1.0-1.4

Vitmins per kg feed	
A	10,000-12,000 iu
B1	10-20 mg
B2	10-18 mg
B6	12-22 mg
B12	25-33 mm
C	1,500-2,500 mg
D3	3,500-3,800 iu
E	50 - 80 mg
K	8 - 12 mg
Biotin	400 - 600 mg
Folic acid	7 - 9 mg
Pantothenic acid	30 - 45 mg
Nicotinic acid	100 - 140 mg
Choline	1,200-1,600 mg
p-Aminobenzoic acid	50 -150 mg
Inositol	1,000 - 2,000 mg
Ethoxyquin (antioxydant) min.	125 mg

Trace Elements per kg feed	
Iron	200 - 350 mg
Iodine	15 - 20 mg
Cobalt	3.5 - 5 mg
Manganese	40 - 60 mg
Magnesium	1,600-2,000 mg
Zinc	40 - 60 mg
Copper	7 - 12 mg

PREPARATION : Mix nine parts of the basic mixture with one part minced cooked meat, combining with meat broth or water to make a stiff mash. Press into a shallow pan. The mash hardens quickly to form a cake, which can be easily cut or broken into pieces for feeding. Keep in refrigerator. Allow 1-10g/kg body weight.

COMPOSITION OF DIET FOR INSECTIVOROUS ANIMALS

Basic Mixture	%
Cereal products Corn, rice wheat bran, wheat oat flakes, barley flakes, corn starch	4.5+/-6
Other sources of energy: Soya bean oil, sugar	10+/-3
Sources of plant protein: Groundnut oil meal, soya bean oil meal, yeast, distillers' solubles	3+/-3
Sources of animal protein: Skimmed milk powder, casein	7+/-2
Minerals : Calcium Phosphate, caicium carbonate, salt, benotonite	3+/-1
Premixtures : Vitamins, trace elements, amino acids	2

Composition	%
Crude protein	22-25
Crude fibre	4-6
Crude fat	7-9
TDN	77-81
Calcium	0.9-1.1
Phosphorus	0.6-0.8
Salt	1.0-1.2

Vitmins per kg feed

Carotene	15-30 mg
A	50,000-60,000 iu
B1	18-23 mg
B2	50-70 mg
B6	20-25 mg
B12	80-90 mcg
C	200-400 mg
D3	9,000-11,000 iu
E	190-220 mg
K	40-45 mg
Biotin	150-250 mg
Folic acid	5-7 mg
Pantothenic acid	130-150 mg
Nicotinic acid	220-280 mg
Choline	1,100-1,500 mg
p-Aminobenzoic acid	20 mg
Inositol	150 mg
Santoquin (antioxydant)	min. 125 mg
Terramycin (antibiotic)	40 mg

Carotinoids added per kg feed

Carophyll Red	100 mg
Carophyll Yellow	25 mg
Exgtract of alfalfa fat-soluble	2 mg

Trace Elements per kg feed

Iron	100-200 mg
Iodine	800-1,400 mg
Cobalt	400-600 mg
Manganese	70-90 mg
Magnesium	1,500-2,200 mg
Zinc	70-90 mg
Copper	8-15 mg

PREPARATION :	%
Basic Mixture	50
Minced cooked meat	25
Ground carrots	20
Ground hard-boiled eggs with shell	5

This feed is usually mixed with minced raw meat supplemented by the Carnivore Supplement

POPULATION CONTROL MEASURES FOR PROLIFICALLY BREEDING SPECIES

Dr. P. O. George
Kerala Agricultural University
Trichur, Kerala

Abstract

Good health, plane of nutrition and proper environment form the vertices of a triangle of good proliferation of a species. With all the benefits available in the zoo, these factors cannot be met in all totality as the animals are subject to management by humans rather than their own instincts. Yet, ironically, there is a problem of prolific breeding in some of the animal species in zoos in India.

Prolifically breeding animals pose a threat not only to themselves but also to the zoo managers. Critical problems faced in a zoo scenario are lack of space, diseases, fighting, inbreeding and hybrids.

Special feeds for animals with special diet becomes difficult to obtain in large quantities. Area available for each individual decreases and diseases become rampant. An increased number with less space leads to territoriality in a constricted place further leading to infighting. Introduction of fresh genes into the inbred population becomes difficult because of the above constraints which inturn affects the vigour of the population. Unknown lineage can also be a factor in propagating hybrids if these animals are not well managed.

There have been suggestions of killing and feeding the excess animals to other carnivores or resort to mercy killing. Both these are looked upon as sensitive issues due to sentimental reasoning. Reintroduction is not a solution for the various problems the exercise faces. Keeping these in mind, the only possible solution is sterilization of either of the sexes to prevent breeding.

The various methods that have been followed are intertesticular injection of irritants to stimulate fibrosis of the testicular tissue, Orchiectomy or surgically removing the testicles, vasectomy, caudectomy and implantation of synthetic polymer in males while in females, implantation of intrauterine loop, subcutaneous implantation of progesterone and ovariectomy or removal of a portion of the oviduct. Of all these methods the best procedure which is the safest and surest is either vasectomy or caudectomy.

POPULATION CONTROL MEASURES IN ZOO ANIMALS

G.P. Talwar
National Institute of Immunology
New Delhi - 110 067

Abstract

Two types of problems are encountered for regulation of fertility of zoo animals. For some, it is necessary to promote fertility. Several animals do not breed adequately in captivity. Furthermore, as the stock of males and females is limited, hypofertility of the available animals fails to engender progeny. Being given that the scientific knowledge of reproduction is now fairly adequate, it is possible to induce superovulation by an appropriate regimen of hormones. Hormones can also be used to enhance libido and spermatogenesis in male animals. Techniques of *in vitro* fertilization and embryo transfer can be used to enhance the reproduction of endangered species with low fertility.

Some animals breed in more numbers than desired or containable in a zoo and thus call for regulation of fertility of these animals. Two types of interventions can be adopted. An LHRH vaccine developed by us can be employed to block the fertility of both male and female animals, LHRH being a common 'master' hormone in both sexes. Immunization with this vaccine also reduces libido and aggressiveness, as it inhibits the production of testosterone. The effect of the vaccine is, however, reversible, which is good for some purposes but may not be adequate in cases where long lasting, if not permanent, sterility is desired. For the latter purpose, we have devised an injectible, TALSUR, that can sterilize or castrate a male mammal permanently.

SECOND PLENARY SESSION : PLANNED BREEDING OF ENDANGERED SPECIES

Remarks of Chairman,
A. K. Mukherjee, I.F.S., Retd.
Former I.G. Forests, Ministry of Environment and Forests

In the early part of the century, wild animals in zoos were considered to be a spectacle and their management was done through word of mouth from the Director or Veterinary doctor. Very little scientific inputs were involved in the management of zoo animals. During the last 3 - 4 decades, significant advances have been made in bio-technology and diagnostic techniques. The zoos in developed countries are taking full advantage of the researches in behavioural sciences, nutritional sciences and reproductive biology in day-to-day management of zoo populations. Genetics plays a significant role in getting populations of zoo animals that may sustain for several generations. Unfortunately, not much interaction has taken place between zoo managers and scientific institutions in our country. It is very appropriate that the Central Zoo Authority has taken an initiative to bring the zoo managers and scientists together on a common forum. In this session we are having presentations from eminent scientists from different disciplines of life science. I do hope these presentations would give the zoo managers an insight into facilities that are available in this country to manage the animal population in zoos more effectively and efficiently. Now, it is time for them to take full advantage of the latest techniques that the scientists can offer to them.

GENETIC MANAGEMENT OF CAPTIVE POPULATIONS: AN OVERVIEW

A. K. Roychoudhury,
Retired Scientist, Calcutta

Resume
Knowledge of genetics is essential for genetic management of captive populations. Simple knowledge of inheritance of coat colour is helpful for breeding animals like white tigers and black leopards. Studies on protein polymorphism by electrophoresis is widely used for studying the genetic variability in a population. It is generally measured by average heterozygosity. Protein polymorphism may be used for testing genetic purity of captive animals. If inbreeding coefficients of the offspring for all possible pairs are known in advance, an objective breeding plan can be made. Continued inbreeding in small populations leads to the reduction in genetic diversity. Some methods for determining the effective size of an actual population and its effect on heterozygosity have been discussed.

The Central Zoo Authority of India has done a great honour in inviting me to present a paper in the workshop on "Indira Gandi's Vision on Wildlfie Conservation - Zoo as one such Instrument." On this occasion I have decided to present a paper on genetic management of captive populations. I believe, this will be appropriate to the vision of our late Prime Minister, Indira Gandhi on widllife conservation. The underlying theme of the present workshop may be traced to the view expressed by Dr. Rod C. McKenzie of University of Southern California, USA about 20 years ago. He said that the zoos are world's only hope for wild animal survival, for population pressures through out the world would inevitably lead to the total economic exploitation of wild animal habitats (Newsweek, Aug. 1974, pp. 91-92). Therefore, if we want to conserve wild animals, we should start from zoos.

Most of the zoos in our country are used for exhibition of animals. Until now scientific research has rarely been done for captive breeding. Efficient management for captive populations depends upon maintenance of good records of births, parentage, etc. of the animals. Unfortunately such records are not available in most of the zoos.

I apologize that a number of references cited in my paper are not consulted in original, because they are not availbale in librarires. Non-availability of relevant books and journals in our libraries is one of the drawbacks of scientific research for captive animals. I sincerely hope that the Central Zoo Authority of India will look into this matter and establish central and/or regional libraries with all the latest information on animals.

Knowledge in Genetics

Knowledge in genetics is useful for efficient management for captive animals. Those who are in charge of breeding animals in captivity do not have much knowledge of this subject. Let me cite one example. The principle of inheritance of coat colour of white tiger was not known for a long time. If Maharajah of Rewa knew it, he would not have sold the normal coloured offspring of white male, Mohan and normal coloured female, Begum. Similar was the case of one animal dealer in

Calcutta who purchased three offspring of Mohan with a hope that they would become white when they would grow old. As the offspring grew older, there was no sign of whiteness in their coat colour. The animal dealer quickly disposed of them and got relief. All these events happened about 40 years ago. Apparently both the Maharajah and the animal dealer were not aware of the fact that the normal coloured offspring they sold out were actually heterozygous tigers carrying a recessive gene for white colour. They have the capability for producing white tigers, if they are interbred or bred with white ones.

Although we now have the knowledge of inheritance of coat colour, still we do not use it judiciously. In many zoos, heterozygous tigers were mated with homozygous ones either unknowingly or inadvertantly. In consequence, when white tigers appeared suddenly from normal coloured parents in Mysore, Patna and Jaipur Zoos, there were claims that they were new white mutants, as they were not biologically connected with Rewa or Nandankanan lineage. When ancestry of those white tigers were traced, such claims for new mutants were found false. To breed white tigers, known heterozygous tigers should not be allowed to mate with known pure normal coloured tigers, for their homozygous and heterozygous offspring cannot be distinguished morphologically. If these mixed up offspring are sold, exchanged or loaned to any zoo, there is a possibility of white tigers appearing any time and any where. This is perhaps one of the reasons why those who are not in favour of breeding and exhibiting the white tigers in the zoos.

Similar is the case of inheritance of coat colour in leopard. Very few people know that the coat colour of leopards is controlled by a pair of autosomal alleles, the black being recessive to normal (spotted) colour (Roychoudhury and Acharjyo, 1984). If known heterozygous spotted leopards are mated with homozygous ones, it is difficult to identify the genotypes of their offspring. The genealogical chart or studbook for white tigers and black leopards is therefore essential for breeding these animals.

Protein Polymorphism:

The extent of genetic variation in a population is generally studied by electrophoretic analysis of proteins. It is measured by proportion of polymorphic loci and average heterozygosity.

(a) Proportion of Polymorphic Loci

A locus is said to be polymorphic, when the frequency of the most common allele is equal to or less than 0.99, otherwise it is called monomorphic. In a sample of n loci, if m number of loci is found polymorphic, the proportion of polymorphic loci (P) is then $P = m/n$

It is a simple measure of genetic variation in a population, when a large number of loci and a large number of indivduals per locus are studied (Nei, 1987).

(b) Heterozygosity

The most widely used measure of genetic variation in a population is the average heterozygosity or gene diversity. Consider a random mating population in which X_{ij} is the population frequency of the ith allele at the jth locus. The heterozygosity for j^{th} locus (h_{jy}) is defined as

$$hj = 1 - \sum_{i-1}^{k} x_{ij}^{2}$$

where k is the number of alleles at j^{th} locus.

Average heterozygosity (H) is the average of this quantity over all loci. If n is the number of loci sampled from a population, then the average heterozygosity is

$$H = 1/n \sum_{0-1}^{n} hj$$

H = 0, when all the loci are monomorphic (Nei, 1987).

O'Brien *et al* (1985) studied 52 loci of blood proteins in cheetah of South and East Africa and found all of them are monomorphic. On the other hand Dinerstein and McCrakin (1990) found a relatively high heterozygosity of 0.099 at 29 loci of one horned rhinoceros.

Protein polymorphism by electrophoresis can be used to ascertain the genetic purity of captive populations. O'Brien *et al.* (1987) found evidence for infiltration of African lion genes into the captive Asiatic lion (c.f. Hedrick and Miller, (1992). Recently there has been awareness for establishing purity of Asiatic lions as some of them have been mated with African lions in some zoos. Identification of pure Asiatic lions from hybrids is difficult. It is now known that 28 Asiatic lions originating from Gir Forest show monomorphism at 46 enzyme loci, indicating that all the animals are genetically similar at least for these loci (Fouraker, 1994). If any lion showing deviation from genetic sameness, they can be suspected as hybrids. In the absence of genealogical chart or studbook, genetic testing of blood proteins by electrophoresis provides an alternative for detecting the hybrids. Besides, analysis of blood proteins in animals may be used for studying their phylogenetic relationships and taxonomy. How the knowledge of phylogenetic relationship is helpful in reconstructing an extinct subspecies of Dusky seaside sparrow has been studied by Avise and Nelson (1989). This is a novel method for conservation of biotic diversity.

Inbreeding

Mating between related individuals is called inbreeding. An individual is said to be inbred, when its parents have at least one ancestor in common. Genetic effects are manifested when an inbred individual possesses double dose of a gene which is present in a single dose in the common ancestor and its parents. A recessive gene hidden in common ancestor is expressed in inbred individuals. Intuitively it is expected that recessive traits occur with increased frequency among the progeny of related parents. That is why most of the white tigers appeared in zoos, when their normal coloured parents were closely related. The degree of inbreeding is measured by inbreeding coefficient. It is the probability that an individual receives at a locus two genes that are identical by descent. The inbreeding coefficients for different types of consanguineous matings like brother-sister, uncle-niece, first cousins and second cousins are 1/4, 1/8, 1/16 and 1/64 respectively.

From a pedigree chart the inbreeding coefficient of an individual (I) can be calculated by using the following formula

$$F1 = \sum (1/2)^{n} (1+F_{A})$$

where n is the number of individuals (except I) in a closed path leading from one parent to other through their common ancestor. The summation is over all possible paths in the pedigree and F_A is the inbreeding coefficient of the common ancestor at the apex of the path. Note, a path cannot pass through the same individual twice.

Most of the animals in a zoo are founded by a small number of individuals. If they are bred in captivity, after few years they grow a large number of individuals and become related to one another. If they mate each other for long time, inbreeding depression in the form of increased juvenile mortality and decreased fertility may occur. Analyzing breeding records of 44 species in National Zoological Park, Washington D.C., U.S.A., juvenile mortality of inbred young was found to be higher than that of unrelated young in 41 species (Ralls and Ballou, 1983). To increase the number of white tigers quickly in captivity, matings betwen close relatives like father - daughter, brother - sister etc., were practiced in Delhi, Calcutta, Bristol and Washington Zoos. In consequence, reduced fertility and early mortality in white tigers were observed in these zoos (Roychoudhury and Sankhala, 1979). Modern studbook of an animal provides inbreeding coefficients of offspring for all combination of potential sires and dams Ballou and Seidensticker, 1982, Smith, 1985; Roychoudhury *et al.*, 1989. The inbreeding coefficient of the offspring can be used as guides in the selection of mates for future breeding of the animal. Apart from age and health consideration, the mates are to be selected in such a manner that the changes in inbreeding coefficient should not go up more than 1% per generation (Franklin, 1980)

When relationship between mating individuals is known, the inbreeding coefficient can be calculated. If it is not known, it can be estimated on the basis of population size. If there are N number of individuals in a population, the inbreeding coefficient (Ft) of individuals in generation t is

$$F_t = 1/2N + (1 - 1/2N) F_{t-1}$$

Sometimes a symbol, P, for the complement of inbreeding coefficient, 1 - F is used. It is called panmictic index.

