125 YEARS OF CALCUTTA ZOO



1875 • 2000



Members of the Organising Committee for celebration of the 125th Anniversary of Alipore Zooligical Garden

125 YEARS OF CALCUTTA ZOO
(1875-2000)



Published by
THE MANAGING COMMITTEE
ZOOLOGICAL GARDEN, ALIPORE, CALCUTTA

FOREWORD

This year the Alipore Zoological Garden, with its glorious history of 125 years, is all set to create another record in the Annals of Indian Zoos. The Managing Committee of the Zoo feels it a great honour to be able to organise and celebrate the 125th Anniversary of the Alipore Zoo. It is, therefore, proper that a Souvenir should be brought out to commemorate the celebration of the said Anniversary.

This Souvenir, containing valuable articles, contributed by the men associated with Wildlife, members of the Zoo and the Scientific community will cast light not only on the foundation and progress of the Alipore Zoological Garden and its unique position as a centre for the breeding of endangered wild animals and birds but also on other significant aspects of the Zoo.

I am grateful to all the contributors of the articles of the Souvenir. I am sure that readers will enjoy the contents.

Supriya Acharyya

(SUPRIYA ACHARYYA)
President
Managing Committee
Alipore Zoological Garden,
Calcutta 700 027.

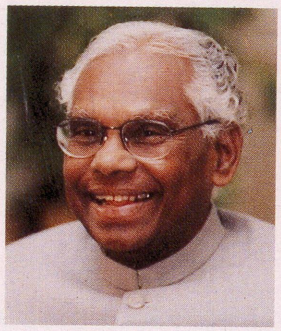


Burdwan House for exhibition of carnivorous animals constructed in 1879

सत्यमेव जयते

विशेष कार्य अधिकारी
OFFICER ON SPECIAL DUTY

राष्ट्रपति सचिवालय,
राष्ट्रपति भवन,
नई दिल्ली-110 004.
President's Secretariat,
Rashtrapati Bhavan,
New Delhi-110 004.



No. F. 2-M/2000

3rd April, 2000

Dear Shri Das,

The President of India, Shri K. R. Narayanan, is happy to know that the Alipore Zoological Garden, Calcutta is celebrating its 125th Anniversary from 28th April, 2000 and holding the Indian Zoo Directors' Conference/Workshop on "Zoos In Next Millennium" on 29th and 30th April, 2000.

The President extends his warm greetings and felicitations to all those associated with the Garden and the participants and the organisers of the Conference/Workshop and wishes the Celebrations all success.

With regards,

Yours sincerely,

(S. N. SAHU)

Shri A. K. Das,
Director & Convenor of the
Organising Committee for
Observance of the
125th Anniversary of the
Alipore Zoological Garden,
Alipore, Calcutta 700 027.

सत्यमेव जयते

Kanchan Gupta
OFFICER ON SPECIAL DUTY

प्रधान मंत्री कार्यालय
नई दिल्ली 110 011
Prime Minister's Office
New Delhi 110 011

6th April, 2000

Dear Shri Das,

The Prime Minister is happy to learn that the Alipore Zoological Garden is organising a conference on 'Zoos in Next Millennium' from 29th to 30th April, 2000 in Calcutta.

On this auspicious occasion, the Prime Minister extends his greetings to the participants and best wishes to the organisers.

With best wishes,

Yours sincerely,

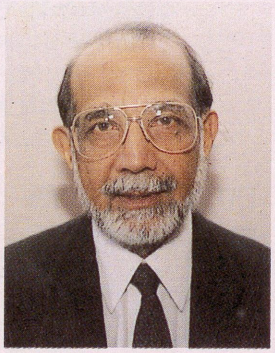
Kanchan Gupta

(KANCHAN GUPTA)

Shri A. K. Das,
Director,
Zoological Garden,
Alipore, Calcutta 700 027.

सत्यमेव जयते

GOVERNOR OF WEST BENGAL



I am glad to learn that the Alipore Zoological Garden will bring out a souvenir on the occasion of its 125th Anniversary Celebration. As one of the oldest of its kind in the world the Alipore Zoological Garden has been attracting and entertaining millions of visitors over the years. The Zoological Garden also plays an important role in the preservation of ecological balance and is useful in imparting education about wildlife and nature.

I am sure that the souvenir will doubtlessly be a prestigious publication containing thought provoking articles and will benefit the readers especially the Researchers.

I hope that the year long programme of the Alipore Zoological Garden to be held in connection with its 125th Anniversary Celebration are successful.

(VIREN J. SHAH)
Governor of West Bengal

Raj Bhavan,
Calcutta,
April 10, 2000.

CHIEF MINISTER
WEST BENGAL

सत्यमेव जयते

No. 127-P/CM
April 24, 2000

I am glad to know that the Alipore Zoological Garden, Calcutta, as a part of its 125th Anniversary, will hold Indian Zoo Directors' Conference and a Workshop on "Zoos In Next Millennium" on April 29 and 30, 2000.

I wish the Conference and Workshop all success.

Jyoti Basu

(JYOTI BASU)

सत्यमेव जयते

MINISTER-IN-CHARGE
DEPARTMENT OF FORESTS
GOVERNMENT OF WEST BENGAL
Writers' Buildings
Calcutta-1

D.O. No. .....

Date 13-4-2000

I am extremely happy to know that the Alipore Zoological Garden, Calcutta, will be celebrating its 125th Anniversary (1875-2000) from 28th to 30th April, 2000. Alipore Zoo is one of the oldest in our country. Since inception it has a glorious tradition in conserving wild animals in captivity. I believe that with the help and sincere efforts of all concerned this will continue.

I am also glad to know that Directors of different Zoological Gardens, eminent Zoologists and Environmentalists will be attending this celebration and will participate in seminar/workshop to mark the occasion. While welcoming them, I hope that they will be able to give us a new direction towards conservation of wildlife both in captivity and wilderness.

In fine, I offer my sincere thanks to the members of the Managing Committee, Officers and employees of Alipore Zoological Garden for their tireless and sincere endeavour to make this Anniversary Celebration successful.

13.4.2000.

(J. C. BARMAN)

Shri A. K. Das,
Director & Convenor of the
Organising Committee for
Observance of the 125th
Anniversary of the Alipore
Zoological Garden,
Calcutta.

Bilasi Bala Sahis

Minister of State
Forests Department
GOVERNMENT OF WEST BENGAL
WRITERS' BUILDINGS
CALCUTTA 700 001

सत्यमेव जयते

D.O. No. .....

Date 5-4-2000

MESSAGE

It is a great pleasure to note that Alipore Zoological Garden is going to celebrate its 125th Anniversary on 28th April, 2000 and to commemorate this occasion, a Souvenir also be published.

Calcutta Zoo has a long glorious history filled with example of pioneering role and significant contribution towards the breeding & management of wildlife in captivity.

I convey my heartfelt gratitude to the organiser and all the Zoo Staff and wish their endeavour be a grand success.

4.04.2000

(BILASI BALA SAHIS)

Director & Convenor of the
Organising Committee for
Observance of the 125th Anniversary
of the Alipore Zoo Garden, Calcutta.

Member Secretary,
Central Zoo Authority,
Bikaner House,
Annexe-IV,
Shahjahan Road,
New Delhi 110 011.

MESSAGE

It gives me great pleasure in extending greeting to the management of Alipore Zoological Gardens on the occasion of its 125th anniversary. In its long journey since 1875, the Zoo registered remarkable achievements in the field of captive management of wildlife which has got epitomized in a classic "Handbook of the Management of animals in Captivity" by Shri R. B. Sanyal, one of its distinguished Directors. It is not easy for any institution to exist with distinction for hundred twenty-five long years. It is a testimony to the devotion to duty and love for animals on the part of the Keepers and Workers of the Zoo which has made possible its continued successful existence.

I wish the anniversary celebrations success.

(P. R. SINHA)

Shri A. K. Das,
Director,
Alipore Zoo,
Calcutta.



Old Directors' Bungalow where the 1st Superintendent of the Zoo, Rai Bahadur Ram Brahma Sanyal also resided

EDITORIAL

It is our proud privilege to act as editors of this compandium published on the occasion of 125th Anniversary of the Alipore Zoological Garden, Calcutta.

Needless to mention, our job is rather a tough one, since a rigorous editing might not please all the contributors who have already achieved a distinct position in their respective fields.

However, we have tried to maintain the ethics of editing so far as practicable. We have altered a few words or a sentence in order to maintain an uniform style without hampering the spirit and decency of the article/paper.

We like to express our sincere thanks to Sri Susanta Bhattacharyya, Assistant Director, Alipore Zoological Garden, Calcutta for his enthusiastic endeavour needed for this publication.

We thankfully acknowledge the active co-operation from the authorities of the Zoological Garden, and also from the staff of the Zoo, who provided a very congenial environ during our work.

(SWAPAN KUMAR DAS)

(DILIP KUMAR MITTRA)

Names of the President of the Managing Committee, Zoological Garden, Alipore, since its inception till date

Year	
1875	Lord U. Browne
1876	Mr. C. T. Buckland
1881	Mr. F. B. Peacock
1890	Mr. J. W. Edgar
1892	Dr. D. D. Cunningham
1898	Mr. C. E. Buckland
1904	Lt. Col. A. Alock
1906	Mr. R. W. Carlyle
1907	Mr. E. A. Gait
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1944	Mr. L. R. Fawcus
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1961	Mr. U. C. Mahtab
1964	Justice P. B. Mukherjee
1969	Mr. S. Dhara
1970	Mr. N. K. Roychoudhury
1973	Justice P. K. Banerjee
1981	Smt. S. Acharyya

Names of the Hony. Secretary of the Managing Committee, Zoological Garden, Alipore, since its inception till date

Year	
1875	Mr. C. E. Buckland
1876	Mr. H. N. Tobin
1877	Lt. Col. P. A. Buckland
1878	Dr. J. Anderson
1890	Dr. D. D. Cunningham
1892	Mr. A. Simson
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1917	Mr. W. K. Dods
1928	Mr. E. H. Marshall
1936	Mr. H. A. Fooks
1939	Mr. E. A. Paterson
1944	Mr. S. S. Roy
1950	Major S. C. Dutt
1956	Mr. B. C. Sinha
1961	Mr. R. C. Sen
1962	Mr. P. K. Sengupta
1964	Mr. P. Ganguli
1967	Mr. K. P. Chatterjee
1968	Mr. K. C. Bose
1969	Mr. L. M. Singh Roy
1969	Mr. A. K. Banerjee
1973	Mr. D. N. Banerjee
1976	Mr. A. Kumar
1977	Mr. D. N. Banerjee
1991	Mr. C. Guha Thakurta
1991	Mr. B. Roy
1997	Mr. A. Dutta

Names of the Superintendent / Director, Zoological Garden, Alipore, since its inception till date

Year		
1876	Sri R. B. Sanyal	*Superintendent*
1908	Sri B. K. Bose	-do-
1930	Sri S. Ganguli	-do-
1935	Sri N. N. Banerjee	-do-
1939	Sri R. N. Bose (OFFG.)	-do-
1941	Khan Sahib S. M. Yaquib Khan	-do-
1949	Dr. R. K. Lahiri	-do-
1964	Sri S. N. Chatterjee (OFFG.)	-do-
1965	Dr. R. K. Lahiri	Director
1969	Sri S. N. Chatterjee (OFFG.)	-do-
1970	Sri S. S. Mandal, I.F.S.	-do-
1975	Dr. A. N. Guha	-do-
1980	Sri A. K. Das	-do-

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1. Smt. Supriya Acharyya, *President*
2. Sri Arunabha Dutta, *Secretary*
3. Sri Adhir Kumar Das, *Convenor*
4. Sri Subodh Roy
5. Dr. Sukesh Ranjan Chakraborty
6. Smt. Chitralekha Todi
7. Sri R. P. Banerjee
8. Sri Bikash Ranjan Bhattacharjee
9. Mr. Abdul Ali
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12. Sri Arin Ghosh, IFS
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13. Dr. S. K. Halder
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14. Sri Sadhan Ranjan Banerjee
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3. Dr. Dilip Kr. Mittra
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   Member, Managing Committee
   Zoological Garden, Alipore
5. Shri Arunabha Dutta
   Honorary Secretary, Managing Committee
   Zoological Garden, Alipore
6. Shri Adhir Kumar Das
   Director, Zoological Garden, Alipore
7. Dr. Sujit Chakraborty
   Scientist-E, Zoological Survey of India
8. Dr. Subir Kumar Chaudhuri
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    Mumbai
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    Asstt. Curator
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    Madras Crocodile Bank Trust
    Chennai



Staff of the Alipore Zoological Garden

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SECTION-I

History of Alipore Zoo with Special reference to the History of last 25 years

THE ALIPORE ZOOLOGICAL GARDEN AFTER ITS CENTENARY

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

The Alipore Zoological Garden, Calcutta which is one of the oldest and finest zoos in India had completed its 100 years of existence in 1975 and celebrated the occasion commemorating the Centenary Year on the 30th September, 1975 in a befitting manner. A souvenir was brought out on the eve of the said celebration where it was given in brief, how the Alipore Zoological Garden came into existence and how did it attain new heights. It also described its long history filled with examples of its pioneering role and significant contributions towards management of wild animals.

The history of management of the Alipore Zoo during its last 25 years is also eventful and interesting. A brief account of the said period is given below highlighting its progress and growth in modern lines, important births, deaths of animals and the episodes.

With the passage of time, the concept of zoo has been expanded and the management is now looking forward to keep the animals in captivity as free and comfortable as far as practicable. These are maintained outside the cages by creating suitable large open areas with moats and fences between them and the visitors. Due to the change in perception of zoo management, the Alipore Zoo has started adopting the modern concepts of animal management by constructing open air moated enclosures for different wild animals. The first attempt of modernisation of the zoo was made in 1957 when the authorities of the zoo constructed an open air moated enclosure for tigers. Thereafter, more and more open air moated enclosures have been added gradually for better housing and display of wild animals in the zoo.

The construction and opening of a freshwater aquarium in 1977 added a new dimension to the Alipore Zoo. It was the first significant addition to the zoo after its centenary. It is one of the largest freshwater aquarium in the Eastern India having 17 large and 48 small tanks. It has now about 1500 freshwater fishes belonging to different species both exotic and indegenous. It stands just opposite to the main gate of the zoo. A system of running commentary both in English and Bengali on different fishes exhibited in the aquarium has recently been introduced that enables the visitors to learn about the origin, distribution and behaviour of the different fishes exhibited in the aquarium.

The accommodation in the old Reptile House for exhibiting lizards, snakes and monitors was very poor and became out-dated and out-moded, a spacious (1063.67 Metres Square) New Reptile House was established in 1979 for better housing and display of different reptiles. As the new house has enough space inside, the movements of zoo visitors have become smooth and easier specially during the rush period. It has 48 exhibition cages arranged in circular fashion for display of different species of reptiles and a big central pool with a canopy of dome shaped wire netted roof for exhibition of crocodiles and gharials. For improvement of the environment some of the cages have been provided with small plants and bushes.

The construction of New Small Carnivora House in 1981 with twelve large cages, each having two dens and a very large cage with wire netted roofing behind the entire house has provided a good opportunity for better exhibition and breeding of jaguar and other carnivores like leopard, puma etc.

The old Chimpenzee enclosure has been suitably renovated in 1982. It has now a wide wet moat around the oval shaped enclosure having two spacious cages, each has two compartments for night shelter of the animals. There is a big dried tree standing in the centre of the open space for climbing of the animals and also for their acrobatic movements. Swings, over-hang nylon ropes have also been provided for swinging and playing of the animals. There is a stand of barrier around the oval enclosure with a green hedge between the moat wall and the visitors.

An open air moated enclosure for Bear Tribes having six dens have been constructed in 1985 by the grants sanctioned by the State Government for breeding and exhibition of different species of Bear. It has wide and deep water moat encircling the open space of the enclosure. There is also a stand off barrier with hedges in between the outer moat wall and visitors.

With the establishment of Central Zoo Authority of India in 1992, the work of modernisation of the Alipore Zoological Garden got a momentum. All the work

pertaining to development of the zoo which were so long being executed by the financial assistance of the State Government, started to be executed by the grants sanctioned by the State Government and the Central Zoo Authority of India. With these assistances, the Zoo Garden Authorities have completed the installation of a deep tubewell with over-head reservoir for providing drinking water to the zoo visitors, in 1998. The work of protection of the bank of the Zoo Lake against gradual erosion of land causing depletion of the bank area was completed in 1997. This saved the trees standing on the bank against uprooting. The lake of the Alipore Zoo becomes the greatest attraction to the visitors in the winter months every year when thousand of migratory birds throng into the lake.

One of the long-felt needs of the Alipore Zoo was the construction of an open air moated enclosure for elephants which has recently been constructed on modern line at the site of the old Director's Bungalow in 1999. The cost of construction of the said enclosure has been shared equally by the Central Zoo Authority and the State Government. The salient features of the said open air enclosure are:

(i) A large arena with an ornamental central pool.
(ii) Dry concrete moat, 320 ft. long, 11 ft. wide and 5 ft. deep to separate the arena from the visitors.
(iii) Retiring room with folded plate roof to accommodate resting space for three elephants.
(iv) Cess pool at the deepest point of dry concrete moat to pump out storm water.
(v) Visitors gallery paved with chequered tiles and fenced outer side of moat for viewing elephants from a safe distance.

The Central Zoo Authority has been now very generous with its financial support for improvement of the old zoos of India on modern line by renovating and replacement of the old cages and enclosures. It has started to provide full financial assistance for better housing and health care of the zoo animals. An amount of Rs. 60.79 lakh for construction of two open air moated enclosures—one for exhibition and breeding of Primates and the other for white tigers has already been sanctioned by the Central Zoo Authority. The work of execution of these enclosures are in progress and is expected to be completed within this year.

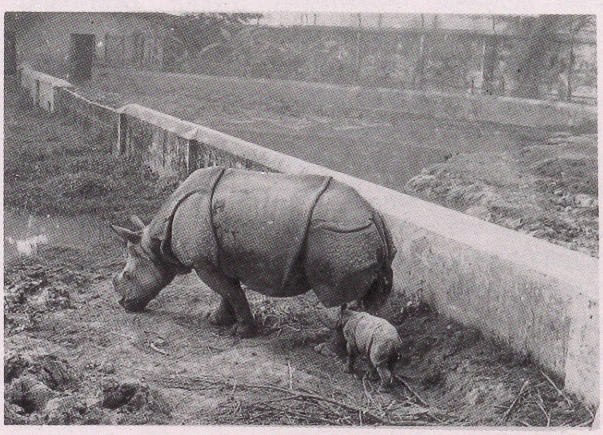


Fig. 9. First surviving Rhino calf with her mother 'Sneha'

Births

Besides the breeding of Great Indian One-Horned Rhinoceros, the most significant and striking achievement of Alipore Zoological Garden during its 125 years of existence is the breeding of giraffe in 1988 when a giraffe calf was born and survived for the first time. Thereafter, further breeding of giraffes was made and mother giraffe, 'Uttara' and her three daughters gave birth of 14 calves from April, 1988 to July, 1998. The Alipore Zoological Garden had supplied a pair each of zoo-bred giraffes to the Arignar Anna Zoological Park, Chennai and the National Zoological Park, New Delhi in 1998 and 1999 respectively.

It is for the first time in the history of Indian Zoos, the Alipore Zoological Garden could only breed and supply giraffes to other Indian Zoos.

This zoo has also bred successfully the fishing cat, an extremely threatened species having less exhibition value and the marsh crocodile for the first time in 1988 and 1998 respectively.

Deaths

In August, 1982, the female rhino, "Sneha" was found in oestrus when the male rhino, "Meghnad" was put in her enclosure. The rhino "Meghnad" had immediately started chasing "Sneha" very severely during their prelude of mating. "Sneha" was also found running very fast inside the paddock and the male rhino was following her, dashing her repeatedly. In course of chasing and dashing, the male rhino,"Meghnad" has suddenly lifted "Sneha" putting its head below her belly and thrown "Sneha" about 15 feet away when she got hurt very severely and succumbed to death.

This zoo had procured one male and two female giraffes (*Giraffa camelopardalis rothschildi*) from Kolon Zoo, Germany in 1986 in exchange of a zoo-bred female Rhinoceros, "Gomoti". But unfortunately one of the females died on 28.03.86 within 15 days of its arrival at this zoo. It happened due to accidental strangulation of its neck when she poked her head and neck between the two iron flats of the fencing to access a blade of grass lying outside the fencing.

The oldest male giraffe, "Sagar" was kept alone from 15.03.99 in a smaller enclosure of the giraffes' house for feeding nourishing diet with vitamins & minerals for sustaining its reproductive health to combat advancing

senility. As a proven sire, proper maintenance of its breeding capacity was needed. Accordingly, "Sagar" was kept seperated from the other giraffes for about a month and a half for giving healthy diet. During its absence from the bigger enclosure, the other adult male giraffe, "Salem", the eldest son of "Sagar" was in company of the three breeding female adult giraffes of the zoo which made "Sagar" jealous against "Salem" leading to a severe fighting on 5th May, 1999 between "Sagar" and "Salem" at the time of shifting to their respective enclosures. As soon as "Sagar" had found 'Salem' in its enclosure, he came rushing to "Salem" and started lashing on its body, with its long head and neck repeatedly. At first "Salem" had also tried to defend him from the attack of his father but later on became exhausted. About 15 zoo garden employees had tried in vain to drive "Sagar" away and to save "Salem". Ultimately, "Sagar" was lassoed simultaneously by two strong ropes and by tieding the two ends of the ropes with the trunk of a big Banyan tree standing inside the enclosure. "Salem" was, thereafter, managed some-how to put in a seperate room and was renderd necessary treatments but the animals died on the same day in the evening.

Bijoli, a 52 years old female Indian elephant of this zoo killed her Mahut, Nabi Mian (47) in a sudden fit of temper in the early morning of 7th August, 1980 when he was cleaning the floor of elephant enclosure. Bijoli was procured by the zoo in August, 1946 and was under Nabi Mian's charge for the past 11 years. For some reason not clear the elephant picked Nabi Mian up by holding his waist with her trunk and after swaying him to and fro, repeatedly dashed his head against a concrete pillar of the enclosure till he died. The zoo was closed for the day after the incident.

On the 1st January, 1996 at about 11-30 hours a Police Constable was on duty in the zoo, informed the Director at his chamber that two persons (Shri Joyprokash Tewari and Shri Suresh Rai as disclosed later on) had entered into the open air moated enclosure for Tigers by crossing the moat water and thereafter, scaling the fencing of the enclosure. On hearing the Alarm Bell of the zoo, the garden employees belonging to different categories including the Director of the zoo rushed to the said tiger enclosure. On reaching there it was noticed that the tiger "Shiva" who was on display in the said enclosure had grabed one person by holding his neck and was dragging him towards the central water pool of the enclosure. Seveal thousand of visitors standing around the enclosure were watching the incident. The Director immediately asked a keeper of the said enclosure to open the door of the den of tiger "Shiva" by operating the winch of the den from above and try to drive the tiger, Shiva inside the den. Accordingly, when a keeper had lifted the door of the den and called the tiger by its name, "Shiva", the tiger had immediately gone inside the den leaving the seriosly injured person from its grab. As soon as the tiger had entered the den, the door of the den was droped and locked. The entire operation of getting the tiger inside the den was done so quickly and successfully that the tranquilising gun which was made ready for shooting was not needed to be used.

It was later disclosed by the Police investigation that both Shri Joyprokash Tewari and Shri Suresh Rai had entered inside the open air moated enclosure for tigers with a garland of coloured paper for garlanding the tiger, "Siva". They also carried a musical steel pipe. It was taken by surprise and irritated when one of the persons touched the tiger. The tiger slapped Suresh with its fore paw. He then went to Joyprokash and mauled his neck, face and chest and pinned him down to the ground. Suresh got up and tried to drag Tewari away from the grab of tiger and gave a blow on its body. Shiva had immediately caught hold of Suresh by putting his jaws around his neck and was dragging him towards the Central Water Pool when the zoo employees reached there and got the tiger locked in its den. Both the seriously wounded persons were immediately admitted to the nearby S.S.K.M. Hospital with the Police help. But Joyprokash Tewari had died on its way to the hospital and Shri Suresh Rai had recovered after prolonged treatment.

The zoo is still holding proudly one Aldebra Giant Tortoise in its collection which came to the zoo along with three other tortoises of same species at the time of establishment of this zoo in 1875. The probable age of this tortoise is now over 250 years.

Research works on conservation of wildlife in captivity were regularly done by the Officers and the Veterinarians of this zoo during the last 25 years who had also contributed many papers on their research activities which were published in different scientific journals in India and abroad. Moreover, students of Natural History Sciences belonging to different Universities had carried out their research activities in this garden. Furthermore, the schools and colleges both within and outside the State are conducting educational excursions for their students to this zoo regularly.

It may be concluded with a hope that Alipore Zoo will play an even more active role in future for conservation, recreation, research and education on wildlife in captivity and the Celebration of its 125th Anniversary will be marked by further efforts in this direction.



Fig. 1. Building of the Alipore Zoo Aquarium ➢



➢ Fig. 2. New Reptile House



Fig. 3. New Small Carnivora House ➢



Fig.4. Newly renovated Chimpanzee Enclosure



Fig. 5. New open air moated enclosure for Bear

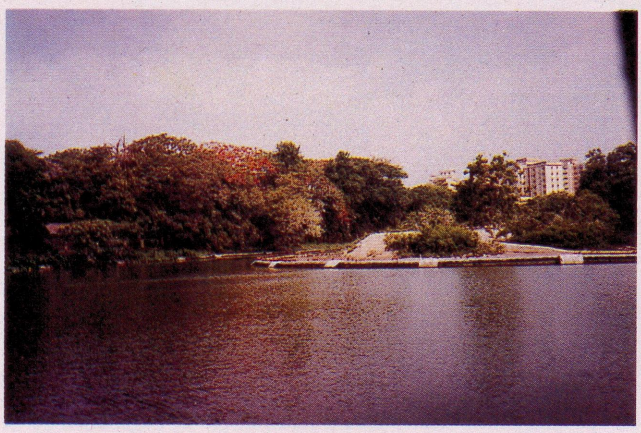


Fig. 6. Development of the bank areas of the zoo lake

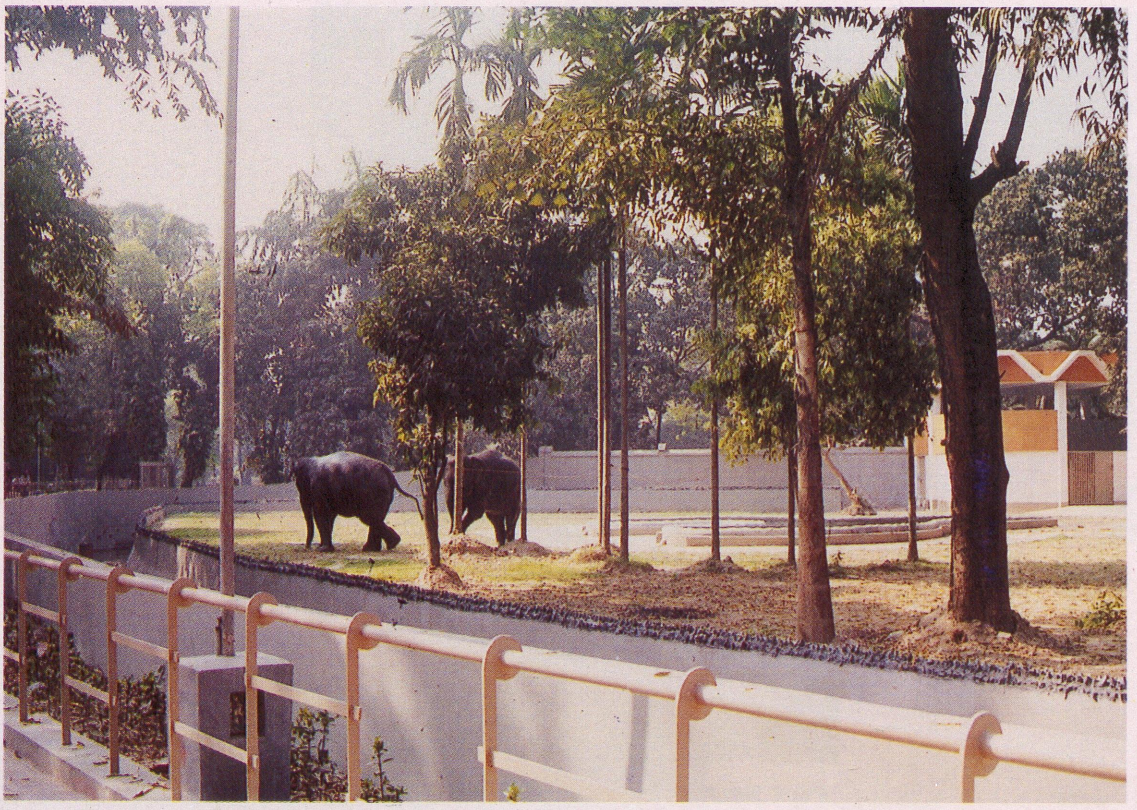


Fig. 7. Newly constructed open air moated enclosure for Elephant

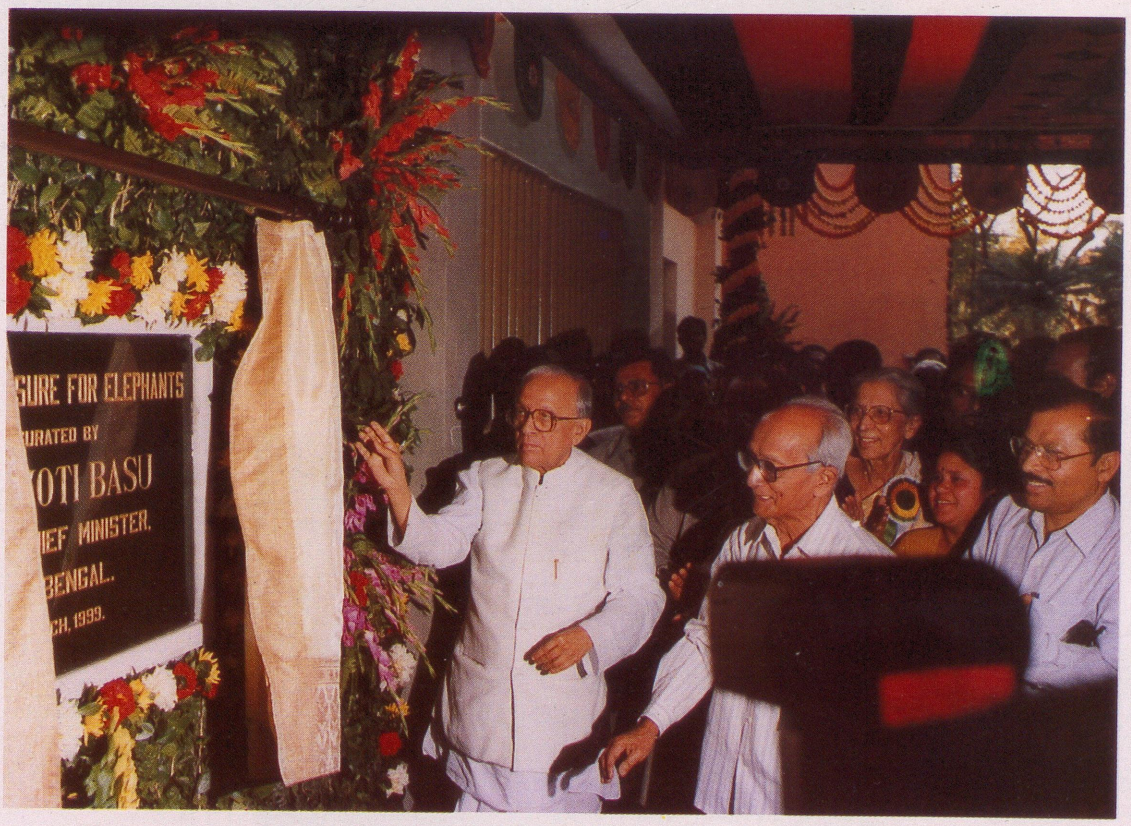


Fig. 8. Ceremonial opening of the newly constructed open air enclosure by Shri Jyoti Basu, the Hon'ble Chief Minister of West Bengal