Substitution of P = 1-F in the above equation gives

$$P_t = P_{t-1}(1-1/2N) = P_{t-2}(1-1/2N)^2 = ...$$
$$= P_0(1-1/2N)^t$$

where P_0 is the panmictic index of the base population. In the base population, the inbreeding coefficient is zero, and therefore $P_0 = 1$. Then,

$$P_t = (1 - 1/2N)$$

The relative heterozygosity (H) is also defined as panmictic index P (Falconer, 1970). If H_t and H_0 are the frequencies of heterozygotes for a pair of alleles at generation t and in the base population respectively, then the heterozygosity at t-th generation is

$$H_t = H_0 (1-1/2N)^t \text{ (Since, } P_t = H_t/H_0$$

When N = 10 and t = 1, the heterozygosity (genetic variability) is 0.95 or 95% of the initial heterozygosity. After ten generations, the heterozygosity will reduce to 60% of the initial heterozygosity.

Effective Population Size

Effective population size denoted by Ne is a number of individuals who actively participate in the reproductive process. Since all the individuals do not take part in reproduction, the effective population size is generally smaller than actual size of census population (N). Various factors cause the difference. Estimates of N_0 for actual populations depend upon (i) unequal number of breeding males and females. (ii) fluctuations in population size, (iii) non-Poisson (non-binomial) variance in distribution of offspring, (iv) overlapping generations, (v) heritability of fertility, and (vi) geographic structure (Harris and Allendorf, 1989).

Inequalities in number of sexes causes reduction in effective population size. In a population if N_m and N_t are the number of males and females respectively, then the effective size of population is given by

$$N_e = 4 N_m N_t / (N_m + N_t)$$

The reduction is pronounced in polygamous animals. Suppose a population consists of one male and 20 females, the effective size of population is 3.8 and not 21. If number of males is equal to that of females, then the effective size of population is equal to actual size of population.

Table 1

Effective size of population (N_e) for different number of males (N_m) and females (N_t)

N_m	N_t	N_e
1	10	3.6
1	20	3.8
2	10	6.7
5	20	16.0
5	50	18.2

If population size varies from generation to generation, the effective population size is the harmonic mean for all generations, i.e.,

$$N_e = n/(1/N_1 + 1/N_2 + \ldots + 1/N_n)$$

where N_1 is the population size of the ith generation and n is the total number of generations.

The harmonic mean is smaller or at most equal to the arithmetic mean. If the number of breeding individuals are constant for all generations, then effective population size is equal to actual size of population. If a population goes through a bottleneck, the effective population size is greatly reduced. Suppose a population maintains its size of 1,000 individuals for four consecutive generations and suddenly it drops to 50 individuals in fifth generation, then Ne becomes 208.

If family size varies, the effective population size will be

$$N_e = 4N/(2+ V_k) \text{ approximately}$$

where V_k is the variance in family size and N is the actual number of population. If all the families contribute equally to the next generation, there will be no variation in family size,

$$N_e = 2N$$

The effective population size is approximately twice the number of actual population. If variance in family size is 2, the effective population size is approximately equal to the actual size. In the literature there are number of formulae of the effective size of the populations under different conditions as mentioned above.

The effective size of a population is sometimes used to measure the amount of inbreeding in a finite population. Its effect on heterozygosity can be determined by substituting the effective population number for actual population size (N) in the above mentioned formula, i.e.,

$$H_t = H_0 (1- 1/2 Ne)^t \text{ (See Crow and Kimura, 1970)}$$

Table 2
Decline of heterozygosity (or genetic variability) for different effective size of populations (Ne) and generations (t)

N_e	Generation (t)				
	1	5	10	50	100
10	.95	.77	.60	.077	.006
25	.98	.90	.82	.36	.13
50	.99	.95	.90	.60	.37
125	.996	.98	.96	.82	.67
250	.998	.99	.98	.90	.82
500	.999	.995	.990	.95	.90

The rate of loss of heterozygosity (i.e., genetic variation) is a function of the effective size of population. The smaller the population, the greater the loss of genetic variation. Franklin (1980) suggested that Ne for large mammals should not be less than 50. However, Ne of order 500 can preserve 90% of the original genetic diversity for 100 generations.

References

Avise, J. C. and Nelson, W. S. (1989) Molecular genetic relationships of the extinct dusky seaside sparrow. Science 243: 646-648. (Not consulted in original)

Ballou, J. D. and Seidensticker, J. (1982) Demographic and genetic status of the captive population of Sumatran tigers *(Panthera tigris sumatrae)*. In: International Tiger Studbook. Zoological Garten Leipzig, Germany. pp. 5-39.

Crow, J. F. and Kimura, M. (1970) An introduction to Population Genetics Theory. New York, Harper & Row. p. 109.

Dinerstein, E. and McCracken, G. F. (1990) Endangered greater one-horned rhinoceros carry high levels of genetic variation. Conservation Biology 4: 417-422 (Not consulted in original).

Falconer, D. S. (1970) Introduction to Quantitative Genetics. New York, Ronald Press Co., p. 66

Fouraker, M. (1994) Asiatic lion studbook history and overview. Zoos' Print, Jan/Feb issue. pp. 65-66.

Franklin, I. R. (1980) Evolutionary change in small populations. Conservation Biology, Soule, M. E. and Wilcox, B. A. (eds.) Sunderland MA, Sinauer Associates, pp. 135-149.

Harris, R. B. and Allendorf, F. W. (1989) Genetically effective population size of large animals: An assessment of estimators. Conservation Biology 3: 181-191.

Hedrick, P. W. and Miller, P. S. (1992) Conservation genetics: Techniques and fundamentals. Ecological Application 2 : 30-46.

Nei, M. (1987) Molecular Evolutionary Genetics. New York, Colombia Univ. Press.

O'Brien, S. J., Juslin, P., Smith, G. L., Wolf, R., Schafer, N., Heath, E., Ott-Joslin, Raval, P. P., Bhattacharjee, K. K., and Martenson, J. S. (1987) Evidence for African origins of founders of the Asiatic lion Species Survival Plan. Zoo Biology 6:99-116 (Not consulted in original)

O'Brien, S. J., Roelke, M.E., Marker, L., Newman, A., Winkler, C.A., Meltzer, D., Colly, L., Evermann, J.F., Bush, M., and Wildt, D.E. (1985) Genetic basis for species vulnerability in the cheetah. Science 227 : 1428-1434.

Ralls, K. and Ballou, J. (1983) Extinction : Lessons from zoos. In: Genetics and Conservation : A reference for managing wild animals and plant populations, C. M. Schonewald-Cox, S. M. Chambers, B. MacBryde, and L. Thomas (eds). London, Benjamin/Cummings Pub. Co., pp. 164-184.

Roychoudhury, A.K. and Acharjyo, L.N. (1984) Genetics of coat colour in the leopard *Panthera pardus*. Ind. J. Expt. Biol. 22: 308-311.

Roychoudhury, A. K., Banerjee, G. C., and Poddar, R. (1989) Studbook of white tigers *(Panthera tigris tigris* Linn) in India. Zoo Outreach Organization, India.

Roychoudhury, A. K. and Sankhala, K. S. (1979) Inbreeding in white tigers. Proc. Indian Acad. Sci. 88B: 311-323.

Smith, G. L. (1985) International Studbook on Indian lion *(Panthera leo persica)*. Knoxville Zoological Park, USA.

COORDINATION OF BREEDING PROGRAMME FOR ENDANGERED SPECIES

S. C. Sharma, Member Secretary
Central Zoo Authority, New Delhi

It has been a common practice in zoos to breed the animals that are least aggressive and easiest to handle. For the sake of convenience the young ones of the same litter are kept together and allowed to breed. This brother sister breeding obviously reduces the genetic variation and essentially leads to unintended domestication.

The importance of genetic variation, had been clear for much of this century. It is important at two levels -- the population and the individual. Within population, genetic variation is the basis for change. When environment changes, a population must change equally as fast, or become extinct. How rapidly a population adapts to the changing environment depends on how much genetic variation it contains. If there is none, it cannot adapt at all. There is a second way in which genetic diversity may be important to populations. Genetic differences between individuals may allow them to utilise slightly different resources. Thus reducing competition, they would allow a larger size of population and probably improve stability of numbers. the magnitude of this is still not known.

On an individual level, genetic variation -- or heterozygosity -- is related but not identical to the genetic variation in populations. Both decline with inbreeding. In small, close populations - such as many existing zoo populations - some inbreeding is inevitable; in most respects it has been found to be individually harmful. The decrease in genetic variation generally leads to loss of 'vigour' and reduced viability, growth rate, fertility, fecundity, lactation and competitive ability. Damage is detectable at various levels of inbreeding and published reports show deleterious effects at inbreeding coefficients of 0.25 to 0.75 (0.25 is the amount of inbreeding from a brother-sister mating).

Laboratory tests have shown that most of the small populations which are excessively inbred can become extinct rapidly. Attempt to produce lines of laboratory animals by brother-sister matings results in about 95% of cases in extinction. The slower rate of inbreeding causes much less damage as selection has an opportunity to counteract the deleterious effects of inbreeding.

How do we conserve the genepool?

Basic pre requisites for any conservation programme should be the founder population. A founder is defined as an animal from a source population (wild) that establishes a derivative population (in captivity). To be effective, a founder must reproduce and be represented by descendants in the existing population. Technically to constitute a full founder, an animal should also be unrelated to any of other representatives of the source population.

Basically the more founders, the better it is. More the number of founders, smaller the minimum viable population required for maintaining genetic diversity, There is also a demographic founder effect. Larger the number of founders, less likely would be extinction due to demographic stochasticity. However, it is easily possible to establish a viable population of a species, if the programme starts with 20-30 effective founders.

Scientific population management would consist of mating the least related animals with each other for each succeeding generation. Any breeding programme that starts with 20-30 founders under the ideal breeding scheme of this would preserve atleast 90% of the genetic diversity for 200 years, (provided we can build up a genetically and demographically viable population). This fact is illustrated by the studies done by various geneticists (Fig.1).

Equal number of offsprings from each founder pair has additional advantages. Equal number of offsprings or equal family size, means that no animals breed in preference to another - in other words that all animals make an equivalent contribution to the next generation. In a population which is expanding, each individual might, for example, be permitted four offsprings. In a stable situation, management strategy would ensure that it had one young that reached the reproductive age. Not only does this approach help minimise inbreeding but also slows unintentional domestication. By equalising offsprings numbers, the trend towards domestication is significantly modified, and the capacity of the species to adapt to wild habitat is preserved.

The second aspect of population management involves maintaining an effective population size, designated as Ne. Ne is not the same as the census size, N. Ne is the effective number of animals that are reproducing and transmitting genes to the next generation. Ne is usually much less than N. This means that founders should constitute an equal family size and to keep the value of Ne at optimum level, each founder should contribute to future generations equally. Ideally each family must have an equal number of males and females. A population with an even (1:1) sex ratio would preserve nearly twice as much genetic material as a population of similar size with a sex ratio of 1:5. For numerous management and behavioural reasons, however, the sex ratio of breeding animals often deviates widely from theoretical ideal.

To avert the consequences of rapid inbreeding and intensified artificial selection resulting from an highly unequal distribution of offsprings between the founders, would require conscious practice which will redress the balance.

The third aspect of population management would be to maintain longer generation time. As generation time is the averge at which animals reproduce, with a longer generation time the species would have fewer oppurtunities to lose genetic diversity.

As a consequence the minimum viable population (MVP) can be smaller for species having longer generation time.

Thus, if reintroduction is to become a reality, a vigorous, genetically diverse population

that is minimally adapted, both genetically and behaviorally, to captive conditions will be required. The optimum plan for achieving a population of this calibre might be constructed along the following lines:

1. Begin with as large a founder group as permissible; its sex ratio should be approximately even.

2. Expand the founder group to maximum captive carrying capacity as quickly as possible, ensuring equal family sizes and breeding all available animals.

3. Select pairs for mating wherever possible in accordance with the maximum avoidance of inbreeding scheme.

4. Rotate males as necessary to meet social criteria for reproduction while at the same time equalising male breeding potential.

For achieving the objectives mentioned above the first requirement - is Studbook data in respect of all endangered species. On the basis of the Studbook data, suitable founder animals, can be identified. Depending upon the founder animals the target population or the minimum viable population can be worked out.

Before starting the actual breeding programme knowing of the carrying capacity of different zoos for the species will have to be determined, and such institutions which have capability for carrying out the programme in a planned manner will have to be identified. Any institute where there are chances of genetic pollution whould be kept out of this programme.

The species coordinator will have to monitor the births, deaths of animals regularly and ensure that the population is growing at the desired rate. If there are any problems arising, help of experts in assisted reproduction should be taken. Any animal that is in excess of the required sex ratio should either be transfered to a participating institution or taken out of the programme and sterilized.

ASSISTED REPRODUCTION IN ENDANGERED SPECIES

Dr. S. Shivaji
Centre for Cellular and Molecular Biology
Uppal Road, Hyderabad 500 007, India

INTRODUCTION

The world with all its biodiversity represented by the various diverse species of plants, animals and micro-organisms is an extremely beautiful habitat with plants like the elegant orchids, birds like the majestic peacock and mammals like the exquisite leopard. This is how, one would like the world to be. But, the reality is not so and our descendents might be denied the benefits of wildlife diversity and may have to be satisfied with a handful of domestic plants and animals. In fact, the sad truth is that we are in the midst of the rapid depletion and extinction of life forms primarily due to human development. It has been estimated that by the end of the present century out of the 10 million living biological species 1 million will probably become extinct. At the rate at which the process of extinction is continuing it is assumed that everty hour one species would become extinct (Myers, 1979). Hence attempts have to be made to curb the extinction of life forms and increase their survival so as to prepetuate the species i.e., maintain biodiversity. It is in this context that several exotic animals have been brought under the shelter of conservation by creating zoological parks and wildlife reserves where the breeding programmes could be controlled.

But, unfortunately, captive breeding programmes did not prove successful with all animals. It was successful with respect to the Mongolian horse, European bison and the Indian crocodile but failed with respect to the clouded leopards, penguins, condors etc. (Schonewald-Cox *et al.*, 1983; Martin, 1975). The reasons for success or failure are obscure and only studies on the reproductive biology of these animals may shed light on the possible reasons. Further, the information acquired may then be judiciously used for assisted reproduction in endangered species.

ASSISTED REPRODUCTION

Intervention of mankind to improve the fertility status and reproductive performance of an organism is referred to as assisted reproduction (AR). In the simplest case assisted reproduction may merely involve the bringing together of the mating pair when both the male and female exhibit signs of mating behaviour. However, in a more complicated case it may involve semen collection, semen cryopreservation, oocyte pick up, oocyte cryopreservation, *in vitro* fertilization (IVF) and embryo transfer (ET). Thus it is obvious that success of assisted reproduction would be measured not merely by the attempts made but by the number of live births obtained.

Fertilization normally occurs when two mature animals of opposite sex mate and the male and female gametes fuse to form the zygote. But in some wild animals even the mating process is affected due to incompatible partners or because the females are not ovulating and as a consequence there is a reduction in the reproductive performance of wild animals.

Reduction in reproductive performance normally results due to reduction in population size and size of breeding grounds. As a consequence the animals are forced to continuously inbreed resulting in increased homozygosity which leads to adverse effects such as reduced litter size and decrease in survival rate of progeny. These effects are referred to as 'inbreeding depression'.

However, increase in homozygosity could be prevented by preserving the natural habitat of animals which could be achieved as follows:

(a) by preventing the degradation of environment due to socio-economic factors such as construction of factories and industries near forests,

(b) by preventing reduction of forest cover due to socio-economic reasons or due to human population pressure and

(c) by preventing indiscriminate exploitation of forest products.

In fact, habitat protection and creation of sanctuaries and wild life parks has resulted in the success of the project tiger and the crocodile breeding programme. Despite this success, one of the major reasons for the dwindling wild life population is due to inbreeding depression which is generally characterised by low sperm count, high morphologically abnormal sperm, increased infant mortality, increased vulnerability to infection and low genetic variation. This is clearly obvious when one looks at the above parameters in cheetah and domestic cat (Table 1) (Wildt *et al.*, 1983). O'Brien *et al* (1985) carried out an extensive study on the infant mortality of 29 mammalian species bred in captivity such as rat, mouse, opossum, deer, elephant, muntjac, giraffe, deer, hippo, zebra, gazelle, reindeer, cheetah, etc. and concluded that inbred zoo species consistently exhibit greater juvenile mortality, non-inbred cheetahs also exhibit increased juvenile mortality and infant mortality in inbred and non-inbred cheetah were not significantly different (O'Brien et al., 1985). One would normally expect captive breeding animals to be more vulnerable compared to free ranging breeding animals. But this is not the case at least in the cheetah indicating that poor reproductive performance is not due to inbreeding but due to genetic uniformity of the species leading to polymorphic spermatozoa (Wildt et al., 1983).