Fig. 10. Zoo bred giraffe with her mother

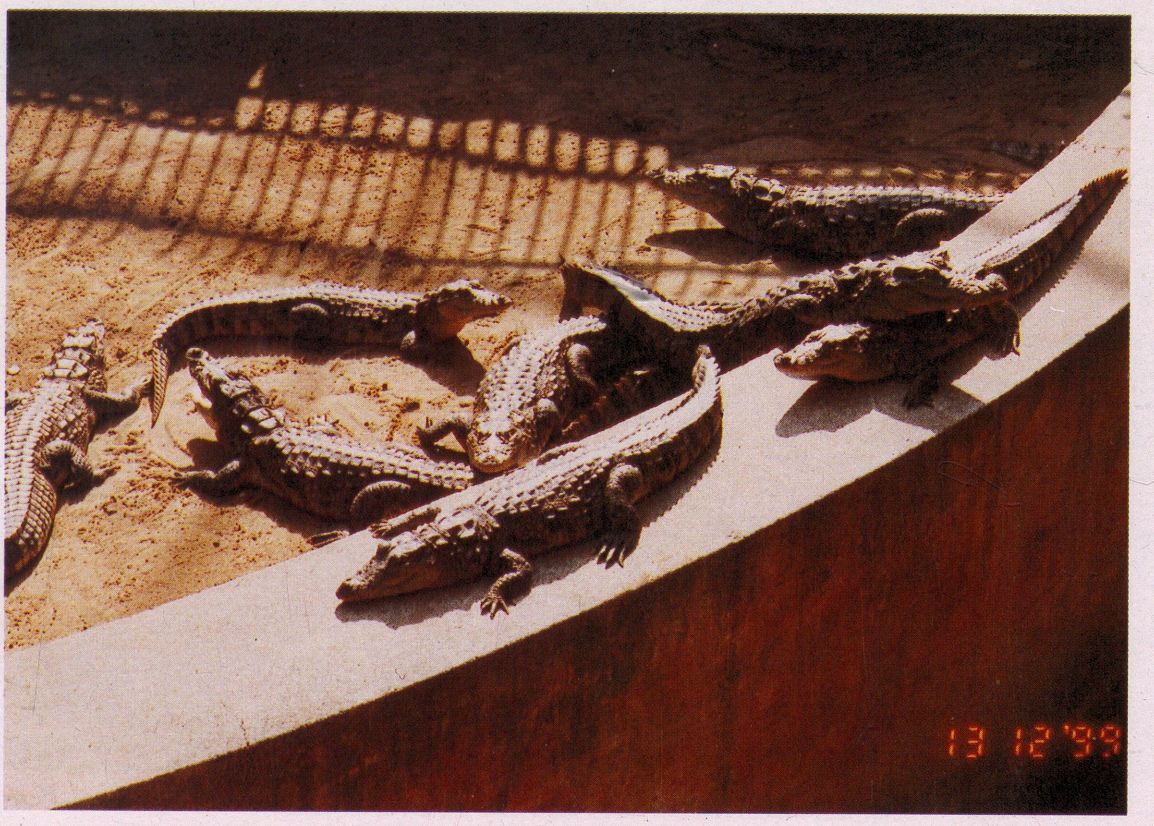


Fig. 11. Zoo bred marsh crocodile

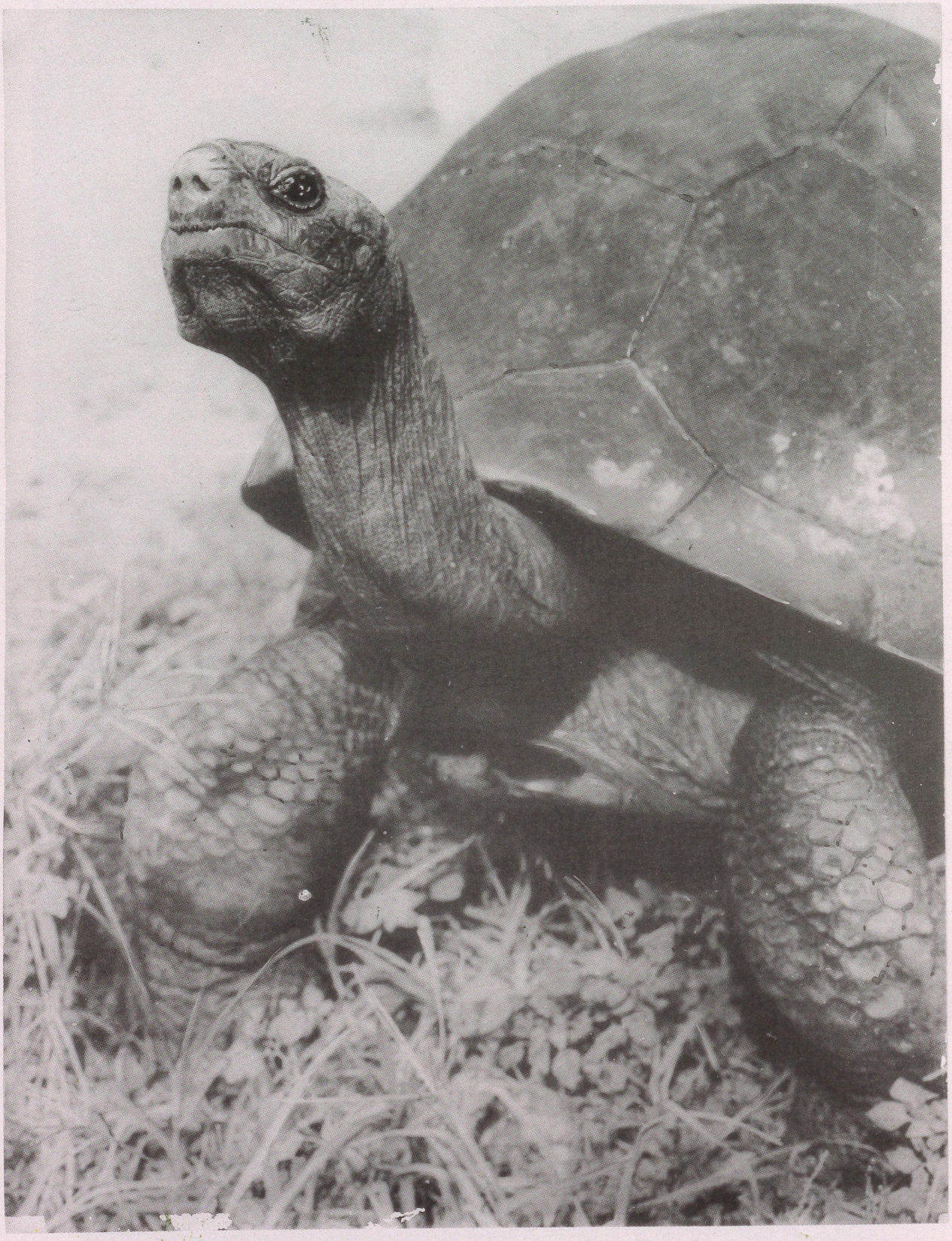


Fig. 12. Aldebra Giant Tortoise the oldest exhibit of the Zoo

REMEMBERING
RAI BAHADUR RAM BRAMHA SANYAL

DR. D. K. MITTRA
Deputy Librarian (Retd.), National Library, Calcutta

If so happened recently that a zoo professional, highly educated and qualified, knew something of R. B. Sanyal and his two important books, surprised me with a number of questions about him.

He was doubtful about the specific contribution of Sanyal in zoology of specialised nature. Even he was not convinced to hear that Sanyal was a 'Scientist', during his time, *i.e.* during the late nineteenth century. *He believed that if Sanyal had not written a book something like "wild animals and its management", these would have been no loss to this special branch of zoology. He was emphatic that there is no science as such in that book.* The crux of the matter was that it is of no use today to evaluate him for his contribution in his branch and rank him high in his scientific attainments which he got in the late nineteenth century.

It would have been a nice gesture if my zoo professional friend could have produced some evidence to justify his claims. It was understood that the above comments were only as a passing remark without thinking seriously about it. Regarding the specific contribution of specialised nature by Sanyal, one has to go back to the eighteenth century history of India.

The British policy was to develop all aspects of India for its economic benefit and naturally fauna was not taken up for its detailed study immediately. Botanical investigations were taken up at the priority level. With the introduction of the English education and as part of it, the scientific and technical education started only in the nineteenth century. According to Dr. R. C. Majumdar, "this century was a great dividing line and these hundred years changed the face of India for more than did the proceeding thousand years". It was in this century, some Indians who began to work with the Europeans, gradually acquired experimental skills towards the closing of two decades of the century.

The study of zoology in a systematic manner can be seen through the valuable publications in the last three decades of the nineteenth century. Examples may be cited as Birds of India by T. C. Jerdon, Stray Feathers edited A. Hume, Natural History of the Mammalia of India and Ceylon by Sterndale, Fauna of British India Edited by W. T. Blanford. These limited literature belonged to the animals of natural environment and habitat.

Against the backdrop of this scenario, let us analyse Sanyal's contribution to the science of zoology. He dealt with captive animals and birds, making his observation on their movement, health, food, housing, treatment in sickness, breeding etc. His scientific guidance came from Dr. John Anderson, Carl Louis Schwendler, Dr. George King and Dr. D. D. Cunningham. Even Sanyal got help from Dr. T. Greenhill, Veterinary Surgeon of M/s Cook & Co (Horse Mart) Calcutta, during his difficullty.

Let us know in short about Ram Bramha Sanyal. Born on 14th February 1851 (approx.) at Mohula village, a few kilometres from the town Berhampore, Dist Murshidabad, West Bengal. He passed his Entrance Examination in 1869 from Berhampore Collegiate School. Ram Bramha was the younger of two brothers. He came to Calcutta for studying Medicine and Surgery (L.M.S.) but his medical studies were cut short due to his eye trouble. Dr. George King who was a Professor of Botany in the Medical College recommended Sanyal for a petty service in the Garden in 1876. His medical education of approximately three years, gave him enough courage to work in later years in Zoological Garden, Calcutta.

The book that has been referred in the second paragraph bears the title as "A hand book of the Management of Animals in Captivity in Lower Bengal" by Ram Bramha Sanyal Calcutta 1892. This is a publication which has been very judiciously compiled by Sanyal, Members of the Management Committee and Mr. C. E. Buckland, Ex-Hony. Secretary of the Management Committee from the writings of 'Daily Register' which started from January 1877 by R. B. Sanyal. This had a permission and order from the Committee. The regular writing of 'Daily Register' went on un-interrupted. The Report of the Committee for the Management of the Zoological Garden, Calcutta for the year 1888-89 was published and Sir Steuart Bayley Lieutenant Governor of Bengal desired that "from the records of the Committee and the re-collections of their



Fig. 1. Ram Brahma Sanyal, the First Superintendent, Zoological Garden, Alipore when he took the charge of the Gardens



Fig. 2. Ram Brahma Sanyal with grand-daughter and grand-son



Fig. 3. The Garden at the time of Ram Brahma Sanyal

able Superintendent, it would be possible for them to produce a hand book which might be of great use to the numerous nobles and other persons who on a smaller scale keep collections of animals or birds in Captivity".

The book was published in March 1892 and was sent to almost all leading scientists, scientific institutions, zoological gardens and scientific magazines in India and abroad for their kind review, comments and opinion about the effort that was made in this new direction. Soon, personal and official letters of appreciation started coming to Sanyal. To quote a few personalities in this regard, Sir Charles Eliot, Lieutenant Governor acknowledged "the good work performed by the author" and that he trusts that "the Committee will take measure to have the book widely circulated". Dr. John Anderson Vice-President, Zoological Society, London was of the opinion that it was a very wise resolution of the Government of Bengal to determine to put on record the great experiences accumulated by you regarding the treatment of animals in confinement and the result you have achieved must be gratifying to the Government, the Committee and to yourself. I congratulate you on the results embodied in your book which is unique in the literature of Zoological Garden." W. T. Blanford, Vice-President of the same society felt that "it is a most useful work and I much regret that I had not the advantage of utilizing some of your observations on the habits of various Indian animals in confinement when preparing my account of the mammals. I have found your notes very interesting indeed". Similarly, Late C. T. Buckland who was previously in the Bengal Civil Service and also President of the Management Committee expressed that "I wish to make no delay in acknowledging the pleasure it has given me offering my humble testimony to the ability and judgement with which you have compiled such a difficult and almost unique work. There can be few people who have had an experience at all equal to yours or who had made such good use of opportunities".

The 'Nature' magazine from London reviewed the book and said that, "It is certainly a work of considerable interest. In the first place it has the merit of giving us a complete classified list of all the mammals and birds that have been kept alive in the Calcutta Garden. These are, of course, mostly species of British India—241 of the class of mammals and 402 of birds—but there are a good many exotic forms among the birds". "On the whole we must allow that this volume is remarkable production, considering the circumstances under which it has been prepared and that its author deserves great credit for the pains bestowed on its composition and for much valuable information contained in it". This review attracted the attention of the various zoological scientists who were better equipped with ample facilities but could not utilise their good opportunity for doing such a work.

Soon after the recognition from abroad, Sanyal sent his observation to Zoological Society, London on 27th July, 1893 entitled "Note on hybrid between the *Sennopithecus phayrei* Blylth and *S. cristatus*" published in November 1893. This was followed by two other interesting writings which appeared in 1894 and 1895 respectively. As a recognition to Sanyal's work towards the advancement of zoological knowledge, the Zoological Society, London honoured him by electing one of its Corresponding Members (C.M.Z.S.) in 1892.

If for a minute it is taken that the book of Sanyal *if it was not published during that time, there would have been some loss to the advancement of knowledge and* instead of Sanyal, after many years Mr. Lee S. Crandall would have been credited for doing the pioneer work on animals in captivity.

Now coming to name and fame of Sanyal after publication of his first book, his presence was needed at the Victoria Garden, Bombay in their development and planning, which he did by visiting there and submitted a detailed report. Sanyal wrote another book in 1896 meant for children entitled "Hours with Nature". His writings that were published in the journal of the Asiatic Society of Bengal were of high quality. This is not possible until and unless the contributor is talented and committed person Sanyal's work on 'Snake Poison' was yet another remarkable work which has to be taken into consideration while labelling him as 'Scientist'. With his gradual accomplishment, the Viceroy and Governor General of India honoured him by the title of 'Rai Bahadur' on 1st January 1899.

The Scientific World accepted him for his work as it was based on rules, concepts and procedures. Let us hope that my zoo professional friend will finally agree with the reasons given above and accept him as others have accepted him and also remember this great son of India through the celebration.

I thankfully acknowledge the help rendered by Late Dr. Amarendra Nath Guha, Director, Zoological Garden, Calcutta and Late Bimalendu Halder, Head Clerk of the Zoo for giving me the opportunity to go through the relevant documents for carrying out my research work on the life and contribution of R. B. Sanyal. I am greatly indebted to Shri Kanailal Mukherjee (Retd.), an employee of the Garden who generously handed over to me all his personal collection in respect to the anecdotes of the zoo.

PHEASANTS IN CAPTIVITY WITH SPECIAL REFERENCE TO CALCUTTA ZOO

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Pheasants with their dazzling colours have become prime attraction to the aviarist as well as to the visitors of any captive breeding centre of the world. Calcutta Zoo in its long past glorious history of 125 years of existence had successfully housed different pheasants of the world like Chinese Silver Pheasant, Golden Pheasant, Lady Amherst's Pheasant, Reeves Pheasant, Kalij Pheasant, Malayan Fireback Pheasant, Bornean Fireback Pheasant, Elliot Pheasant etc. Most of the pheasants are delicate to handle and need special care for housing them. Very offen they are attacked with deadly dangerous diseases like Ranikhet Disease, Fowl Cholera etc. causing huge death toll in any captive pheasant population.

In the present article an attempt has been made to give a comprehensive idea about pheasant keeping in captivity.

Housing

The size of the aviary may vary but a cage of an aviary of 40 ft. (long) × 12 ft. (wide) × 8 ft. (high) would be found very conducive as pheasants require a good space for flight and also a space for roaming around the cage throughout the day. Moreover, the cage of the aforesaid size would be found effective during the breeding time when a hen may find enough place for retreat at the time of chasing by the male bird. In addition to all these points, a mixed collection of compatible ground (pheasants) and perching birds may be kept together in the said cage and this will add more variation and naturalistic appearance to the aviary. Finches, Koels etc. and even some colourful wild ducks can be kept together in the aviary of a pheasant without causing any disturbance amongst themselves.

The indoor and outdoor enclosure of the cage

The cage should have an indoor and outdoor enclosure of the dimension of 10 ft. (long) × 12 ft. × 8 ft. (high) and 30 ft. (long) × 12 ft. × 8 ft. (high) respectively. An enclosed area on the rear end of the indoor enclosure can be used as service passage for the keepers as well as a nursery. Door should be placed on the side wall of the indoor enclosure so that keeper can enter from the other cage of equal dimension of the aviary.

Lot of care should be taken to provide a good rats proof floor for the pheasants. The rats, specially during the time of egg laying may eat away the eggs, if they can have access to the cages. The left out food of the birds has to be taken out of the cages daily, otherwise the food will attract rats.

The floor will be covered partly by silver sand and partly by good earth. Pheasants like sand for bathing.

Perches may be placed in the indoor enclosure. Pheasants will rest on the perches during night. If the perches are placed in the outdoor enclosure, the birds might then sit on the perches exposed to rains, cold etc. which may cause health problem to the pheasants.

Bushes may be planted in the outdoor enclosure which will provide some hiding places for the phesants. Bushes with gravels of various size and shapes and even a narrow strip of water body, if provided, will give some naturalistic appearance to the cage.

The chain linked m.s. wire net used for the purpose of covering outdoor enclosure and the rear end of the indoor enclosure should have the proper mesh having better visibility of the pheasants. The painting to be used for the netting and the two side wall of the indoor enclosure should be soothing one so as to merge with the nature, otherwise the same will definitely be an eye-sore to the visitors.

M.S. guard railing may be used on the three sides of the aviary and this should be placed three feet away from the outer surface of the aviary. Between the aviary and guard railing, thorny hedges may be planted to act as barrier to the visitors.

The aviary should have side by side four to six cages of the dimension as mentioned above. Four to six varieties of pheasants, if kept side by side in an aviary, would definitely be a prime attraction to the visitors.

Food

Pheasants require a varied range of food as their diet. It ranges from grains, minced meat to insects. They also require a good amount of cut green vegetables in their daily diet. It is better to depend on the good quality poultry feed having all important nutrients for the birds than that of the constituted food. Together with the poultry feed, cut vegetables and ant's eggs or mealworms have to be added in the daily ration



Fig. 1. Cock of a Golden Pheasant



Fig. 2. Cock of a Lady Amhersts' Pheasants

of an adult pheasant. Following diet schedule may be followed for the pheasants:

Chicks up to the age of 4 months

1. Ant's eggs/mealworms (very little quantity) for 2/3 days after the birth of a chick.
2. After 2/3 days, add chicken mash (Starter) with ant's eggs/mealworms.

Gradually the quantity of food has to be increased.

4 months onwards up to the age of 10 months

Ant's eggs/mealworms + minced meat + mash (Grower's) + cut green vegetables.

Birds of 10 months and onwards

Ant's eggs/mealworms + minced meat + mash (Layer's) + cut green vegetables.

The quality of food is very important. Bad quality of food will increase the chance of egg spoilage besides other diseases caused due to malnutrition and will also cause deformity in the chick. Fine grit should be provided for the Pheasants as the same would be used by the pheasants.

During breeding season, the adult birds should be provided with Calcium, Vitamins and minerals with the usual diet for better breeding success.

Acquisition of Birds

Before acquisition of birds, it has to be made sure that the cock and hen are unrelated with each other. If possible, the cock may be procured from one breeder and the hen from the other. This will definitely stop the chances of inbreeding. Breeding success in the inbred population is very less and sometimes successful breeding does not take place in an inbred population.

The Lady Amherst's Pheasant and the Golden Pheasant, if kept together, very often produce hybrids. It is better to procure the adult birds in full plumage otherwise it is extremely difficult to identify the purity of chicks.

Breeding of Pheasants

Pheasants are mostly polygamous with a few exception of monogamous varieties like Peacock Pheasants.

In case of polygamous varieties like Silver Pheasant, Lady Amherst's Pheasant etc., one male bird could be kept with two or three female birds. Sometimes a cock even enjoy the company of as many as seven hens and eggs will still all be fertile.

Some pheasants incubate their own eggs. But some birds do not sit on their own eggs for incubation and for such hens, broody hen or bantam or even incubator can be used for the purpose of hatching.

After laying of eggs is over, the cock, if possible, may be shifted to other cage so that the hen can peacefully sit on the eggs for incubation, otherwise the cock may disturb the hen.

The broody hen used for the purpose of hatching should be free from ectoparasites, otherwise due to infestation of ectoparasites, the hen may not sit on the egg peacefully as she may feel uneasiness. It is better to treat the birds against ectoparasites before allowing her to hatch the eggs, if the bird is infected with ectoparasites.

The first clutch of eggs may be taken out of the cage from the pheasants and the same may be hatched by broody hen or incubator. The last batch of eggs may be left to the hen for hatching and rearing the newly born chicks. This method will enhance the chances of getting more chicks in a season.

A brooder is required for the chicks hatched out in an incubator. The brooder should be lighted properly so as to provide desired temparature required for the newly hatched chicks. Sometimes the broody hen or even the mother hen may not take care of the chicks; in those cases the brooder may also be used. Lot of care be taken for the newly hatched chicks to provide good quality of food and fresh drinking water. Chicks of different age should be kept in different brooder, otherwise there will be competition for food etc. amongst the chicks.

Hygiene of the Pheasants

Food tray and the drinking water troughs have to be cleaned regularly. The drinking water troughs may be placed in the shade. A fountain type drinking water trough will be the better one for the birds. Cleanliness of both the indoor & outdoor enclosures should be maintained meticulously. Foot bath may be used before entering the cages of the pheasants and the same will curb the chances of getting infection of the birds.

Prevention against coccidia, round worm, even rarely Tape Worm infestation and ectoparasites should be adopted as routine procedure.

Pheasants may be infected with Fowl Cholera and Ranikhet Disease. Vaccination against those diseases may be done as and when required. The same process is also adopted at Calcutta Zoo.

If proper nutrition, health and hygiene of any efficiently managed captive population of pheasants be maintained meticulously, remarkable breeding success with healthy progeny could be achieved.

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CONTRIBUTION OF ALIPORE AND NANDANKANAN ZOOLOGICAL PARK, BHUBANESWAR IN BREEDING OF TIGERS

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Indian tiger (*Panthera tigris tigris*) commonly known as the Royal Bengal Tiger occurs almost from the southern tip of India to Himalayan forest hills in the north and from Gir in Gujarat to Arunachal Pradesh. They are mainly an Indian subspecies, though they do occur beyond the India in the neighbouring countries in very small number. This majestic animal and number had been declining fast due to biotic pressures and loss of habitat. 'Project Tiger' was launched in 1973 to save this tawny centered graceful species, when its number dwindled to 1827 in 1972. From then it has made slow recovery, though last two census have indicated marginal decline. But the white colour variation is very rarely seen in the wild though there have been sporadic reports of shooting of white tigers from different parts of the country. The earliest being recorded in 1907 and last in Roe in 1964. Of course black coloured variation has also been reported from Similipal, Orissa in nineties.

First white tiger cub, about 9 months in age was captured by Maharaja of Rewa in 1951 and he named him 'Mohan'. It was reared in Govindgarh palace and mated with normal coloured tigress 'Begum' captured from same forest. Though the offsprings were all normal coloured, the mating of Radha of the 2nd litter with Mohan resulted in birth of 4 white cubs. Thus started the captive breeding of white tigers with magnificient snow white coat, black or ark coloured strips, pink nose and paw pad and icy blue eyes. White tigers were supplied from this origin to Washington D.C., Bristol Zoo & National Zoological Park, Delhi, Alipore Zoo and later to many other zoos.

But normal coloured tigress, 'Ganga' when mated with 'Deepak' between 24.9 to 30.10.79 gave birth to a litter of three white tiger cubs (1 male and 2 females) named as Debabrata, Alaka and Nanda with snow white coats and light black strips on 8th January, 1980 at Nandankanan Zoological Park.

The geneological chart maintained by National Zoological Park (Saharia '79) did not point to any lines between the white tigers of Rewa origin with the parents of the white cubs. Thus producing a entirely new line of white tiger.

It was found that both the parents were descendants of the 'Sikha' and 'Pradeep' both of whom were brought to Nandankanan Zoological Park from Alipore, Calcutta. On search of records it could be located that while 'Sikha' was bought from animal dealer S. K. Acharya of Ranchi at 3 years of age, 'Pradeep' was brought from Variety Birds Emporium, Calcutta in May, 1964. No record beyond this point is available. It is possible that both could have been captured from Orissa or Bihar forests from when there have been reports of shooting of white tigers. Hence Deepak & Ganga were heterozygous. The geneological chart gives the details.

After this systematic breeding followed and several litters were born with white offsprings, the white males of Nandankanan lineage was also mated with Diana (Rewa origin) brought from Delhi Zoo in 1979 and was renamed Subhra to prevent inbreeding depression, as according to A. K. Roychoudhury of Bose Institute, the white tigers failed to survive when inbreeding coefficient attained 0.4687 or higher. By 1979, only 2 zoos namely Delhi Zoo & Alipore Zoo, Calcutta who were holding white tigers were already experiencing congenital defects in the offsprings due to intensive inbreeding.

By production of this new blood line and mixing with the Rewa lineage further inbreeding depression could be avoided.

One hundred twenty-two white tigers have been bred in Nandankanan so far and many were given to different zoos in India like Jaipur, Guwahati, Ahmedabad, Pune, Madras, Aurongabad, Bhilai, Mysore and Lucknow and other countries like U.S.A., Indonesia and Malaysia. Even a pair has gone back to Madhya Pradesh, the original home of white tigers. Zoological Gardens, Alipore has also been given a white tigress 'Gayatri' on 9th August, 1991. There has been long cooperation between Alipore and Nandankanan from the day of establishment of Nandankanan in 1960 in various spheres like exchange of information, visits by staff, training, exchange of animals, which has done lot of good to both the zoos in neighbouring states. Late R. K. Lahiri, the then Director, Zoological Gardens, Alipore visited Nandankanan twice in the early sixties and advised about zoo management to the officers of



Fig. 1. White Tiger in white Tiger Safari—Nandankanan
—Photo K. L. Purohit



Fig. 2. Mother with normal and white cubs at Nandankanan
—Photo K. L. Purohit

the newly established zoo, as Alipore Zoo had long experience in managing wildlife in captivity. We are looking forward to further cooperation in the 3rd Millennium to enrich both of the zoos and establish them as zoos of examplary high international standard.