Table 1. Effects of inbreeding depression 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'Brien *et al.* (1985).

However, inbreeding depression effects are very well observed in lions where one could compare the parameters between an outbred population (Serengetti, Tanzania), a slightly mixed (Ngorongoro, Tanzania) and a totally inbred population (Gir Forest, India). One could see a decrease in sperm count, increase in abnormal sperm, decrease in motile sperm, decrease in testosterone and decrease in heterozygosity (O'Brien, 1994) (See Table 2).

Table 2. Correlation of genetic variation and reproductive parameters in three lion populations *

Parameters	Serengeti, Tanzania	Ngorongoro Crater, Tanzania	Gir Forest, India
Heterozygosity , %			
Allozyme	3.1	1.5	0.0
MHC RFLP	21.8	8.0	0.0
DNA fingerprinting	48.1	43.5	2.8
Reproductive measure			
Sperm count ($x10^{-6}$)	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 ($x10^{-6}$)	228.5+/-65.5	236.0+/-93.0	45.3+/-9.9
Testosterone (ng/ml)	1.3-1.7	0.5-0.6	0.1-0.3

* Data compiled from O'Brien (1994) and Wildt *et al.* (1987).

METHODS OF ASSISTED REPRODUCTION

The objectives of AR are to overcome infertility and thus improve fertility status of animals especially endangered species which exhibit a reduction in reproductive performance. The various methods of AR are:

1 Semen collection - by electroejaculation

2 Semen cryopreservation

3 Semen evaluation with respect to morphology, motility, sperm acrosome reaction, sperm fertilizing ability, etc.

4 Artificial insemination or intrauterine insemination (IUI)

5 *In vitro* fertilization (IVF) and uterine embryo transfer (ET)

6 Embryo transfer (ET)

7 Gamete intrafallopian transfer (GIFT)

8 Zygote intrafallopian transfer (ZIFT)

Methods have been standardised for the collection of semen from captive and free ranging animals and best results have been obtained by the use of rectal probes. Simultaneously attempts have also been made to cryopreserve semen for future use. These two methods need to be mastered to perfection since they form the basis for assisted reproduction especially when the mating couple are separated from one another or are unwilling to mate due to various reasons. However, semen thus collected could be evaluated with respect to morphology, mortility, sperm acrosome reaction and fertilizing ability. Table 3 shows the characteristics of ejaculates obtained from tiger (Donoghue *et al.*, 1992 a), cheetah (Donoghue *et al.*, 1992 b) and leopard (Roth *et al.*, 1994). In these three studies the ability of the spermatozoa to fertilise eggs was also evaluated using cat oocytes and in certain cases the oocytes from the female of the species. It was observed that fresh and thawed spermatozoa of tiger fertilized tiger oocytes with the same efficiency (70% of the oocytes were fertilised) (Donoghue *et al.*, 1992 a) and were also capable of fertilizing oocytes from the domestic cat but the efficiency was less than 50% (Table 4). Cheetah spermatozoa were also capable of fertilizing cheetah oocytes *in vitro* but the fertilisation rates between individuals varied from 0 to 73% (Donoghue *et al.*, 1992 b). However, the snow leopard spermatozoa were incapable of penetrating cat eggs (Roth *et al.*, 1994).

Table 3. Characteristics of semen ejaculates of tiger, leopard and cheetah *

Characteristics	Tiger	Leopard	Cheetah
Ejaculate volume (ml)	-	2.6+/-0.3	1.1+/-0.2
pH	-	8.6+/-0.1	4
Total spermatozoa ($x10^{-6}$) -		277.3+/-71.8	44.7+/-21.1
Motility (%)	88	78.1+/-2.1	74.4+/-3.6
Progressive motility (%)	-	4.3+/-0.1	3.8+/-0.2
Motility index (%)	90	81.6+/-19	75.1+/-3.7
Normal spermatozoa (%)	86	63.3+/-3.0	-
Abnormal spermatozoa (%)	14	36.7+/-1.6	51 to 92%
Motile spermatozoa per ejaculate ($x10^{-6}$)	112	-	41.3+/-22.9

* data compiled form Donoghue *et al.*, (1992a; 1992b) and Roth *et al.* (1994). The data for tiger represents the mean of individual ejaculates.

Table 4. Fertilization of tiger and cat eggs using fresh or thawed tiger spermatozoa *

	Spermatozoa	
	Fresh	Thawed
Number of tiger eggs cleaved	34/49	33/47
% of tiger eggs cleaved	70%	70%
Number of cat eggs penetrated	13/41	20/41
% of cat eggs penetrated	32	49

* Data compiled from Donoghue *et al.* (1992 a).

One method of assisted reproduction which has been extensively used is IUI. This method is relatively simple and has been effectively used to eliminate inbreeding depression for the following reasons :

1 Ensures reproduction between incompatible partners.

2 Eliminates risk of animal transport.

3 Increases chances of gene mixing.

An excellent example of IUI has been with respect to breeding of Eld's deer (Monfort *et al.*, 1993). Eld's deer is an endangered species consisting of wild population in Myanmar and captive population in North American zoos. Both breed well in captivity but have inbred for a very long time and exhibit inbreeding depression. Hence attempts were made to breed the two populations by estrous synchronisation and IUI. Oestrous synchronisation was achieved by using intravaginal progestrogen releasing devices and IUI was done with cryopreserved semen which was thawed before use. Pregnancy has now been achieved in a number of deers by this method (Monfort *et al.*, 1993). Attempts are in progress to use IUI in case of the Florida panther which is close to extinction. The numbers of this animal have reduced to less than 50 and the animals exhibit all signs of inbreeding depression such as low heterozygosity, increase in abnormal sperm, increase in cryptochidism and increase in vulnerability to disease (Barone *et al.*, 1994).

From the foregoing description it is obvious that the application of AR methods has been restricted to very few methods such as electroejaculation, cryopreservation, IVF and ET and barely anything has been done with regard to the use of GIFT and ZIFT (Amso and Shaw, 1993). The later two methods have been successfully used for a variety of laboratory animals and human beings and could be potentially used also for wild animals. Recently two new methods, namely ICSI and zona drilling, of AR have been developed and used with success in human beings (Tournaye *et al.*, 1994; Schutze *et al.*, 1994). ICSI is the

acronym for intracytoplasmic sperm injection and in this method a spermatozoan is directly injected into the oocyte cytoplasm so as to achieve fertilization even in the absence of motility. This method could be applied wherever the sperm quality is poor and it could be used in conjunction with IVF and ET. However, the most recent method of AR uses a UV-laser microbeam and an optical tweezers trap, to drill holes into the zona pellucida of oocytes, to catch and transport a sperm through the hole into the perivitelline space and to bring it in close contact with the oolemma (Schutze *et al.*, 1994).

CONCLUSIONS

Thus it is obvious that AR methods have been applied to wild animals only in a limited way because of the inherent difficulties involved in handling of the animals and standardising 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 standardised before it is too late and preferably before inbreeding depression sets in. Further AR techniques for wild animals 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.

REFERENCES

Amos, N.N. and Shaw, R.W. (1993) A critical appraisal of assisted reproduction techniques. Hum. Reprod. 8: 168-174.

Barone, M.A., Wildt, D.E., Byers, A.P., Roelke, M.E., Glass, C.M. and Howard, J.G. (1994) Gonadotrophin dose and timing of anaesthesia for laparoscopic artificial insemination in the puma *(Felis concolor)*. J. Reprod. Fertil. 101:103-108.

Donoghue, A.M., Johnson, L.A., Seal, U.S., Armstrong, D.L., Simmons, L.G., Gross, T., Tilson, R.L. and Wildt, D.E. (1992 a) Ability of thawed tiger *(Panthera tigris)* spermatozoa to fertilize conspecific eggs and bind and penetrate domestic cat eggs *in vitro*. J. Reprod. Fertil. 96: 555-564.

Donoghue, A.M., Howard, J.G., Byers, A.P., Goodrowe, K.L., Bush, M., Blumer, E., Lukas, J., Stover, J., Snodgrass, K. and Wildt, D.E. (1992b) Correlation of sperm viability with gamete interaction and fertilization *in vitro* in the Cheetah *(Acinonyx jubatus)*. Biol. Reprod. 46: 1047-1056.

Martin, R.D. (1975) Breeding endangered species in captivity. Academic Press, New York.

Monfort, S.L., Asher, G.W., Wildt, D.E., Wood, T.C., Schiewe, M.C., Williamson, L.R., Bush, M. and Rall, W.F. (1993) Successful intrauterine insemination of Eld's deer *(Cervus eldi thamin)* with frozen-thawed spermatozoa. J. Reprod. Fertil. 99: 459-465.

Myers, N. (1979) The Sinking Ark. Pergamon, Oxford.

O'Brien, S.J. (1994) A role for molecular genetics in biological conservation. Proc. Natl. Acad. Sci., USA, 91 : 5748-5755.

O'Brien, S.J., Roelke, M.E., Marker, L., Newman, A., Winkler, C.A., Meltzer, D., Colly, L., Evermann, J.F., Bush, M. and Wildt, D.E. (1985) Genetic basis for species vulnerability in the cheetah. **Science, 227:**1428-1434.

Roth, T.L., Howard, J.G., Donoghue, A.M., Swanson, W.F. and Wildt, E.D. (1994) Function and culture requirements of snow leopard *(Panthera uncia)* spermatozoa *in vitro*. J. Reprod. Fertil. 101: 563-569.

Schonewald-Cox, C.M., Chambers, S.M., Mac Bryde, B. and Thomas, L. (1983) Genetics and conservation. Benjamin-Cummings, Menlo Park, California.

Schutze, K., Clement-Sengewald, A. and Ashkin, A. (1994) Zona drilling and sperm insertion with combined laser microbeam and optical tweezers. Fertil. Steril. 61: 783-786.

Tournaye, H., Devroey, P. and Liu, J. (1994) Microsurgical epididymal sperm aspiration and intracytoplasmic sperm injection: a new effective approach to infertility as a result of congenital bilateral absence of the vas deferens. Fertil. Steril. 61: 1045-1051.

Wildt, D.E., Bush, M., Howard, J.G., O'Brien, S.J., Meltzer, D., Van Dyk, A., Ebedes, H. and Brand, D.J. (1983) Unique seminal quality in the South African Cheetah and a comparative evaluation in the domestic cat. Biol. Reprod. 29: 1019-1025.

Wildt, D.E., Bush, M., Goodrowe, K.L., Packer, C., Pusey, A.E., Brown, J.L., Joslin, P. and O'Brien, S.J. (1987) Reproductive and genetic consequences of founding isolated lion populations. Nature, 329: 328-331.

BREEDING BIOLOGY AND ASSISTED REPRODUCTION INCLUDING GENOME BANKING

Dr. Dharmeshwar Das.
Head, Dept. of Animal Genetics & Breeding
College of Veterinary Science, Assam Agricultural University
Khanapara, Guwahati 781 022, Assam

Abstract

Dwindling numbers of free-ranging populations of wildlife has necessitated captive populations to reproduce successfully to ensure the future requirements of sustaining animal life in captivity and in the wild by reintroduction. With a knowledge of the breeding biology in the wild, a breeding programme needs to be evolved for each group of animals. Evaluation of the animals in respect of genetics, physiology, anatomy, behaviour and breeding soundness of the animals is also a must for this purpose.

In an intensive breeding programme, there may be several different ways the animals and their biology may be manipulated. For natural breeding, animals of satisfactory quality are only acceptable for mating. In assisted reproduction or artificial breeding schemes, even unfit animals if are genetically fit are considered as potential players. Artificial Insemination and Embryo Transfer are two important tools of artificial breeding.

Genome Banking is fast becoming an important tool in wildlife conservation. Genetic engineering and biotechnology has opened up possibilities for moving genes across sexual barriers to meet new needs and situations.

TECHNOLOGIES FOR BREEDING BIOLOGY AND ASSISTED REPRODUCTION INCLUDING GENOME BANKING

M. L. Madan, S. K. Singla and R. S. Manik

Embryo Biotechnology Centre
National Dairy Research Institute
Karnal 132 001 (HARYANA)

India is remarkable for the variety of its large mammals, a richness in species exceeded by few countries in the world. From the rain forest of Assam to the snows of the Himalayas and the deserts of Rajasthan, from the deciduous forests of the Central highlands to the mangrove swamps of the Sunderbans, India presents a great diversity of vegetation types, each with its unique fauna assemblage and harbouring a variety of animal wealth.

Several factors have acutely contributed to the decrease of wildlife and our national wealth, which include hunting, animal diseases, quality of the range, habitat destruction, uncontrolled slaughter, malnutrition and pressure on land both from man and livestock.

India has an estimated 271 million cattle and buffalo and 161 million goats and sheep, of which over 25 million of the former and 15 million of the latter grazed exclusively in the forests. Livestock is permitted to graze in virtually all forests and most sanctuaries, and serious damage to the vegetation culminating in widespread erosion is common particularly in the thorn and deciduous forests. The carrying capacity of many forest areas and other uncultivated lands is so far exceeded by livestock alone that a substantial amount of wildlife could not support itself even if it were protected from game.

Livestock diseases, especially rinderpest and foot-and-mouth disease, also affect the wild ruminants. There are numerous records of gaur, chital, and others contracting diseases from cattle and dying in large numbers, whole populations having been wiped out in this manner. The health of domestic and wild hoofed animals is mainly a function of the quality of the range, and animals in poor condition as a result of malnutrition become highly susceptible to parasites and disease, making the problems of range condition and disease inseparable. The net effect of all these conditions is that the number of animals get reduced and breeding failure becomes the major constraint in wildlife sustainance.

Over the years several technologies have been developed which has helped in augmenting reproductive function. These technologies including embryo collection, storage and transfer provide incentive for solving management problems and improvement of the endangered status of many zoological species. Achieving these objectives will be neither simple nor immedite. The currently conventional use of semen and embryo procedures for breeding cattle can became "routine" only if basic and applied research by scientists is supported by commercial grants and unlimited animal numbers. Similar resources are unavailable to the researchers, and the constraints for extremely endangered species further complicate the task. Nevertheless, zoological researchers should now concentrate on establishing physiological

norms for selected species of interest. Comparative studies in domesticated animals will accelerate progress. The immediate goal should be publication of sound scientific data, including information concerning negative results. Only then can organized, composite strategies be formulated to consider artificial propagation available alternative for preserving species. Some concerns in this connection include.

a) Influence of stress and the potential value of field studies:
There is a great need for basic research, a requirement originating as a result of unique specialization. These specializations exist either as biological norms or potentially as a result of the captive environment. Therefore, it is prudent to recognize and appreciate temperamental sensitivities of wildlife animals used for research purposes. Also, because of variations in susceptibility to stress, physiological norms measured in captivity may not correlate with values found in free-ranging species. Therefore, studies to evaluate adrenal reproductive relationships, improved chemical and physical restraint noninvasive techniques for physiological monitoring are of high priority.

b) Animal availability :
Scientifically sound, physiological research is impossible without access to animals. Species requiring the most study usually are available in the fewest numbers. Additionally, physiological studies generally require animal restraint and/or immobilization, frequently a concern and point of contention between the curatorial/keeper staff and researcher. The lack of unavailability of a certain species at any one zoo may be compensated by close cooperation among different zoos. Therefore, a clear and open line of communication and collaboration among the administrative, curatorial and research staffs within and among zoos assures species accessibility and optimal research productivity.

c) Financial support :
Artificial breeding technology and related basic/applied research programs are costly to initiate and maintain. The primary obstacle to rapid growth and improvement of zoo research is the lack of resources to provide salaries for highly qualified research staff. The actual laboratory effort (requiring equipment and supplies) is a secondary problem which in many instances could be alleviated by the closer collaboration with local universities with existing research programs. Nonetheless, new mechanisms for financial support require exploitation. The popularity of preserving endangered species should not be neglected and has lately been accepted as a national priority. Financial needs should be publicized to the private sector and commercial enterprise.

d) Trained personnel :
Graduate student education programs are critical to future needs for good investigators well trained in research concepts, but with a background and appreciation for the management skills associated with studying, maintaining and handling wild species. Reproductive physiologists in animal science, biology and veterinary departments at local universities also offer an important resource for zoo research needs.

e) Image of physiological research :
Frequently the concept of physiological research in a zoo is misunderstood by nonresearchers and the public. At one extreme, animals are perceived as being excessively manipulated to the point of being treated inhumanely; at the other, these novel research techniques offer a "quick fix" to the endangered or infertility status of many species. The justification for such research, of course, exists at an intermediate level. Therefore, increased communication and awareness within the zoo community is needed, non only for applauding the benefits of basic research but for stressing the limitations of current technology toward practical artificial breeding.

ASSISTED REPRODUCTION

Artificial insemination :
Artificial insemination (AI) has been the most widely applied assisted reproduction technique in nondomestic species. Offspring have been produced by AI in diverse species of carnivores, nondomestic ungulates, primates, marines mammals, reptiles and birds (9, 18, 34, 37, 45). For nondomestic species, an emphasis has been placed on developing non-invasive AI methods by depositing the sperm vaginally or transcervically. The efficiencies of these approaches generally have been poor, particularly for frozen semen, presumably due to reduced sperm motility and longevity after thawing. This reduction in motility is thought to affect sperm transport to the oviduct. Improved pregnancy rates have been obtained more recently by depositing sperm into the tip of the proximal uterine horns by laproscopy, with efficiencies in some species (e.g. deer) approaching those reported for domestic animals (4, 45).

The domestic livestock industry has demonstrated the utility of semen extension and AI for enhancing the reproductive capabilities of valuable male animals. Coupled with semen cryopreservation, AI can maximize the reproductive potential of males, while eliminating any limitations of time and distance. Moreover, genetic material can be preserved indefinitely without taking up valuable space in zoos; therefore, genetic goals can be achieved even for small captive populations. Using computer simulations, Johnston and Lacy (20) demonstrated the possibility of retaining maximum genetic diversity in the captive gaur herd with as few as 40 individuals using AI and a frozen semen bank (excluding demographic constraints). The species survival plan for gaur has implemented the use of assisted reproduction with the development of effective methods for semen collection and cryopreservation (36). Currently, semen has been stored from 41 animals, 15 of which are on longer living, and gaur offspring have been produced by AI and in vitro fertilization using frozen/thawed semen (14).

The main limitation in the application of AI to nondomestic animals is the lack of detailed information on reproduction in most species. For example, in many species captive females do not display estrus; therefore, the proper timing of AI depends on other methods of detecting ovulation. Measuring blood hormone concentrations for this purpose can be confounded by the effects of the physical restraint or anesthesia that is often necessary for blood collection (16, 19). Alternatively, methods for characterizing reproductive events and even

diagnosing reproductive failure have been performed using urine, milk or fecal samples (17,30,31,32). These methods for endocrine evaluations should eliminate some of the problems associated with AI in the future by reducing the stress associated with capture and restraint.

Embryo Transfer Technology

There is no doubt that embryo transfer is an extremely useful research tool. It has been used to investigate the degrees to which the mother and tetus or newborn control characteristics such as gestation length, birth weight, fleece qualities and immunoglobin absorption from colostrum; it continues to add to our understanding of the interrelationships between the embryo, uterus and ovary that are essential to establish and maintain pregnancy; and it is an essential component of all embryo manipulation procedures.

It has been used in the production of calves, lambs, kids and foals from frozen embryos; in the production of identical twin calves, lambs, pigs and foals and even identical quintuplet lambs; to produce calves and lambs of known sex; to produce calves, lambs and pigs from oocytes fertilized in vitro to produce chimeric animals comprising cells from sheep and goats, and sheep and cattle; to produce interspecific pregnancies (lambs have been born to goats, kids to ewes, donkeys and even a zebra to mares, and a gaur calf to a cow); and most recently, in the production of transgenic livestock (for example; pigs and sheep into which foreign genes were injected at the pronuclear stage). It has been used to treat some kinds of infertility and for certain disease control measures (e.g. the introduction of new blood lines into specific-pathogen-free pigs herds). The AI industry has made direct use of embryo transfer to test its bulls for Mendellian recessives, and many AI stud bulls are being derived from contract transfers.

Transcervical collection devices are normally based on a fine rubber Foley-type catheter with a balloon cuff that is introduced under aseptic conditions through the cervix into the base of a uterine horn. Sterile flushing medium (most often an enriched, phosphate-buffered saline) is run into the horn by gravity or from a syringe until adequate distension can be felt per rectum. Infusion is then stopped and the medium collected back through the same catheter into suitable vessels. This procedure is repeated several times on each horn.

To receive the embryos from the flush, its volume is first reduced to a convenient amount that can be throughly searched in petri dishes under a dissecting microscope. The volume can be reduced by siphoning off most of the medium after a period of sedimentation because embryos gravitate to the bottom of the collection vessel. However, it is now more usual to pass the flush thorugh a plankton filter that retains the embryos which are then rinsed off into the Petri dishes. Once located under the microscope, the embryos are transferred with a Pasteur pipette to a smaller volume of fresh medium for closer examination. Those assessed as morphologicly normal are held in medium room temperature or at 37°C until they are transferred to recipients, or prepared for more specialized treatment such as sexing or freezing.

Transfer is still sometimes performed surgically through a flank incision in standing animals under regional anesthesia. The uterine horn is punctured with a blunted probe to admit a Pasteur pipette, from which the embryo is expelled into the uterine lumen with a small volume of medium. However, non-surgical transfer with an AI gun (for example, the Cassou or the Hannover models) passed through the cervix is now more widely used because of its simplicity.

The real advance in increasing rate of animal reproduction has been achieved through the production of as many as 10 calves from a single elite Karan Fries donor mother within an years's time at NDRI, Karnal. Through this technology, more than 4 calves within a year have been also produced from other high merit donor cows.

Through the use of different superovulating hormones in Karn Fries, Karan Swiss and Sahiwal cows, with standardized protocols, an average of 5.5 embryos are collected from each animal of which an average of 3.0 are transferable. Among the buffaloes, on the basis kof over all responses, an average 2.7 embryos are harvested out of which about 1.5 embryos are transferable.

This centre of the project has been able to obtain more than 1300 cattle and buffalo embryos of which nearly 70% are from cattle. About 50 percent of these harvested embryos have been of transferable quality.

The technology at this institute has distinguishably been also extended to native breeds wherein embryo transfer calves from the best zebu dairying breed i.e. Sahiwal have been produced, thereby demonstrating the utility of this technology both among the native breeds of cows and buffalo as well as crossbred animals (3, 26, 27, 30, 31, 32, 40, 41, 42, 43). Morphologically, the embryos from zebu breeds are similar to those harvested from crossbred animals.

Interspecies transfers :

Interspecies embryo transfer provides a special challenge in that its success depends on selection of an appropriate donor/recipient combination. A number of examples of successful interspecies transfer of embryos from rare and endangered species are available, including gaur embryos and banteng embryos transferred to domestic catle (38, 44), bongo embryos transferred to elands (8), Przewlski's horse embryos transferred to domestic horses (15, 39) and Indian desert cat embryos transferred to domestic cats (33). In addition to these successes are many failures, including early resorption of the foreign embryo and late-term abortion of the xenogeneic fetus (e.g., zebra embryos transferred to donkey recipients) (39), and inexplicable developmental abnormalities in aborted xenogeneic fetuses (e.g., Dall's sheep embryos transferred to domestic sheep recipients). Even among the examples of successful interspecies embryo transfer are instances of complicated pregnancy. When Grant's zebra embryos were transferred to domestic horse recipients, one more suffered symptoms of polyarthritis before foaling a term, stillborn zebra (39). Horse and donkey females carrying zebra fetuses had low levels of chorionic gonadotropin for an abnormally

brief period of gestation, suggesting poor endometerial cup development and a strong cell-mediated cytotoxic response. Stover et al (38) reported the successful birth of a gaur calf to a domestic Holstein heifer but also reported failed interspecies pregnancies that were lost between 5 weeks of gestation and near term. The placenta from the live gaur calf contained an abnormally low number of placentomes (38) and abnormal histological architecture (12).

Selection of a recipient for interspecies transfer of an embryo from a nondomestic species usually is based on known or perceived similarities in reproductive characteristics of the estrus cycle and gestation (e.g., similar types of placentation, similar gestation periods). The ability of two species to hybridize also appears to be associated with successful interspecies pregnancy. Understanding of the underlying basis for interspecies pregnancy failure is essential for optimal selection of recipients and development of procedures to overcome existing barriers. Intuitively, failure of interspecies pregnancy has been assumed to be due to maternal immunological rejection, and several lines of evidence support this assumption. Certain abnormalities of the sheep-goat hybrid placenta are suggestive of a maternal immune response (7) and loss of a second consecutive hybrid pregnancy in the goat occurs earlier in gestation than does loss of the first one (23). Moreover, female horses that resorb or abort a donkey fetus tend to lose a subsequent donkey pregnancy earlier in gestation (1,2).

Evidence is mounting that maternal immune rejection may not be the sole or even primary cause for interspecies pregnancy failure. Croy et al. (6) were unable to prevent loss of *Mus caroli* (a wild asian species of mouse) embryos after transfer to domestic *M. musculus* females by various immunosuppressive treatments. Furthermore, *M. Caroli* embryos failed to survive in uteri of *M. musculus* females with several combined immunodeficiency involving both T and B lymphocytes (5). Evidence is also available to suggest that maternal immune response is not the primary cause of interspecies pregnancy failure in ruminants. Interspecies pregnancy between sheep and goats can elicit a maternal hormoral immune response, but high levels of circulating anti-species antibodies need not result in loss of pregnancy (21, 35). Sheep-goat chimeras produced by combining sheep and goat embryos are as adults immunologically tolerant of both sheep and goat species antigens (10). These experimental animals might be expected to be capable of carrying both ovine and caprine pregnancies to term if interruption of interspecies pregnancy is due to maternal immune rejection. In fact, sheep-goat chimeras have been shown to carry ovine (22) but not caprine (22) or hybrid (11) conceptuses to term. Unlike ewes and does carrying interspecies pregnancies, sheep-goat chimeras do not produce anti-species antibodies during ovine or caprine pregnancy (21); nonetheless, caprine but not ovine pregnancies fail to survive to term.

If maternal immune response is not the primary cause, what other factors might be responsible for interspecies pregnancy failure. Formation of a functional placenta may be critically limited in some interspecies pregnancies. Altered ability of trophoblast to invade maternal caruncles has been observed in interspecies sheep-goat pregnancy (20). Both normal and abnormal placentation was observed in successful ovine pregnancy in sheep-goat chimeras (i.e. ovine trophoblast and potentially chimeric endometrium) (20), and sheep-goat chimeric pregnancy in ovine and caprine recipients (i.e. potentially chimeric trophoblast and either ovine or

caprine endometrium) (35). Placental abnormalities reported with other interspecies pregnancies (e.g. gaur conceptus that developed in the uterus of the domestic cow) support placental formation as a limiting factor in succesful interspecies pregnancy. Whether or not aberrant placental formation has an underlying immunological basis, or is due to faulty signaling between trophoblast and maternal epithelium in interspecies pregnancy, is unknown. Our base of knowledge on events supporting or leading to loss of pregnancy must be enlarged in order for intellignet choices to be made that will maximize the likelihood of maintaining pregnancy when using available embryo technology across species.
In Vitro Fertilization:

Although in-vitro fertilization (IVF) may seem too complex technicIly to be practical for nondomesic species, the approach has severl advantages including : 1) circumvention of the problem of timing ovulation for AI, 2) production of more embryos than can usually be collected from hormonally stimulated donors, 3) making use of animals with certain types of infertility, such as endometritis or tubal obstruction, 4) reduction in the numbers kof viable sperm needed as compared with AI or natural breeding, 5) the potential of salvaging genetic material from female animals after death for oocyte maturation and IVF, 6) the increased use of potential males being crossed to one female, and

7) the possible inclusion of pre-pubertal animals as oocyte donors, as has been recently demonstrated in domestic cattle..

To this date, offspring have been produced from transferred embryos generated in vitro in two exotic fields (Siberian tiger, Indian desert cat), five primates (baboon; common marmoset; cynomologus, rhesus and pig-tailed-lion-tailed hybrid macaques) and the water buffalo. The rhesus and hybrid macaque and the water buffalo offspring were produced from embryos generated from in-vitro matured oocytes. More recently, Johnston et al reported the birth of an Indian gaur calf produced from an embryo generated by in-vitro maturation, fertilization and culture, then transferred to a domestic cow recipient. Only the cynomologus and hybrid macauque offspeing were derived from frozen/thawed, in-vitro produced embryos. Recently Armenian red sheep lambs were produced from oocytes aspirated from prepubertal lambs, fertilized in vitro, then transferred laparoscopically to domestic sheep recipients.

In-vitro embryo production procedures for nondomestic species are currently limited to effective model systems that have been developed in humans, laboratory (e.g. rodents and rabbits) or domestic (e.g. ruminants and cats) animals. Sperm quality and the availability of methods for inducing sperm capacitation in vitro are particular limitations for certain species. In addition, *in vitro*-derived embryos generally are more sensitive to cryopreservation than *in vivo*-derived embryos.

This centre has created history with the birth of the world's first test tube buffalo calf "PRATHAM". The male calf, weighing 38 kgs, was born to a Murrah buffalo in November 1990. The breakthrough in *in vitro* fertilization of buffalo oocytes with the successful pregnancy in a buffalo and the birth of the calf has been achieved by the team of scientist of

the project (24, 25, 28, 29).

Oocytes were aspirated from ovaries obtained from buffaloes immediately after slaughter and evaluated for the presence of good granulous mass around it. The oocytes were subjected to an incubation process for maturation in a special medium. The matured oocytes were treated with pre-capacitated sperm and were allowed to grow in a fortified medium after fertilization. The in vitro culture resulted in the formation of morulae and blastocysts which were transferred to suitably prepared recipient buffaloes. Besides the birth of gestation term before giving birth to their young ones.

The recent advances in the understanding of the physiologic mechanism governing gametogenesis, fertilization and early embryo development together with advances in cryogenics and its application to assisted reproductive techniques with non-domestic species provide the best hope for the future. While it is clear that traditional breeding programs are not sufficient to safeguard the future of many species on their own the combining of the essential components of traditional breeding programs with the selected aspects of the emerging assisted reproductive techniques provides the basis for new strategies for nondomestic species. For instance, the collection of gametes from individual animals that cannot or will not be bred and the storage of easily transported embryos for future and distant use seems to be two of the most efficient means to maximize existing genetic resources.

The application of assisted reproductive technology to conservation biology has tremendous potential in the management and preservation of germ plasm from nondomestic ungulate species. The traditional approaches of superovulation and nonsurgical embryo recovery have been hampered in these species by inconsistent responses to commercially available gonadotropin preparations and by substantial interspecific variations in the details of reproductive regulartory mechanisms. Although our general knowledge of comparative reproductive physiology/ endocrinology is increasing, it appears that an IVM/IVF approach to embryo production would advance wildlife preservation efforts. With the increasing interest in cryobanking genetic material from nondomestic species, research on pathogen interactions with the zona pellucida would aid in the approved importation of embryos from free ranging animals.

Genome Banking

Embryo of cattle and other species can be held at room temperature or in an incubator at 37°C during the day of transfer without evidently reducing their viability. When held in a refrigerator at 10°C a reasonable porportion remain viable after about 2 days, and an occasional one survives transfer after up to 10 days storage. The oviducts of rabbits and sheep have also proved useful biological incubators for experimental work. However, for proactical purposes, deep-freezing in liquid nitrogen at - 196°C is required for embryos to be banked indefinitely, and transported and transferred as required.

Efforts to preserve embryos by freezing began at about the same time as semen freezing, but no young were produced until the early 1970s. A basic differences between freezing semen

and freezing embryos is that a vial or straw with one killed embryo cannot produce a pregnancy, whereas a vial or straw with millions of killed spermatozoa can, provide enough living ones to remain. Freezing embryos involve carefully controlled cooling rates and the use of 'cryoprotective' agents (such as dimethylsulphoxide, glycerol, propanediol, methanol or ethylene glycol) which allow balanced dehydration of cells so that they are not damaged either by intracellular ice crystals or by adverse effects on cell membranes. Techniques and apparatus for freezing and thawing embryos in ampoules or straws have been improved and simplified to the point where careful use of published receipes on good quality bovine embryos produces pregnancy rates that appraoch those obtained by transferring fresh embryos. Methods for freezing bovine embryos in straws allow thawing and transfer of the embryo to be done on the farm, very much like AI.

REFERENCES

1. Allen, WR, Kydd, JH, Antezak DF. Equine response to the trophoblast in xenogenic equine pregnancy. In : Gill TJ, Wegman TG (eds), Immunoregulation and Fetal Survival. Oxford Press, 1987, pp. 263-285.