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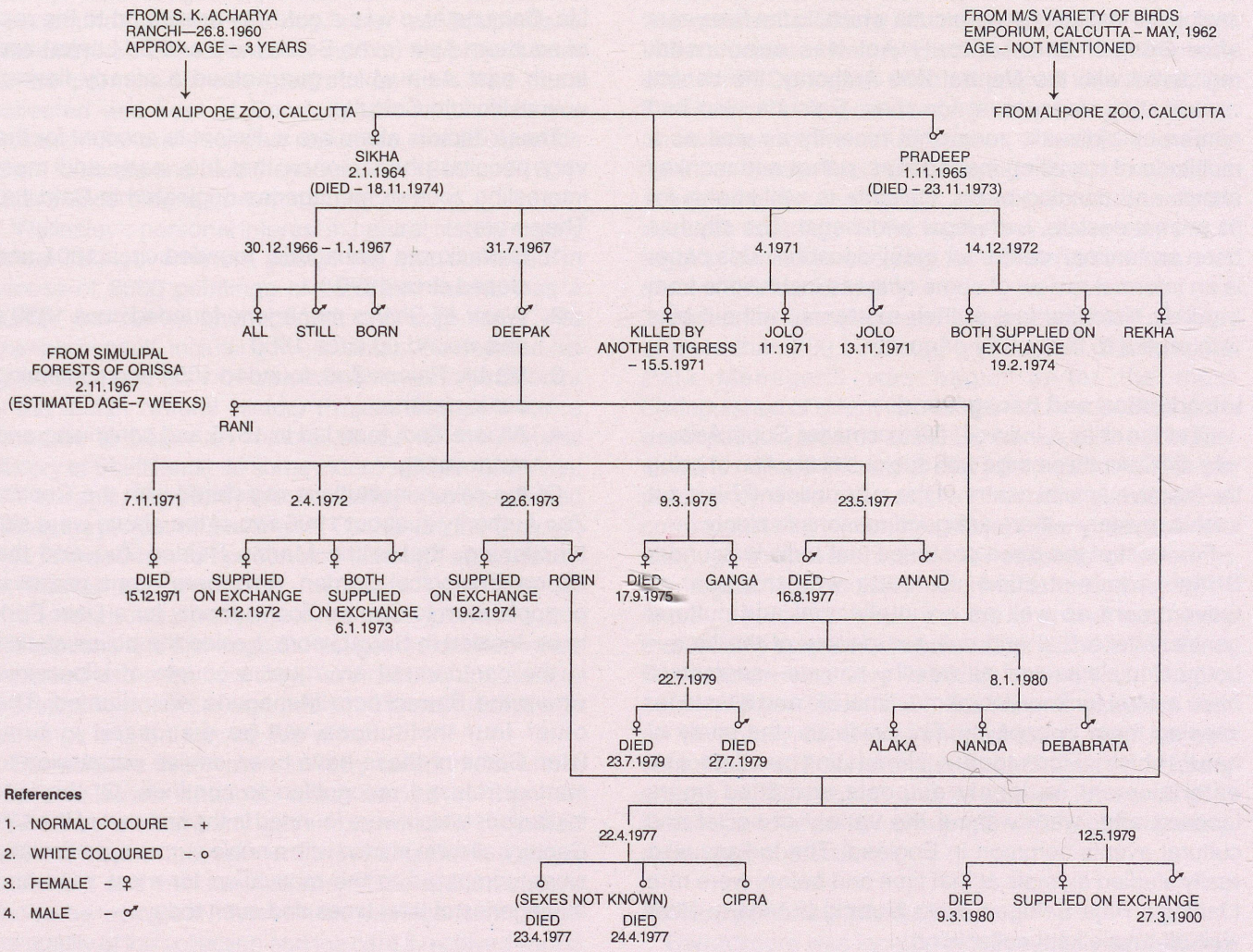


Fig. 1. Chart showing the genealogy of white tiger cubs born at the Nandankanan Biological Park, Orissa.

CALCUTTA—CITY OF ZOOS

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Abstract

In the early 19th Century—starting from 1801 there were four well documented institutions of some significance which could properly be called menageries or even zoos in Calcutta and a host of hearsay private collections. Even in very recent times, there are 7 zoological institutions in Calcutta which, in the five years after Central Zoo Authority Act was announced, registered with the Central Zoo Authority, the central coordinating department for zoos. Calcutta also had numerous sidewalk zoos until recently as well as a multitude of travelling menageries, parrot and monkey shows and dancing bears. Calcutta is well-known for its animal dealers, both legal and illegal. The city has been an "animal" centre for many decades. This paper is an informal review of some of these institutions from a purely historical fact of their existence, without bias with regard to their utility or quality.

Introduction and background

Of all the cities in India or—for that matter, South Asia,—why did Calcutta emerge with dubious distinction of being the "captive animal centre of the subcontinent"? It is not such a mystery—there are good reasons in plenty.

For most of the three centuries that India was under British administration, Calcutta was the seat of Government as well as an intellectual and cultural centre. Intellectual and cultured people of the time—both colonials as well as wealthy natives—seemed to have a thirst for knowledge of animal life and a taste for keeping them in captivity. For colonials, the study of natural history provided a stimulating pastime and entertainment on lonely outposts and filled hours looming after work without the variety of social and cultural events common in England. The Indians who really studied animals at that time and before were rare (Jahingir, Raja Sefogee, Raja Mullick) but many other well-off royals kept collections.

The fact that Calcutta was a busy sea port where ships from Europe, Africa and Asia brought luxuries and exotica for the colonial administrators and wealthy and powerful among Indians surely played a role also. It allowed both colonials and natives to ship Indian animals out to friends, colleagues and governments abroad and also to order strange and wonderful specimens in return. Trade in animals had been going on in India for quite some time, however.

The rich forests of North-east India, Burma and other border countries, and the state of Bengal itself has its own rich forests to supply a very great diversity of animal life. Calcutta also was a gateway or seaport to the rest of southern Asia (even South India and Sri Lanka) and south east Asia which guaranteed a steady flow of animal life into Calcutta.

These factors alone are sufficient to account for the very peculiar phenomenon that four early and most interesting zoos or menageries originated in Calcutta. They were:

1. Barrackpore Menagerie, founded circa 1801 and closed circa 1879
2. Wazir Ali Shah's menagerie founded circa 1830's and wound up circa 1880
3. Marble Palace Zoo, founded 1854 and continuing but in decline
4. Alipore Zoo, founded in 1875 and continuing and rennovating.

Of the seven institutions registered with the Central Zoo Authority in about 1996 two of the above were still functioning, that is the Marble Palace Zoo and the Alipore Zoological Garden. Also there was a proposal or application to Central Zoo Authority for a Deer Park to be located in Barrackpore, beside the police station in the cantonment area just a couple of kilometres where the Barrackpore Menagerie was situated. The other four institutions will be discussed in brief later. Some of these have been denied permission to start or refused recognition to continue. Of the four institutions which were founded in the first part of the 19th Century, all were started with a noble purpose, particularly when compared to the motivation for most zoos and menageries of later times and even today.

Barrackpore Menagerie

Today we speak of the concept of biodiversity as if it was something new on earth! In point of fact the first 'modern' biodiversity project in South Asia (and perhaps much farther afield as well) was initiated in 1801 by then Governor General Lord Arthur Wellesley. Wellesley was

an impetuous, impulsive, arrogant and tactless individual with, nonetheless, a passion for knowledge and some very avant-garde ideas. It was his dream to found a college which would employ the best pundits and scholars from all religions and cultures of India to teach the young English administrators who came over to join civil service. He thought that such a background in Indian culture would uplift the standard of civil government. He was probably right but his superiors were not so prescient and foiled his college plan. However, as the Company managers were always interested in something which would enhance the economic potential of their ward, they permitted Wellesley to initiate a portion of the college proposal, that is the Indian Natural History Project.

The Indian Natural History Project was an ambitious attempt to catalogue the entire faunal wealth of the Subcontinent, which we now refer as South Asia. Wellesley had already made a start on the project even before permission was granted: animals had been collected and kept at Barrackpore, which was the Governor General's summer residence, and 350 pounds spent to house and feed them between 1800 and 1804. This is according to government record.

Wellesley's personal interest in natural history clearly influenced government policy. He had collected in excess of 2660 paintings of flora and fauna, was a hunter and fan of animal fights and kept some wild animals himself, including five cheetas. He deputed his personal physician, Dr. Francis Buchanan to be Director of the Indian Natural History Project and gave him a mandate to begin an "official study" of the Natural History of South and—to some extent—South-east Asia.

It is tragic, therefore, that Wellesley was transferred just as the project was taking off. Buchanan, the Director, also followed him to London and although an assistant to Buchanan continued for some time, due to circumstances, personalities and politics, the descriptions and drawings did not get the attention they deserved and even now they have not been published. A project to annotate and publish the manuscript and drawings is underway by this writer.

Barrackpore itself was a military cantonment with a 300 acre estate attached which served as Summer Residence of Company governors which it remained until the seat of government moved to Delhi. Various governors and their families spent time at Barrackpore and some took great interest in the menagerie. Although the quality of the collection and the care it received varied immensely, there are periodic references in the India and Bengal Despatches in later years to indicate that the menagerie remained a concern of Government for more than 75 years until the Calcutta Zoo was founded and the remaining animals were transferred. During that time the public came from Barrackpore Cantonment and even Calcutta—both official visitors as well as local people—and it continued as a zoo before the word was born.

Barrackpore as a scientific institution

The significance of this project is yet to be acknowledged in the history of zoos, in the history of natural history and in the history of science. This scientific project to illustrate, describe and classify all the birds and quadrupeds of South Asia was the first systematic study of Indian zoology and well advanced in relation to other scientific activities. The Zoological Club of the Linnean Society of London formed 18 years later. The Zoological Society of London began 22 years after the Indian Natural History project and is likely to have been influenced by it as Stamford Raffles, founder of London Zoo, had visited Barrackpore Menagerie on two occasions before returning to London. The first Indian Journal of Natural History was founded 36 years after INHP. During the short six years it was active, the INHP made an impressive beginning towards creating an inventory of the natural history of India, particularly for those times. Two hundred years later, many of the countries of South Asia still are not up to date with an accurate inventory of the fauna and all are very much lagging behind in knowing the conservation status of most of their biodiversity.

Buchanan described and supervised the illustration of more than 200 birds and quadrupeds. Barrackpore Park Menagerie was begun under the most distinguished of scientific motives—pure research, pure description. In order to assist Buchanan, all the principal civil and military officers at every field station under the presidency were requested to instruct their officers to correspond with him on this subject. Early menageries, although they were started for reasons of scientific investigation were equally experiments in acclimatization and domestication which is more of animal husbandry than wildlife science or natural history. The mandate as Barrackpore was very explicitly scientific. In August 1807, William Gibbons, Dr. Buchanan's assistant sent an inventory to Government stating that he had commissioned 70 original drawings himself since taking charge of the Project and 31 copies for sending to Europe, a total of 107 drawings, which, unfortunately, never saw publication.

Barrackpore as a public Zoo

Barrackpore was located in a beautifully landscaped area, planted with lovely trees, shrubs and flowers which were a mixture of Indian tropical and English garden varieties. It is obvious from the glowing descriptions of visitors that Barrackpore was a refreshing treat after the hot and dusty city of Calcutta. Letters of distinguished visitors to the Governor General's Summer Residence

over the decades trace the history of the collection and its condition.

In 1810 there was a pelican, a sarus crane, flamingos, an ostrich, a cassowary, Java pigeon, two tigers and two bears in the Barrackpore Menagerie. A black leopard had been added by 1814. Between 1817 and 1819 a new aviary was constructed and by 1822 a new menagerie was built with the animals confined in structures which were "partly of Gothic and partly of classical style"—very typical of the times.

In 1820 there is a watercolour of Barrackpore Menagerie by Charles D'Oyly in which a bear, a lion and a pelican can be seen in their cages.

In 1924, Fanny Parks, adventurous wife of a British official and lively writer of Indian life, visited Barrackpore and commented on the "remarkably fine tigers and cheetahs."

On 1828 Bishop Reginald Heber, saw the Gayal, a very noble creature of the ox or buffalo kind, an African wild ass, two lynxes, tigers and leopards, two kinds of bears, a porcupine, a kangaroo, monkeys, mouse-deer, birds and a tame hyena.

In 1929 the French naturalist Jaquemont noted "bears of two species, a caracal, a wild ass, a gibbon, some musk deer, an ostrich, a cassowary and some fine large water birds as well as about ten elephants and a tame one-horned rhinoceros. The latter was attached by a long chain to a tree beside a pond where it stayed the whole time."

Lord Auckland and his two intrepid sisters, however, took a lively interest in it. In letters to home, Auckland's sisters reported "two rhinos, a tiger, two black bears, two cheetahs, a white monkey, three sloths, a baboon, a giraffe, and some birds. Lord Auckland himself started new aviary for some golden pheasants from China.

By 1941 it seems that natural historians of the area were again using Barrackpore to some extent for the purpose it was intended. In July of that year the Calcutta Journal of Natural History record the receipt of animals "for Barrackpore" from Captain Bogle and Lieutenant Phayre who were stationed in the northest—two consignments of animals; the first consisting of a papio Rhesus and a Hoolook, which died on the way; several specimens of Lemur tardigradus; several Rhizomys, or bamboo rats, and Monitors and the second despatch consisted of a young hoolook, three lenurs, a Martin, two young swine, a Rhizomys, a porcupine, a small Felis, and two spotted deer.

In 1847 a visitor reported seeing the following animals at Barrackpore: tigers, leopards, bears, ostriches, monkeys, rhino, giraffe and water birds, white egrets, flamingos, China pigeons, as well as monal pheasants. In 1848 the Private Letters, Lord Dalhousie reported that Barrackpore has an aviary and a menagerie.

In 1864 , a marvellous little story of a child and an ostrich includes the information that Barrackpore had an official Gamekeeper and refers to a "Government Aviary". In the latter part of the same decade, an article in the Calcutta Review advocated the starting of a new zoological garden in Calcutta as the collection in Barrackpore "had deteriorated" and was "not deserving of the name".

There were no more "saviours" for Barrackpore. From 1874 to 1880 practically the last news of the Menagerie is that Lord Lytton handed the remaining animals (and whatever were donated afresh) over to Calcutta Zoo which had been opened at Alipur in 1875.

Barrackpore Park was a transitionary institution, having begun before the word "zoo" was in use and continuing long after it was coined, inspired by London Zoo in the 1820's. Although some references claim that Barrackpore was open only to Britishers, this is not the case in fact. Even London Zoo, however, was not "public" in the sense of allowing everyone. Only members could see the collection for many decades.

An interesting watercolour dated 1820 by Charles D'Oyly shows Indians, as well as Europeans, in Barrackpore Menagerie by the cages looking at the animals and in 1924, when Fanny Parks visited Barrackpore, her ayah asked to go with her to see the hyena demonstrating that Indians were "comfortable" going to the menagerie and it was not off limits to them, as such.

Lord Curzon wrote in 1924 that there was "no distinction" between the Parks and the Gardens originally and that the public were increasingly admitted to the Park. In 1862 Lord Elgin complained that there was only one private walk remaining for him and that the whole of the Garden as well as the Park was open to the public.

Finally, an irrefutable indication that Barrackpore was a public zoo is published in a small booklet written in 1931 by Mr. A. C. Pal, a former Superintendent of Barrackpore Park which continued after the zoo was wound up. Pal relates in this booklet that he knew people in the 1930's who could remember visiting Barrackpore when it was a going concern and could relate stories of happy days of childhood looking at animals at Barrackpore Park.

Menagerie of Wajid Ali Shah, circa 1830

The nephew of Wajid Ali Shah has written about his uncle's many interests one of which was animals. He had kept an enormous establishment of fighting animals in Lucknow and again in Calcutta where he was exiled he created another. This was maintained in an enormous estate called Nur Mahal surrounded entirely by an iron fence. Although the public was not admitted as a policy, passers-by could see hundreds of spotted deer, buck

and other animals running free in the large compound along with a water pool in the middle of the estate which was full of partridges, ostriches, turkeys, sarus cranes, geese, herons, demoiselle cranes, ducks, peacocks, flamingoes and hundreds of other birds, and tortoises.

Shah's biographer claims that much attention was given to sanitation and that animal droppings and other artifacts of live animals could not be seen in this park. There were monkey cages with an immense diversity of primate species from around the world. There were also thousands of shining brass bird-cages and scores of large wire-net aviaries where many and various species of birds were kept, including 24 to 25 thousand pigeons and "all possible arrangements were made for their upkeep and breeding." According to Shah's biographer there were over 800 keepers and 300 pigeon fanciers employed by the King with the same number to look after the fish and some 30-40 for the snakes.

It is advised that one must make allowances for exaggeration in such accounts but even so, Ali Khan's menagerie must have been formidable. This information came from one book which was translated from Urdu and also contains a long section on the animals the King maintained for fighting in Lucknow which was even more elaborate than this. Wajid Ali Shah's arrangements for combat and references to this pastime are not infrequent all of which lend credence to the incredible account of his Calcutta Menagerie. Also when the menagerie was finally wound up, many of the animals, albeit in poor condition by that time, were sent to the Calcutta Zoo where R. B. Sanyal had to accommodate them and coax them back into a fit condition.

The Marble Palace Zoo—1854 to the present

Rajah Rajendro Mullick Bahadur founded the Marble Palace Zoo in Chorebagan, Calcutta in 1854, and it still stands today in the centre of Calcutta city. The Rajah consciously and intentionally founded it as a public service for the education and entertainment of the public. Rajah Rajendro Mullick was a student of natural history and the menagerie in his house contained birds and mammals collected from different parts of the world as well as India and visited by crowds of people daily. His biographer, Dinabandhu Chatterjee, opines that his Zoo must have been an important (animal) collection, even before opening to the public. Mullick gave numerous animals to other institutions such as London Zoo and Antwerp Zoo. He also gave the Calcutta Zoo valuable animals and was honoured by having the first animal house named after him.

Marble Palace Zoo was nurtured by persons who admired and cared deeply about the dramatic and beautiful interesting creatures from around the globe. Much thought went into the keeping and display. It was known, for example, that Hispid hare required privacy, so they were kept in a very long cage so that the animal could retreat to the back away from the public. In addition they put a bamboo "partition" and provided sand for burrowing. These enclosures can be seen today although most of them are empty. The first cage ever to be constructed in the Marble Palace Zoo still stands, today holding rabbits and guinea pigs. Even the travelling cages of early days are still there but quietly going to rot. The Marble Palace, while its value as a viable animal facility in the present context may not be much, would nevertheless make a excellent medium for explaining the origin and development of zoos and natural history—in Calcutta and India.

Alipore Zoological Garden—1875 to the present

Although Barrackpore Menagerie continued there were people as early as 1841 who felt that Calcutta should have a proper zoo. The July 1841 issue of the Calcutta Journal of Natural History of July 1841 relates a proposal by Mr. Raleigh for the formation of a Zoological Garden. Although the Jardin de Plantes had been formed only 40 years ago in France and the Zoological Society of London less than 15 years ago in London, these institutions apparently had had such an impact that in a relatively short time it was deemed "necessary" that a city have a zoo! Acquisition of knowledge was the primary motivation according to these discussions and the writer was at pains to point out the necessity of assembling animals in collections to learn about them but NOT like "native courts" which put on animal fights. That these entertainments were much enjoyed colonials as well as natives was not stressed. Instead "zoological gardens" where the animals were arranged with the "utmost convenience for observing their habits and acquiring a knowledge of their names and peculiarities" were described as the need of the hour.

This is a true description of the modern menagerie—interest in taxonomic differences as opposed to mere curiosities and fighting stock but without regard for habitat or ecological features or conservation. The comment also established the value of a collection for reasons other than domestication or finding new sources of food. Also in referring to "myriad creatures that compose creation" Raleigh comes close to speaking of what we mean by biodiversity today.

For three decades the intelligensia of Calcutta dithered around about the zoo and finally started it in 1876 primarily due to the generosity of Indians, the "native section of the community" for the contribution of Rs. 2,40,000 plus the subscriptions of 1867 which were "at once paid and even increased."

The early history of the Calcutta Zoo is synonymous with R. B. Sanyal who was the first Superintendent of Calcutta Zoo and author of the first true work of zoo

management, the "Handbook of the Management of Wild Animal in Captivity in Lower Bengal." Sanyal was a medical student who had to discontinue his studies on account of his vision and was hired to supervise the labour landscaping the zoo. He worked hard and rose swiftly. In a few months he was promoted and given more supervisory responsibilities including the nutrition and medical care of the growing number of animals. He exhibited such a facility for management and documentation that he was made Acting Superintendent and then Superintendent by default, as no more suitable person could be found.

Practically all that we know about Sanyal today is due to the efforts of his biographer, Dr. Dilip K. Mittra who has written a definitive biography of this eminent zoo man in Bengali language. He is currently working on a translation and expansion of the biography which will include a history of Calcutta Zoo as well.

If we consider Dr. Heini Hedigger the father of zoo biology, then R. B. Sanyal might well be considered great grandfather of the science. Sanyal contributed significantly to the development of a professional identity and was probably the first to practise zoo management as a holistic inter-disciplinary scientific endeavour. He was certainly the first to write about it as such.

Sanyal began his scientific observations into the biology and behaviour of captive wild animals in 1877 recording his experiences in the 'Daily Register' of the Zoological Gardens, Calcutta. It was from the detailed register that he took the material for the Handbook. Sanyal was first to write specifically about zoo enclosure designs, including even dimensions and furniture or props required for animals' general welfare and biological requirements. Regarding nutrition, Sanyal gives details of food, including quantity and also occasional changes in their food habits. He has also pointed out the food habits of some exotic animals under Indian conditions as well, distinguishing between their natural diet and what might be fed in captivity that is readily available in India.

Breeding of animals in general and conditions prevailing in the Gardens for this vital factor in zoo management has been dealt in detail giving therein the reason of failure in breeding. In considering this, it is important to remember that those were the days of Menageries, when most of the people managing captive animal collections were not particularly concerned about breeding. Sanyal was the first to deal with breeding as a serious subject and seemingly an objective of the institution. Sanyal was unquestionably the first truly modern zoo man,—and the last for many decades. The next book to equal his was written in 1960 by Lee Crandall.

The Calcutta Zoo is still a very much going and growing concern today, although it is not without its problems. What was a quiet tropical suburb in Alipore in the days of its inception is today an intensely crowded part of the metropolis of Calcutta. Visitation is reflected in the growth of the city's population: twenty thousand visitors a day is not unusual for the 45 acre zoo and on special days the count reaches 100,000! This takes an enormous toll on the animals. For a long time there has been a plan to shift the zoo to a large area so that open spacious enclosures could be given for all the animals but, as before, finding an available and appropriate site has delayed the project.

In 1996, Calcutta had no less than seven registered animal collections in or near it—these were school animal collections, deer parks, snake parks and mobile zoos as well as more traditional zoos. In the intervening years a number of these collections have been given notice by Central Zoo Authority to improve or close. Other animal "entertainments" such as sidewalk zoos and performing animals are on the wane. The demise and departure of most of these establishments is welcome for there was no redeeming value or justification at all for keeping animals in the conditions in which they lived.

However, since Calcutta has had such a history of zoological institutions, it is a shame that so little has been done to mark this history or to preserve the valuable documents which are being consumed by insects both in the Calcutta Zoo Library in Alipore, in the National Library next door at Belvedere and at the Marble Palace Zoo.

It is also a great tragedy that an Indian Natural History Project and Barrackpore Park is virtually lost to history. The Government of West Bengal still owns the property on which it sat and undoubtedly there are documents pertaining to it rotting away somewhere. These institutions and the stories connected with them are not just Calcutta treasures or Indian treasures but precious archives of the history of zoos of the world. On the 125th anniversary of the Calcutta Zoo, let us hope that awareness might be raised to the extent that funds to preserve and promote these treasures might be found and that it is not too late to find missing information which would fill the gaps in the fascinating zoo history of an entire city.

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SECTION-II

Articles on wildlife other than Veterinary aspects

MANAGEMENT OF INDIAN PANGOLIN IN CAPTIVITY

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The name pangolin was derived from the Malay word "peng-goling" meaning "roller" which refers to the animal's habit of rolling up into a ball. Earlier the pangolins were described along with ant-eaters, sloths and armadillos under the order EDENTATA (meaning lack of some or all teeth). But recently they are placed in a separate order PHOLIDOTA (meaning scaled animals). There are seven species of living pangolins belonging to one genus *"Manis"* and placed in the family Manidae. Four of these species (Giant pangolin, *Manis gigantea;* Cape pangolin, *Manis temmincki;* Long-tailed pangolin, *Manis longicaudata* and African tree pangolin, *Manis (tricuspis)* are found in Africa and the rest three species (Indian pangolin, *Manis crassicaudata;* Chinese pangolin, *Manis pentadactyla* and Malayan pangolin, *Manis javanica)* are found in Asia. Two species, the Indian pangolin and the Chinese pangolin occur in India. The former is widely distributed in the plains and lower slopes of hills of India, south of the Himalayas and Sri Lanka whereas the later speccies ranges through Assam and the eastern Himalayas to Nepal, Myanmar and South China (Prater, 1998).

The Indian pangolin *(Manis crassicaudata)* is one of the most fascinating animals of the Indian jungle. It is a toothless mammal with a prehensile tail. The mouth is more or less like a orifice through which it darts out its thick, sticky, slender and unusually long tongue for securing food and water. In appearance it looks more like a reptile than a mammal. They are usually terrestrial but are capable of climbing up a tree.

The first report on the management of three species of Asian pangolins in captivity is that of Sanyal (1892) based on his observations at the Zoological Garden, Calcutta. Since then Indian pangolin specimens are being received and maintained in several Indian zoos from time to time though for short periods. But reported informations on the captive management of this species in Indian zoos are scanty. Therefore, this is an attempt to place on record some of the observations made on the management of this species at the Nandankanan Zoological Park, Bhubaneswar (NKZP) for general information. The available published literature on the subject of other zoos have been cited.

Procurement of Specimens

The first female specimen of Indian pangolin was received at NKZP on January 16, 1962. Since then up to June 30, 1997, 65 specimens (30 males & 35 females) were received in the park from all over the State of Orissa. During this period of 35 years and 6 months, 1 to 4 specimens per year were received except during 1962-63, 1964-65, 1965-66 and 1975-76.

The specimens were received in all the months of the year with a minimum of one in the month of December and a maximum of 13 in the month of July. They were carried to the park in bamboo baskets/wooden boxes/ gunny bags by individual public or staff members of Orissa Forest Department. The mode of capture and transportation had a profound effect on their survival in the park.

Three Indian pangolins were received at Manipur Zoological Garden from two hill districts of Manipur during a period of two years (Ramakantha, 1992). Six Indian zoos (Guwahati, Bellary, Mysore, Bhubaneswar, Sepahijala and Calcutta) were exhibiting 22 specimens of this species as on March 31, 1997 (Indian Zoo Year Book, Vol. II, 1997). Yadav (1973) reported on the rearing of Indian pangolin in Jaipur zoo.

Housing

The pangolins of the park were housed in an enclosure measuring $2.5 \times 1.5 \times 2$m high. A dark sleeping den measuring $0.85 \times 0.50 \times 0.50$ m high was attached to the enclosure. A branched cement tree was erected inside the enclosure.

Some of the specimens were also exhibited in a well-type semi-open air enclosure having a floor space of approximately 16 square metres and depth 1.5 metres for some period. Provision was made for digging inside the enclosure as it is a burrowing animal.

Oklahoma

A pair of Indian pangolins of Oklahoma zoo were housed together in a room measuring 2.4×3.0 m in animal nursery. The floor was covered with a litter of wheat straw or hay (Ogilvie and Bridgwater, 1967).

Feeding

Initially several attempts were made to maintain these animals with an artificial diet consisting of a mixture of raw egg, minced meat and milk without success. They preferred to starve rather than to accept the artificial diet.

Subsequently, better results were obtained with the arrangement of their natural diet, the termites. Each adult specimen was fed with red tree ants (adults, young and eggs) every evening at the rate of 600 gm per day and occasionally termites with combs were also given. They break open the combs with their strong claws of fore feet to release out the ants. With the frequent and rapid in and out movement of the tongue, the ants and termites are taken in.

The strong muscular stomach along with the swallowed tiny pebbles and sand probably acts like gizzard of gallinaceous birds for crushing the chitinous exoskeleton of its insect food.

Sanyal (1892) states that due to the difficulty of procuring regularly and insufficient quantity their natural diet, the termites, it was not possible to keep these animals alive for any length of time and various other things have from time to time been tried but without avail. So these animals were let loose to forage for themselves.

The pangolin in Manipur Zoological Garden has survived for over three months and developed a liking for a diet of a mixture of mashed bananas and raw eggs (Ramakantha, 1992). Efforts of Jaipur Zoo to put the pangolins on milk diet did not succeed and so they were let loose to forage near ant-hill or hallows of tree trunks for feeding every night for 1-2 hours (Yadav, 1973).

The artificial diet consisting or dry dog-food, ground horse meat, evaporated milk, raw eggs and multivitamin drops provided to the Indian pangolins of Oklahoma zoo were not eaten (Ogilvie and Bridgewater, 1967). According to Crandall (1965) out of three specimens of this species maintained at New York Zoological Park on an artificial diet of thick viscid mixture consisting of finely ground raw beef heart, precooked cereal (pablum), reconstituted evaporated milk, warm water, ants' eggs, raw yolk of eggs and mulitple vitamin supplements, one survived for only 4 months, another for 7 months but the third survived for over 2 years. In captivity, they eat a variety of food, such as milk, custard, sago and tapioca puddings and raw eggs (Prater, 1998). According to Lal Mohan (1997) the Indian pangolins in captivity are fed with minced meat, yolk of egg and milk. A standard diet has been formulated with beef, raw egg, milk powder, oat meal, ant larvae, vitamin and salt known as 'Glukopur' (Hoyet, 1987).