2. Allen, WR, Kydd J, Miller J, Anteczak DF. Equine endometerial cups: maternal uterine responses following extraspecific embryo transfer between horses and donkeys. J. Anat 146 : 233 (abst.) (1986).

3. Ambrose JD Singla SK Jailkhani Sujata Prakash BS and Madan ML Superovulation response in buffaloes *(Bubalus Bubalis)* to different treatment regimes of Folltropin. Theriogenology 35 (1) : Pp 181. (1991)

4. Asher GW, Kraemer DC, Magyar SJ, Brunner M, Moerbe R, Giaquinto M. Intrauterine insemination of farmed fallow deer *(Dama dama)* with frozen-thawed semen via laparoscopy. Theriogenology 34 : 569 - 578 (1990)

5. Crepeau MA, Croy BA. Evidence that specific cellular immunity cannot account for death of *Mus caroli* embryos transferred to *Mus musculus* with severe combined immune deficiency disease. Transplantation 45 : 1104 - 1110 (1988)

6. Croy BA, Rosant J, Clark DA. Effects of alternations in the immunocompetent status of *Mus musculus* females on the survival of transferred *Mus caroli* embryos. J. Reprod Fert 74 : 479 - 489 (1985)

7. Dent J, McGovern PT, Hancock JL. Immunological implications of ultrastructural studies of goat x sheep hybrid placenta. Nature 231 : 116 - 117 (1971).

8. Dresser BL, Pope CE, Kramer L, Kuehn G. Dahlhaussen RD, Maruska EJ. Reece B, Thomes WD. Birth of bongo antelope *(Tragelaphus euryceros)* to eland antelope *(Tragelaphus oryx)* and cryopreservation of bongo embryos. Theriogenology 23 : 190 (abstr) (1985).

9. Gee GF, Temple Sa. Artificial for breeding non-domestic birds. Symposia of the Zoological Society of London 1978; 43 : 51 - 72.

10. Gustafson RA, Anderson GB, BonDurant RH, Mahi-Brown C. Tolerance of sheep-goat chimeras to their component cells. J. Reprod Immunol 23 : 155 - 168 (1993).

11. Gustafson RA, Anderson GB, BonDurant RH, Sasser GR. Failure of sheep-goat hybrid conceptuses to develop to term in sheep-goat chimeras. J. Reprod Fert 1993; in press.

12. Hradecky P, Stover J, Stott GG. Histology of a heifer placentome after interspecies transfer of gaur embryo. Theriogenology 30: 593 - 604 (1988).

13. Johnston LA, Lacy RC. Utilization of sperm banks to maintain genetic diversity in captive populations of wild cattle. Proc. Wild Cattle Symposium, Omaha's Henry Doorly Zpp pp. 107 - 108 (1991)

14. Johnston LA, Parrish JJ, Monson R, Leibfried-Rutledge L, Susko-Parrish JL, Northey DL, Rutledge JJ, Simmons LG. Oocytes maturation, fertilization and embryo development in vitro and in vivo in the gaur *(Bos gaurus)*. J. Reprod. Fert 1993 : in press.

15. Kydd J, Boyle MS, Allen Wr, Shephered A. Summers PM. Transfer of exotic equine embryos to domestic horses and donkeys. Equine Vet J Supply 3 : 80 - 83 (1985).

16. Lasley BL, Czekala NM, Presley S. A practical approach to the evaluation of fertility in the female gorilla. Am J Primatol, Suppl 1 : 45-40 (1982).

17. Lasley BL, Kirkpatrick JF. Monitoring ovarian function in captive and free-ranging wildlife by means of urinary and fecal steroids. J Zoo Wildlife Med 22(1) 23-31 (1991).

18. Loskutoff NM, Betteridge KJ. Embryo technology in pets and endangered species In : Lauria A. Gandolfi F (eds), Embryonic Development and Manipulation in Animal Production : Trends in Research and Applications. London, Portland Press, 1993, pp. 235-248.

19. Loskutoff NM, Raphael BL, Nemec LA, Wolfe BA, Howard JG, Kraemer DC. Reproductive anatomy, manipulation of ovarian activity and non-surgical embryo recovery in suni (neotragus moschatus zuluensis). J. Reprod Fert 88 : 521 - 532 (1990).

20. MacLaren LA, Anderson GB, BonDurant RH, Edmondson AJ. Inter and intraspecific placenta in sheep, goats and sheep-goat chimeras. J Comp Path 106 279 -197 (1992 a).

21. MacLaren LA, Anderson GB, BonDurant RH, Edmondson AJ. bemoco D. Maternal serum reactivity to species -specific antigens in sheep-goat interspecific pregnancy. Biol Reprod 46: 1-9 (1992b).

22. MacLaren LA, Anderson G?B, BonDurant RH, Edmondson AJ. Reproductive cycles and pregnancy in interspecific sheep-goat chimeras. Reprod Fert Dev 1993 : in press.

23. McGovern PT. The effect of maternal immunity on the survival of goat x sheep hybrid embryos. J. Reprod Fert 34: 221 - 225 (1973).

24. Madan ML, Singla SK, Jailkhani S. and Ambrose JD. in vitro fertilization in buffaloes and birth of test tube buffalo calf "Pratham". Proceedings III World Buffalo Congress, Varna, Bulgaria, 6-18 May, 1991. (1991).

25. Madan ML, Naqvi SMK, Chauhan MS, and Singla SK. In vitro production of ovine pre-implantation embryos from in vitro matured oocytes using epididymal and frozen thawed spermatozoa. Proc. 12th Int. Congr. Anim. Reprod. The Hague, The Netherlands. 3: 1318-20 (1992).

26. Manik RS Ambrose JD Singla, S. K. Chuhan MS and Madan ML. Real time ultrasound evaluation of follicular changes in superovulated Murrah buffaloes. Buffalo J., August issue. (1994).

27. Manik RS, Madan ML, Ambrose JD, Singla SK and Chauhan MS. Real time ultrasound scanning for study of follicular population on the day of estrus and ovulation in buffaloes. Proc. 12th Int. Congr. Anim. Reprod. The Hague, The Netherlands. 1: 234-236 (1992).

28. Naqvi SMK, Madan ML, Manik RS, Chauhan MS and Singla SK. In vitro fertilization of in vitro matured goat oocytes and development of embryos in oviductal epithelial cell co-culture medium. In: Recent Advances in goat production. Proc. V. Int. Conf. on goats. pp : 1348-1351. (1992).

29. Naqvi SMK, Madan ML, Manik RS, Chauhan MS and Singla SK. In vitro development of ovine oocyte matured and fertilized in vitro to compact morula in co-culture system of oviductal cell and conditioned medium. Proc. 12th Int. Congr. Anim. Reprod. The Hague, The Netherlands. 3 : 1327 - 1329 (1992).

30. Prakash BS, Madan ML , Jailkhani Sujata and Singla SK. Development of a simple, direct, microtitre plate enzymeimmunoassay (EIA) for progesterone determination in whole milk of buffaloes. British Vety. Journal, 146, pp 571 (1990).

31. Prakash BS, Jailkhani Sujata, Singla SK and Madan ML. Application of a sensitivie, heterologous enzyme-immunoassay for progresterone determination in unextracted buffalo plasma samples collected in an embryo transfer experiment. Anim. Reprod. Sci. 27: 67-74. (1992).

32. Prakash BS, Singla SK, Ambrose, JD, Jailkhani S. and Madam ML. Assessment of superovulated response in terms of palpable corpora lutea and embryo recovery using milk progreterone. Theriogenology 37: 897-905. (1992).

33. Pope CE, Gelwicks EJ, Wachs KB, Keller, GL, Maruska EJ, Dresser BL. Successful interspecies transfer of embryos from the Indian desert cat *(Felis silvestris ornata)* to the domestic cat *(Felis catus)*. Biol. Reprod 40 (1) 61: (1989).

34. Quinn H, Blasdel T, Platz CC. Successful artificial insemination in the checkered garter snake. International Zoo Yearbook 28 : 177 - 183 (1989).

35. Ruffing NA, Anderson GB, BonDurant RH, Pashen RL, Bernoco D. Antibody response of ewes and does to chimeric sheep-goat pregnancy. Biol Reprod 1993 ; in press

36. Schiewe MC, Junior SM, Armstrong DL, Simmons LG, Gross TS, Hopkins SM, Wildt DE. Post-thaw viability and acrosomal integrity of garu *(Bos gaurus)* sperm following comparative cryopreservation. Proceedings of the American Association of Zoo Veterinarians pp. 62-65 (1989).

37. Schroeder JP, Keller KV. Artificial insemination of bottlenose dolphins. In : Leatherwood S, Reeves RR (eds), The Bottlenoe Dolphin. San Diego, Academic Press 1990, pp. 447 - 459.

38. Stover J, Evans J, Dolensek EP. Interspecies embryo transfer from the gaur to the domestic holstein. Proceedings of the American Association of Zoo Veterinarians 1981: 122-124.

39. Summers PM, Shephard AM, Hodges JK, Kydd J, Boyle MS, Allen WS. Successful transfer of the embryo of Przewalski's horse *(Equus prezewalskii)* and grant's zebra *(E. burchelli)* to domestic mares *(E. caballus)*. J Reprod Fert 80 : 13-20 (1987).

40. Singla SK and Madan ML. Single ovulation and embryo transfer (SOET) in non-superovulated buffaloes. Theriogenology, 33 (1) : pp 329. (1990)

41. Singla SK and Madan ML. Comparative supervulatory responses in crossbred dairy cattle *(Bos indicus* x *Bos taurus)* with FSH-P and SUPER-OV. Theriogenology 23 (1) : pp 328 (1990).

42. Singla SK and Madan ML Response of superovulation in buffaloes *(Bubalus Bubalis)* with SUPER-OV and FSH-P. Theriogenology, 33(1) : pp 327. (1990).

43. Singla SK, Madan ML, Manik RS, Ambrose JD and Chauhan MS. Fertilization and early embryo development pattern in superovulated buffaloes. Proc. 12th Int. Cong. Anim. Reprod. The Hague, The Netherlands. 2 : 817-819. (1992).

44. Wiesner H, Lampeter WW, Rietschel W. Erfahrungen beim unblutigen embryo transer vom banteng auf hausrinder. Verhandlungen 26. Inst Symp Erkrankungen Zoo tiere, Brono, Czech 1984, pp. 99-102.

45. Wildt DE, Monfort SL, Donoghue AM, Johnston LA, Schmidt PM, Howard JG. Embryogenesis in conservation biology - or, how to make an endangered species embryo. Theriogenology 37 : 161 - 184 (1992).

ENSURING GENETIC PURITY OF ZOO ANIMALS

Lalji Singh
Centre for Cellular and Molecular Biology
Hyderabad 500 007

Abstract

The destruction of natural habitats and illegal poaching of wild animals are putting them in danger of extinction both physically and by 'genome pollution' through contact with domestic and other animals. Researchers have recently discovered that supposedly purebred European wolf populations *Canis lupus lupus*, a subspecies of the gray wolf *Canis lupus*, are in fact mainly hybrids between wolves and dogs. Most wolves now kept in British Zoos are American hybrids. This has made it essential to identify purebred individuals and then establish stable founder populations. It is, therefore, important to have a method for confirming the identity and purity of the breeds bred in captivity. It is also essential for the health of captive populations and for the preservation or eventual increase of genetic diversity of wild populations that genetic variability is maintained by the reintroduction of captive bred animal. A method, therefore, is also needed for measuring the genetic relationship among individuals.

Recently developed technique of DNA fingerprinting, also known as genetic profiling, offers an attractive method of choice for the above purpose. DNA fingerprinting utilizing multilocus and single locus probes is of proven utility for identification of individuals and for paternity determination. Application of DNA fingerprinting to studies of wild populations has provided the behavioural ecologist with a powerful tool with which to estimate genetic relatedness among socially interacting individuals. Among vertebrates DNA fingerprinting has been widely applied to studies of fishes, birds, and mammals. These include demonstrations of reduced genetic variation in clonal and colonial species. By using Bkm-2(8) probe developed by us, we have been able to obtain individual-specific DNA fingerprints of crocodilians which permitted us to identify individuals, assign parentage, and reconstruct the DNA profile of a missing parent. Band sharing between animals of known pedigrees increased predictably with relatedness and provided a basis for distinguishing relatives from non-relatives. This approach could facilitate genetic studies of wild and captive populations.

Recently using our indigenously developed probe we have shown for the first time that DNA fingerprinting can effectively be used to infer the genetic affinities among related groups of animals. This was hitherto thought not to be feasible largely because the fingerprint profiles are believed to evolve too rapidly to be informative over large time intervals. Based on qualitative differences in the fingerprints and quantitative differences in the copy number of Bkm-related sequences in the genomes, we have been able to infer generic affinities among different species/genera of crocodilians, which are in agreement with the consensus phylogeny reconstructed using various other approaches together. This observation is of great importance as it establishes for the first time the potential utlity of this molecular technique in the study of evolutionary relationships of plants and animals.

TECHNIQUES FOR DIFFERENTIATING PURE STRAINS AND HYBRID STRAINS, INCLUDING DNA-FINGER PRINTING

N. V. Giridharan
National Institute of Nutrition
Hyderabad 500 007

Abstract

Laboratory Animals though evolved from their wild ancestors, are quite different from the latter, as they are selectively bred to meet the specific requirements of biomedical research. They are generally docile and genetically more homozygous. They have to be maintained in 'pure' status to avoid confusion in interpreting experimental results. A genetic monitoring protocol is thus highly essential for the successful maintenance of these strains. Such a programme basically analyses a series of polymorphic traits like coat colour, skeletal features, immunological and pharmacological responses, chromosomal banding patterns and DNA finger print profiles which are characteristic of each strain. Similar programmes can also be extended to wild and zoo animals, to study the evolutionary trends and for the efficient management of breeding in captivity.

ENVIRONMENTAL ENRICHMENT IN ZOOS

S. C. Sharma & B. Chakrabarty
Central Zoo Authority
New Delhi

Abstract

Naturalistic behaviour is often lacking in any captive animal and with change in human perceptions, captive animals are not just looked as prize exhibits but in their entirity atleast with respect to their behaviour. Several 'methods' have been used as environmental enrichment to help captive animals from boredom and instill some kind of predatory, foraging, playing and abandoning skills.

This paper deals with the history of the techniques of environmental enrichment and its evolution with an effort to highligting naturalistic additions as a form of environmental enrichment.

ENVIRONMENTAL ENRICHMENT FOR RED PANDAS

Dr. Angela Glatston, Research Biologist
Rotterdam Zoo, Netherlands

Regarding environmental enrichment for Red pandas, Mr. Sharma's paper covered all the essential points. Red pandas are very easy to house in a situation that is optimal. It is easy in captivity to mimic a very naturalistic environment.

Although we don't know a lot about the way Red pandas behave in the wild we do know that they live in forest environments. We know that their main diet is bamboo. We know that they spend a lot of time in trees and we know that their natural activity pattern is to be active both during the day and at certain times, during the evening. And from these basic facts of their biology, it is easy to design a simple enclosure which allows the animals to exhibit most of their natural behaviour.

Trees are very important. They let the animals retreat from the public when they don't want to be too close. It allows them to exhibit natural climbing behaviour. And trees also provide a part of the animal's diet. It is important, of course, to make sure there are no poisonous trees or plants in their exhibit, but if Red pandas are housed in a relatively natural way, they will spend a lot of their day walking around their exhibit foraging in much the way they would do in the wild. This also means that when you have provided them a scientifically analysed, well constituted, nutritionally healthy diet, which as we have herd is in the form of pellets or diet which can be eaten in a relatively short time. They can still spend a lot of their waking hours foraging and feeding on materials in the exhibit the way they would do in the wild.

Social groupings are also important from an environmental enrichment point of view. Red pandas are not group-living animals but at times of the year in the breeding season they will exhibit a month or two of social behaviour, males and females, and after young are born, not only do you see maternal behaviours you would expect but also as the young become more mature and start walking around the exhibit on their own, a lot of their play behaviour is directed towards their fathers. Therefore it is very important to leave the males with their young and the female in the exhibit because you see an awful lot of this play behaviour which is important to the development of the young animals. Another point of enrichment is providing suitable retreats for the animals, not only trees where they can climb if they are afraid but also nest boxes where the females can retreat when they have young and exhibit again their normal behaviour.

I have a copy of the most recent International Studbook for Red pandas which has some articles on husbandry and housing which I will be happy to show, or to send a copy if anyone is interested and will give their address.

ROLE OF ENVIRONMENTAL ENRICHMENT IN BETTER MANAGEMENT OF ZOOS

R. Sunderaraju, M. Jagannadha Rao and A. Manimozhi

Abstract

Great changes have taken place since the first public zoo which have evolved from menageries into highly complex professionally managed zoological parks. With this, the importance of environmental enrichment has been recognised and practised.

The Arignar Anna Zoological Park has adopted some techniques such as hiding honey soaked bread in the bear enclosure, dry leaves and logs with litter in the big cats enclosures, live fish in ponds in otter and bear enclosures, termite mounds in the bear enclosure and many others in an attempt to improve the environment for their animals.

RE-INTRODUCTION OF CAPTIVE BRED ANIMALS IN WILD

S.C. Dey, Addl. I.G.F., (WL)
Ministry of Environment and Forests

The Zoos in India originally evolved as a source of recreation fostered by the Rajas and Maharajas to entertain their VIP guests and family friends. Subsequently when the government and public bodies started establishing zoos, in addition to entertainment, education also became a part of the process. With the passage of time, the need of zoos for captive breeding programmes to support endangered species *ex situ,* and its role in strengthening *in situ* conservation became more and more apparent. It is because of this, in the conservation of biological diversity formulated in the Earth Summit at Rio, Article 9 of the Convention contains *ex situ* conservation as a step in the achievement of global Bio-diversity conservation. The sub-article 9 (c) recognises the need for adopting measures for the recovery and rehabilitation of threatened species and for their reintroduction into their natural habitats under appropriate conditions.

Captive breeding programmes may have various objectives, but reintroduction of captive born individual into the wild population is, perhaps, the requirement under the current stress situation. Owing to destruction of habitat and increased biotic pressure to which the crucial habitats of the wild animals have been subjected to in recent times, the need of captive breeding of endangred species to replenish diminished wild stock is being felt more and more as a tool for conservation of the species.

Reintroduction is the proess of strengthening or reestablishing populations of animals within the area of its original wild habitat. It is, therefore, not quite the same as introduction, which is the process of establishing populations of animals in an area remote from its original wild habitat. The distinction needs to be made. In the case of reintroduction we know that the genepool of the population was moulded by the range of natural pressures which once existed in the habitat. In the case of introduction we can only guess if the range of natural pressures is within the normal range of which the introduced gene has been subjected.

Thus, reintroduction involves a precisely defined population being returned to a precisely defined location. Since the species in danger of extinction are present in too few numbers in the wild for their survival to be assured in the long run, and induction of more animals might lessen the danger of extinction, if an endangered species is being successfully bred in captivity then the surplus population might be released in order to boost up the number in the wild.

For a successful reintroduction programme, both the suitabiity of the animals and that of the wild habitat need to be considered. Many pre-requisites must be met before any reintroduction programme can be taken up. Basically these pre-requisites are:-

a) The capacity of the wild habitat to absorb the introduced animals and their progeny on sustained basis.

b) The capability of the animal to adapt itself to the newly introduced home having different anthropogenic and habitat conditions, and its ability to survive the stress situation of capture and translocation.

c) The reintroduction programme does not constitute a physical and health hazard to local human population or animal population.

d) The conditions which were responsible for the decline or the decimation of the species in the site have been largely addressed and a proper management plan prepared to follow up the reintroduction programme.

e) Public perception towards conservation of the species through reintroduction has been developed by extensive education and awareness programe.

f) Trained and dedicated manpower is available to follow up the reintroduction programme along with the sustained availability of financial resources to back up the action programme over a long time frame.

A. Carrying capacity of the wild

The carrying capacity of the habitat for a species can be reduced through a variety of causes like modification of the floral composition, fragmentation of the habitat through diversion of land for various industrial and commercial activities, increasing population, and so on. In many cases the existing habitat may not be even in a position to support the surviving wild population. Any attempt to over-crowd the habitat by further releases of captive bred stock would not be at all useful. The real utility of the reintroduction programmes will be for habitats where the carrying capacity of the habitat has been increased to a considerable extent through management intervention but where the native wild population has declined badly and is not in a position to build up a viable population without augmentation of the number through reintroduced animals.

B. Characteristics of the captive bred stock for reintroduction

C. Reintroduced animals should ot constitute any physical health hazard to the local human population and animal population

The reintroduction programme should not prejudice the existing wild population. Unplanned release of captive or translocated animals into or near the already existing wild population, no matter how small is the latter, can be sometimes be harmful and can even have the opposite effect of what is desired. The reintroduction programme should not pose any health hazard to the wild population through disease, genetic swamping or social disruption. Careful behavioural study of existing animals and stringent pre-release veterinary screening is necessary to ensure, as much as possible, that the animals ear-marked for release are free from contagious diseases, genetic defects and other medical problems which could be tansmitted to the native animals.

(D) Elimination of the conditions responsible for decline or extinction of the species

Before any introduction programme is planned, it is necessary to study the historic events which led to decline of the species, in the area, *viz.* whether it is due to habitat shrinkage, reduction of food availability, pressure of poaching, biotic disturbance, presence of predator or disease. It is very much necessary that such factors are identified with respect to individual sites and necessary steps are taken to eliminate such factors before any reintroduction programme is taken in hand.

(E) Public perception to reintroduction

In a heavily populated country like India where the forests are used by local population for some necessity or other it is very much necessary that before a reintroduction programme is conceived or planned, there is extensive education of local people so that their perception about reintroduction of the species and the need for conservation is properly developed. If this is not done then any minor problem arising out of such species reintroduction may be taken by local people as detrimental to their interest causing public apathy, which may turn to mobilisation of opinion for liquidation of such reintroduced species. In case, however, local people are taken into confidence in the process of reintroduction from the very beginning then peripheral problems that are likely to develop because of such reintroduction are expected to be absorbed by them due to the sense of belonging, being a party in the process of reintroduction.

(F) Trained manpower and funding

It is very much necessary, that before any introduction programme is undertaken proper selection of staff is made based on aptitude and they are placed in strategic location and offered suitable training and support. This is essential to ensure constant monitoring of the reintroduced population through radio collar and studying of adaptive ecology and biology of the species. It will be dangerous to go for any reintroduction programme without placing suitable selected and trained manpower to carry out the job of studying the demographic, ecological and behavioral studies of the released stock including dispersal and straying of the animal in the newly introduced habitat.

(G) Process of reintroduction

(a) **Pre-release training** - Captive born animals have to be trained and acclimatized before release. Training programme includes restoring the locomotive, navigational, predatory and other survival skills.

(b) **Post-release monitoring** - Constant monitoring of the movements of the reintroduced animals, occurrences of birth, occurences of death, causes of death and the behaviour of individuals is very important. Individual identification through tatoos, tags or bands, natural or applied body marks and transmitters should be done.

(c) **Involvement of locals :** As far as possible, employment should be provided to the local people for post-release training and monitoring. Local employment means getting support from the local people for the project. Community education programmes and enhanced eco-tourism can also help the project.

(H) Past history of reintroduction

(a) In India the only species which has been introduced extensively in the wild from captive bred stock is the spotted deer, and despite the fact that not much of the precautions have been taken prior to reintroduction in many cases, the species have adapted into the wild and are breeding well. There are, however, many areas where the introduced population have been subjected to disease because of inadequate veterinary screening. A little bit of technical input to the process and observing some basic requirements and precautions can help in better rehabilitation programme including reduction of mortality at the time of capture and translocation.

(b) Another group of animals which were initially successfully reintroduced into the wild are the three crocodilian species, but today due to improper planning and absence of linkages between captive breeders and the field managers, the process of reintroduction is suffering, even though population of the captive bred stock is plenty. This could have been largely avoided if the captive breeding programme from the very beginning was linked up with habitat identification for release, and drawing up of community education programme about the necessity of such reintroduction, and elimination of undue fear from the minds of people regarding such species. If this was done in time and the management planning in the site of reintroduction was implemented in advance, it would have been possible to absorb the reintroduced population largely.

(c) The other species for which a systematic reintroduction programme has been undertaken in the last decade are turtles which are being reintroduced into the river Ganges since middle 1980s. This programme is also having the limitation that hardly any monitoring of the released population is being carried out. Much of such released stock is stated to have been captured by unscrupulous businessman and finding their way into the markets of Calcutta and Howrah. The species and size of the seized stock of Calcutta, which run to couple of thousands of turtles every year, gives an impression that much of such seized stock are the released stock from captive rearing stations.

(d) Efforts were also made in the past to introduce African lion in Shivpuri areas of Madhya Pradesh in the 1920s and 30s, and reintroduction of Asiatic lion in Chandraprabha Wildlife Sanctuary of Uttar Pradesh - in mid 1950s. These efforts failed because the introduction of African lion in Shivpuri area was done without proper investigation of habitat requirement, availability of prey base and follow up action. With respect to Chandraprabha there was hardly any monitoring after release of the population, which started breeding, but unfortunately strayed out into the villages causing man-animal confrontation which led to perhaps, poisoning and killing of the lion by the local people.

(e) We, however have a successful story of reintroduction of Rhino in the Dudhwa National Park of U.P. stock of which came partly from Assam and partly from Nepal. The introduced population is breeding in the new area and with a little bit of caution in management and further reintroduction, Dudhwa can easily contain a regular population of 50-100 Rhinoceros.

(I) Future programme

(a) We do have in hand a proposal for reintroduction of Asiatic Lion in Madhya Pradesh centering around the Kuno-Palpur sanctuary. The prospects and the problems have been identified and an interim line of action has been drawn up to make the effort of reintroduction a success. It is needless to mention that the details are to be discussed and deliberated upon to improve the plan of reintroduction including elimination/tackling of issues which may create problems against reintroduction both currently and in future.

(b) Certain endangered species like the Great Indian bustard, Black-necked crane, Musk deer, Tibetan antelope, Brow-antlered deer which are reaching a critical state of endangerment in India, requires immediate attention of captive breeding followed by reintroduction. If this is not done now, time will run out and we will land into the same stage which the reintroduction of captive bred Siberian crane is facing in Bharatpur today. The experience gained with respect to enrichment of western flock of Siberian crane population in Bharatpur requires analysis by all reintroduction specialists, so that this experience can be fruitfully utilised to evolve better strategies for future especially with respect to migratory birds.

(J) Conclusion

The reintroduction programme of captive bred animal in India is in its infancy. A lot of research and management inputs are required to ensure successful implementation of reintroduction programme. However, with the phenomenal rise of human population and corresponding growth of cattle population, the habitat of wild animals will be under severe threat in future. A combination of *ex situ* conservation with *in situ* conservation will perhaps be required to arrest the extinction of the species that have reached endangered stage, and are gradually proceeding to the critical stage. This presentation is being made not to teach anybody, but to expose this gathering to the ideas which are in my mind on the topic of captive breeding followed by rehabilitation of the species in the wild.

WORKSHOP ON
SCIENTIFIC MANAGEMENT AS AN INSTRUMENT FOR CONSERVATION OF WILDLIFE

SCIENTIFIC SESSION III

Developing Public Perceptions on Wildlife Conservation

Veterinary doctors demonstrate vasectomy surgery on a hybrid lion at the National Zoological Park

DEVELOPING PUBLIC PERCEPTIONS ON WILDLIFE CONSERVATION

Remarks of Chairman
R. Rajamani, I. A. S., Retd.
former Secretary, Ministry of Forests and Wildlife

From my very childhood days I thought of zoos as evil. However, thanks to the efforts of many friends like Mr. Pushp Kumar and Mr. Kamal Naidu, I came to think of zoos as a "necessary evil". Still further efforts, rammed home by people like S. C. Sharma and Sally Walker, have caused me to come to the view that zoos are a "necessary good!" If there had been zoo education in past years, I might have been converted long back, instead of through a torturous process.

The second problem I had was when the Zoo Act was being put through was that I did not like the word "Authority". The words "Central Zoo" were all right but I was always worried that there was going to be one more "authority". We have enough authority in life. If you use that word "authority" it has a psychological disadvantage. I thought why can't we call it the "Central Zoo Responsibility." People were apalled at my suggestion, but if you use the word authority, you will always only exercise authority. You will set up standards and close zoos which don't conform to them. But when will you exercise the responsibility to take on tasks which may be hundrum but are nonetheless important and necessary like zoo education? I am glad that CZA after two years has come forward in the form of this conference to address these tasks.

Someone mentioned that education was the most important factor of conservation, but I do not agree with that. There are four factors for conservation which are equally important; they act as "pillars" which support conservation. Education is one and factors such as policy, legislation and administrative support are another. The third is scientific understanding, including the veterinary sciences, which is so necessary for integration with *in situ* conservation. Fourth is the financial and human resources which are equally important. I grumbled and grumbled about keepers education. So I was delighted to hear Mrs. Rajeshree Sharma refer to keeper education. I think zoo keepers education should preceded public education even. If we don't do that and go straight for public education, still the animals will feel the difference. They may or may not feel some difference if we convince the public not to tease them. But if their keepers with whom they have to interact every day are not educated, they will definitely feel it. I hope there is something in the offing in this subject area.

The message I got today is that some effort is on. Mr. Patnaik at Nandankanan spoke of the guide service, and we heard about the efforts at Patna. There must be other activity as well but constraint of time has kept us from hearing what is going on all around the coun-

try. There was also a message that there needs to be much more done in this field. Organisations like Friends of the Zoo must be there but they should try and reach more people. Somehow we have to rope in every member of the public who is interested in the zoo and wants to help. If we don't take advantage of people's interest, we won't get anywhere.

You also have to do a lot of work outside the zoo as well as inside. It is not just what the Director and Curator can do but also what others can do to help you by networking with like minded institutions and individuals. We want to reach out with this message of conservation, not just in terms of animal welfare, but also to use the scientific aspect of conservation to reach out to the public.

You have to use the print media much more as well as Doordarshan and All India Radio. These are two powerful media which were not mentioned by anyone. When London Zoo was about the close, there was a powerful barrage of publicity about the zoo from people who had been there and loved the zoo. It made them garner their resources to keep it going. We need that kind of support.

I have some suggestions. In developing your education programme, you have focused on fauna very well but something has to be done about flora also. If you are developing towards biological parks, you have to find ways of educating people about plants as well as animals.

Also the welfare of animals has always to be attended in education, to use the opportunity to make people develop a sense of protectiveness over the animals.

I would also like to suggest that we use our cultural resources such as the Panchatantra to educate people. What more perfect resource to educate with humour than this very old body of literature. We can also use some of the rural people, as Rajeshree Sharma mentioned, to tap their provincial knowledge. Some of the boards at zoos do not have all the names of animal but these people will have many names of so many species.

EDUCATION AND INTERPRETATION IN THE INDIAN ZOO CONTEXT

Sally Walker,
Secretary, Zoo Outreach Organisation

Abstract

Zoos are a very powerful education centres aiding conservation. To make education more effective the following elements have to be addressed. Zoos should be theme oriented ,and effective interpretation techniques be developed for this. The educational approach should be also visitor (age group) oriented and educators should be chosen according to the audience. Outreach programme should be organised frequently when the education programme is a long term one. Education process is an ongoing one and should exploit special events to generate media attention. The Education aspect must be planned seriously and organised over an extensive period. The Government and CZA should offer support to zoos for being effective education centres.

"FRIENDS OF ZOOS" FOR CREATING PUBLIC AWARENESS FOR WILDLIFE CONSERVATION

Latha Thampi, Friends of the Zoo
Trivandrum

Role of zoos today -- There is an increasing controversy about the purpose of zoos; are they really necessary ? Zoos today are an indispensable component of wildlife conservation. Their essential role is to promote scientific research and public education as well as conservation and breeding programmes.

Zoos: "An Endangered Species" ? -- Zoos today are faced with increasing difficulties such as rising costs, inefficient administration and acts of cruelty. Government support is not enough; concerned citizens must take initiative and become involved with their local zoo.

Friends of Zoos and their Role in Indian Society -- ZOOWATCH is one example of a group of concerned citizens. Our members and volunteers monitor the condition of the animals and also concentrate on improving public awareness about the importance of conservation.

Creating Public Awareness on Conservation -- The systematic guidelines developed by ZOOWATCH may prove useful for similar groups in the future :

Selection of Volunteers -- Only those volunteers may be chosen who have studied the entire zoo thoroughly and have great tact and patience.

Isolation of Problems -- The chosen zoo workers then identify the areas of greatest harassment. For increased effectiveness they work only in pairs.

Prevention of Teasing and Feeding : A Systematic Procedure -- The Friends of Zoos persuade the members of the public not to tease or feed the animals.

Role of Mass Media -- One component of the ZOOWATCH strategy in raising public awareness is the close link with the media. Through frequent articles or interviews we can influence the maximum number of people.