Captive Management and Behaviour: The cemented floor of the enclosure and water trough were cleaned of droppings and food refuses daily and washed thoroughly. The termites were served once daily in the evening hours on the floor. Supply of fresh clean water was always made available in the water trough.

Out of 65 specimens, two females could manage to escape out on the 8th and 38th day of their arrival in the park. Sanyal (1892) reports that a pangolin has been found to swim across a tank 110 feet (33 m) wide, and burrow under the foundation of a wall 6 feet (1.80 m) deep. One out of three Indian pangolins of Manipur Zoological Garden managed to escape wihtin two days of captivity (Ramakantha, 1992).

Throughout the day time they remain curled up in the dark sleeping den. While coiling, they keep their heads underneath the scale-less ventral parts of the body and the tail covers the whole body into a tight ball like mass. All attempts to uncoil the animal have failed. They were found active from late evening to early morning and move about inside the enclosure. It is interesting to see them climbing the cement tree with the help of the claws and the prehensile tail. The animal at times takes a good grip of a branch of the cement tree with a curl of its tail and releases its body freely in almost in a hanging position. It only releases the tail after anchoring its claws of the fore-limbs firmly in another part of the tree.

The only vocalisation noticed was a hissing sound when disturbed.



Indian Pangolin *Manis crassicaundata* along with her 3-month old baby

Breeding: During the period of observation four births were recorded at NKZP as follows: January 1; April 1; September, 1 and November 1. One pregnant female Indian pangolin gave birth to a young on 23rd day of its arrival. The rest three births were the result of captive breeding. The litter size was always one and all the four young were males only.

One new-born male young of November 17, 1971 measured 30 cm tip to tip including 12.5 cm long tail and weighed 235 gm. The eyes were open at birth and the young was able to crawl over the mother's body soon after birth. The new-born young had soft scales and coarse grey hairs were present on the under-surface of almost all the scales throughout the body and projecting beyond the scales. After delivery, the mother weighed 10.6 kg. The young when handled could not curl up like the adults. The mother along with the young curled up keeping the young under the ventral part of her body and made a hissing sound as a sign of annoyance when disturbed (Acharjyo and Misra, 1972). Another male young born on April 4, 1977 measured 33 cm tip to tip including 12 cm long tail and weighed 242 gm. The mother of this young weighed 7,920 kg whereas the male partner weighed 9.250 kg on the fourth day of delivery (Acharjyo and Mohapatra, 1978).

Interestingly the first captive birth of an Indian pangolin was recorded at Zoological Garden, Calcutta in 1963 (International Zoo Year Book, 1965).

There are records of birth of this species in July (Prater, 1998), November (Asdell, 1964) and at Oklahoma Zoo in January (Ogilvie and Bridgwater, 1967). The birth season is given as between November and March and the gestation period as 65-70 days (Lal Mohan, 1997).

Growth: One male young born on September 26, 1982 was successfully reared by its mother up to an age of 11 months and 4 days. The baby died on August 29, 1983. As the young was growing, the mother pangolin used to relax its coil to accommodate the increasing size of the baby. The grown up baby of about 15 weeks was seen hiding its head underneath the ventral part of mother's body, keeping its tail curled up over mother's body or tail. At times the baby was seen crawling over the body of the mother.

On December 1, 1982 (10th week of its age) the baby was seen coming to the heap of tree ants along with the mother and sniffed. For the first time it took very small quantity of termites on December 8, 1982 (12th week). But from December 15, 1982 onwards it used to take termites regularly. The baby pangolin weighed 4.150 kg on March 17, 1983 at the age of about 25 weeks.

Mortality: Out of 65 wild caught specimens received in the park, 2 specimens escaped out and three specimens were under exhibition on June 30, 1997. Deaths of the rest 60 (28 males and 32 females) specimens were recorded as follows: January, 7; February, 4; March, 1; April, 9; May, 7; June, 3; July, 2; August, 2; September, 2; October, 12; November, 5 and December, 6.

Forty-two animals (70%) died within one year of their arrival in the park. Further analysis revealed that 35 animals (58.3%) died within six months. Sixteen animals (26.7%) died within 1 to 5 years whereas only two pangolins (3.3%) died after remaining in captivity for over 5 years. Besides, out of four zoo born young, 3 died within 1 to 5 days of birth whereas the fourth one died at the age of 11 months and 4 days. Lal Mohan (1997) states that in captivity 67% of pangolins die within one year.

The causes of death of 46 specimens including four zoo born ones as determined by post-mortem examination were maternal rejection (3), septicaemia (2), gastroenteritis (5), intussusception of small intestine (1), pneumoenteritis (1), pneumonia (9), pulmonary hydatidosis (1), hepatitis (1), pericarditis/ cardiac failure (3), starvation debility (17), traumatic injuries (1) and heat stroke (2).

Narayanan *et. al* (1977) isolated several species of bacteria from stool (*Escherichia coli, Klebsiella aerogenes, Proteus vulgaris, pseudomonas aeruginosa, streptococcus faecalis* and *coliforms)*, from urine (*E. coli*) and from blood (*E. coli*, *streptococcus faecalis* and *staphylococcus* sp.) of dead pangolins during autopsy, at USPHS-JIPMER Leprosy Research Project, Pondicherry. Tick infestation of the pangolin with *Amblyomma javanense* from NKZP (Sanyal *et. al.* 1987) and *Aponimma gervaisi* from Thrissur zoo (Pillai and George, 1997) have been reported. No other reports on the causes of mortality could be known from the available literature.

Longevity: One pangolin (male) received in the park on July 16, 1976 died on December 28, 1981 after remaining for 5 years, 5 months and 13 days in captivity. Another female specimen received on October 21, 1984 died on February 13, 1991 after remaining for 6 years, 3 months and 23 days in the park. These longevities of Indian pangolins established at NKZP appears to be the longest for this species in any zoo.

A pangolin lived in captivity for 2 years (Prater, 1998). Yadav (1973) reported that Jaipur zoo could rear pangolins for a period of over six months. The pangolin in Manipur Zoological Garden survived for over three months (Ramakantha, 1992). According to Crandall (1965) out of three Indian pangolins received at New York Zoological Park on 28 April, 1961, one lived for 4 months, another for 7 months but the third one remained in good condition till late 1963. One pangolin of USPHS-JIPMER Leprosy Research Project,

Pondicherry survived for a little more than 2 years in captivity (Narayanan, 1977).

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BLACKBUCK, THE ELEGANT ANTELOPE

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The misadventure of certain eminent film personalities during October 1998 by carrying out illegal poaching of two Blackbucks (*Antelope cervicapra*) highlights the urgent need to protect this elegant species from extermination. There is no doubt about the fact that the Bishnoi Community has set up an example by protecting animals and trees as such protection forms a part of their religion. This is precisely the reason the Bollywood stars could not get away by bribing the Bishnois and were subsequently apprehended.

Blackbuck, the only true antelope found in India, belongs to the family bovidae of the order Artiodactyla. As per Dr. M. K. Ranjit Sinh, it is the only animal perhaps to feature in two classical ragas i.e. Bhimpalas and Todi. Blackbuck stands prominently in the religion, history, art and culture of the country. This animal is undoubtedly one of the most handsome of all antelopes. This species was once found in large herds in open woodlands, cultivated tracts, dry and arid areas. They formed a popular hunting games of the Rajputs and the Moghuls of medieval India. Cheetah or hunting leopard (*Acinonyx jubatus*) was used by them to hunt these animals whom probably only cheetah could outrun. Before independence, large herds comprising of thousands of animals were a common sight. Today, the herd size have dwindled to 50-100. The animal has been listed in Schedule I of the Indian Wildlife (Protection) Act of 1972 as amended up to 1991 with the status of endangered species. The animal has also been listed in Appendix III of CITES and has been termed vulnerable in both India and International by the I.U.C.N.

In India four subspecies are recognized. These are *A. c. rajputanae* in Rajasthan, Gujarat, Punjab & Haryana; *A. c. rupicapra* in U.P. and Eastwards; *A. c. centralis* in Central India and *A. c. cervicapra* in Southern India (Ellerman and Morrison-Scott, 1951). However, due to hybridization and intermixing, only *rajputanae* and *cervicapra* subspecies are distinguishable.

A male Blackbuck stands between 73 cm.-85 cm. at shoulder height weighing 34 kg-45 kg. The does are slightly smaller weighing between 31 kg.-39 kg. A matured buck has a contrasting striking black on upper parts and white at the lower; with spiralled straight horns 50 cm.-60 cm. in length. The does have a light brownish tan on the upper parts of the body, tail, outer flanks of hind legs, face and neck with similar coloured stripe running down the forelegs. The under parts are white. The juvenile bucks have colour same as the does till reaching the adulthood. Generally, it takes about three years for a blackbuck to turn to its handsome striking black and white colouration.

The does, in general live in separate herds. It is during the rutting season the bucks try to get maximum does in their harems. It is the dominance of the buck that decides on his harem. The bucks otherwise live independently holding territories marked by visual and olfactory signs. The individual scent is left by rubbing preorbital glands on grass or bushes or from the glands located underneath their hooves. The pellet dug-in holes or defecation sites are very commonly used to mark their territories. The poachers take advantage of the holes as the blackbucks go out to fields for feeding and return to their marked territories and often get trapped in traps laid for them.

An per Dunbar Brander (1931) chief rutting season is around March and fawns are born shortly before the rains though fawns can be seen throughout the year. Schaller ( ) observed the chief rutting season in Kanha to be April and August-October. In Rajasthan also it has been observed that the chief rutting season vary from January-April and August-October. The gestation period is about three months. The fawns are capable to sprint soon after their birth.

The chief food of the Blackbuck are grass, herbs, sedges and agricultural crops. They also feed on the leaves, tender branches and fruits of trees such as ber (*Zizyphus jujuba*) and khejri (*Prosopsis cinararia*). They generally go for feeding at night and move into the agricultural fields. Perhaps, this is the most significant reason that promotes man-animal conflict. However, the Bishnois permit these animals to feed in their fields and find no problem with them.

Blackbucks prefer plain land with soft soil. Being an animal for the desert region, they need very little water as they can recycle nitrogen in their bodies rather than

pass it out with urine. This added with low protein diet, helps in conserving water.

The population of Blackbuck which was estimated around 80,000 in 1947, has gradually dwindled. In Pakistan, the Blackbuck population had become totally extinct. In India, these animals did not face extinction because of the protection given by the Bishnois. In addition, they have received protection in sanctuaries like Talchhapar in Rajasthan, Point Calimere and Guindy National Park in Tamil Nadu, Velvadar National Park in Gujarat and Palpur in Madhya Pradesh. The present captive population as per Zoological Survey of India's estimate is approximately 850 in Indian zoos and 900 in zoos abroad. Hence, captive breeding programme in Indian zoos protecting the surviving sub-species, must be undertaken. The Indian zoos no doubt have been playing a positive role in the survival of this species. Hence, there is a definite need for ensuring protection of this elegant antelope and the Indian zoos can play a major role in this sphere.

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A ZOO DIRECTOR'S DILEMMA

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On thirteenth August, 1999 the male tiger "Shyamal" housed with "Chameli" for a long time in the smaller enclosure was tranquillised by Dr. D.C. Deka, Forest Veterinary Officer and housed in the cage near "Kartik" other larger male. This was done to have a close observation on his (Shyamal) ailment.

On the same night, Dr. Deka had to leave for Silchar (400 Km.) on being informed that his son who is studying in the Engineering College fell seriously ill.

Next day the animalkeeper reported that "Shyamal" appeared to be panicky at the sight of "Kartik" in the vicinity and had not touched the food except little water. The same situation continued till the next day. The Pathologist Dr. Upen Kakati was on deputation to I.V.R.I.I. consulted several senior Faculty of Khanapara Veterinary College, suggested that some vitamin supplement be added to water.

On the night of fifteenth, the tiger torn apart the chain link fence of its arena and ventured out to the large enclosure of "Kashyap", the largest *albino* male but fortunately he was taken to its retiring chamber on the previous night on apprehension. "Kashyap" was kept confined and "Shyamal" was offered normal quota of beef on 16th, but was left untouched.

The same situation continued on till 17th, 18th and 19th too. It became a matter of great concern for me as it had taken its last meal on 12th, i.e. one week before. Because of large undergrowth in this enclosure it could not be located since 18th.

On 20th the keepers tried to locate it whole day by shouting and even pelting stone chips at different bushes but of no avail.

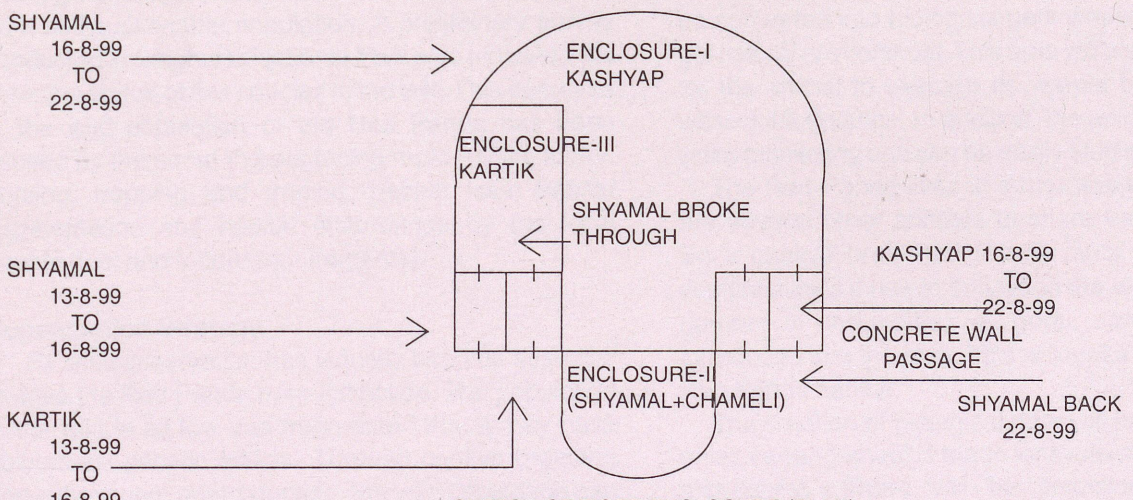
My patience started running out and was thinking about the worst. During same afternoon, I directed the keeper to release one live goat inside the enclosure. The goat kept on bleating till midnight when the keeper left confirmed that Shyamal is no more and that he will look for its carcass next day.

Early next morning (21-8-99) the keeper rang my doorbell at 5 A.M. and in excitement that the goat is killed and "Shyamal" is sifting hugging the dead goat. I rushed to the spot and saw the same and was surprised as "Shyamal" was Zoo bred and never had an opportunity to kill anything like that.

There was no blood in the vicinity of the punctures in the neck of the goat so we surmised that it had sucked the blood and regained our hope.

Two pieces of dressed chicken was dropped near it of which one piece was taken after fifteen minutes. Some more mutton was dropped from which one portion was taken. Despite the fact that it had not taken food for almost ten days the tiger looked healthy. On the same day a hole was made by breaking the concrete wall separating the two large enclosures as we were worried for "Kashyap" confined for one week now.

On the morning of 22nd August, we found Shyamal playing with "Chameli" in its own enclosure from the same day to our relief it resumed to its normal diets as Dr. Deka also reported for his duties.



SKETCH OF TIGER ENCLOSURE (PLAN)

PELICANS BRED IN ASSAM STATE ZOO

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There are at present nine (6:3) numbers of Rosy or White Pelicans *(Pelecanus onocrotalus Linn.)* housed in the Zoo since 1982. The enclosure is spacious enough and is shared with the Hoolock Gibbon. There is no record of pelicans breeding in this Zoo in the past. Further, Assam does not fall under the normal breeding ground of the birds.

Although the birds laid eggs on a few occasions in the past, those never hatched. On certain occasions the Hoolock destroyed the eggs.

During the rainy months of 1998, the ponds of the pelican was cleared off debris and desiltation was done. Rainwater was funneled. This measure was resorted to, as severe water scarcity was experienced in the previous years. During 1999, much improvement in the water regime was noticed and water remained in the pond round the year.

On 13-11-99, two birds laid eggs on one extreme corner of the Hoolock island, on the ground. Apprehending that the Hoolock may destroy the eggs, it was confined in a small chainlink enclosure.

It was noticed that three birds sat on the eggs and the others were guarding them. All possible measures were taken to reduce the disturbances to minimum, even no attempt was made to count the eggs laid.

On 14-12-99, three chicks were hatched. They were deep black in colour and were approximately of 500 gms. Antibiotics and calcium supplement were provided with small fish diets for one month. The remainder did not hatch.

The chicks were guarded by the entire flock for almost one and a half months, then they ventured out to the water. Now, after one and a half months, they are 5-7 kgs. and coat is gradually turning to grey to whitish.

This is another example which shows that with minor manipulation miraculous results can be achieved in a Zoo. This is also a matter of concern that one species can be stimulated to breed outside its natural range. According to Salim Ali and Dillon Ripley, the pelican chicks are brown but they are actually black in colour.

This matter has been referred to all concerned including B.N.H.S. and W.I.I.

RED PANDA CONSERVATION PROGRAMME

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Introduction

Conservation of the environment has, of late, become a very important issue due to the exponential increase in the species extinction rate. It is no longer sufficient to think just in terms of habitat preservation, many species on the verge of extinction can only be saved in the wild through reintroduction. The Red Panda (*Ailurus fulgens fulgens)* is one of these species.

The Red Panda in the monotypic (last surviving) member of the family Ailuridae. The relatively long reproductive cycle of the female (typically two cubs per year) means that if the population suffers a decline then the recovery rate is relatively low. As a carnivore adapted to bamboo feeding, the Red Panda occupies a highly specialised niche.

The geographical range of the *Ailurus fulgens fulgens* population extends from Eastern Nepal through Bengal, Sikkim, Arunachal Pradesh and Bhutan while *Ailurus fulgens styani* is found in China and Burma. The *fulgens fulgens* occupies a highly specialised region where several zoo-geographical areas converge.

The habitat of *fulgens fulgens* consists of mixed forest with a dense understorey of bamboo between altitudes of 1500 and 4000 m.

From the available information it is suspected that the existing number of Red Pandas in the wild is too low to be a self-sustainable population. A preliminary survey conducted in Singhalila National Park also indicated the alarming status of this species in the wild. This decrease in the wild population of the Red Panda has been caused by the same threats facing most wildlife today: hunting, trapping and trading, habitat loss, habitat fragmentation and habitat disturbance by the local people (fuel and fodder requirements).

Conservation Strategy

Ex situ conservation has virtually become essential to save the Red Panda from extinction. The population in the wild is so low and fragmented that it may have deleterious genetic effects. Through captive breeding and subsequent reintroduction, the wild population can be brought back to carrying capacity.

Moreover, Red Pandas have not been recorded in some suitable habitats within their geographical range.

Therefore, there is a need to develop a systematic captive breeding programme with a strong foundation of research so that a scientific process can be developed for reintroduction.

PNHZP proximity to each potential area of reintroduction makes it ideally situated as the locus for the captive breeding and *vice versa.*

PNHZP has now developed a systematic and scientific breeding programme for the Red Panda. Successful breeding since 1994, is the result of such programme . A breeding is called a success only if the animal born survives to become a parent. In spite of this success, the animals cannot be considered suitable unless scientifically assessed. This requires a detail study and research. The Red Panda might find themselves unfit to survive in the wild, since for last many generations they are being fed artificially. They may carry zoonotic diseases with them. There may be various other factors which need further study. The process of releasing the Red Panda directly in the wild may be a failure. This problem can be sorted out through a study made in a semi-wild enclosure for which PNHZP has a big patch of virgin forests. This area can be converted into biological park where the animal will get natural environment. This area will also provide scope for the animal to exercise its normal biological activity without interference. In addition, the animal will be under close monitoring and can be easily studied for research.

The Red Panda lives in an ecosystem where there are several other animals to share the same habitat. So a captive bred Red Panda must get used to its conspecifics if it has to survive in the wild. Therefore, a number of herbivores, i.e. goral, serow etc. will be introduced into the park. This will make the park a mini-Red Panda habitat.

The creation of biological park will have no meaning unless arrangement is made for systematic study in this mini-habitat. There will be provision for research fellowship on practical aspects of this study.

Financial Outlay

(Rs. in lakhs to be spent in three years)

Item	Expenditure
Construction of biological park	50.00
Fellowships for research	14.00
Equipment (Electronic chip for identification Research Microscope (Nikon) PCR for DNA study)	14.00
Awareness Programme (Slide Projector, overhead projector interactive teaching programme)	8.00
Contingency	4.00
Total	**90.00**

If species surviving today provide the raw material for future evolution, then the unique characteristics that the red panda has developed over the last ten million years simply cannot afford to be lost.

Project location

The Reserve Forests (113 acres at Lebong, which is approximately 2.5 km. away from the PNHZP Zoo complex under Darjeeling district of West Bengal has been chosen as the proposed site for such biological park. This area is situated at the Lebong Hill Cart surrounded by dense mixed Coniferous and Bamboo forest. The proposed site is approximately 600 km. away from Calcutta and well-connected by road and railway.

Research Background

There is mushrooming of the zoos throughout the world. This not only causes unplanned development but also results in non-fulfilment of the objectives. The veterinary input in India is mainly oriented towards the domestic animals and the research in laboratory oriented. Moreover, there is no institution in the region dealing with research on wildlife biology. Despite the great need for research in relation to conservation objectives, manpower and financial resources for extensive research is rarely available in the zoos. In addition, the zoos provide better opportunities for study on the physiology and inherent behaviour of the wild animals. Therefore, there is a need of creation of research institute which can take up the work with the cooperation of other research institutions, universities and nature conservation organisations. This should include research on other sciences that may be relevant to aspects of zoo conservation such as botany, sociology etc.

ELEPHANTS MENACE AND A PROBABLE SOLUTION

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Even a mere forty years back most educated people had a fixed idea—a wild animal is better dead than alive. Only recently India has become conscious of wild animals. In India, elephants exist since by gone past and they are the largest land animals.

In recent years it often becomes news (particularly in winters) that elephant herds are in villages of South Bengal districts damaging crop and dwelling houses, sometimes even attacking and killing villagers. According to forest officials, the elephants are from Dalma of Bihar. The mountain range of Bihar-West Bengal border is threatened like many other places by the decline of greens. Moreover, the Ranchi-Tata industrial belt is rapidly swallowing its neighbouring areas of Dalma.

A 4-5 ton animal–elephant needs not only a huge quantity of various plants, but also they need a large sanctuary to maintain their normal health. Due to decline of greens and rapid industrialization and urbanisation, the elephants of Dalma are compelled to come down plain lands of neighbouring districts of West Bengal to have their choiceable food. The recent news in the districts of Purulia, Bankura, Midnapur, Bardhaman etc., since last 14-15 years about the wilderness of elephants is the mere result of their food shortage. The huge loss of crops, properties, even human lives now become a menace to villagers. Government has to pay a fabulous amount as compensation. Meanwhile, electric fencing, driving of herds and other futile attempts were made to prohibit the elephants passage. However, these were not at all any fruitful solutions.

Visiting the affected villages and Dalma area during elephants' migration to plain lands, it reveals that an area containing some parts of several district of West Bengal and Bihar, may be demarcated and reserved for these elephants. In this specified area, the farmers may be encouraged for cultivation, sapling seeds etc. to grow plants for elephants, so that elephants can enjoy them ad libitum, the rest part will come for farmer. If, for consecutive years elephants do not come to take share, the farmer would be deprived of any help. This type of arrangement if possible, surely will make a bridge of sympathetic relationship between man and elephant and definitely help in the survival of largest land animals in our country.

Needless to mention, the survival of elephants is not only conservation for conservation's sake (i.e., art for art's sake) but they are also a part of nature helping a balance between vast world of plants.

EVOLUTION OF ZOO CONCEPT *VIS-A-VIS* MANAGEMENT

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Standing just beyond the 20th century, the opening lines of a thirty-two years old "Life" Magazine story by famous Zoologist, Desmond Morris, sounds prophetic in context to modern-day zoo management, "if zoos are to survive in the 20th century, they will have to reform". In an article titled "Must we have zoos?" Dr. Morris answered "Yes" but emphasised that future zoos would have to change a lot in character and management to justify their continuing existence. Though he did not clearly specify how these changes would occur but definitely had hit the nail. Just like the existence of animal species, zoos also have to adopt to the newer times for its survival. In fact the zoo management concept had undergone significant changes and/or evolution since its beginning in Egypt, five thousand years from now.

The Early Years & Birth of Zoo Concept

The relation between human beings and non-human animals was mainly of dreaded adversary in the early years. Actually most of the animal groups had come to the world much before human. In fact, it is being said that the era of human evolution occupies only thirty seconds if the entire 'period of life' is considered to be a full day. The early hominids used to kill animals at will to feed themselves. Afterwards dead animals were used to produce cloth, weapons and even ornaments. Some of the cave paintings drawn by artist within these early men are the silent proofs of these exercises. With the advent of time, human species have become more and more qualitatively superior and cultural development was an important contributor in that growth. Ultimately the modern man has become the most intelligent and developed within the animal kingdom, called 'the highest animal'. It will not be out of place if we say that man is the unquestioned king of modern world. With this increasing civilized status and growth in knowledge, man could understand the importance of protection and conservation of plants and other animals for its own survival. It is understood that human is a mere 'part' in this evolutionary chain and any major disturbance in the 'chain' would not only cause the extinction of other life forms but also of the human species itself. Basically, from this understanding, the 'hunter' had turned into 'animal protector' and the concept of zoo was born.

The Early Zoos

The oldest zoo of the world was in Egypt, around 2500 B.C. (Bachkheti and Desai, 1994). The zoo had fair enough collection having hyena, monkey, deer, giraffe, mongoose etc. In those times, zoos were mainly private collection of kings or rich people, to most of whom it was another way to display their status and wealth. Afterwards zoos were built in China, Rome and Greece mainly either as personal or collective exercise. Though little information are available about the zoos around the world till twelfth century till it has been known that mainly Greeks were interested about the research on the ethology of captive animals. As a matter of fact, the first detailed information about a zoo and its management was available regarding the zoo built by king 1st Henry in England, which had lions, cheetah, camels and domestic animals in its list. Though the main idea behind having the zoos in those early years was to provide harmless entertainment to the people still the increasing feelings regarding animals was slowly germinating the idea of animal protection. In India, the 'Arthasastra' (321-300 B.C.) by Kautilya had chapters where certain rules were specified about hunting the animals to ensure their minimum conservation. Even the 'mrigodyan' or 'topobans' built by either animal loving kings or saints were actually older forms of modern day sanctuary or national parks, because in those areas animals were free to roam about without any fear of being hunted. As a matter of fact, under the advice of Kautilya, King Chandragupta Maurya had fixed up penalties for unauthorised slaughter of protected animals, damage to the forests etc. He even introduced the concept of animal census through retreating places, foot-prints—dung and damage caused to river banks. However, literally the 'zoo' was first built by Mughals. Mughal Emperors like Akbar and Jehangir had interesting contradiction, one side they loved hunting and on the other hand they were interested in animal conservation. One of the book written at that period was 'Ain-I-Akbari' by Abul Fazal has been considered as the first real animal husbandry text in India.

The Change of Concept

The zoo management concept started changing drastically in the 20th century when it had been felt throughout the world that zoos have much important role to play rather than be a place of mere amusement. Already a large group of animal species were extinct due to increasing pollution or excessive poaching of animals. It has been felt by one and all that if this continues unabated then the harmony of nature will be in danger and the very existence of human species will be in trouble. Tikadar (1983) observed that five species of class aves and mammalia had been extinct only in nineteen eighties while an whopping 141 others from class amphibia, reptilia, aves and mammalia are on verge of extinction. Zoologists, Naturalists all over the world agreed that the mere role of 'animal lover' won't do and man has to take much more active role in protection and/or conservation of other animal species. With the advent of this concept, number of laws have been framed all over the world to provide a legal umbrella to the cause. Even in our country, 'Wildlife Protection Act' was formulated in 1972 which was later revised in 1992.

This changing concept about animal conservation has also changed the outer and inner faces of zoos and their management, zoos which had been previously considered mere place of amusement, is now considered as an extension of forests. Previously it was believed that the success of a zoo depends on the number of displaying species, but modern management concept suggest that a zoo should focus on the theme of conservation and propagate awareness. Gunther Nogge of Zoological Gardens, Cologne zoo quite aptly said that 'what the zoos now want to show is not more animals but animal like'. As an example he cited the management policy in his zoo, where the number of mammalian species were reduced to 42% within two decades. He argued that this reduction in number of mammalian species also ensure better keeping of animals and thus contribute to their conservation. As a matter of fact, within the given period 71% mammalian species increase numerically and overall average number of animals per species rose significantly. Dr. Nogge also observed a very important point from conservations and as well as zoo management point of view as he suggested that 'it is almost certain that in the long run only those species will be retained whose populations are maintained solely by breeding in captivity'. Actually captive breeding is the 'main thing' in modern zoo management and the concept of 'nature to zoo' has changed to the concept of 'zoo to nature' (IUCN, 1987). The animals, which are on the verge of extinction, are tried to be resurracted through captive breeding in zoos and then are sent back to nature. Take the case of 'manipuri dancing deer' or *Cervus eldi eldi.* In the early fifties, it was found that only twenty animals are left in Manipur's Kaibul Lamzao Sanctuary. A pair of animals each were taken in Alipore Zoo, Calcutta and Delhi Zoo in 1956 and 1962 respectively. As a result of the captive breeding programmes, fifteen zoos of India now have more than hundred animals of the species, all of which have genes from first four animals. Now, it is being conceived that whether some of these animals can be sent back to nature. Already in zoos outside India, similar experiments have taken place successfully with other animals. Californean Condour was taken back from the clutches of extinction through captive breeding in America during late eighties. Similarly American Bisons faced extinction due to excessive poaching, when they were bred in the captivity of Bronx Zoo and then sent back to their natural abode of Oklahama mountains. Another example worth mentioning has been Oryx in Arab, which was virtually lost, following first World War. 'Operation Oryx' started in 1961 involving captive breeding of animals. Oryx went back to its natural environment in few years time. Similarly golden lion tamarin went back to nature in Brazil; Hawaian Duck in Hawai; Bali Myna in Bali and so on. Interestingly, this new zoo management concept has found its approval and acceptance much later, when 'Central Zoo Authority of India' was formed in 1992, February. Central Zoo Authority decided in October, 1993 that every recognised zoo will have to breed at least single species in captivity. Zoologists agree that though the practice of captive breeding was *in vogue* before Central Zoo Authority directive but the said rule/rules have paved the way for far systematic documentation of facts regarding captive breeding and exchanges of the same within various zoos.