Strategies of Interaction : Cooperation of the Zoos with Voluntary Groups: -- All zoo groups should maintain an amicable relationship with the zoo authorities. Criticism offered must be constructive. The zoo authorities should also realize the immense value of such zoo friends and tap their maximum potential for the benefit of their wildlife.

Conclusion -- The Indian Government should encourage the efforts of these "Friends of Zoos". Such groups play a mediating role between the zoos and the public and can thus create a greater public awareness about conservation.

FRIENDS OF THE ZOO -- FROM A DIRECTOR'S PERSPECTIVE

P.C. Mishra, Director
Sanjay Gandhi Biological Park

Abstract

The Govt has failed to generate a favourable reponse from the public to all its conservation activities. Hence the need for giving conservation education to the people has been felt. Friends of the zoos can be used as an educational tool. The role of Friends of the Zoos should be to educate the public with unique and creative methods and be directly involved with the public. They need to be encouraged and supported by the zoo director as well as the government to be more effective educators.

PROVIDING GUIDE SERVICES FOR ZOO VISITORS

S. K. Patnaik
Director, Nandankanan Zoo

The objective of maintaining a zoological garden has changed drastically over the years. The primary objective of having a zoo in the early part of this century and before that was amusement of kings, nobles and affluent people close to them and later for the general public. They used to see the animals which were difficult for them normally to see in so close proximity in the forest and in other countries. In small cages the animals were being poked, teased and ordered to roar, run or attack for the enjoyment of those who desired pleasure from such activity. With growing awareness among the masses for conservation and preservation of endangered species, however, the zoos were gradually considered as places for education and research. While the latter involved biologists, veterinarians and researchers of other disciplines, education embraces all sections of society, young or old, rich or poor, educated or illiterate. In creation of awareness and empathy for the animals, whom they can see in close quarters, and study closely, depended their support for conservation of the wildlife in the wilderness.

Keeping the above objectives in view, gradually the zoos started focusing their attention on proper signages, ecological displays, brochures, picture post cards, guide books, film shows and natural history museums, etc. All these were introduced in Nandankanan Biological Park also. Even a format for recording observations of the visitors was introduced. While following groups of visitors by the Director and senior zoo staff it was seen that very few of the visitors spent time enough to go through any signage. A small fraction go through any publication or go to a Natural History Musesum. This is partly because they do not have enough time to go through so much signage, or they did not know the language, or they are illiterate. Thus it was felt that possibly oral communication could be effective.

Some groups did come to the park on conducted tours accompanied by tourist guides. These guides had no exposure to wild animals, but they used to make their lectures so interesting that the visitors heard them with rapt attention. It was also found that most of the information given by them were far from true. Stories such as like 'Black deer of Bangladesh for black buck' were a common feature. Another popular story was the "Great owl of Srilanka" for horned owl and so on. Thus instead of going back without any addition to their knowledge, visitors were aquiring misleading information with a risk of transmitting the same to many others, particularly, the younger ones.

At this juncture it was thought proper to train guides on wildlife in general and captive animals in particular. But training the existing guides, coming with tour operators, conducted groups can only cater to about 30% of visitors. Other visitor groups who came on their own looked for somebody to guide them but had none in the park, as the park had only one official guide meant mostly for official guests. Hence it was decided to

create a cadre of trained, self -employed park tourist guides out of local youth. It was decided that a fee shall be prescribed for them depending on the size of group they handle and they will be given a brief training.

Initially a one-week course was organised taking some tourist guides, after their selection, guides of tour operators and officers of the State Tourism Department and Tourism Development Corporation. Senior zoo staff, Veterinarians and Wildlifers were assigned the job of training them. Their course contained some exposure to geography of the country, broad distribution of flora and fauna, protected areas, animals - their life span, habitat, feeding and breeding habit - animals of the zoo and their distribution, food, "do's and don'ts" in a zoo - health care of animals and important wildlife laws etc. They were exposed to some publications on the subject and shown few films. Some, who were busy with guiding tourists were given training on a few Mondays which were the weekly off days for them.

After successful completion of the course, they were registered on payment of Rs.100/- as security deposit. An identity card was issued to each of them with their photographs at their cost. Whenever within the zoo premises they were expected to wear their identity card.

The zoo guides take round the visitors in small or large groups and tell them about different animals and their care in the language they can follow. As they are responsible to see that the group in their charge behaves well, they control vandalism. They do not allow visitors to play loud music and they maintain the serenity of the park as well as to prevent littering and offering food to animals. They do not allow visitors to disturb resting animals and they guide in such a way that the visitors can see most of the exhibits in the shortest possible time. They follow the laws and rules of the zoo and they make the groups which they are leading to follow the same also. They report any unruly behaviour or vandalism by other people to zoo staff. In case any guide does not behave as he is expected to, his licence can be cancelled, but so far such eventuality has not arisen. Mere temporary confiscation of identify card from erring ones has imporved matters.

This system has been continuing in the park for the last seven years and about 50 guides are operating within the park. It has been noticed that the level of vandalism, noise and misbehaviour has been reduced drastically by the visitors. Visitors are more orderly. With the information given by the guides, about different species of animals, some of the visitors have shown keen interest in knowing more about them, their food, care, treatment, habitat and phrenology, etc. and approach senior zoo staff for such information. This addition of about 50 people has reduced an unnecessary work load of the otherwise busy zoo staff in preventing vandalism as they were harrassed earlier. Oral communication has proved to be much more effective then written communication to spread zoo education and hopefully shall be put to use by other captive breeding outfits in the country with good advantage in years to come.

ROLE OF "FRIENDS OF ZOOS" IN CREATING AWARENESS ABOUT WILDLIFE CONSERVATION

Dr. (Sister) Doris D'Souza A. C.
President Eco Task Force
Patna

Abstract

All things are connected whatever befalls the earth befalls the children of the earth. Hence there is an urgent need to educate the public about our heritage and the ways to conserve it for the generations to come. If every living being loves freedom and wants to live in its natural habitat why keep animals in captivity - in 'Zoos?' and what is Zoos' role in wildlife conservation and how do we tell the public their purpose. Most of the people visit a Zoo for a picnic and during their spare time take pleasure in teasing the animals, feed them with odd things and often cruelty towards these animals is seen rather than appreciation and love.

Eco Task Force, (ETF) a Student Body of Patna Women's College works for environment protection through various activities. In everything that the members do, they keep in mind the objectives of Awareness, Knowledge, Attitude, Skill, Evaluation, Participation.. For the past two years the members have taken active part in building in themselves love for animals in our Zoo (Sanjay Gandhi Biological Park, Patna). Often field trips to Zoo were arranged. Animal feeding and care was demonstrated and behaviour was explained. Their presence in the Zoo made the public ask "What's on today?" The curiosity itself was enough to create awareness that animals in the Zoo are for appreciation.

The ETF members, are now rightly can be called the 'Friends of Zoos'. Keeping their objectives in mind they conducted a public awareness programme about wildlife conservation, through "Spot Zoo Photography Contest" which was unique to Bihar, and may be even to the Nation, on 20th March 1994, at Sanjay Gandhi Biological Park, Patna. Through the medium of photography, ETF sought to inculcate in the public, an attitude of appreciation towards beauty in wildlife.

All our activities at the Zoo have been joyful and useful for us and for the public because of the magnanimous nature of the Zoo Director, P. C. Mishra who has remained open to educational programmes and actively participated in innovative experimental methods.

As 'Friends of Zoos' we plan to do many more activities to create public awareness in wildlife conservation. Our next move will be 'Philately and Wildlife'. We want to capitalize people's interests and Hobbies as means to create love for wildlife and to prevent cruelty to animals by the public specially at the zoos.

EDUCATIONANDINTERPRETATIONINZOOS

Rajashree Sharma

Abstract

Zoos have undergone a radical transformation within the past few years in their role, with the recognition of education as an important tool to aid conservation. The purpose of Zoo Education should be educating the public (irrespective of the age group), by making them more conservation conscious, to moblise human resources for conservation, and focus attention on threatened species. The approach to zoo education should be a participatory one and the target groups need to be categorised and dealt with accordingly for effectiveness. Interpretation is also an important aspect of zoo education and should be done rightly to convey the right message. Education in zoos should ultimately be striving towards making people, more and more responsible towards their environment and eco-system.

WORKSHOP ON
"SCIENTIFIC MANAGEMENT AS AN INSTRUMENT FOR CONSERVATION OF WILDLIFE"

PRACTICAL DEMONSTRATION AT NATIONAL ZOOLOGICAL PARK

PRACTICAL DEMONSTRATION AT NATIONAL ZOOLOGICAL PARK

Since 1981, it has been a concern of the Ministry of Environment and Forests (then the Department of Environment) that large carnivores, particularly lions whose ancestry was questionable, were prolifically breeding in Indian zoos, thereby usurping space and resources which might be utilised for rare and endanagered species, or even other lions of known parentage. The Department then appointed a Committee of One, Dr. J. H. Desai, at that time Director, National Zoological Park, to research the subject and come out with recommendations for birth control. The Report covered several methods of birth control but vasectomisation was the method of choice.

In 1984 some of the zoos began vasectomising their lions but this management technique was not fully understood and appreciated by the public and there were questions and reprisals at different levels. The zoos became reticent to use vasectomisation, and as other methods are difficult or unreliable, the population of lions increased to a point that some zoos now have 50 or more lions of questionable subspecific purity.

The Central Zoo Authority, in order to give encouragement and approval to birth control in general and vasectomisation in particular at the highest level, arranged a practical demonstration of the technique at the National Zoological Park in New Delhi on the 2nd day of the Workshop. Dr. P. O. George and Dr. Jacob Cheeran assisted by other veterinarians, performed the vasectomisation on a generic male lion at the zoo while participants of the Workshop observed.

WORKSHOP ON
"SCIENTIFIC MANAGEMENT AS AN INSTRUMENT FOR CONSERVATION OF WILDLIFE"

SESSION - IV

WORKING GROUP SESSIONS

i. Planning and Management Group
ii. Planned Breeding and Related Problems Group
iii. Health Care Group
iv. Education Group
v. Reintroduction Group

Discussion session; meeting of Working Groups.

Planning and Management : Report of the Working Group

Members: Pushp Kumar, Leader; S. K. Patnaik and Jagannadha Rao, Rapporteur; D. R. Ramesh Singh, Ms Sangeeta, S. S. Naidu, M. S. Jain, Dinesh Kumar, Rajeev Kumar Pawar, K. Raveendran, George Mathen, B. S. Bonal.

It is crucial that in the present stress condition when zoos are required to back up wild populations in difficulty and to educate the public about the value of wildlife and wild areas and the need for conservation that they manage their facilities in the most effective manner. The Planning and Management Group was requested to discuss the effective utilisation of available resources by zoos, including master planning, preparation of management plans and population control measures for prolifically breeding species. The Planning and Management Group discussed the planning of zoos and their management and made the following suggestions / recommendations, complementary to the standards laid down by the Central Zoo Authority.

PLANNING AND MANAGEMENT GROUP

Complementary to the standards laid down by the Central Zoo Authority, the following recommendations are made.

1. Every zoo should have a Master Plan a for period of 20 years and a Management Plan for a period of 6 years.

2. Master Plans should be drawn up keeping in view conservation objectives of the zoo which might be reflected in a theme for the enclosures. As far as possible open-air enclosures without visual barriers should be constructed. The enclosures should meet the biological requirements of the animals housed.

3. Wherever possible Safari Parks may be set up for selected species in a suitable site of as large a size as possible, so that undesirable effects such as hybridization in herbivores can be avoided. These should be set up preferably near urban areas, as per Guidelines drawn up by CZA.

4. All zoos should concentrate on providing adequate space to each indvidual species, even if it means reduction in number of species displayed.

5. Whenever feasible more than one compatible species may be displayed in a natural setting which conforms to their biological needs.

6. The enclosure planned in any zoo should provide for optimum number of animals to be housed, keeping in view future needs.

7. A data base regarding disease and treatment of zoo animals should be maintained by every zoo.

8. All zoos should have proper facilities for storage of food and a kitchen to supply wholesome food to animals. Proper feed charts for all taxa should be prepared.

9. Regional Training Programme should be organised for Zoo Keepers as per curriculla developed by the Wildlife Institute of India. Such training may be organised under the aegis of the CZA/WII.

10. Feral, laboratory or confiscated wild animals may not be kept in a zoo for public exhibition. Separate funding may be provided for keeping them off exhibit with a seperate animal record.

11. Workshop / seminar / symposium for exchange of information and updating zoo management skill.should be organised at least once a year in different parts of the country for the zoo directors and middle level zoo staff under the aegis of CZA.

12. A bulletin may be brought out under the aegis of CZA.

13. Zoos should take measures to control populations of prolifically breeding common animals.

Health Care :
Report of the Working Group

Members: Drs. Jacob V. Cheeran, Leader; D. S. Balain and Vinay Gorhe, Rappoteurs; M. A. Salam; M. J. Kachhela, S. K. Sherawat, S. K. Modi, L. N. Acharjyo, Tapan Barthaken, Gowher Ali Khan, C. J. Chandra, B. M. Arora, P. O. George, L. M. Tripathy, Ganesh Kumar Dubey, R. A. Verma.

The Health Care Group discussed the various prophylactic measures and care of animals and made the following suggestions which should form the "stock in trade" of every zoo veterinary programme:

1. Screening and deworming of endoparasites should be carried out at regular intervals.

2. Vaccines utilized in zoos should be preferably of killed viruses.

3. Diagnostic test for tuberculosis in cervids and primates should be carried out as and when required as per the guidelines laid down by the IVRI.

4. Zoo veterinarians should be deputed in phases for three months course to be organised by Indian Veterinary Research Institute.

5. Regional workshops and national seminars for zoo veterinarians should be organised once in a year and once in two years respectively under the aegis of Indian Veterinary Research Institute and the Central Zoo Authority.

6. Zoos should coordinate with veterinary research centres for diagnosis and treatment of zoo animals with good effect.

7. Every zoo should maintain and retain their records so as to form a database regarding diseases and treatment of zoo animals.

Education and Public Awareness : Report of the Working Group

Members: S. Walker & Manoj Mishra, Group leaders, R. Sharma, Recorder; D. C. Desai, R. N. Satro, V. V. Kumar, D. D'Souza, M. Pandhya, M. K. Naidu, V. A. Abraham, P. C. Mishra, R. K. Singh.

The Education Group tried to avoid recommendations that were obvious or are already being done by CZA. The Group focused on enhancing measures that are not currently in practice in most of the zoos, or to reinforce programmes that require official approval.

Initially it was suggested that the education group merge with the Planning and Development Group after coffee break, but the group felt that time would not be sufficient to discuss all the subjects. Therefore in the first part of the session, the Education Group discussed what should be for education in the planning stage and with respect to development of zoos in general. These suggestions were taken to the Planning and Development Group by Mr. Manoj Mishra representating the Education Group. Two of the important points in these suggestions concerned the development of new zoos and the value of small as opposed to large zoos.

Also conveyed to the Planning Group was the need to involve an educator in the overall planning and all developmental phases was assessed as very important. Visitor facilities and conveniences should be given more importance in planning. It was also felt that as children formed a significant portion of the the actual users of the zoo, the opinion of some children in the planning stage should be taken so that a child's perspective might be represented and respected.

The Education also wished to convey the following points to the Planning and Management Group: large size was not necessarily the indicator of potential to educate the public. Quality, attractiveness, and appropriateness of exhibits, interest of the staff and other factors are equally important. While it may not be desirable to start any new small or mini zoos, those existing should be upgraded.

Some of the small and mini zoos which are unable to serve conservation by breeding endangered species or research, could be improved and used as educational zoos only and given some of the surplus common species which are causing problems to some of the other zoos. These small zoos can educate about endangered species even if they do not exhibit them by creating innovative educational programmes.

The second half of the morning was spent discussing three items given by Mr. S. C. Sharma and other identified points of importance.

1. Mr. Sharma requested the group to discuss the merits and demerits of handling animals in zoos for stimulating affection and creating awareness among visitors. The Education

Group felt that in no circumstance should animals intended for conservation be handled or subjected to stress of any kind by visitors. However, there may be animals which are surplus to conservation purpose and also safe for handling and these may be utilised judiciously for education, bearing in mind the health and welfare of the animal. Only trained persons in the zoo staff or selected volunteers should actually handle the animals for demonstration. It should be made clear that these tame animals are special cases and that wild animals are not appropriate pets.

2. Mr. Sharma requested that the group consider the matter of expensive signage which cannot be replaced if damaged, worn or stolen. The Education Group felt that when planning educational signage, a zoo should ensure that the materials utilised in construction of signage should be replaceable.