However, not only regarding captive breeding, Central Zoo Authority also specified certain rules to be followed by all the zoos. According to Pushp Kumar (1990), as the main aim of present day zoo is to conserve and not to amuse, hence semblance of cruelty should not be shown to any animal. Elephants no longer have to amuse the visitors by lifting their trunks while they are being chained. As a matter of fact Alipore Zoo recently started its open air enclosure for elephants. Animals are to be kept in their natural environment as far as possible and emphasis should be given in lessening the cages. At maximum 1/5th of the zoo area can have cages and any zoo should only have animals which find the environment suitable. Captive breeding should never involve interspecific breeding. Previously the creation of unnatural animal hybrids like tigon; litigon or liger through captive breeding was considered creditable, but no longer so. Even while allowing breeding within same species, care should be taken to minimise inbreeding error so

that the subsequent generations do not have genetic diseases. Animal exchanges within various zoos are now done keeping the numerical balance of animal population; documentation through computerised system; following scientifically prepared diet chart etc. are also being introduced in modern zoos. Emphasis is also on to make the zoos earn more revenues and thus make them more self-sufficient (Ahsan, 1990).

Zoos of the developed world have already gone steps ahead in the concept of zoo management. In those zoos, the sperm and ova of the extinct and as well as threatened animals are being kept in freezing temperature, so that they can be made to fertilize under laboratory condition as and when required. Thus, those days are not far away when newspapers will carry story of a testube Orangutun or testube Hawaian Mynah. These types of frozen zoos have been already planned in USA while ideas are also developed with respect to microzoos. Moreover, zoos of this century may have confined visitors but free roaming animals. Modern zoo management will evolve and modify as a natural corollary. Zoos, 2000 will perhaps be so designed and managed so that the parameters like light; temperature and other influencing factors will be modified to give the visitors the opportunity to observe the diurnal and nocturnal animals simultaneously. All in all, it is quite obvious that the management methodology has been evolved a lot since the early zoo days, even from the days of Rambrambha Sanyal, the first Indian Superintendent of Alipore Zoo, who wrote the famous book on animals management titled 'A handbook of the management of the Animals in captivity in lower Bengal' published in 1892.

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ROLE OF ZOOS IN CONSERVATION OF WILDLIFE

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Epilogue

Zoos attract people of all communities for thousand of years. The earliest zoo dates back to the time of Egyptian Pharaos, some 3000 B.C. The Chinese Royals of the contemporary ages also built up collections of animals and birds. The same practice of keeping both native and exotic animals were maintained by the ancient Greeks and Romans. Interesting to note that during the rule of Caesar Augustus (63 BC-AD14), there was an wanton slaughter of many exotic animals including tigers, lions, crocodiles, hippos, rhinos and leopards. These terrible practices continued until the fall of the Roman Emperor, when zoo collections declined throughout Europe.

The first modern zoos of the 19th century provided facilities to see strange animals brought from far off countries. But very little care was taken to extend comfort to the animals or to promote their breeding in captivity. Visitors rushed to the London Zoo in 1835 when it received the first chimpanzee. Again the zoo became the centre of prime attraction in 1850 with the arrival of the first hippopotamus. At that time, a popular Victorian Music Hall song included the lyrics, "Walking in the zoo is the okay thing to do". In fact, London Zoo can be considered as the oldest surviving zoo in *sensu stricto* where the animals were not treated merely as the items of exhibit.

The main objectives of Zoo

The main objectives of the zoological gardens may be summarized as follows:

1. To provide recreation and amusement for all classes of the community.
2. To facilitate scientific observations of the habits of animals.
3. To propagate awareness about the status of the wild animals and their importance as an essential component of the environment.
4. To promote the science of zoology by the interchange, import and export of animals.
5. To encourage the acclimatization and breeding of animals in captive condition.

All these above mentioned objectives were taken into consideration while the Calcutta Zoological Garden was established in 1875. Needless to mention, that all these objectives were in the mind of the members of the Asiatic Society of Bengal who took the initiative for the foundation of the Alipore Zoological Garden. But from the last part of the nineteenth century and up to the first quarter of the twentieth century, importance of the zoological gardens in conservation of wild animals was not realized. Although, along with the objectives just mentioned, provision of breeding animals within the zoo enclosures was adopted by the founder members of the Alipore Zoological Garden, the scheme was primarily meant for the cattles and other farm animals. The main goal of such captive breeding was to improve the stock or 'breed' of such animals through selective crosses. At present, however, no zoological garden or park of the world are interested to include programmes on breeding of domestic or farm animals. Moreover, domestication of the wild animals is also excluded from the purview of these gardens.

Conservation of the 'Bio-diversity'

Naturalists of the 18th and 19th century were aware of the fact that each and every part of the globe's land surface has its own quota of plant and animal species. But their importance in maintenance of the ecological balance has remained largely obscured. The interdependence of the abiotic factors, plants and animals which make a delicate and fragile but very complex network is rather a recent realization. And that realization too, has emerged after the extermination of some form of living organisms. Importance of forest cover in conservation of soil, both in quality and quantity, maintenance of hydrological cycle and as a home of numerous wild animals is now gaining its ground in the mind of people. On the contrary, contribution of wild animals in conservation as well as propagation of the plant species is not appreciated so much. Only in the recent years, a dramatic decrease in the production of the oilpalm seeds in Mauritus could be correlated with the extinction of Dodo. It has been also established that the hard kernels of the oilpalm seeds became softened by the digestive juice produced in the stomach of Dodo, and such process could aid in the germination of the

seedling. After the disappearance of the bird, the rate of successful germination of oil palm seeds declined despite the efforts of stimulating the germination process by artificial means. An almost identical relation appears to exist between the mulberry plants and myna, between graminaceous herbs and rhino etc. Thus, conservation of the biological diversity as a whole, with their respective habitats, is at present seems to be the most logistic approach.

India, along with some other tropical countries, is considered to be the land of "mega-bio-diversity". Prof. Madhab Gadgil (1996) gives a detailed group-wise list of Indian flora and fauna. This is depicted in the following table.

Table 1 Bio-diversity in India

Group	No. of species	Percent of the known species
1. Flowering plants	15,000	6.0
2. Amphibians	182	4.4
3. Reptiles	453	7.2
4. Birds	1,200	13.0
5. Mammals	350	8.4

It would not be out of place to mention that the wealth of the biodiversity of this country reflects only the current status. A number of wild animals such as the hunting cheetah (*Acinonyx jubatus*), the lesser one-horned rhino (*Rhinoceros sondaicus*), the Asiatic two-horned rhino (*Didermocerus sumatrensis*), the pink headed duck (*Rhodonessa caryophyllacea*), Jerdon's courser (*Cursorius bitorquatus*) and the forest spotted owlet (*Athene blewitti*) have been either exterminated from this country or faced extinction in *sensu stricto.* Further, not only these animals were exposed to such tragic fate in this century, it is highly feasible that a sizable number of apparently insignificant and to some extent obscure or inconspicuous faunistic components as well as a number of 'no so useful' plant species have disappeared by this time. The status of the Indian biodiversity would expose many more lacunae, the so-called 'grey areas' if the invertebrates and the marine organisms are taken into consideration.

Importance of the conservation of these diverse types of plants and animals can be appreciated much easily when the rate of extinction is taken into account. Zuber (1978), a famous French Naturalist estimates that one animal or one plant species disappears for good from the earth's surface, each year. Moreover, according to a recent estimate, the rate of extinction for the plant and animal species is much higher in the 20th century than that during the time elapsed since the dawn of civilization. Nomadic hunters of the ancient times killed wild animals and birds out of bare necessity but they did not overexploit the wild stocks up to the extent so as to push them to the threshold of extinction. Unfortunately, that critical sense of balance between exploitation and conservation has been noticed to fade out with the progress of civilization and urbanization. Indeed the final blow came with the advent of industrialization and mechanization of the human societies. At present, the entire concept of conservation and its implementation primarily depend upon the will and sincerity of the politicians who usually turn their deaf ears to the warnings and advices of the scientific personnels.

Zoo enclosures as the safe refuge of the endangered animals

Until quite recently, zoological gardens were essentially places of public entertainment where many kinds of strange and beautiful animals could be maintained as exhibits. If a zoo management could be able to breed certain species, that was regarded as an interesting experiment and not much else. Nowadays, the propagation or rare animals has become one of the main functions of any reputed zoo all over the world. Some spectacular success has already been achieved with the captive breeding of okapi (*Okapia johnstoni*), gorilla (*Gorilla gorilla),* and orangutan (*Pongo pygmaeus*). According to Guggisberg (1970), the pigmy hippo (*Choeropsis liberiensis*) and the Asiatic tapir (*Tapirus indicus*) are also doing well in captivity. But the most remarkable success is, perhaps achieved with Pere' David's deer (*Elaphurus davidianus*). This deer is thought to have originally thrived in marshy habitats in Northeast China but became extinct some 1,800 years ago (Burton & Pearson, 1987). Captives, however, survived in the Imperial Hunting Park until the end of the 19th century. Some animals of that stock were sent to Europe by Father Armand David, shortly before they were completely exterminated from China. European stocks were gathered together at Woburn, U.K. by the Duke of Bedford and as the herd increased in size, many breeding groups were subsequently established in different zoos. By the 1980's, there were over 1,000 animals of this species world wide and a semi-wild population has been transplanted in China.

Another instance of saving a rare animal, the Arabian oryx (*Oryx bucoryx*) from extinction through captive breeding needs to be mentioned, Guggigberg (1970) provides a detailed account of the conservation story of the Arabian oryx. This massive antelope with huge horns, once roamed in the arid grassy plains in Arab peninsula in thousands. Hunting by the Oil Sheikhs and habitat destruction have posed a serious threat to the survival

of the oryx. By the 1970's, a very small population consisting of about 100 individuals survived in the wild, despite a stringent protective measure adopted in Oman and Muscat. It was decided, therefore, to establish a breeding herd in a safe place with a suitable habitat. Afterwards, they were, transferred to the Phoenix Zoo in Arizona and San Diego Zoo in California. Wildlife experts believe that this is the only option left to protect the Arabian oryx from being wiped out.

This story of conservation is not very different in Indian scenario. Some success are already in the record of which the names of the Sangai or Brow-antlered deer (*Cervus eldi eldi*), the White-Winged Wood Duck (*Cairina scutulata*), the Marsh Crocodile (*Crocodylus palustris*), Salt water Crocodile (*C. porosus*) and the Gharial (*Gavialis gangeticus*) need special mention. All of these animals became rare and were on the borderline of extinction. However, captive breeding in zoos and other such centres has restored some more chance of their survival. Similar efforts are being made with the King Cobra (*Ophiophagus hannah*) the Olive Ridley turtle (*Lepidochelys olivacea*) and a few birds.

Contribution of the Alipore Zoo

Alipore Zoological Garden, one of the oldest zoos has also taken such endeavours in breeding endangered native as well as exotic animals. Until now, the Manipur or Brow-antlered deer, the Rothschild Giraffe (*Giraffa camelopardalis rothschildi*), the Jaguar (*Panthera onca*), the Indian Tiger (*Panthera tigris tigris*), the white variety of tiger, African Lion (*P. leo leo*), White Fallow Deer (*Dama dama*), African Eland (*Taurotragus oryx*), various birds like the common Peafowl, the Peacock Pheasant, the Painted stork (*Mycteria leucocephala*) etc. are doing well in this Zoo. Breeding of reptiles in captivity is a rather difficult task. This year (1998) is also remarkable for the incidence of mating of Marsh Crocodile in a moat of this Zoo. A clutch of 10 eggs has been produced by a crocodilian pair. Perhaps, the environ of the enclosure provided all the conducive factors which resulted in 100% hatching success.

In the recent past, hybridization between two large cats—the Indian tiger and an African lioness is done. The pair ("Munna" and "Munni") produced two female hybrid cubs, the tigons that survived for several years. They were the member of the sixth and the seventh litter while the preceeding litters produced either deformed and inviable offspring or the pregnancy terminated in a mere foetal wastage. Chaudhuri and Das (1991) present a detailed account of the hybridization programme and point out the reasons for the closure of such interspecific breeding ventures. The Central Zoo Authority (CZA) has also taken a firm decision to stop such hybridization programmes because the interspecific hybrids are usually sterile, and therefore, these experiments stand against the purpose of conservation of rare and endangered wild animals.

The Alipore Zoo also functions as a safe home of various migratory water birds. In addition, a few water birds like the little Cormorant (*Phalacrocorax niger*), Night Heron (*Nyeticoran nyeticoran*) and the Indian Darter (*Anhinga melanogaster*) have settled on the small island at the centre of the lake. Both of these avian species are rarely seen elsewhere and the latter named one may be aptly called a vanishing species (Das 1999). It is reported by the ornithologists that the newly hatched chicks of the Indian Darter is devoid of feathers and they progress on ground by crawling with difficulty. They, therefore, nest in secluded places and prefer islands as the suitable nesting site. As per recent census by a well known Nature Club, only a small number of Darters exist in the island of Alipore Zoo but this particular bird species is not seen any where, in any wetland of Calcutta metropolis along with its suburbs.

Modern techniques adopted for captive breeding

Various modern techniques are adopted in the reputed zoos for captive breeding of rare and endangered wild animals. Some of these techniques are:

1. Simulation of natural habitats in the zoo enclosures; eg., the Congo Gorilla forest in the Bronx Zoo (Silver 1966).
2. Adjustment of the 'bio-rhythm' of the animals by controlled environmental components, *viz.,* light intensity, temperature, relative humidity etc. that are congenial to promote sexual drive.
3. Artificial insemination (implemented in Giant Panda), use of surrogate mother (adopted in case of European Bison) etc.
4. Sometimes, embryos of the endangered animals are kept in frozen state and then are transferred to the womb of a suitable foster mother, the 'frozen zoo'.
5. Incubation of eggs of the rare birds by domestic varieties.
6. By gene cloning; this method is already applied successfully for recreation of a recently vanished animal, the Quagga (*Equus zebra quagga*).

List of animal successfully bred in different Zoos in India; as per Management of Zoos in India, 1975 (Central Zoo Authority, India, 1975)

[Ex = Exotic; In = Indian; endangered animals are marked by an asterik (*).]

Mammalia

Order Marsupialia

1. Red Kangaroo (Ex)
2. Grey Kangaroo (Ex)
3. Bennett's Wallaby (Ex)

Order Primates

4. Slow Loris (In*)
5. Slender Loris (In*)
6. White-fronted Capuchin Monkey (Ex)
7. Squirrel Monkey (Ex)
8. Spider Monkey (Ex)
9. White-eared Marmoset (Ex)
10. Lion-tailed Monkey (In*)
11. Sooty Mangaley (Ex)
12. Hamadryas Baboon (Ex)
13. Yellow Baboon (Ex)
14. Mandrill (Ex)
15. Java Monkey (Ex)
16. Nilgiri Langur (In*)
17. Chimpanzee (Ex)

Order Rodentia

18. Malayan Giant Squirrel (Ex)
19. Indian Porcupine (In*)
20. Golden Agouti (Ex)

Order Carnivora

21. Smooth Indian Otter (In*)
22. Sloth Bear (In*)
23. Himalayan Bear (In*)
24. Brown Bear (In*)
25. Lesser or Red Panda (In*)
26. Kinkajou (Ex)
27. Binturong (In*)
28. Asiatic Lion (In*)
29. Tiger (White Tiger) (In*)
30. Usuri or Siberian Tiger (Ex)
31. Leopard (Black Panther) (In*)
32. Golden Cat (In*)
33. Caracal (In*)
34. Clouded Leopard (In*)
35. Puma or Cougar (Ex)
36. Jaguar (Ex)

Order Proboscidea

37. Indian Elephant (In*)

Order Perissodactyla

38. Tapir (Ex)
39. Zebra (Ex)
40. Indian Wild Ass (In*)
41. African Black Rhino (Ex)
42. Indian one-horned Rhino (In*)

Order Artiodactyla

43. Warthog (Ex)
44. Hippopotamus (Ex)
45. Guanaco (Ex)
46. Sika Deer (Ex)
47. Spotted Deer (albino) (In)
48. Fallow Deer (Ex)
49. Musk Deer (In*)
50. Thamin Deer (In*)
51. Masai Giraffe (Ex)
52. Reticulated Giraffe (Ex)
53. Blackbuck (also albino variety) (In*)
54. Four-horned Antelope (In*)
55. Chinkara (In*)
56. Indian Bison or Gaur (In*)
57. American Bison (Ex)
58. Gayal (In)
59. Gnu or Wildebeest (Ex)
60. Eland (Ex)
61. Banteng (Ex)
62. Nilgiri Tahr (In*)
63. Thomson's Gazelle (Ex)
64. Goral (In*)
65. Beisa Oryx (Ex)
66. Impala (Ex)
67. Nilgai (In)
68. Hog Deer (In*)

Aves

Order Struthioniformes

1. Rhea (Ex)

Order Ciconiformes

2. White Ibis (In*)
3. Flamingo (In*)
4. Night Heron (In)

Order Anseriformes

5. Mute Swan (Ex)
6. Black Swan (Ex)
7. White-winged Wood Duck (In**)
8. Lesser Whistling Teal (In)

Order Gallifarmes

9. Golden Pheasant (Ex)
10. Chinese Silver Pheasant (Ex)
11. Green Pheasant (Ex)
12. Swinhoe's Pheasant (Ex)
13. Kalij Pheasant (In*)
14. Cheer Pheasant (In*)
15. Monal Pheasant (In*)
16. Chuckor (Ex)
17. Indian Peafowl (albino variety) (In*)
18. Grey Jungle Fowl (In**)

Order Charadriiformes

19. Black-winged Stilt

Order Columbiformes

20. Imperial Green Pigeon (In*)
21. Grey-fronted Green Pigeon (In*)

Order Psittaciformes

22. Senegal Parrot (Ex)
23. Red and Green Macaw (Ex)
24. Blue and Yellow Macaw (Ex)

25. Sulphur-crested Cockatoo (Ex)
26. Bare eyed Cockatoo (Ex)
27. Red-bellied Conure (Ex)
28. Brown-eared Conure (Ex)
29. Jandya Conure (Ex)
30. Rose-ringed Parakeet (In)
31. Large Indian Parakeet (In)
32. Blossom-headed Parakeet (In)
33. Budgariger (Ex)

Order Passeriformes

34. Javan Sparrow (Ex)
35. Zebra Finch (Ex)
36. Bull Finch (Ex)
37. Red Avadant (In)
38. Green Munia (In)
39. Spotted Munia (In)

Reptilia

Order Chelonia

1. Starred Tortoise (In*)

Order Crocodilia

2. Salt-water Crocodile (In)
3. Marsh Crocodile (In*)
4. Gharial (In**)
5. Spectacled Caiman (Ex)

Order Squamata

6. King Cobra (In)

** indicates that the species is with a threat of extinction.

Concluding Remarks

A serious question very often larks in the mind of the common people and many wildlife lovers regarding the eventuality of the zoo-bred animals. Are these animals stocks able to settle in the wild when introduced in the suitable habitats? The possibiliy of a change in the basic ethology in the zoo animals that are adapted to live in controlled environment and under adequate care, can not be negated. But how far these behavioural shifts might pose any problem in successful rehabilitation, was not known. When two species of bisons, the American bison (*Bison bison*) and the European bison (*Bison bonasus*) become rare and were on the verge of extinction, they were protected in zoo enclosures. Of the two bison species, the condition of the European bison was much more precarious. They were completely exterminated in the wild in 1913 and only a dozen of this magnificent huge herbivore was maintained in the zoos of U.S.S.R. This zoo-bred population was reintroduced into the Bialoweiza Park, situated on the border of Poland and U.S.S.R. with a considerable success.

Another important instance is the conservation of the Mongolian Wild Horse (*Equus przewalski*). A zoo population comprising only a few animals was established during 1898 to 1900. This species of horse subsequently became extinct in the wild. The zoo population is still thriving well in captivity and has produced 14 generations by 1990. Flesness and Foose (1990) state that the plan for reintroduction of this zoo-bred horses has already been taken in Mongolia, China and U.S.S.R.

In more recent years, reintroduction of the zoo-bred animals is done by the specialist group of IUCN, SSC and CBSG adopting suitable scientific and sophisticated methods. Reintroduction of the Californian Condor (*Gymnogyps californiacus*) and the Black-footed Ferret (*Mustela nigripes*) in the suitable wild habitats appears to be a successful venture.

Development of co-operative, national, regional and international conservation management plans for zoo populations of important taxa has added the required thrust. Anthropoid Ape Advisory Panel, Species Survival Plans (SSP), Species Management Programme (SMP) etc. are already in operation.

IUCN has recognized the logic and contribution of captive breeding in 'the Policy statement of Captive Breeding' (Sept.1987). This document emphasizes on the point that the programme should be launched on any endangered wild animal when they are still represented by thousand individuals in the wild. In practice, such attempts have been resisted till the population size of California Condor and that of the Black-footed Ferret declined to 20 or less in the wild. These very small populations, however, indulge inbreeding and eventually leads to genetic erosion (Flesness and Foose, 1990).

Apart from the captive breeding, the zoo's contribution in educating the people is no less important. A Senegalese writer Baba Dioum sums up this thought in the following lines:

"In the end, we will conserve only what we love. We will love only what we understand. We will understand only what we have been taught".

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THE ROLE OF INDIAN ZOOS IN CONSERVING THE WILDLIFE OF INDIA

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In the olden times, collection of wild animals have been made by Kings, wealthy individuals and VIPs as symbols of wealth and power. Lot of animal-lovers also collected such animals and reared them for zoological interest, and others for public entertainment and recreation. This was not restricted to any region and was a practice wihtin the Roman Emperors, Emperors of China and the Emperors of Mughal time. During the 14th and 15th centuries zoo sprang up in Europe, South Africa, Russia and Egypt also.

While all the categories of people who kept wild animals in captivity had pride, love and affection for the animals, it cannot be said that they were all adequately aware about the requirements of welfare of these species. It is because of this that the presence of zoos have often been questioned by those who see them as self-seeking, anthropocentric, concerned more with charisma, publicity, object of study and even earning rather than the welfare of the species. The people who run the zoos thus have been looked upon more as consumers rather than conservators of wildlife.

The concept of modern zoo started evolving only in the middle of this century when we saw the development of zoos as breeding centres for endangered species, centres of dissemination of conservation information, behavioural study of the animals and for education. While conservation, research, recreation and edcuation are arguments put forward for establishment and maintenance of any zoo, but opinion differs as to their relative merits.

While it is agreed that *in situ* conservation is best in conserving the wildlife including study of their natural behaviours and for education and recreation, but all research cannot be done & monitored effectively under *in situ* condition. Apart from this, due to rise in human and cattle population in developing world, more so in Southern Asia, habitat of the species are getting degraded, fragmented and isolated. The expansion of agriculture, industrial development, rise of the level of consumerism and other reasons increasing stress on wild denizens have pushed some of the species to near extinction in the wild.

It is because of this that National Wildlife Action Plan, 1983 also included captive breeding programmes for endangered and threatened species and rehabilitation of the same in protected portion of their former habitat in a manner which may provide some reflection of their original distribution. Even in UN Convention on bio-diversity (1992) there is a separate article for *ex situ* conservation (Article 9). They have recognised *ex situ* conservation as a component of conservation of biological diversity, serving as gene bank, in vitro collection for research, public education and awareness. One of the programmes under this article is also to adopt measures for recovery and rehabilitation of threatened species includig their re-introduction in their erstwhile natural habitats under appropriate conditions.

In India prior to the creation of Central Zoo Authority, a large number zoo's were established for different purpose and they were managed by various departments, autonomous bodies, organisations, institutions and private people. While some were managed in a reasonably good condition but most of them suffered from serious deficiencies.

The main reasons for which zoos of India had been subjected to various criticism are:

1. Earlier zoos were managed by Government, autonomous bodies, various societies, institutions, organisations and even private individuals including hotel and cafeteria owners etc. with diffused priorities lacking focussed scientific attention.
2. Out of nearly 300 zoos in India, 22% belong to the category of large, medium and small zoos, but an alarmingly high 78% belong to the category of mobile and mini-zoos, without required scientific and technical inputs.
3. There was very little finance available with most of the zoos to provide adequate space for the natural behavioural display of animals.
4. The upkeep, management and treatment of animals were inadequte causing high degree of unnatural death of animals or otherwise inflicting cruelty to them.
5. Education programmes that can raise the level of environmental awareness were hardly existing, and where existing, were mostly of primitive nature to motivate visitors towards conservation values.

Even though as far back as 1973 Government of India appointed an expert committee to study the management of zoos in India and to make recommendations for their improvement. In absence of any institutional set up to follow up the recommendations effectively, hardly any action was taken by the zoos to implement the recommendations and improve their condition. In fact most of zoos lost sight of the main charter of the zoo that was laid down in the report, and a lot of illegal procurement and disposal of animal were carried out by some of the zoos knowingly or unknowingly. A number of zoos were more concerned with the total number of exhibits in terms of species and compromised with the quality of environment, and health of the animals that were required to be provided.

In absence of proper education and awareness programme which can turn a stranger to the zoo into a regular visitor, visitors into participants, participants into believers. While a number of people saw zoo only as recreational centres and did not understand the role that the zoo can play in complimenting the *in situ* conservation. I distinctly remember that former Secretary, Environment and Forests, Government of India, Shri R. Rajamani used to tell that during his younger days he always thought of zoo as evil. However, when he joined the administrative service and came across some well-known wildlife conservationists in the state, he came to think zoos as necessary evil. In subsequent period when he became the Secretary to the Government of India and came across a large section of zoo communities and had visited a number of Indian and Foreign zoos, he came to understand zoos also as necessary goods. It was his feeling that if there had been proper zoo education in past years, he might have been converted long back.

Now that the Central Zoo Authority (CZA) has been established (February 1992), and the CZA is striving to ensure that the zoo animals are provided with conditions that are congenial to their psychology and physical health and have been able to successfully co-ordinate the activities of zoos under various ownership and areas, Indian zoos can help in conserving the wildlife in India in various ways. In fact a number of such programmes are already in way and some of them have produced encouraging results. I am giving a list of some such important programmes with respect to rehabilitation of species in the wild which by no means is exhaustive, but is only indicative of what the zoos can do for conservation.

(a) The species which has been introduced extensively in the wild from captive bred stock is spotted deer, and despite of the fact that not much of precautions were taken prior to re-introduction in many cases the species have adjusted itself into the wild and are breeding well. If such population were reintroduced with proper veterinary screening and advance preparations at the designated site of release, and the released populations monitored regularly, this programme could have been expanded for rebuilding the population in the wild shifting surplus spotted deer from zoos and deer parks.

(b) Another group of species which have been successfully reintroduced into the wild are the three crocodilian species, but due to absence of proper linkages between captive breeders and field managers as well as proper public relation work, the process of reintroduction is suffering owing to resistance by local people even though the stock in captivity is plenty. Identification of the site of release and drawing up of community education programme about the necessity of such reintroduction well ahead including elimination of undue fear from the mind of the local people regarding these species, are necessary for large scale reintroduction of the species in the wild.

(c) The other group of species for which systematic reintroduction programmes were undertaken in the last two decades were turtles. However, in absence of subsequent monitoring of the released population and surveillance method to ensure safety of the released stock, a lot of such released turtles found their way through unscrupulous businessmen into the markets of Calutta and Howrah. If monitoring of the released stock along with installation of machinery of their protection were put into operation simultaneously, the result would have been much more encouraging.

(d) Captive bred stock of blackbucks have also been released in the Vanasthaly forest area situated in the outskirt of Hyderabad city. The population grew up considerably and Andhra Pradesh forest department is now extending the conservation area by connecting it to another adjacent forest block.

(e) Captive bred pigs from wild stock were also released regularly in the late 70s and early 80s in the Sundarban tiger reserve to rebuild the depleted stock of prey base of tiger along the northern fringe of the Sundanban tiger reserve. This considerably reduced the straying of tigers from the tiger reserve to nearby villages in search of food, which helped in reducing the man and animal confrontation and building up of a platform for conservation of tiger with support of fringe dwellers.

Apart from the objectives of recreation, public education and rehabilitation of species in the wild.

Zoos can also help wildlife conservation in many other ways like:

1. By taking over problem creating animals from any area save them from killing.
2. By taking custody of disabled, diseased and, deserted young animals and then arranging their treatments and rearing them to save their life.
3. By helping in the development of captive animal management study and allowing veterinarian an exposure to wild animal treatment and management.
4. By allowing scope for biological study of wild animals throughout its lifecycle for filling up the gap of scientific knowledge.
5. By making common people aware about the wildlife heritage of the country and creating empathy regarding the need for their conservation.