3. Mr. Sharma cautioned against recommendations which were not within the financial ability of the zoo. The Group felt that educationists should also be aware of the limited resources of the zoos and recommend activities which are practical and "do-able" within the Indian zoo context and within the resource base of the average zoo. The Group later discussed some ways of assisting the zoo add to its resources.

The Education Group isolated a few points which came out in the suggestions of the early session for detailed discussion. They were :

1. Keeper Training for Utilising Keepers as Educators,
2. Volunteers,
3. Media,
4. Funding

1. Recommendation: Zoo keepers are important potential educators, particularly for rural visitors, and should be given special training for interacting with the public

a. It was felt that zoo directors, zoo vets and curatorial staff would probably be the persons to train the zookeepers. A training booklet of suggestions on how to behave and talk to visitors for zookeepers as well as some simple facts about animals common to Indian zoos which could be translated into local languages would be useful in organising in-house training.

b. Keepers can tell visitors about the daily life of the animal as their zoo routine is very interesting to lay persons and particularly persons from rural areas. They should be instructed NOT to convey superstitious and erroneous information or to incite the animal to do unnatural things for the entertainment of visitors.

c. Zookeepers should be given training in how to approach misbehaving visitors to distinguish between well-intentioned but ignorant visitors and outright vandals and handle accordingly.

d. In recruiting new Zookeepers, the zoo should attempt to get people with a natural love for animals as they will automatically communicate it to visitors.

2. Volunteers can be of immense use to a zoo and should be encouraged. Measures can be taken to insure that volunteers are positive and constructive for the zoo.

a. Volunteers should be given an orientation course of a minimum of four days and also official zoo badges identifying them with photo.

b. Volunteers can be utilised very well as guides as this educates visitor as well as decreases vandalism. Special training may be organised for this as well.

c. A nodal person in the zoo administration should act as Coordinator to supervise volunteers, assign work and insure no problems arise either for them or from them.

d. As the cooperation of the zoo director is crucial in the successful conduct of volunteer programmes, some incentive could be offered by CZA such as a Certificate of Recognition for the best volunteer programmme and to the Director for conducting it.

3. Media should be fully realised and utilised for communicating the conservation purpose and message of zoos.

a. It was generally felt that zoos do not give sufficient importance to media and its potential for education. The negative publicity which some zoos get from media may be countered by a systematic attempt to court the media and give interesting articles and news items about the zoo.

b. It was felt that it would be useful if CZA contacted the Ministry of Information and Broadcasting with a suggestion to make zoo education one of its priority subjects.

c. CZA should make a handout listing the myths and realities about zoos which could be circulated to zoos for use with media.

d. CZA should circulate "facts about Indian zoos" for use by zoos when zoo personnel are being interviewed by media

e. Someone should be identified in the zoo who knows it well and can write effectively to see that weekly articles go to the press for publication.

4. Funding was identified as serious problem in developing an Education Programme or carrying out educational activities. These problems range from having no budget at all to having funds allocated for education diverted elsewhere. Ways of rectifying this were suggested:

a. C.Z.A. should give an instruction to state and municiple governments that a percentage of their total budget should be allocated to education. It was also felt that if zoos were allowed to retain a part of their gate money or a percentage of it for education this would give incentive to increase visitation by courting more visitors and improving facilities in the zoo.

b. Volunteer groups can be extremely useful in fundraising for education, either in cash or in kind, by interacting with the business and industrial community.

c. Businesses and industries can often be convinced to donate items like Waste bins, drinking fountains, educational boards and other visitor-oriented items by allowing them to include their advertisment on the item.

d. Finance and Planning officers in the state and central ministries should be targeted and made aware of the utility of zoo education so that they will approve requests for projects.

General suggestions were:

- An Education Department with a staff should be started in every existing zoo which does not have it. The size of the Department should be appropriate to the requirement of visitation. Volunteers can be used to strengthen the Education Department when funds do not permit more staff, particularly in outreach programmes to schools, community groups, etc.

- National academies such as police, army could be requested to include some zoo conservation education in their curriculum as they can be very useful to the zoo in a community.

- CZA should circulate a guideline as an information sheet or booklet giving the basic facts about Indian animals which could be used in educational signage.

Appendix I : Planning and Development of Zoos -- Education in the Planning Stage

1. Education department, staff, offices and activity rooms, other infrastructure and budget should be included in the Masterplan and Management Plan of the Zoo. The educational objectives should be very clear and target groups identified.

2. An educator and even others associated with the educational objective should be on the Planning Committee from the beginning and throughout the developmental process.

3. In planning a zoo, a consumer survey should be done to ascertain the need and impact of visitors so that it can be taken into account in the design. A demographer should also be consulted so that the futher growth of the city can be kept in mind when making the education plan.

4. In planning the zoo, children -- one of the zoo's important customers -- can be used as "evaluators" to gauge the potential of different exhibits to convey the right message. All educational waysides should be tested on all age groups to ensure that the correct message is being conveyed.

5. Visitor needs and comfort should be given considerable attention in the planning stage. Abundant visitor conveniences and facilities should be provided with capacity visitation in mind.

6. A "Friends of the Zoo" can be started from the inception of the process to start preparing the community for the upcoming zoo in outreach programmes to schools, community groups, etc.

7. Literature about the upcoming zoo can be prepared giving the conservation objectives of the zoo and explaining the rules of good behaviour in zoos.

8. A suggestion or recommendation may go out from CZA to new zoos that they should plan their budget to include education. At least 5% of the total zoo budget should be earmarked for education.

9. CZA should recommend that a nominal entry fee should be charged for every zoo. This will reduce the number of unproductive visitors and ensure that some value is given to the exercise of visiting a zoo.

10. The planning and construction process itself is very fascinating and educational. Correctly communicated and interpreted, it can be used to create interest in the public for the zoo.

11. Every zoo should have an Education Unit with an education officer or in the case of small or mini zoos a person should be designated as being in-charge of education. (In case of small or mini-zoos this could even be a volunteer.)

12. Conservation Education should be given importance at the entrance of every zoo, by a special construction or exhibit according to the zoos financial ability. It was felt that an elaborate, expensive building was not necessary for interpretation but some well done attention-getting device to orient the visitor correctly was absolutely essential. This can be done even during the construction stage to build up interest in the future facility.

Planned Breeding of Endangered Species
Report of the Working Group

Members: D. K. Lahiri Choudhury, Leader; J. H. Desai, Rapporteur; Sheila Pasricha, Jethva Bharat, S. Somasunderam, Dr. M. V. Giridharan, Dr. Prabhakar Gupta, Dr. Dharmeswar Das, R. K. Sahu, A. K. Das, Vijayraj Jadeja, P. P. Raval, Shruti Sharma, S. C. Sharma, Ram Krisna, Chinrapu, A. K. Roychoudhury, T. Ramakrishna.

I. AIMS AND OBJECTIVES:

The Working group recommends the following as the main objectives of the planned breeding programme:

1. Ensuring the survival, primarily of indigenous species which are endangered, threatened or rare, as enlisted in the Red Data Book of IUCN, and keeping the genepool of such species alive and viable in *ex situ* condition.

2. Creating adequate ex-situ stocks in coordination with other available *ex situ* facilities to obviate pressure and dependence on the wild stock by zoos.

3. Disseminating conservation education through exhibition in zoos

4. Serving the purpose of research, with the end of conservation in view, to understand species biology, behaviour, reproductive physiology, etc. by judiciously using latest available techniques and improving the technology with further research inputs.

5. The working Group recommends that for the selection of priority species for planned breeding projects, the list drawn up by CZA may be accepted for the present, subject to periodic updating and review in future.

6. As genepool preservation, conservation and research are considered the main objectives of the planned-breeding programmes in zoos, the question of breeding for commercial purpose does not come within the purview of zoos.

II. PROTOCOL

The Working Group recommends the following as the protocol for well coordinated planned breeding programmes:

1. Any planned breeding programme of an endangered, threatened, or rare species should take into consideration the entire captive stock both within the country and which may be available through exchange, loan or gift. To achieve this objective the Central Government .may

request all the zoo authorities in the country to remove price tags from animals used for such planned breeding programmes within the country. However, acquisition from outside the country may also be considered on merit.

2. No planned breeding project should begin without knowing the geneological records of the individual animals used in the breeding programme, except when wild stock is being used in such a programme.

3. All ~~planned~~ breeding projects should be preceded by or have a simultaneous built-in species biology research programme involving qualified scientific personnel and specialists.

4. Zoos should contribute tissue samples / genetic material for coordinated research programme to institutions running projects approved by the Central Zoo Authority. Such tissue samples/genetic material must not be allowed to go outside the country in violation of the country's rules and regulations.

5. In case of a planned breeding programme meant exclusively for reintroduction, a complementary programme to identify and evaulate suitable habitats for reintroduction and a post-release monitoring programme should be developed.

6. Recognising that planned breeding of wildlife is a specialised subject, the zoo authorities in the country should be persuaded to train personnel in advanced techniques and management practices, and develop their own expertise in this field.

7. Care should be taken to avoid interfererence with the natural behaviour of animal bred *ex situ*, and human imprinting should be avoided as far as possible in the case of animals bred for the purpose of reintroduction.

8. The Central Zoo Authority should constitute a special Technical Committee to examine, approve, guide and monitor all the major planned breeding programme in zoos.

Reintroduction of animals to wild
Report of the Working Group

Members : ***S. C. Dey, Leader. Suresh Chugh and Sanjay Molur, Rapporteurs. Tuhin Chakrabortry, N.C. Bahuguna, A. Glatson, Dipak Mitra, S.M. Hasan, T. Ramkrishna, C.L. Sehgal, Gurmeet Singh, A.R. Bharti, D.M. Singh, A.K. Dutt, Mahendra Singh, Ravi Chellam, L. Sahgal***

The group considered two types of reintroduction i.e. from captive to wild (reintroduction) as well as from wild to wild (translocation). In both types there are instances in which it will be necessary to carry out some activities.

(a) to re-establish a population in areas from which it has become extinct and

(b) for supplementation in areas where the population has declined considerably, in order to re-build or ensure a viable population.

The group discussed the past experiences of reintroduction and translocation of wild animals in India as reported with respect to certain species.

Priority species that need to be reintroduced (or translocated) in future:

Catetory-1

1. Brow-antlered deer
2. Great Indian bustard
3. Siberian crane
4. Blacknecked crane
5. Red panda
6. Musk deer
7. Asiatic lion (W)
8. Hangul
9. Rhino (further strengthening of population in Dudhwa) (W)
10. Tibetan antelope

Category-II

1. Lesser florican
2. Swamp deer
3. Pheasants
4. Wild buffalo

Category-III

1. Lion-tailed macaque
2. Kiang
3. Snow leopard
4. King cobra

Preconditions for reintroduction

The actual process of reintroduction should be carried out only after careful preparation and satisfaction of preconditions:

1. It is necessary to identify the cause of past decline or decimation of the species to be reintroduced, such as habitat loss, human interference, disease, hunting, poaching, natural disaster, pollution, poisoning or any other mutualistic species loss.

2. The carrying capacity and the condition of the habitat should be determined with respect to the species that needs to be reintroduced. For herbivorous species, availability of fodder and the competition by domestic cattle needs to be assessed. For carnivores, prey base requirement should be worked out. These are to be worked out not only as per the present situation but also under projected future conditions.

3. The adaptive capacity of the animals to reintroduction should be assessed and the species with higher adaptive capacity should be tried first.

4. Long term management plan and a short term detailed action programme should be prepared for the reintroduction, so that the continuity of the project is not jeopardised due to transfer of personnel. Proper documentation will also make the approach systematic.

5. Local communities should be fully involved in the process of reintroduction from the beginning through education and awareness programmes, so that they develop a sense of belonging and pride on the issue. They must also have clear perception of the gains from such a project.

6. Long term availability of dedicated and trained manpower is a must for any reintroduction efforts to be successfull.

7. Lasting financial support in consonance with the favourable policy of the government should is a prerequisite to any reintroduction programme.

8. Long term protection of the reintroduction site is a must.

Process of reintroduction

Process of reintroduction should have the following components:

1. The animals selected for reintroduction should be healthy and disease free and proper quarantine measures should be taken to ensure this.

2. The capture methodology needs to be identified and properly worked out before the actual capture. Transportation should immediately follow capture, and for this all necessary arrange-

ments should be made in advance. The translocation cages / boxes should be specifically designed for the needs of the species and individual animals to be transported.

3. The time of capture must not coincide with extreme heat, pregnancy, horn in velvet for stags or any other such stress situation so as to avoid high degree of mortality.

4. Animals in captivity that are identified to be reintroduced to the wild should be trained under semi-wild conditions so as to acclimatise them to the natural wild habitat.

5. In support of all these efforts, there should be a multidisciplinary team which should be well qualified, experienced and trained in all aspects of reintroduction. The team must also be provided with all equipments, drugs and medicines that are required.

6. Once the process of reintroduction is through, a long term monitoring should be continued till the proper establishment of the reintroduced population at the new site, or further interventions that may be required on the basis of monitoring. There should also be periodic evaluation of such projects.

CLOSING CEREMONY

Central Zoo Authority Workshop
Indira Gandhi's Vision on Wildlife Conservation :
The Zoo as One Such Instrument

Resume
S. C. Sharma

After the inaugural sessions the Central Zoo Authority Workshop participants had a brain storming discussion for more than one and a half days. Participating in these discussions were 25 zoo directors, nearly 15 research institutions, 4 universities and a number of animal lovers and educationists. Out of these delibrations the Workshop reached certain conclusions about the direction in which *ex-situ* conservation in this country should move. We request Mr. Pushp Kumar, Member of Central Zoo Authority to present the recommendations to the Honourable Minister for Environment and Forests.

Recommendations on Behalf of the Indian Zoo Community
Pushp Kumar, Hyderabad

Five groups were formed and later on, these merged in to three groups. One was for Planning Management, Health Care and Education, the second was for Planned Breeding and the third was for Reintroduction.

Recommendations of the Working Groups representing the Zoo Community

PLANNING AND MANAGEMENT GROUP

Complementary to the standards laid down by the Central Zoo Authority, the following recommendations are made.

1. Every zoo should have a Master Plan a for period of 20 years and a Management Plan for a period of 6 years.

2. Master Plans should be drawn up keeping in view conservation objectives of the zoo which might be reflected in a theme for the enclosures. As far as possible open-air enclosures without visual barriers should be constructed. The enclosures should meet the biological requirements of the animals housed.

3. Wherever possible Safari Parks may be set up for selected species in a suitable site of as large a size as possible, so that undesireable effects such as hybridization in herbivores can be avoided. These should be set up preferably near urban areas, as per Guidelines drawn up by CZA.

4. All zoos should concentrate on providing adequate space to each indvidual species, even if it means reduction in number of species displayed.

5. Whenever feasible more than one compatible species may be displayed in a natural setting which conforms to their biological needs.

6. The enclosure planned in any zoo should provide for optimum number of animals to be housed, keeping in view future needs.

7. A data base regarding disease and treatment of zoo animals should be maintained by every zoo.

8. All zoos should have proper facilities for storage of food and a kitchen to supply wholesome food to animals. Proper feed charts for all taxa should be prepared.

9. Regional Training Programme should be organised for Zoo Keepers as per curricula developed by the Wildlife Institute of India. Such training may be organised under the aegis of the CZA/WII.

10. Feral, laboratory or confiscated wild animals may not be kept in a zoo for public exhibition. Separate funding may be provided for keeping them off exhibit with a seperate animal record.

11. Workshop / seminar / symposium for exchange of information and updating zoo management skill.should be organised at least once a year in different parts of the country for the zoo directors and middle level zoo staff under the aegis of CZA.

12. A bulletin may be brought out under the aegis of CZA.

13. Zoos should take measures to control populations of prolifically breeding common animals.

HEALTH CARE :

14. Screening and deworming of endoparasites should be carried out at regular intervals.

15. Vaccines utilized in zoos should be preferably of killed viruses.

16. Diagnostic test for tuberculosis in cervids and primate should be carried out as and when required as per the guidelines laid down by the IVRI.

17. Zoo Veterinarians should be deputed in phases for a 3-month course to be organised by IVRI.

18. Regional workshops and National Seminars for zoo veterinarians should be organised once in a year and once in two years respectively under the aegis of IVRI / CZA,

19. Zoos should maintain proper co-ordination with veterinary research centres for diagnosis and treatment of zoo animals.

20. A database regarding diseases and treatment of zoo animals should be maintained by every zoo.

EDUCATION :

21. Each existing and new zoo should establish an education unit. This should be manned by qualified staff which may include voluntary organisations and children.