6. By acting as rescue centres of seized and confiscated captive animals obtained from traders and smugglers in detected wildlife cases.
7. By serving as a biological park and providing urban green lung for the city dwellers specially in metropolitan cities.
8. A well-laid zoo with proper signage and murals can also present a holistic veiw of the living world with animals as integral part of our eco-system.

If the present trend of population growth continues, the world human population may touch 12. Billion mark by the year 2050. This is bound to result into acute pressures on our land and water resources leading to degradation, fragmentation and shrinkage of our great wildlife abode causing decline and even extinction of some of the species in the wild. In preserving some such species in *ex situ* condition and providing a gene bank for any future programme and development of species, and for education and recreation of the generations to come, the role of zoos is likely to become more crucial in future.

EDUCATION IN INDIAN ZOOS—STRATEGIES FOR THE NEXT MILLENNIUM

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India is a vast country with many diverse life forms, both flora and fauna. The country also is burdened with an ever-growing upsurge in the human population, which, according to many, is a tool for development, while many others deem it as a reason for many debacles and conservation failures. I consider our force as strength to be reckoned in spite of the fact that a vast majority of our population are illiterates as they lack of grades and degrees. Education, however, is not degrees alone. It is well-known that intellectual education influences the head and value-based education influence the heart. Thus true education is training of both the head and the heart. I cannot think of any better institution in the country other than a zoological garden which can provide both to an average Indian, who has desire to see, listen and learn. Zoos are a place where many positive attitudes and positive thinking can be developed. If wildlife conservation is serious threat, then why is it that zoos are not using their educational facilities to develop positive attitudes and action for the conservation, amidst all the zoo visitors. I feel, our zoo education policies, programmes and plans need a new direction and dedicated approach so that all zoo visitors become active supporters for conservation momentum. Conservation unfortunately even today is being talked about by just a few. Why do zoos not create moral stories for conservation? Do Indian zoos have clear cut education plan, which is part of the zoo management plan? Do zoos have perspective zoo education plan and policy? Even today when many argue that the only justification for existence of zoos are for creating eco-awareness and imparting education amidst, masses, why are zoos not coming out with clear zoo education action plans? A quick and early introspection is needed on the above issues by Indian zoo managers and zoo educators, and zoo biologist.

My interest in zoo education got boosted after I attended the 14th International Zoo Education Conference from 1st to 6th October, 1998 in Taipei zoo, where zoo educators from all parts of the world were present. I do not know if there ever has been a meeting of Indian zoo educators to discuss conservation education programme. The status of the zoo education, exchange views for improvement etc. I do not know how many Indian zoos have zoo education officers and full-fledged education departments. Many zoos have some educational programme piecemeal experience and success stories. It is time that Indian zoo managers, educators, biologists and zoo PROs sit to discuss approaches in education for the next millennium. Many zoos have education programme for teachers and students. The impact of the programmes has to be analysed. In case, zoos have education plans are they in tune with the National Zoo Policy, 1998? Have Indian zoos redesigned the educational strategies, as the emphasis in the National Zoo Policy is mainly on conservation and captive breeding of endangered species and support *in situ* conservation programmes. This requires and calls for the changing attitudes of visitors to zoos, who hitherto have mostly being used to seeing displayed animals. For this to happen, the zoo manager and education officers themselves need to develop positive attitudes. Zoo education programme has to be transparent innovative educational programmes teaching techniques need not be concealed by zoos for fear of prying eyes, as all of us have a common goal (i.e.) to educate every individual who visits the Zoological Garden and take part as a community, to bring about positive conservation attitudes in the country. Let us start exchanging zoo Newsletters, highlighting educational programme and strategies being implemented. While we need education plans for visitors, we need continuous education programmes and trainings for all the zoo staff to update their knowledge, skills and capabilities in the zoo management and animal upkeep. Education for biodiversity conservation should be our emphasis appeal and action area to create a position in human-biodiversity relationship. It is interesting to know that attempts are being now made to identify a cadre of zoo educators whose service experience are to be utilised in PHVA'S and CAMP'S. Many Indian zoos have developed extremely popular vernacular education materials and conducting successful outreach programmes efficiently using education as a successful conservation tool. Such experience should be shared with those who are yet to

start in a more organised manner. Zoo educators today are playing a great role in zoo designing by actively collaborating with zoo designer in many European zoos, while Indian zoos are searching for a class called zoo educators. The zoo educators also have great role in exploring people's perception of conservation actions, carried out in *ex situ* centres national parks and sanctuaries and also assess attitudes of visitors about conservation message put up in the zoos.

Some attempts have been made by International zoos educators' association (IZE) by selecting regional representative and creating a network of Asian zoo educators. However, what is urgently needed is identifying Indian zoo educators and creating a network. The Central Zoo Authority and Indian Zoo Directors' Association and Zoo Directors may have to play a role in this regard. All Indian zoos, National Parks, Sanctuaries, Biosphere Reserve, should have well-structured educational department supported by volunteers, failing which, the objective of forming zoos and creating National Park, Sanctuaries are to fail. The zoo and *in situ* manager have to be backed up by a strong education wing, and a team of student volunteers. This country has no dearth of student with strong background in zoology and wildlife biology, whose services can be utilised in imparting education to all visitors. Eco-tourism and wilderness tourism cannot succeed without education coordinators. When zoos abroad are talking of zoo education in cyber space and using Internet for professional interchange, we need to develop new quests desires and dreams to improve the zoo education techniques, policies, plans and strategies to create positive wildlife conservation attitudes in our society.

ARIGNAR ANNA ZOOLOGICAL PARK'S APPROACH TO BREEDING OF ENDANGERED SPECIES OF WESTERN AND EASTERN GHATS

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Introduction

The range of impacts that humans have had on animal, though large can be grouped conveniently into five categories, viz. domestication, dispersal, extinction, expansion and contraction (Andrew Goudie, 1986). The extreme effect of human interference with animals is extinction, but the prelude to it is the contractions in animal number and distribution. The reasons for animal decline are too many. Positively one of the most fundamental ways in which are extinction by reducing the natural habitat for species. Even Wildlife Reserves tend to become small islands in an inhospitable sea of artificially modified vegetation or urban sprawl, some times no better than a closed zoo. Ehrenfiled (1972) has listed out characteristics of species affecting survival. According to these animals of larger size, predatory behaviour, narrow habitat tolerance, value for products, long gestation periods, intolerance to human are listed as endangered. Similarly, it is argued that larger reserve, single reserve, reserve connected with corridor with similar vegetation and placed with equal distance and near to each other, are ideal for holding large populations and augmenting conservation. According to Myers (1979) during the last quarter of this century we shall witness an extinction spasm accounting for one million species. This is a considerable proportion of the estimated number of species living in the world today for which Myers gives a figure of between 3 to 9 million. He has calculated that from AD 1600 to 1900 humans are accounting for the demise of 1 species every 4 years, that from 1900 onwards the rate increased to an average of around 1 species per year and today the rate is about 1 species per day and that within a decade we could be losing 1 species per every hour.

The Western and Eastern Ghats the region in the influence of Arignar Anna Zoological Park also faces innumerable pressures. Many of the smaller animals, innumerable reptiles, birds, amphibians and invertebrate face acute threats in the tract. The problem is that there is no exchange of scientific data between zoos and *in-situ* conservation areas, parks and sanctuaries. Conservation calls for sharing of data and concerns between agencies involved in *ex-situ* and *in-situ* conservation. The large open zoo like Arignar Anna Zoological Park has immense scope for captive breeding of many critically endangered species. The innumerable pressure within and out side the forests both natural happenings and mostly man made have resulted in untold disturbances to the wildlife and its habitat in the Western and Eastern ghats of South India, thereby driving many animals to critically endangered and vulnerable status. Arignar Anna Zoological Park the largest zoo in South East Asia has been playing a significant role in the conservation and captive breeding of over 50 endangered species both native and exotic. We plan to change the conservation strategy, by giving more emphasis on endangered species of our region.

Guidelines on Captive breeding

The national zoo policy 1998 in its preambles state that "Today when wildlife habitats are under severe pressure and a large number of species of wild fauna has become endangered, the zoos have not only to sustain their over population but also augment the depleting populations of endangered species in the wild". The new role has been acknowledged by the global conservation community, article 9 of the convention on Biological diversity. The main objective of the zoos shall be to complement and strengthen the National efforts in conservation of the rich biodiversity of the country, particularly the wild fauna. Arignar Anna Zoological Park though a generalized zoo has been playing a vital role in the captive breeding of many endangered animals, since its inception from 1985. Today it has on its captive breeding programme list around 44 species of animals both indigenous and exotic species. The zoo is the recognized national stud-book keeper for Lion Tailed Macaque. The zoo has been successful in breeding Lion Tailed Macaque (*Macaca silenus*). Nilgiri Langur (*Presbyters johnii*), Lion (*Panthera leo persica*), Tiger (*Panthera tigris*), Black buck (*Antelope cervicapra cervicapra*), Sambar (*Cervus unicolor*), Python (*Python molurus*), Wild dog (*Cuon alpinus*) etc. The Indian zoos hold about 83 species of mammals as per the list provided by Central Zoo Authority (Table 1). The Indian mammals camp

report summary has listed out mammals that are critically endangered and vulnerable. The research wing of this zoo has listed out all the critically endangered and vulnerable species of mammals of the southern region, which numbers 27 species (Table: 2) that will be specially attended in our zoo. The CAMP workshop report on endangered mammal list is large, and also includes many marine forms like dugong etc. We are committed to conservation of 27 species of life forms of our region on priority basis to start with.

Aazp's commitment in captive breeding programmes

Arignar Anna Zoological Park, like any other zoo has been concentrating in captive breeding programme of mega mammals. The zoo is fortunate to have a large area 510 ha. The zoo in its Mission statement, 1998 has committed itself to the conservation of endangered species of the Western and Eastern ghats. This is the vision plan for the millennium 2000. Adopting the national zoo policy guidelines, we in Arignar Anna Zoological Park have decided to focus our full attention on endangered and vulnerable mammals of this region with special emphasis on small mammals. Our animal collection and breeding plans from now onwards shall lay more emphasis in the following order to cover locality, region, country and other areas. With this new effort Arignar Anna Zoological Park will assume significance as an important wildlife captive breeding, awareness and education centre, involved in conservation educative people on the biodiversity of Western & Eastern ghats.

This sought of captive breeding programme involves a great planning and co-operation between zoos in the southern region as it involves loaning, pooling and exchanging animals for the programme and creation of socially, genetically and demographically viable groups. Arignar Anna Zoological Park will thus be bestowing all efforts in the breeding of endangered species representing the zoo geographic zones i.e. Western & Eastern ghats areas in which it is located. A detailed captive breeding programme document and plan is under preparation. Planning for prioritizing species, collecting data on biology, behaviour other demographic factor, deciding released sites, minimum number of Founder animals and planning for improving the quantum of housing facilities etc. are part of the document feature, so as to arrange for a planned and scientific captive breeding programme.

We in the zoo have now drawn out a new vision plan i.e. to involve ourselves in the conservation of critically endangered, threatened and vulnerable species of Western and Eastern ghats and also to impart wildlife education and awareness to the park visitor particularly to the student communities. We have identified suitable area inside Arignar Anna Zoological Park to start a Western and Eastern ghats species exhibit and conservation centre. This centre would involve fully in captive breeding of endangered species and their reintroduction into wild, with the support of Central Zoo Authority and involvement of *in-situ* managers and wildlife Institutes. To start with we will concentrate on mammals. The rescue and rehabilitation centre to be established shortly may also strengthen our captive breeding endeavours. We also understand that there are many in the public who still possess precious wildlife in shabby holdings in the name of pets, giving no opportunities for such animals to breed. We expect people to voluntarily come forth to leave the animals with Arignar Anna Zoological Park, authorities to be handled in the rescue and rehabilitation centre before being released into the wild or such animals can also be utilized for an organised captive breeding programme. The zoo will be involved in the breeding of the following 27 species listed below which fall in the category CR, VU and EN identified as per recent status surveys, IUCN reports and camp workshop reports.

The zoo is also involved seriously in the conservation and education of endangered invertebrate like butterflies. It has to its credit an invertebrate house and butterfly breeding centre. With the success, breeding of small and endangered mammals we will include into our efforts endangered birds and reptile, amphibians and butterflies of Eastern and Western ghats. Arignar Anna Zoological Park will shortly become the conservation and breeding centre for all threatened and endangered species of the South Indian tract by 2010. The zoo activities and efforts are being geared up to take up such challenges.

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Table-I

Animals Head in Indian Zoos in Captivity (CZA) Report

Sl. No.	Common Name	Sclentific Name	IUCN
1.	Antelope, Four horned	*Tetracerus quadricornis*	LR-nt
2.	Badger, Chinsese ferret	*Melogale moschata*	EN
3.	Badger, Honey, Ratel	*Mellivora capensis*	LR-nt
4.	Bear, Himalayan black	*Ursus thibetanus*	LR-lc
5.	Bear, Himalayan brown	*Ursus arctos*	LR-nt
6.	Bear, Sloth	*Melursus ursinus*	VU
7.	Bear, Sun	*Helarctos malayanus*	DD
8.	Binturong	*Arctictis binturong albifrons*	DD
9.	Black buck	*Antilope cervicapra*	LR-lc
10.	Boar, Wild	*Sus scrofa*	LR-lc
11.	Cat, Fishing	*Prionailurus viverrinus*	VU
12.	Cat, Golden	*Catopuma temminckoi*	NE
13.	Cat, Jungle	*Felis chaus*	LR-nt
14.	Cat, Leopard	*Prionailurus bengalensis*	LR-nt
15.	Civet Common palm	*Paradoxurus hermaphroditus*	LR-lc
16.	Civet, Himalayan palm	*Paguma larvata*	LR-lc
17.	Civet, Large Indian	*Viverra zibetha*	VU
18.	Civet, Small Indian	*Viverricula Indica*	LR-nt
19.	Deer, barking	*Muntiacus muntjak*	LR-lc
20.	Deer, hog	*Axis porclnus*	LR-nt
21.	Deer, Manipur, Sangai	*Cervus eldii eldii*	CR
22.	Deer, Mouse	*Moschiola memminna*	LR-nt
23.	Deer, Musk	*Moschus chrysogaster*	CR
24.	Deer, Sambar	*Cervus unicolor*	LR-lc
25.	Deer, Spotted	*Axis axis*	LR-lc
26.	Deer, Swamp	*Cervus duvauceli duvauceli*	EN
27.	Deer, Indian Red; Hangul	*Cervus elaphus hanglu*	CR
28.	Dhole, Wild dog	*Cuon alpinus*	LR-nt
29.	Elephant, Asian	*Elephas maximus*	VU
30.	Flying fox	*Pteropus giganteus giganteus*	LR-nt
31.	Fox, Common	*Vulpes bengalensis*	LR-nt
32.	Gaur	*Bos gaurus*	VU
33.	Gazelle, Indian, Chinkara	*Gazella bennettii*	LR-lc
34.	Glbbon, Hoolock	*Hylobates hoolock*	EN
35.	Goral	*Naemorhedus goral*	NE
36.	Hare	Lepus nigricollis	LR-lc
37.	Hedgehog, Long-eared	*Hemiechinus collaris*	LR-lc
38.	Hyaena, Striped	*Hyaena hyaena*	LR-nt
39.	Jackal	*Canis aureus*	LR-lc
40.	Langur, Capped	*Trachypithecus pileatus*	LR-nt

Sl. No.	Common Name	Sclentific Name	IUCN
41.	Langur, Golden	*Trachpithecus geel*	CR
42.	Langur, Hanuman	*Semnopithecus entellus*	LR-lc
43.	Langur, Nilgiri	*Trachypithecus johnil*	VU
44.	Leopard, Clouded	*Neofells nebulosa*	LR-lc
45.	Leopard, Snow	*Uncia Uncia*	EN
46.	Lion, Asiatic	*Panthera leo persica*	CR
47.	Loris, Slender	*Loris tardigradus*	LR-nt
48.	Loris, Slow	*Nycticebus coucang*	LR-nt
49.	Lynx	*Lynx lynx isabeling*	EN
50.	Macaque, Assamese	*Macaca assamensis*	LR-nt
51.	Macaque, Bonnet	*Macaca radiata*	LR-lc
52.	Macaque, Crab-eating	*Macaca fasicularis umbrosa*	CR
53.	Macaque, Lion tailed	*Macaca silenus*	EN
54.	Macaque, Pig tailed	*Macaca nemestrina*	DD
55.	Macaque, Rhesus	*Macaca mulatta*	LR-lc
56.	Macaque, Stump tailed	*Macaca arctoides*	LR-nt
57.	Martin, Yellow throated	*Martes flavigula*	LR-lc
58.	Mongoose, Common	*Herpestes edwardsji*	LR-lc
59.	Mongoose, Crab eating	*Herpestes urve*	VU
60.	Nilgai	*Boselaphus tragocamelus*	LR-lc
61.	Otter, Common	*Lutra lutra*	NE
62.	Otter, Smooth India	*Lutrogale perspicillata*	NE
63.	Panda, red	*Ailurus fulgens fulgens*	VU
64.	Pangolin, Indian	*Manis crassicaudata*	LR-nt
65.	Panther	*Panthera pardus*	VU
66.	Porcupine	*Hystirx indica*	LR-lc
67.	Porcupine, Brush tailed	*Atherurus macrourus*	EN
68.	Rhino, Indian	*Rhinoceros unicornis*	EN
69.	Serow	*Naemorhedus sumatraensis*	VU
70.	Sheep, Blue	*Pseudois nayar*	LR-lc
71.	Squirrel, 5-striped palm	*Fundambulus pennantil*	LR-lc
72.	Squirrel, Grizzled giant	*Ratufa macroura dandolena*	EN
73.	Squirrel, Indian giant	*Ratufa Indica indica*	VU
74.	Squirrel, Malayan giant	*Ratufa bicolor gigantea*	VU
75.	Tahr, Himalayan	*Hemitragus Jemiahicus*	LR-nt
76.	Tahr, Nilgiri	*Hemitragus hylocrius*	EN
77.	Takin	*Budorcas taxicolor*	EN
78.	Takin	*Budorcas taxicolor*	NE
79.	Tiger, Bengal	*Panthera tigris*	EN
80.	Wild ass, India	*Equus hemionus khur*	EN
81.	Wolf, Indian	*Canis lupus pallipes*	LR-nt
82.	Wolf, Tibetan	*Canis lupus chanco*	NE
83.	Yak, Wild	*Bos grunniens*	CR

Table-II

Species that requires attention in the South Indian Tract

Sl. No.	Common Name	Sclentific Name	Distribution in India	Family	IUCN
1.	Indian Gaur	*Bas gauurus* (Smith)	Central, East, South, West	Bovidae	VU
2.	Ellerman rat	*Cremonomys elyira* (Ellerman)	South	Muridae	VU
3.	Indian Elephant	*Elephas Maximus* (Linnaeus)	Central, North North East, South	Elephantidae	VU
4.	Kelaar's long clawed shrew	*Feroculus feroculus* (Kelaart)	South	Soricidae	VU
5.	Nilgiri Tahr	*Hemitragus hylocrius* (Ogilby)	Western ghats	Bovidae	EN
6.	Brown Mongoose	*Herpestes fuscus* fuscus (water house)	Western ghats	Herpestidae	VU
7.	Leafnosed Bat	*Hipposideros lankadiva* (kelaart)	India	Hipposiderid ae	VU
8.	Salim Alis Fruit Bat	*Latidens salimalii* (Thonglongya)	India	Pteropodidae	EN
9.	Lion-tailed macaque	*Macaca silenus* (Linnaeus)	India	Cercopitheci dae	EN
10.	Sloth Bear	*Melursus ursinus* (Shaw)	India	Ursidae	VU
11.	Yellow throated Martens	*Mertes gwatkinsi* (Horsfield)	Western ghats	Mustelidae	VU
12.		*Mus famulus*	South, Andaman & Nicobar	Muridae	VU
13.	Wroughton's free tailed bat	*Otomops wroughtoni* (Thomes)	-do-	Molossidae	CR
14.	Leopard	*Panthera pardus* (Linnaeus)	India	Felidae	VU
15.	Tiger	*Panthera tigris* (Linnaeus)	India	Felidae	EN
16.	Brown Palm Civet cat	*Paradoxurus jerdoni* (Blanford)	-do-	Viverridae	VU
17.	Hedgehogs	*Paraechinus micropus nudiventris* (Horsfield)	South India	Erinaceidal	VU
18.	Small travancore flying squirrel	*Petinomys fuscocapillus fuscocappillus* (Jerdon)	South Western ghats	Sciuridae	VU
19.	Fishing cat	*Prionailurus viverrinus* (Bennett)	East, North, North East, South	Felida	VU
20.	Field Rat	*Rattus ranjiniae* (Agarwal & Ghosal)	Western ghats	Muridae	VU
21.	Indian giant squirrel	*Ratufa indica indica* (Erxleben)	South Western ghats	Sciuridae	VU
22.	Indian giant Squirrel	*Ratufa indica maxima* (Erxleben)	-do-	Sciuridal	VU
23.	Grizzled Giant Squirrel	*Ratufa macroura dandolena* (Pennant)	South Western ghats	Sciuridae	EN
24.	Musk Rat	*Suncus dayi* (Dobson)	Western ghats	Soricidae	VU
25.	Shrews	*Suncus montanus* (Kelaart)	Western ghats	Soricidae	VU
26.	Nilgiri langur	*Trachypithecus johnii* (J. Fischer)	-do-	Cercopithecidae	VU
27.	Malabar civet	*Viverra civettina* (Blyth)	-do-	Viverridae	CR

REDESIGNING THE INDIAN ZOO

A. PAL
Landscape Architect & Zoo Exhibit Designer

Introduction

As we review the overall scenario of Indian zoos at the start of the new millennium, it is quite clear that much change is needed for our zoos to fit in with the contemporary world. Today, the best international zoos not only incorporate current ideas in planning, design and education but also play an important role in getting public support for wildlife and habitat conservation through their outreach programmes and donation campaigns. In this scenario, most Indian zoos are lagging behind the trends that have been evolving in the zoo world for over twenty-five years. Zoos in India play a smaller role, serving mostly as areas for relaxation and picnicking around cities, and in a fairly limited way as educational institutions.

The Indian audience has matured over the last decade through exposure to the National Geographic and other wildlife television programmes, while those who can afford to have travelled abroad and visited international zoos. As a result, the educated visitor now has some idea of the natural habitats of animals and is no longer content with looking at animals in small cages and concrete rooms, or even in 'garden' settings. Also, while a visit to the zoo rates high on a parent's scale of satisfaction for their children, most Indian parents who have the financial ability end up taking their children to a museum, *mela,* amusement park, or movie. The reasons for this lie in the fact that most Indian zoos do not offer a quality experience for the visitor. Replanning and redesigning the existing zoo cannot only help address these concerns but also take it into the twenty-first century as a leading institution in education and conservation.

The Mission Statement

Over the last century, the zoo mission has gone through a sea of changes: from being the menagerie with exotic animals, to animal collections, and into natural habitat design, with conservation and communication being the trends for the future. The priorities of Indian zoo directors today is at odds with what the public thinks of zoos (Fig. 1). The priorities, therefore, need to be formalized into mission statements for their zoos. A mission statement, established by the zoo management and staff, is a set of stated goals and objectives that sets a guiding framework for the zoo as it develops over the years and is the first step in the redesigning of any existing zoo.

What The Indian Zoo Director Thinks Is Important	The Existing Zoo Scenario In India (Public Impression)
1. Bio-diversity & Conservation	1. Visitor Relaxation
2. Education	2. Exhibits (Display)
3. Exhibits (Display)	3. Education
4. Management (Animal Care & Welfare)	4. Bio-diversity & Conservation
	5. Management (Animal Care & Welfare)

Fig. 1

While not the only factor, coordinated zoo planning & design of exhibits, helps to achieve the Zoo Mission Statement in the following ways:

- Improved education & conservation message through natural habitat design and interpretive graphics,
- Improved animal health and management through behavioural enrichment,
- Improved visitor entertainment through natural, rather than forced, animal behaviour,
- Improved visitor management and, therefore, zoo maintenance,
- Improved fund raising possibilities.

The Master Plan

To start the redesign process, the zoo must first develop a Master Plan that is a document to guide the re-development of the zoo in accordance with the mission statement. The Master Plan itself consists of a physical plan and financial/management plan. The purpose of the physical plan is to control the physical re-development of the zoo according to criteria established by the management plan and within the budgets established by the financial plan. The objective of the financial/management plan is also to increase zoo revenues while improving management processes within the zoo itself.

The Planning Process

The success of a Master Plan depends completely on the process established and the commitment of the participants. However, too often, one sees a segregated design process in which the zoo staff and design professionals do not work together, resulting in a non-integrated design that fails to communicate the zoo mission. Noted American zoo designer Jon Coe reiterates this point when he notes that "*...we must remember that it is people, not technology, who bring success. Leadership at every level is more important than ever for integrating exhibit design and operation.*" Closer to home, the ongoing development of the Master Plan for the new national zoo of Sri Lanka at Pinnawala serves as an excellent model to illustrate the contemporary way of thinking in zoo planning.

A multi-disciplinary team in consultation with the Dehiwala Zoo client is currently preparing the Master Plan for the Pinnawala Zoo, keeping in mind the latest trends in zoo planning as well as the social and physical realities of Sri Lanka. While the client is represented primarily by the Zoo Director, Additional Director, and Chief Curator, the consultant team at present consists of:

- An ecological team that includes qualified experts on mammals, reptiles, birds, butterflies and trees. The team has additional expertise on specialized facilities such as the Zoo Kitchen, Zoo Hospital, and Quarantine Section;
- A landscape & habitat design team with expertise on natural habitat zoo planning and design;
- A sociological team with inputs on integrating the project with local inhabitants' desires;
- A structural engineering team with experts on roads, bridges, and other structures;
- An architectural team with expertise on visitor and administration buildings; and
- A services team with expertise in water supply, waste management, and recycling.

Analyzing the Existing Situation

The first step in the Pinnawala Zoo Master Plan was for the ecological team to carry out a comprehensive site analysis in which existing landform, vegetation, soils, water, and native flora and fauna were surveyed. Similarly, before commencing with the redesign of a zoo, the first and essential task is to undertake a comprehensive analysis of the existing situation. This is a process by which the zoo planning team surveys the existing zoo and carries out a cost-benefit analysis of maintaining deteriorating exhibits versus the capital cost of redesigning them. Structures, utility and road networks are surveyed, as is mature vegetation. From these findings, the zoo planning team would develop an analytical map showing the physical conditions of various parts of the zoo. The map would allow the team to make a judgement as to which parts of the zoo were most appropriate for redesigning in different phases in the future, based on their physical condition.

Equally important to the physical analysis is a survey of existing species in the zoo. Some questions to be answered are:

1. Are there too many/too few species for the given area of the zoo?
2. Is there any duplication or cases of similar species in the collection?
3. Do the existing species support the Zoo Mission Statement?

Answers to these questions would lead the zoo management to a strategy of possibly reducing numbers of certain species, and procuring others through exchange programmes with other zoos. This strategy would be integrated with the phasing of the physical plan as well as the annual budgets of the financial plan.

Reorganizing the Zoo Plan

A survey of Indian zoos, and indeed of many older zoos around the world, will show that they are not organised around modern concepts of master planning or exhibit organisation. Typically, if a traditional zoo has any planning concepts it is driven by considerations of taxonomy, garden-image, exhibit-area-requirements, or even architectural-fashion. The key to the notion of wildlife conservation in zoos today is the concept of dividing the zoo into bio-climatic zones, that is, areas of specific climate-vegetation associations that are home to different kinds of wildlife habitats that need to be preserved. Many modern zoos around the world have been successfully reorganised around bio-climatic zones or vegetation zones, in fact, two contemporary zoos on the Indian sub-continent, the Nilgiri Biosphere Conservation Park outside Coimbatore, and the previously mentioned Pinnawala Zoo in Sri Lanka, have also been planned along the same lines (Fig. 2).

Vegetation Zones—Nilgiri Biosphere Conservation Park (Proposed)	Habitat Zones—Pinnawala Zoo (Proposed)
1. Evergreen Rain Forest	SRI LANKA SPECIES ZONE
2. Semi-evergreen Rain Forest	1. Sri Lanka Forest
3. Moist Deciduous Forest	2. Sri Lanka Grassland
4. Dry Deciduous Forest	3. Sri Lanka Scrubland
5. Grassland (*Shola*)	4. Sri Lanka Marsh
6. Thorn Forest	WORLD SPECIES ZONE
7. Rainshadow Forest	5. Tropical Forest
8. Riverine Forest	6. Tropical Grassland
	7. Tropical Marsh

Fig. 2

Within each bio-climatic zone, exhibit reorganization could take place in more detail keeping several parameters in mind. These include:

- Specific exhibit scenarios based on animal and habitat relationships, symbiotic relationships between animals, and prey-predator relationships between animals.
- Visitor attraction quotient with popular and/or larger animals being prominently located while supporting species are arranged in surrounding areas.
- Animal health, with hoofstock being kept in drier upland areas, aquatic and semi-aquatic animals kept in low-lying areas, and nocturnal animals being kept in cooler shady areas.
- Servicing, with larger exhibits, being provided complete vehicular service access.

Getting Visitors around the Zoo

Critical to visitor experience of the zoo is the way in which visitor circulation is planned. The traditional zoo, abroad or at home, typically has not clearly defined circulation patterns or hierarchies. All roads are similar in size and texture and are interconnected everywhere giving visitors no sense of direction and allowing them to walk in all directions, as a result of which three things happen:

(a) Visitors get tired since they are not able to plan out their visit sequence properly and end up walking over the same roads more than once.
(b) Visitors may not get to see all the animals they want to see, especially if they have limited time on their hands.
(c) Visitors end up seeing the animals in haphazard manner and leave the zoo with no clear ideas about wildlife habitats or related conservation issues.

Additionally, in a traditional zoo there is little or no segregation between visitor and service vehicles circulation leading to the disturbance of visitors and at worst the increased possibility of accidents.

The redesigned zoo by comparison attempts to maximize the visitor experience in the time available by organizing the circulation into an efficient layout. A hierarchy of paths helps in visitor control and the viewing experience—primary pathways guide the visitors around the zoo while secondary and tertiary pathways allow smaller groups to view the exhibits in a relatively quieter environment. While the primary pathway may be designed around criteria such as tram movement and fire-engine access, the smaller path layouts are determined by the nature of each exhibit. Finally, the redesigned zoo attempts to maximize separation between service and visitor circulation leading to a disturbance-free viewing experience.

Natural Habitat Design (Landscape Immersion)

The overall reorganization of the zoo described here forms the setting for redesigning specific exhibit areas along the lines of natural habitat design. The phrase 'landscape immersion' describes exhibits in which the visitors share the same created landscape, but not the same areas, as the animals. The objective behind 'landscape immersion' is to give the viewer a sense of being in the landscape of the animal rather than outside it—to make the experience more real. According to Jon Coe, the large goal is that by making the experience thus dramatic and exciting, it may become a part of the long-term memory of the visitor. Also, the image thus created of wildlife living undisturbed by humans would hopefully render the visiting public more conducive to education and conservation-related information.

From the point of view of the zoo staff, important advantages of natural habitat design would be in permitting animals' greater freedom of movement, with minimal hoof disorders, leading to their better health. Animals in simulated native habitats also display normal behavioural patterns, natural feeding habits as well as natural playing behaviour, leading to less strain and therefore easier keeper management. Social relationships between animals are enhanced leading to natural sexual behaviour and mating, resulting in healthy reproductive lives. All these animal activities are also perceived by the visitors, thus underlining the importance of the conservation of natural habitats.

Jon Coe and others have not only written extensively on 'landscape immersion' but also practised it extensively, and an in-depth review of all the methods used would be well beyond the scope of this article. However, some of the salient features of natural habitat design are summarized thus:

- Predator exhibits are often placed at a location higher than the viewer. This reduces the sense of human domination and increases the level of excitement through the perceived threat to the visitor.
- Viewing areas never encircle the animal as in a traditional zoo. This removes the sense of domination and circus-like atmosphere. Viewing areas are often hidden from the main path and from each other to create a 'safari-like' experience.
- Animal barriers are hidden from the pathway through careful manipulation of earth levels, views, rockwork, and vegetation. This is critical to make the visitors feel that they are in the animal's natural habitat.
- Interesting and varied habitats are created to help combat animal boredom. Naturalistic pools, waterfalls, high contours, perching rocks and dead trees that are found in nature encourage animals to display their natural behaviour apart from creating an impression of a real habitat.

Visitor Attractions and Zoo Finances

Reorganizing a zoo costs money, and the zoo management must face the financial reality that government funds are not there for the asking. The exposure of the Indian public to quality entertainment from amusement parks and multiplex cinema theatres has resulted in increasingly large amounts of public money being spent on entertainment. In an era of static or dwindling government subsidies, Indian zoos must find a way to tap the increasing reservoir of public money. While the zoo has something that no other entertainment attraction—wildlife—the Indian visitor increasingly takes into account the cost-benefit of a visit to an amusement park or other such attraction, and is willing to pay for the higher level of services and value-added attractions in such areas.

A study of selected zoos in India has shown that on average only about 7-16 per cent of annual running expenses are met through visitors' fees, the rest being provided through government subsidies. Even by increasing gate collections it is estimated that at a maximum of 50 per cent of expenses can be met through ticketing. By comparison, one of the most successful zoos in the world, the Singapore Zoo generated 84 per cent of its finances from direct revenue and 16 per cent from Animal Adoption and Friends of the Zoo schemes.

A high quality of visitor services and value-added-attractions (Fig. 3) is essential for a modern zoo to be able to generate revenue especially when external compulsions determine that the entrance fee cannot be increased by large amounts. Additional revenue generation methods to those listed below include sponsorship of exhibits, zoo memberships, and donations. In addition, as the Singapore Zoo has shown, the zoo needs to have a programme of continuous development and repair to be able to sustain visitors' interest for it has been shown around the world that the maximum gate collections at zoos are from local citizens and not tourists.

Singapore Zoo Entrance Area Visitor Services	Value-Added Attractions
1. Waiting areas (covered & open)	1. Children's Adventure Park
2. Information	2. Picnic grounds (inside zoo)
3. Wheelchairs/Strollers*	3. Picnic grounds (outside zoo)
4. Lost & Found	4. Petting (touching) Zoo (farm animals)*
5. First-Aid	5. Interpretation Center (movies/television)
6. Friends of Zoo*	6. Tram rides*
7. Shops/Zoo Shop*	7. Pony/elephant rides*
8. Fast Food/Snacks*	8. Snack bars/restaurant (outside exhibit area)*
9. Toilets	9. Zoo Nature (gift) shop*
	10. Zoo Nursery (plant) shop*

*Revenue generation sources.

Fig. 3

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ROLE OF ZOO IN EDUCATING STUDENTS

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Zoology is the science of animals. All facts, theories and laws related to animal life are included within the scope of zoological science. It is impossible for one to give proper knowledge about the entire Animal Kingdom sitting in a study or laboratory. A student can gather comprehensive knowledge about animals only when vivid descriptions are coupled with graphical illustrations. It is, at this juncture, that the necessity of field study becomes prominent.

Zoological Garden is an ideal place for animal study. Study of an animal demands consideration of the following facts:

1. A brief sketch of the conditions under which the animals live i.e. animal havitat,
2. A brief survey of the whole Animal Kingdom to learn the variety of animal life,
3. Their classification, and
4. The physical organisation of animal body.

A visit to zoo enables a student to enrich his or her knowledge substantially. A student may be aware of the diversity of animals and their classification from class lectures but his knowledge remains incomplete unless he encounters these animals in their natural habitat. Moreover, students—understand the physical organisation of animals better after they observe the living animal. Thus, the feeding habits, ecology, and behaviour of different animals can be gathered from a visit to the zoo.

Zoological Garden is a sort of educational institution where the students become acquainted with different types of animals, both indigenous and exotic.

If we turn our attention towards the natural history, we see that almost 359 species in the last 350 years succumbed to the tragic fate of extinction. This is primarily due to population explosion and secondarily due to wanton killing of animals for food, as sport, indiscriminate hunting for leather and other commercial commodities. Establishment of National Parks, Sanctuaries, Reserve Forests and Zoological Gardens are conscious human efforts to preserve wild animals from extinction. Thus, zoo is a safe heaven for the endangered species and species which have entered the 'Red Data Book'. The authorities of the zoo gardens are committed towards the wise management of wild animals and preservation of their habitat. Students should be grateful to the zoo as it provides them the scope to interact with the living animals in reality. Visit to a zoo garden serves as a rewarding exposure to the students as it reinforces their concepts gathered during class lectures.

Above all, that the impact of zoo is universal cannot be denied since it arises keen interests in the mind of common people who have no attachment with biology in their personal spheres. So, it appears that Zoological Garden is not only an educational institution but also serves as a great entertainer for the society.

BREEDING OF BENGAL TIGERS IN CAPTIVITY

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Background

Recently the Nehru Zoological Park in Hyderabad has published an Indian Studbook for Bengal Tigers (1998-99). The total number of Bengal Tigers living in 38 zoos in India is recorded as 275 of which 136 are males and 139 females. This number includes white and normal coloured tigers with white genes.

The total number of wild born tigers living in 15 zoos is 24 of which 11 are males and the rest are females. There are single wild males and females numbering six and seven respectively in 13 zoos. So only two zoos (Bhupal and Indore) are available for breeding Bengal Tigers of wild origin. Apparently, tigers bred in Safari have not been included in this studbook.

In addition to 275 captive and wild born tigers there are several tigers of circus lineage, distributed in many zoos in India as reported earlier in 'Indian Studbook of Royal Bengal Tigers' published by he Central Zoo Authority. How did the circus acquire the animals? Have they been obtained from any animals dealer or from any zoo? No information about their ancestors is available. Whether or not they belong to Siberian or Sumatran tiger is not known (Roychoudhury, 1995).

A tigress generally starts procreating at the age of four and continues up to the age of ten to twelve years, though there are some exceptions. She usually produces two to three cubs in a litter after a gestation period of 95-103 days. On the other hand, a tiger becomes adult at the age of three and a half years and can be a father even at the age of 15 years.

Problems

One of the problems for breeding Bengal tigers is that there are very few tigers in captivity in India which are of certifiably wild origin. At least third of the tigers in Indian zoos are said to be the descendants of tigers purchased from circus over 25 years ago (Tilson, 1993). It is true that a few years ago there were restrictions for procuring tigers from Indian forests. As consequence some zoo Directors tried to get them from any other source. For example, a Burmese tiger was brought to the Calcuta zoo in late 70's and was used to mate with one white female living in the zoo. The descendants of this tiger cannot be said to be pure Bengal tigers. Similarly, the Mysore zoo purchased tigers from a local circus for breeding.

Again, there is a dearth of suitable mates in most of the zoos in India. In such a situation the zoo Directors are tempted to use available tigers of uncertain origin for mating purposes, when pure Bengal tigers are not available. Besides, age and health, compatibility of a pair of tigers is an important factor for matings. For example, a white tigress named Gayatri was brought to Calcutta from Nandankanan in August 1991. Several attempts had been made to mate her with a number of males, but they were of no avail.

There is a controversy over breeding of white tigers in a zoo. In many zoos heterozygous tigers with white genes were mated with normal homozygous ones either knowingly or inadvertently. In consequence, it is difficult to distinguish normal homozygous and heterozygous offspring morphologically. If these mixed up offspring are sold, exchanged or loaned to any zoo, there is a possibility of appearing white tigers any time any where. This is perhaps one of the reasons for those who are not in favour of breeding and exhibiting the white tigers in the zoos (Roychoudhury, 1994). Besdes, a large space in a zoo is required for segregating white and heterozygous tigers from normal homozygous ones.

Now there is a growing awareness for conserving pure Bengal tigers of wild origin in captivity. I believe that the Central Zoo Authority is in favour of this idea.

Solutions

To maintain white tigers in a zoo is now a costly affair. Nandankanan has the largest number of tigers, most of which are white or normal coloured tigers with white genes. This zoo may be kept aside for breeding and exhibiting white tigers. If this measure is taken, tigers with white genes will not be able to mix up with pure Bengal tigers living in other zoos. Now it is a matter of opinion whether zoo Directors would consent to this proposal or not.

All the tigers of Nandankanan are derived from four founder animals, namely, Pradeep, Sikha, Rani and Diana/Subhra. Most of their descendants are highly inbred so they are related to one another. To avoid deleterious effects of inbreeding, parents are to be

chosen in such a way that the changes in inbreeding coefficient should not go up more than 1% per generation (Franklin, 1980). Sometimes a studbook provides inbreeding coefficients of offspring for all combination of potential sires and dams as they are given for white tigers in India (Roychoudhury *et al.,* 1989). The inbreeding coefficient of the offspring can be used as guides in the selection of mates.

Although it is difficult to distinguish homozygous normal coloured tigers from heterozygous ones, there are some animals who can be identified as known heterozygotes. For example, if two normal coloured tigers produce at least one white cub, then both the parents must be heterozygous. Similarly, if a normal coloured tiger is mated with a white one, all their normal coloured offspring will be carrying a white gene; if by chance a white offspring is produced, then normal coloured parent can be identified as heterozygote. If known heterozygous tigers are segregated from normal homozygous ones at the time of their births, problem of differentiating them later may not arise (Roychoudhury, 1989).

For argument's sake, if the tigers of circus lineage originally belonged to Siberian or Sumantran tiger, it is doubtful that their ancestral characteristics would prevail in their descendnts after three or four times backcrosses with Bengal tigers. If they are not morphologically much dissimilar from Bengal tigers, it will be too unkind to castrate all of them for maintaining the purity of Bengal tigers.

When there is a dearth of wild tigers in the zoos, a pair consisting of one wild and one captive born Bengal tigers of known origin may be used for breeding purposes. The zoos having wild or captive born single male or female may be provided with suitable partners, so that they can produce some pure Bengal tigers.

To maintain the purity of Bengal tigers some zoos in India should be kept reserved for their breeding. No undesirable tigers will be housed in these zoo. As far as practicable single male or female should be paired by bringing consorts from neighbouring zoos. In this respect the Central Zoo Authority can act as a liaison in obtaining tigers of certifiably wild origin to the zoos lacking suitable mates. This measure prevents the wild tigers from being mated with any tigers of unknown origin.

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MANAGEMENT AND CAPTIVE BREEDING OF INDIAN ROCK PYTHON (*PYTHON MOLURUS*) AT JAWAHARLAL NEHRU BIOLOGICAL PARK, BOKARO STEEL CITY, BOKARO

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Introduction

The present paper on the management and captive breeding of Indian Python (*Python molurus*) is based on the observations made over a period of 2½ years (from December, 1993 to June, 1996), on five individuals (2 : 3) housed in the python enclosure of J. N. B. Park.

Two pythons a male and a female introduced in the python house in the year 1989 and 1990 respectively then in the year 1992-93 one male and two females were added. At the time of their release the age of the pythons could not be ascertained.

Although the first breeding occured in 1993, the present note is based on the breeding records collected during 1995 breeding period.

All these snakes are housed in a dome shaped enclosure mesuring 4½ metre in length and 5 metre in breadth, with glazed tiles as barrier on its internal walls. A transparent glass has been provided on the front side which is the viewer's side. A protective iron barrier at a height of 2 ft. has been provided towards the viewers end. Provision of service passage has been made from the rear side of the enclosure. A cemented water vat measuring 1' x 2' has been placed inside the enclosure.

Observations

With the onset of summer pythons spend more time in the water provided in the water vat. This begins in March and increases during the first week of April and usually remain submerged during the whole May and June.

It has been noticed that they start hibernating from the last week of October or 1st week of November and remain so till 2nd and last week of February. During the whole period they cease their movement and stop their feeding and all the five snakes remain hidden under the straw provided in the pits during the winter season. However, python distributed in Pennisular India are not known to hibernate (Bhupathy, SACON, Pers Com.)

Daniel (1983) in his book reported that python hibernate during the cold season in North India and perhaps in the hills in the South.

The food of Pythons at J. N. B. Park consists of live chicken. Each snake is given about 750 grams of chicken once in a week i.e. on Monday. It has been observed that during the month of June & July, each python consumes the chicken immediately after their releasing or within one day. Generally they start their feeding in the late afternoon. During these two months their appetite and desire has been noticed quite high, or even take extra number of chicken too. After the first week of August they do not show the same degree of interest of their food and chicken some times remain un-consumed till 3 to 4 days. Some time it has been noticed that immediately after consuming the chicken, the whole chicken is regurgitated out. With the advent of winter i.e. from October they start discarding their food completely and the chicken remain un-consumed, so during that period, i.e. when the snakes hide themselves under the straw their diet has been stopped.

Breeding

The mating of *Python molurus* was noticed during the months of December, January and February by Daniel (1983). In the present study, once in the month of February mating was noticed and male was noticed spirally coiling the female.

Egg laying started on 5th May. This also confirms the egg laying period of wild python, May-June in North India (Smith 1935). However, the period of incubation appears to be quite variable and it varies with the variation of ambient temperature. According to Acharjyo & Mishra (1998) i.e. 82 to 83 days, according to Daniel (1983) it is three to four months. The shorter period of incubation has been reported by V. Kalaiarasan and B. Rathinasabapathy (1991) and by Paulraj and Thiruthalinathan (1989) (37 days & 46 days respectively).

The clutch size is reported to vary from 8-107 (Daniel 1983, Acharjyo and Mishra 1976). In this case python laid 18 eggs. Eggs measured 900 mm (length)x 600mm (breadth), 125gm weight. Eggs were whitish yellow in colour and soft in appearance and stick together after laying.

Parental Care

The female python incubate its eggs by coiling around them. The body temperature remain higher

than normal during the brooding time. According to V. Kalaiarasan and B. Rathinasabapathy (1991), the body temperature of the brooding python is always 3-4°C higher than the ambient temperature. This rise in the body temperature is due to spasmodic contraction and according to Engelman (1981) the rise in the body temperature helps in true incubation of entire clutch.

During the entire incubation period, the brooding female left the clutch of eggs only twice, once for a period of two days to remain submerged in water and once to feed on the chicken provided during the incubation time.

On 5th July (i.e. just on 60th days) hatchlings hatched out. However, the variation in incubation period have also been recorded; it is 55 to 60 days according to Acharjyo and Mishra (1976) and Daniel (1983). Wagner (1976) stated this to be of 60 days.

Only 7 eggs hatched out, 3 eggs were having dead embryos, 8 eggs could not hatched out, this might be due to unfertilized condition of the eggs. Out of seven, 2 numbers hatchling died soon after the hatchling out.

Hatchling Management

All the five hatchling were seperated from the mothet as she was not taking further interest in her hatchlings. They were placed in a specially fabricated wooden box with wire mesh measuring 3' (length) × 2' (breadth) × 1½' (Height).

First sloughing was noticed on 14th July and other moulted epidermis was found on 15th July. The hatchlings were fed with small birds like munia and Budgerigars by removing primary feathers and tail fearhers. Generally 1 to 2 birds per head were given every week.

Body weight & length of the hatchlings

	Body weight		Length	
	0 (zero) day	60 (sixty) days	0 (zero) day	60 (sixty) days
1.	125 gm	225 gm	600 mm	770 mm
2.	125 gm	150 gm	600 mm	680 mm
3.	125 gm	140 gm	580 mm	645 mm
4.	100 gm	140 gm	500 mm	565 mm
5.	90 gm	100 gm	520 mm	630 mm

Health Care

De-worming & other preventive medication is done by implanting anthelmentic tablets and other tablets inside the skin of the chicken.

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STATUS OF ASIATIC LIONS IN INDIAN ZOOS

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Since time immemorial, the shape of the lion has captivated human imagination. Even in countries such as China and Sri Lanka the lion became a symbol of power and supremacy, even though lions never appeared there. Perhaps it is the lion's large head with its broad forehead, or the showy mane, some males have that resembles a mantle, that bring images of power and majesty to mind. Even today, when lions no longer pose threat to human lives, provided reasonable caution is exercised, and now that research has demystified so many old sagas and fables, the lion still retains his place as "king of beasts."

The Asiatic lion *(Panthera leo persica)* is one of the rarest and most important wild animals of India, and yet it is one of the least known. It used to be very common

Age Class	Mortality Rate (d_x)			d_x	No. Entering age class	l_x	$q_x=d_x/l_x$	Survival rate ($l-q_x$)	Fecundity (m_x)
	Male	Female	Unknown						
0	—	—	—	—	303	—	—	—	—
1m	62	55	39	156	147	0.485	1.061	–0.061	—
6m	12	10	—	22	125	0.850	0.176	0.824	—
1 year	10	18	—	28	97	0.776	0.289	0.711	—
2 years	11	6	—	17	80	0.825	0.213	0.788	—
3 years	4	3	—	7	73	0.913	0.096	0.904	—
4 years	1	1	—	2	71	0.973	0.028	0.972	0.974
5 years	1	2	—	3	68	0.958	0.044	0.956	0.921
6 years	1	5	—	6	62	0.912	0.097	0.903	1.158
7 years	3	3	—	6	56	0.903	0.107	0.893	3.237
8 years	4	2	—	6	50	0.893	0.120	0.880	0.632
9 years	1	2	—	3	47	0.940	0.064	0.936	1.079
10 years	3	4	—	7	40	0.851	0.175	0.825	0.818
11 years	2	7	—	9	31	0.775	0.290	0.710	0.658
12 years	2	3	—	5	26	0.839	0.192	0.808	0.368
13 years	1	1	—	7	19	0.731	0.368	0.632	0.158
14 years	1	2	—	3	16	0.842	0.188	0.813	0.263
15 years	3	1	—	4	12	0.750	0.333	0.667	0.026
16 years	1	2	—	3	9	0.750	0.333	0.667	—
17 years	2	3	—	5	4	0.444	1.25	–0.250	—
18 years	0	1	—	1	3	0.750	0.333	0.667	—
19 years	0	1	—	1	2	0.667	0.5	0.5	—
20 years	0	2	—	2	0	0	—	—	—
			Total					Total breeding females = 38	
	125	139	39	303					

Fig.—1 Life Table of Asiatic Lion in Indian Zoos

l_x—number of individuals surviving after regular time intervals.

d_x—number dying during successive time intervals.

q_x—mortality rate during successive time intervals.

e_x—life expectancy at the end of each time interval.

m_x—age specific natality.

in India, till around the middle of the nineteenth century. By 1880, there were no lions in India, except in the Gir Forest of the erstwhile princely state of Junagadh, where about a dozen were left (Gee, 1964). Habitat destruction and hunting had decimated the species. At present, the population is estimated to be approximately 300 individuals.

Besides the wild population, sixteen zoos in India are also maintaining Asiatic lions. This population stands at 83. Sakkarbaug Zoo, Junagadh, is maintaining systematic records for lions in form of a studbook. The present paper attempts in reflecting the status of Asiatic lion in Indian zoos with respect to inbreeding and population characteristics.

1. Methodology

National Studbook of Asiatic lion being maintained by Sakkarbaug Zoo, Junagadh was the basis of the studbook analysis. It had data compiled till March 1998. The data has been presented in the form of Stud Number, Name, Sex, Birth date, Sire, Dam, Location, Date, Local ID., Event and Death date.

Based on the information contained in this studbook, Founder animals were iidentified and Inbreeding coefficients calculated. A life table was also prepared for the individuals who had completed their life cycle.

1.1 *Life Table*

Mortality and natality regulate the dynamics of a population. Both vary greatly with age and are thus, of great interest to those involved in management of captive and natural populations of wild animals.

Life tables consist of several columns headed by standard notations. Using the notations a life table for Asiatic lions in Indian zoos was constructed and is given in Fig. 1.

1.2 *Coefficient of Inbreeding*

The coefficient of inbreeding indicates the percentage of loci that were heterozygous in the base populations that now have probably become homozygous due to the effects of inbreeding. The base population is that point in history of the population from which we desire to begin a calculation of the effects of inbreeding. Many loci probably are homozygous at the time of establishment of the base population. The inbreeding coefficient thus measures the additional increase in homozygosity due to mating of closely related individuals. The inbreeding coefficients of Asiatic lions (Fig. 2) were determined by using the following formulae:

1. If the common ancestor is not inbred.

   $F_x = \Sigma (0.5)^{p_1 + p_2 + 1}$

   Where p_1 is the number of generations from one parent back to the common ancestor and p_2 is the number of generations from the other parent back to the same ancestor.

2. If the common ancestors are inbred (F_A), the inbreeding coefficient must be corrected for this factor.

   $F_A = \Sigma [(0.5)^{p_1 + p_2 + 1} (1 + (F_A)]$

Sl. No.	Inbreeding coefficients	No. of animals
1.	0	276
2.	.07031	3
3.	.03125	10
4.	.0625	31
5.	.125	50
6.	.5	4
7.	Parent/s not known	36

Fig.-2 Inbreeding coefficients of Asiatic lion in Indian zoos

2. Results

The total population of Asiatic lions so far held captive in Indian zoos from 1958 to 1998 is 410. However, only 303 individuals, which had completed their life cycle, were taken into account for preparing the life table. The sex ratio of this population was 125:139 with an additional 39 individuals of less than one month age whose sex was not ascertained. The maximum longevity of males was 17 years and that of females 20 years. Analysis of life table shows that breeding between individuals started in the fourth year, peaking in the sixth and seventh years. However, breeding has been found to occur till fifteen years of age in some individuals.

The major finding from the life table analysis was that infant mortality, which is maximum in the first month of life and was 156 (62:55:39). By the end of the first year another 50 (22:28) individuals were observed to have died. Thus, 206 individuals which comprises 64.6% of the population died in the first year itself.

A total of 43 founder (wild caught) animals were identified from the stud-book of which only 27 animals contributed to the captive population. Stud No. 7, a founder male (Ram/Badal) had sired maximum number of offspring (20) and stud No. 65 founder female (Kamini) had given birth to maximum number of offspring (19). Inbreeding coefficients calculated for 331 individuals ranged from a low of 0 to a maximum of 0.5. Inbreeding coefficients could not be calculated for 36 individuals as their parentage was not known.

3. Discussion and Suggestions

Species survival is critically dependent on its reproductive success. A complex process regulated by genetic control and environmental conditions. So far in Indian zoos breeding of animals has been more of an incidental event with little emphasis on planned breeding. Results obtained show a very high rate of infant mortality, especially in animals below one month

of age. The reasons for such a high infant mortality could be due to poor management practice, like improper housing and veterinary facilities. Another possible reason could be due to inbreeding. However, our analysis has shown that inbreeding is low in the captive population. This statement is further supported by the findings of Shankarnaryanan *et al. (1997),* who have carried out a genetic study of captive Asiatic lion in Indian zoos and reported an average heterozygosity of 25.82% with four primers.

Therefore, the main reason for high infant mortality is due to the poor management of animals in zoos, in view of the above. Indian zoos, prior to planning breeding programme, for Asiatic lions should provide proper housing and health care facilities. The animals selected for the breeding programme should be identified and kept away from the main display area and minimum human intervention should be practiced. In order to avoid inbreeding zoos should encourage mating between non-related individuals, the information on which may be obtained from the studbook. Only after arriving at a protocol for planned breeding of Asiatic lions by Indian zoos, we may be able to achieve a minimum viable population, which is genetically sustainable.

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TRAPPING CAGE FOR DEER

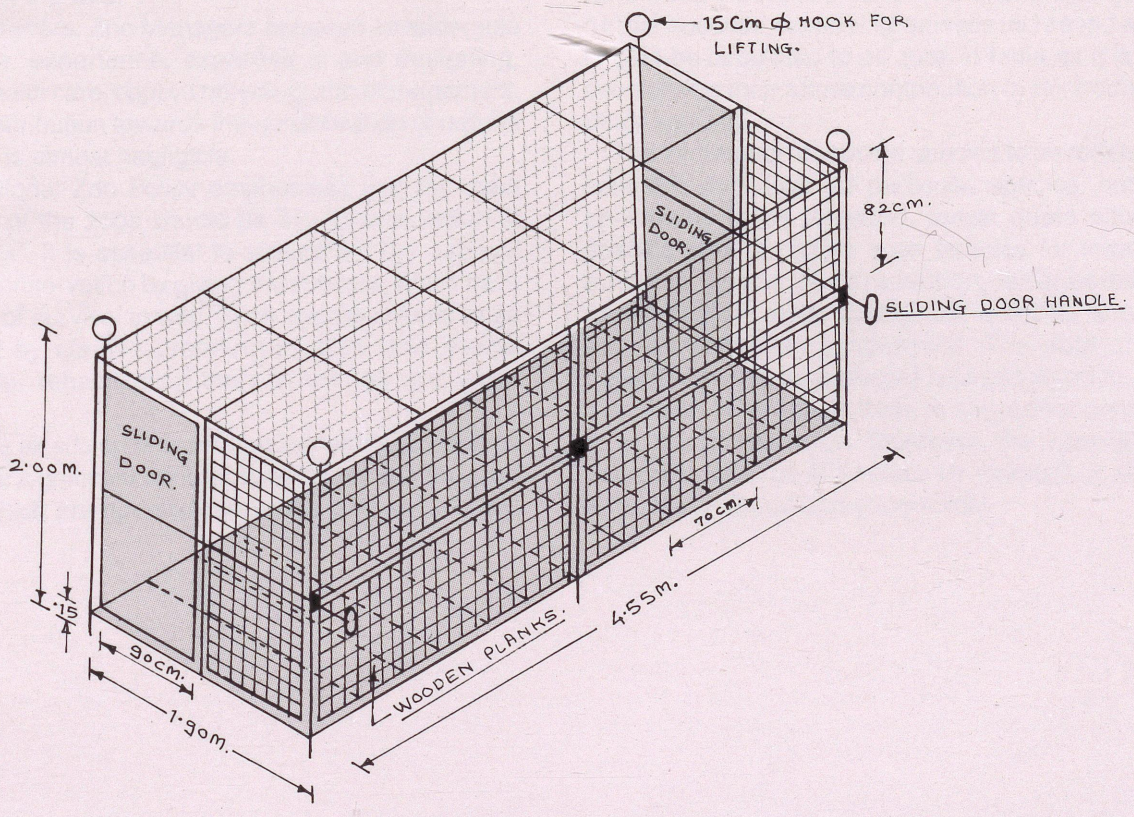
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The main objective of the zoo is to complement and strengthen the national efforts in conservation of the rich bio-diversity of the country, particularly, the wild fauna. To achieve this goal, breeding wild animals in captivity and rehabilitating them in the wild is essential. In addition to this, zoos also play a major role in educating the visitor.

Veermata Jijabai Bhosle Udyan Zoo has started rehabilitating the excess animals at "Sanjay Gandhi National Park", Borivali from the year 1990. The National Park is very close by and within the jurisdiction of "Municipal Corporation of Greater Mumbai". There are wild animals in the park. The population of Leopard seems to be more in comparison to the herbivorous animals in this park. It is also noticed that the wild cats sometimes come in the City area in search of prey. In this process many accidents happened along with the neighbouring area of the National Park. The authorities of the Veermata Jijabai Bhosle Udyan Zoo have undertaken the captive breeding programme of the herbivorous animals so as to meet the demand of the carnivorous animals in the Sanjay Gandhi National Park.

First time in the year 1990 to 1996, in all 31 number of deer were released by tranquillising them by the veterinarians. However, it was not advisable to use the tranquillisation method further more to restrain them, because it was not only expensive but also time-consuming. The exercise of tranquillisation was done by the veterinarians for days together with hardly any successful result. Also after two-three attempts, the animals became alert and started keeping a safe distance thus creating the situation more difficult.

Veterinarians informed and explained their problems in detail. We discussed on the matter and came to the



conclusion that it is necessary to find out and apply some other technique to overcome the problem.

During the discussion, I suggested that these problems can be solved by using a trapping cage. Accordingly, a suitable trapping cage was designed and got fabricated.

The cage was made of steel angles and chain link mesh. The flooring was made out of wooden planks. These materials were chosen to minimize the chances of the animals getting injured in the trapping or transportation process. The cage had two sliding doors on either sides.

Afterwards, the cage was taken to a Powai Deer Park by truck and was suitably placed inside the deer enclosure with the help of a crane.

Then the cage was lined with dry hay and gunny bags to make its inside surface soft.

Initially both the doors were kept open and the deers' favourite food was kept inside it. At first the deer were suspicious about the presence of the cage, but within 3 to 4 days their curiosity overcame the fear and they started approaching the cage. Soon they started entering the cage without any hesitation. Now we have decided to close one of the doors and further continued feeding them. One day we found around 10 to 15 animals, at a time, inside the cage. Then the another sliding door was pulled and all of them easily got trapped inside. Then the cage was lifted with the help of a crane and was carefully placed in a truck.

Thereafter, the deer were taken to the reserved forest area near Sanjay Gandhi National Park and were released safely and successfully. This method was accepted successively for three more times and so far we have released in all 105 spotted deer in the open.

While transporting and releasing the deer, there was not a single case of slightest injury to the animals. At the time of releasing them in their natural habitat, they were certainly in a good mood.

After this, some time later, the veterinarians have again came to me with the difficulty that when two stages get trapped, they fight and this causes injury to the trapped females. I further suggested them some modifications and accordingly a cage was provided with separate partitions so as to separate the animals apart. This simple idea was also worked very well and thus solved the problem.

I hope this technique will be much useful to all the zoos while capturing the animals for rehabilitating them in the wild.

CONTRIBUTION OF ZOOS TO CONSERVATION

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Are zoos contributing to conservation? Answer varies. For *ex situ* conservation it is Yes. For *in situ* conservation conclusively it is not adequate and up to the satisfaction. In olden days, zoos were set up for mere entertainment and recreation. Now due to a decline in natural resources and wild life in nature "Conservation" is one of the main objectives for the management of zoos. The National Wildlife Action Plan of 1980 emphasised the role of *ex situ* conservation in the national conservation efforts. It is essential to retain and increase the declined populations of endangered species in the wild.

Zoos are playing important role in developing the awareness among people and educating the people about the linkage between natural resources and existance of wildlife threat unless the natural resources are not protected or set up to the requirement of species for their survival, the identified species cannot be relocated in the wild.

Over the years, Zoo Managers acquired considerable knowledge, experience, expertise in zoo designing, upkeep, health care, captive breeding, zoo management. But the contribution towards the conservation of natural resources is almost negligible.

The National Zoo Policy emphasises that the main objectives of the zoos should be the "Conservation of Wild Fauna". It is essential to strengthen the national efforts in conservation by giving the species, which have no choice of survival in wild. Such species needs to be increased by captive breeding in zoos and should be given for rehabilitating them in wild as and when asked for.

As far as *ex situ* conservation is concerned, the zoos have made significant contributions. Many endangered species which are not available in the wild are with the zoos and many zoos are breeding them successfully. What is needed further is, *in situ* conservation of the rare endangered species. It is expected that to begin with the species like Manipur Deer, Great Indian Bustard, Siberian Crane, Black-necked Stork, Red Panda, Musk Deer, Western Tragopan, Hangul, Swamp Deer, Tibetan Antelope and Snow Leopard are to be considered for reintroduction after planned captive breeding programme.

As far as *in situ* conservation is concerned, data collection at central place is needed and it is essential to circulate the collective information to all zoos in India. After identification of a particular species for reintroduction, it is obligatory to locate the suitable habitat for providing home for such species. It is known that home for Manipur Deer is identified similarly the alternative home for Rhinos has been created at Dudhawa National Park in Uttar Pradesh and Rhinos have been introduced there. The information about the further success, number of animals increased annually should be circulated to all zoos in India as it is a must considering their future contribution in reintroduction of other species.

The information about the species to be reintroduced, selection of habitat for particular species, number of specimens to be released, target quota allotted for specific zoos to spare such species for inroduction, tentative period of introduction, arrangements for transportation, responsibility and authority to organise the reintroduction programme. The data on these aspects need to be collected and circulated to all zoos in India so as to enable them to share their contribution in *in situ* conservation. Moreover, the interstate/inter-zoo transportation of animals by road/rail or air needs to be made liberal and economical.

CAPTIVE HUSBANDRY OF THE KING COBRA (*OPHIOPHAGUS HANNAH*) AND OTHER COMMONLY KEPT INDIAN SNAKES

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Introduction

This paper has been written for the purpose of sharing information on the maintenance of a representative nine species of commonly kept Indian snakes in zoos. Some of the observations and suggestions are from the author's own experience; others from reliable texts and authentic sources. It is not in the author's capacity to provide a "do it yourself guide" to maintaining snakes in captivity, rather hopefully some of the given information could aide certain aspects of husbandry and management of the selected snake species. The more interested reader might wish to refer to the references listed at the end for detailed information. Primary purposes of exhibiting snakes in zoos is to acquire knowledge on their behaviour, get hold of species-specific dietary/temperature/requirements, and public education.

It is imperative that Indian zoos realize that any animals (and reptiles are NOT an excepton) captive requirements be researched prior to collecting specimens. In cases where these requirements are not researched prior to capturing snakes for exhibition, the snakes are usually doomed to succumb eventually to a variety of disorders encountered in captivity, faulty husbandry and management techniques usually being the dominant factors.

Zoos that regularly capture snakes from wild population to replace ones which have died in captivity, should realize that the resource is not infinite, and in time species that had been known to be extremely abundant will become scarce. Keeping in mind that very few surveys on the abundance of Indian snakes have been conducted, start paying attention to your collection's requirements, don't keep snakes that you cannot properly care for.

Snakes like the king cobra and flying snake, although beautiful and impressive to view, are snakes that require intensive management. Zoos are important centres for public education, where endangered snake species are concerned; they are the institutions which will be involved in captive breeding programmes to ensure continued survival of these snakes.

What follows, is a general section on enclosures and their maintenance, eradication of mites and ticks, avoiding stress. Species specific management and husbandry notes, and longevity for nine species of Indian snakes representing four families precedes this section.

(i) Enclosures and their maintenance

Enclosures should be designed in a way which facilitates easy cleaning. Newspaper makes for an ideal substrate as it can easily be removed when soiled with feces or spilt water and replaced with fresh paper. King cobras and the arboreal species discussed below are visually oriented species. Therefore, considerations must be made as to how these snakes are displayed to the public and enclosures be designed in a way which will minimize stress to the snakes. One way glass is an option to tackle this problem, or a wood/metal fence can be constructed 200-250 cm from the exhibit. Cage furniture should include large logs for climbing and smooth rocks to assist the snakes in ecdysis (shedding of the skin). It is important that the snake is not handled during ecdysis as handling at this point can damage the fragile new skin. Neither should gravid (gravid=pregnant) female snakes be handled, unless absolutely necessary. Any zoo maintaining potentially lethal snake species such as the Russel's viper and krait should have a ready stock of anti-venom. Staff should be drilled on emergency protocols. Any zoo maintaining these snakes should also have a handler who is capable of handling and/or restraining the animal. One of the many reasons for this is that only when a person comes into close contact with the snakes, can identify unusual growths, ticks, unshed eyecaps, etc. Only a person who has had experience should perform procedures like removing unshed eye-caps and ticks. Irreparable damage can be done to the cornea when an inexperienced person mistakes it for a unshed eye-cap and removes the cornea, therefore blinding the snake for life. Light cycles for most species can be on a 12-hour light/12-hour dark cycle. The water bowl provided in the enclosure for drinking and soaking should be of a fixed type with an efficient drainage system. Snakes are expert escape artists and the enclosure should be secure prior to releasing a snake into it. Prior to releasing the snakes, a thorough evaluation of the enclosure is made to look for cracks and corners where ectoparasites, uneaten prey, and baby snakes can hide. These should be sealed off when found. The enclosure should be constructed in a

way that neither faeces or water is absorbed. Adequate ventilation is an important factor. This can be provided by a large (4″) PVC elbow joint pipe with an exhaust fan and a well-sealed piece of fine plastic mesh at either end (inside to prevent the snakes getting in the pipe, and outside to prevent insects coming in). The areas which specific snake species frequent (i.e., arboreal or terresrial) should be taken into account. Arboreal species can have a enclosure with a high ceiling, branches, access to sunlight, and a refuge when they want to cool down. No artificial lighting system can effectively substitute the vitamins acquired by exposure to natural sunlight.

(ii) **Mites and Ticks**

Mites and ticks can be found on both captive and wild reptiles. Free ranging snakes in the wild have parasites dispersing frequently. Therefore, the host is not adversely affected. In captivity, parasites are confined to a limited space and their concentrations increase dramatically. Ticks that are visible should be manually removed with a pair of delicate forceps. Make sure the mouth part is removed when the tick is dislodged. If left behind, it can cause skin abcesses. Ivermectin, with a recommended dosage of 0.2 mg/kg is given once intramuscularily and then again in two weeks. Additionally, mites can be eradicated by placing the infested animal on 5% sevin dust for 4-5 hours. The animal is then rinsed with a mixture of 5 mg Ivermectin and one litre of water. This method has been reported to be safe and 100% effective. Prior to putting the snake back, the enclosure should be throughly cleared of ecto-parasites. Special attention should be paid to cracks, crevices, and other hiding places of ecto-parasites. Bleaching powder or pyrethroid spray can be used to disinfect cages and cage ornaments (rocks, logs, etc.).

(iii) **Stress**

While maintaining snake species in captivity, efforts should be made to reduce stress to the specimens. Stress can be direct, resulting from excessive handling and people tapping on a glass enclosure. Indirect stress stems from improper thermal gradients within the enclosure and excessively high concentrations of endo-ecto-parasites. Dyecdysis (abnormal shedding), subcutaneous abcesses, and diminished food intake are a few of the symptoms that could result from thermal stress. As retreat is the first primary defense of most reptiles, hiding places should be offered to provide security for animals that feel threatened by other individuals within the enclosure or by human visitors. Excessive indirect or direct stress will adversely affect a snake's food intake and normal behaviour. Efforts should be made to reduce stress as much as possible. This can be initiated by briefing zoo keepers on the matter and dissuading them from handling the snakes unless it is required for routine veterinary examination (i.e., removing ticks, administering medication that cannot be administered by oral route, collecting faecal samples, etc.) or management reasons (i.e., shifting the snakes enclosure, cage maintenance, etc.).

(iv) **Notes on species specific enclosure requirements, diet, and longevity**

Key to symbols: The symbol † beside a snake species name indicates that they are potentially lethal, whereas the symbol ∅ indicates that the snake is non-lethal.

(a) **King cobra** (*Ophiophagus hannah*) (Family: *Elapidae*) † : A difficult snake to maintain in captivity; most attempts have resulted in death. Capturing wild adults is not recommended. Firstly, since abundance and density of the king cobra is low and secondly because these snakes rarely do well in captivity. They are susceptible to a variety of disorders in captivity if improperly maintained.

Enclosure requirements: As these snakes are a forest species humidity has to be maintained at 80-90%. Particular attention should be paid to the period of ecdysis, may require spraying (with a plant spray gun) to aid shedding. Problems in shedding could relate to too low temperature and humidity levels. Either a heat-pot at one end of the enclosure (to facilitate digestion) or access to sunlight (which is ideal) is essential. A colling sink provided by having large 4″ PVC pipes connected to an air-conditioner coming into the enclosure should be provided which maintains that particular "micro-thermal-gradient" at 26.0°-27.0°C is essential, and the rest of the enclosure can have an ambient temperature of 27.0°-30.0°C.

Feed: Although ophiophagus (snake-eating) in nature, these snakes have been acclimatized to feeding on rats in facilities abroad and at the Centre for Herpetology, Chennai. Initially, rats were rubbed against a road-killed snake, and then manipulated in front of the snake in serpentine-like movements. Main cues to feeding seem to be visual and olfactory. Eventually, odour manipulation is not necessary (Tampal & Whitaker, 1994). Prior to feeding, rats have their fur clipped off, and have their complete gastro-intestinal system removed via a ventral longitudinal incision. The gut may well harbour pathogenic organisms, and the fur might cause an intestinal obsruction. This area is then stitched back together with cotton threat. Both front legs are clipped off to facilitate easier swallowing.

Handler: There should always be a keeper adept at handling king cobras at any zoo maintaining a specimen, as handling and/or restraint may be required to facilitate veterinary examination/management. Reasons for this is that only a person who comes into close contact with a snake can spot unshed eyecaps, ticks, abcesses, etc. At this point, it should be mentioned that there have been documented cases of



Fig. 1 King Cobra *(Ophiophagus hannah)*: The World's Longest Venomous snake

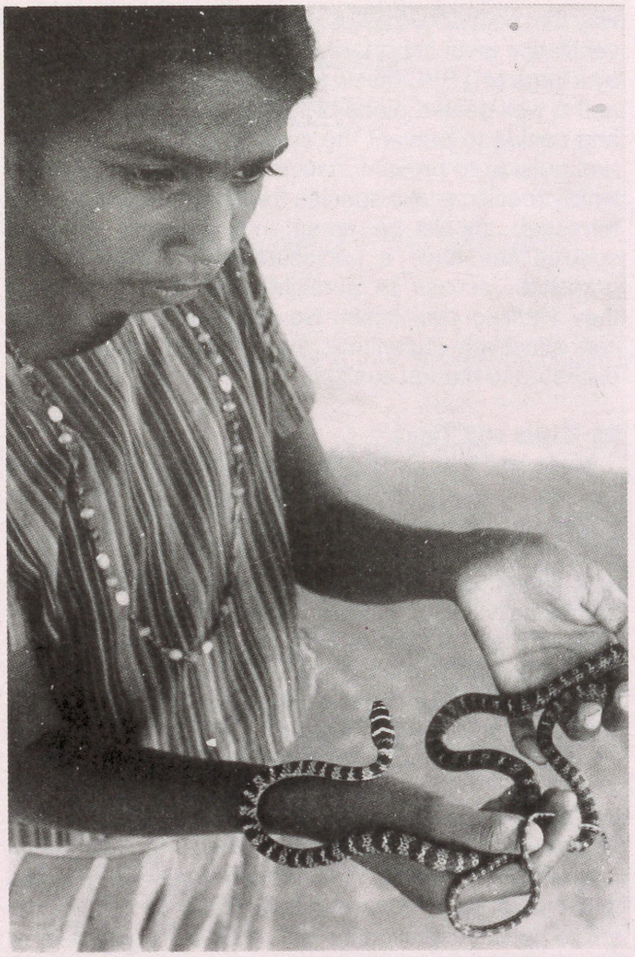


Fig. 3 Flying snake *(Chrysopelea ornata ornata)*

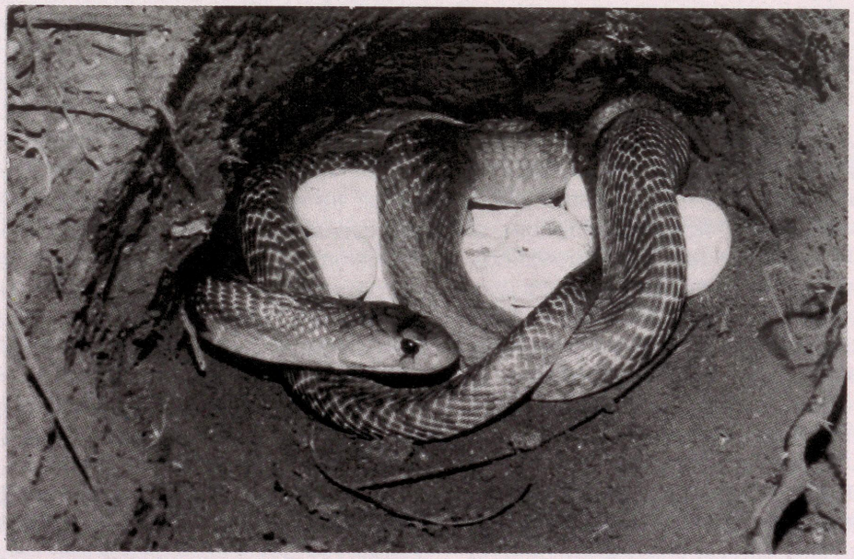


Fig. 2 Spectacled Cobra *(Naja naja)*: Female Spectacled Cobra guarding a clutch of eggs

keepers succumbing from king cobra envenomation in three minutes. THERE IS NO ANTI-VENOM AVAILABLE FOR THE BITE OF AN INDIAN KING COBRA. Specialist procedures such as extracting unshed eyecaps, administering drugs, etc. should be done only by a trained individual.

Longevity: A wild caught adult king cobra has lived for seventeen years in captivity at the Lincoln Park Zoo, Chicago (Bowler, 1977). However, there have been unconfirmed records of these snakes living for up to twenty-five years.

(b) **Spectacled cobra** (*Naja naja*) (Family: *Elapidae*) † : A relatively hardy species if maintained well in captivity. Does best if maintained in individual enclosures. Easy to handle as it's strikes are more nervous than that of the perceptive calculated advances of the king cobra when provoked.

Enclosure requirements: Ambient temperature within the cage should fluctuate between 28°-30°C, with a heat-pot (as described in the above *O. hannah* section) at one end of the enclosure. Enclosure humidity can be maintained between 60-75%. Spraying may be required during ecdysis. To correspond with its natural habitat where it is commonly captured around rice paddy (due to the large density of rats in these areas) an underground hole can be provided. This can be constructed in such a way that visiting public can view the snake (via a sheet of one-way glass set in the enclosure wall at the level of the chamber in the burrow).

Feed: Juveniles have succesfully been reared on pieces of frog leg meat during early stages of growth and with field mice once they attained the sub-adult/ adult stage. As a general rule, care should be taken to ensure that all snakes feed separately (if maintained in a group). Ideally, an adult cobra is fed 2-3 large size rats once a week.

Longevity: A record exists of a captive bred Indian cobra living for 17 years at the San Diego Zoo (Bowler, 1977).

(c) **Common krait** (*Bungarus caeruleus*) (Family: *Elapidae*) † : A nocturnal species, much of the day is spent coiled under a pile of construction rubble, tarmac sheets, etc. Responsible for a large percentage of venomous snake-bites within rural India since it is a nocturnal snake. Snake catchers have observed that this snake is docile and unwilling to bite (despite provocation) during the daytime, but at night they react aggressively to being handled.

Enclosure requirements: To allow public to see the snake in the daytime without stressing the animal, a hide (with three-four largish rocks cemented together to create a small cave) can be constructed at eye-level of the visitors. Kraits can be maintained at an ambient temperature ranging between 28°-30°C. A heat-pot is provided at one end of the enclosure. Enclosure humidity can be maintained at 70-80%.

Feed: Both the common krait (*B. caeruleus*) and the North Indian banded krait (*B. faciatus*) are known to be ophiophagous in nature (Smith, 1943; Deraniyagala, 1955; Deoras, 1965; Whitaker, 1978), with a record of cannibalism in the former species (Dattatri, 1984). However, at least the common krait which had been one of the species in a captive breeding study at the Centre for Herpetology was maintained in captive successfully without providing ophidian prey. They had been fed on rats. When in captivity, groups housed in the same enclosure should consist of no more than 2-3 similar sized individuals. Whitaker (1983) remarks "kraits are true cannibals and it is not unusual to find a few smaller kraits missing from a captive group".

Longevity: A wild caught adult *B. caeruleus* lived for ten years in captivity at the St. Louis Zoo, U.S.A., and a wild caught adult *B. fasciatus* lived for a further eleven years in captivity at the same zoo (Bowler, 1977).

(d) **Green vine snake** (*Ahaetulla nasuta*) (Family: *Colubridae*) ∅ : A delicate arboreal species which is commonly seen exhibited in zoos. Commonly believed to peck out peoples eyes in Tamil Nadu, therefore called the 'kana-kuthu-pambu" (eye pecking snake). This snake often does not survive long in captivity. The slender probosis is often damaged during capture or in captivity, thus resulting in ulcerative stomatitis. Soon after the snake becomes annorexic (does not feed) due to the infection and eventually succumbs.

Enclosure requirements: As this an arboreal species, an enclosure with a high ceiling which allows the snake to climb up to at least 200-250 cm is desirable. A small live tree with dense foliage can be transplanted into the enclosure to allow the snake to climb. Due to its arboreal nature, a heat-pot on the ground may not be utilised. Therefore, a small portion of the cage might be allowed to extend into an area where sunlight can enter. Several experienced herpetoculturists have noted that there is nothing like being able to give herptiles the opportunity to bask in unfiltered sun (but they have to have a way of escaping the heat once they have basked enough!). Alternatively, a 25 Watt bulb within a plastic bottle placed in the tree might be experimented with. Ambient enclosure temperature can be maintained between 28°-30°C, and at humidity levels of 60-80%.

Feed: The Madras Snake Park (1981) reports that their captive population were fed with the frogs *Rana cyanophlictis* and *Rana tigrina.* Various species of the smaller lizards and geckos can be tried. No other information on the feed accepted by this species in captivity is available to the knowledge of the author.

Longevity: No published longevity records found for this species found.

(e) **Flying Snake** (*Chyrosopelea ornata ornata*) (Family: *Colubridae*) ∅ : This beautiful, extremely active arboreal snake is definitely not for the amaetur zoo keeper who does not understand the requirements of this snake.

Enclosure requirements: Enclosures need to have a high ceiling of 200-250 cm, and a fair amount of space to range in as these snakes are very active. A dense foliage tree with long, slender branches (which can be periodically trimmed) can be put in the enclosure, and the leaves are to be misted twice a day with a plant sprayer. An ambient enclosure temperature can range between 27°-30°C, with a humidity of 80-90%. Above all, any snake kept in captivity must have access to varying thermal gradients within an enclosure.

Feed: These snakes have successfully been fed on small mice, geckos, amphibians, and small birds. When feeding any species of snake, it is important to relate body size of prey to predator, particularly when feeding the snake prey which can damage or even kill the snake. Learning to judge this association between predator vs. prey size is an important factor of successfully maintaining snakes in captivity.

Longevity: A wild caught adult (area not known) *C. ornata ornata* for the Philadelphia Zoo lived for 4 years in captivity (Bowler, 1977).

(f) **Bronze back tree snake** (*Dendrelaphis tristis*) (Family: *Colubridae*) ∅: This snake frequents both arboreal and terrestrial habitats. Shebbeane (1939) notes that this snake is difficult to get to feed in captivity. This species does not do well maintained together in an enclosure with other snake species, and no species of snake should ever be subjected to such an improper husbandry technique.

Encolsure requirements: A semi-high enclosure with a ceiling of ~ 200 cm with enough space for movement is required. Small trees with moderate foliage can be placed in the enclosure. Additionally, any snake exhibit should have two to three rocks to aid the snakes in ecdysis. Care must be taken when choosing these rocks, as they should not have jagged surfaces which might damage the fragile new skin, nor should they be too smooth.

As shed skins contain all of the ecto-parasites on the snake since the last time it shed, the skin should be removed soon, if not immediately. Obviously, some ecto-parasites (particularly the smaller mites and ticks at larval stages) will remain in the enclosure. Therefore, a routine changing of cage substrate, drinking/soaking water, and a thorough disinfecting of the enclosure (described in Section II of the introduction) is mandatory. These snakes can be maintained at an ambient enclosure temperature ranging between 27°-30°C, and a humidity ranging between 70-80%.

Feed: These snakes have been fed with the frogs *Rana cyanophlictis* and *Rana tigrina* at the Madras Snake Park (1981). Also known to feed on various species of geckos, birds, and small rodents.

Longevity: No published longevity records for this species found.

(g) **Common cat snake** (*Boiga trigonata trigonata*) (Family: *Colubridae*) ∅ : This rearfanged snake with a generally feisty temperament when freshly caught are both arboreal and terrestrial in habit. The "Y" shaped marking on the dorsal surface of the head clearly differentiates this snake from the similar looking much more venomous saws-scaled viper (*Echis carinatus*) in which this pigmentation is absent.

Enclosure requirements: This snake is delicate, and therefore among those snakes which should not be kept by novice zoos. Rajendran (1978) found this snake common in scrub jungles. Due to its excitable nature, it is best to keep these snakes in enclosures which provide the snake with maximum amount of refuge. An enclosure can be landscaped with rocks, and large, high logs. When landscaping enclosures, always make sure that rocks/logs are well set into the substrate or against each other as they may fall on the snake if improperly positioned. As with the captive maintenance of all other snakes, enclosures should be frequently (1-2 times a week) checked for ecto-parasites. Ambient enclosure temperature can be maintained at 28°-31°C. Enclosure humidity can be maintained at a varying 70-80%.

Feed: Rajendran (1978) points out that getting these snakes to feed in captivity was difficult. *Boiga* that were kept in captivity by him were fed on house geckos of the *Hemidactylus* genus only. A died including other vertebrate prey also is recommended. Small rats and amphibians can be experimented with.

Longevity: A wild caught adult specimen of *B. trigonata* has lived in captivity for 8 years at the Los Angeles Zoo (Bowler, 1977).

(h) **Shaw's sea snake** (*Lapemis curtis*) (Family: *Hydrophidae*) † : Sea snakes, or for that matter any species of fully or partially acquatic snakes rarely do well in captivity (Reitinger & Lee, 1978; Mattison, 1986). Indeed despite institutions in India and abroad maintaining sea snakes, none survive very long in captivity. Both sub-families of sea snakes, *Hydrophiinae* and *Laticaudinae,* can be found in Indian waters. *Laticaudines* differ from *Hydrophines* in that they frequently venture onto land for digestion and egg laying. *Hydrophines,* which include the annulated sea snake (*Hydrophis cyanocinctus*), the yellow sea snake (*Hydrophis spiralis*), the hook-nosed sea snake (*Enhydrina schistosa*), and the narrow headed sea snake (*Microcephalophis gracilis*) are completely adapted to a life in open water.

Enclosure requirements: In captivity, *Laticaudines* require dry surfaces on which to bask and rest. Circular enclosures have been recommended for sea snakes over rectangular aquariums as the snakes spend much of their time swimming into the sides of the flat-sided tanks. In a rectangular aquarium, this has been reported to result in damage and infection of the mouth. A good circular flow of water within the aquarium has been reported to decrease this continuous swimming behaviour. It is mandatory that sea snakes be maintained in saline and not fresh water. Saltwater can

be made, provided that the salinity is adjusted to that of local waters using a hydrometer. Water temperature should mimic that of the native habitat. The above recommendations may seem unnecessarily extensive, but proper knowledge of any species of snake's requirements should be researched prior to bringing them into captivity.

Feed: Chhapgar and Kewalramani (1967) ascertained that *Hydrophis cyanocinctus* feed on the marine eels *Sodonophis boro* and *Trypauchen vagina* through stomach-flushing of wild specimens. However, they note that sea snakes in captivity very rarely accepted prey. Although no information on optimal space per sea snake has been published, this can be figured out through experience, and eventually acquiring a "feel". If small enclosures exist, it is best that only one individual be kept per enclosure. Sea snakes tend to feed aggressively and bites from cagemates have been reported.

Longevity: A wild caught adult specimen of *Pelamys platurus* (Genus *Hydrophidae*) captured and kept in captivity at the Brookfield Zoo, U.S.A., lived for two years.

(i) **Russel's viper** (*Vipera russelli russelli*) (Family: *Viperidae*) † : Usually a terrestrial snake, but known to take to trees during a heavy rainy season. Another difficult snake to maintain healthily in captivity as it is particularily susceptible to acriasis (tick infestation). A commonly seen venomous snake in rural areas, it is a good public education display to educate people about snake bite and the significance of anti-venom. These *Viperids* have extremely long fangs (compared to kraits and cobras). Also known for their reputation of biting people through snake bags, therefore, while in a snake bag they should not be allowed to touch the body (carry the snake away from the body).

Enclosure requirements: Enclosures can be landscaped in a way that allows the snake to bask when it desires to do so. It is felt that basking is particularly important for this species. However, the snake must be able to retreat to a cooler thermal gradient when it desires to do so. Continuous open-mouthed gaping can be a sign that the snake is overheating, upon observing this the snake should immediately be taken out of the sun (Mader, 1996). Substratum maintenance should be paid particular attention to for any snake species, but it is emphasized on this snake. Substrate should be periodically replaced and faeces cleaned every time the snake defaecates. Substrate that is soiled or has water spilt on it and that is left unkempt creates an ideal situation for ecto-parasite outbreaks.

Feed: Has been known to successfully survive on a diet of principally rats (Whitaker & Tampal, 1994). When feeding snakes adult snakes large rats, always kill the rat humanely and then feed it to the snake. Injuries and even death have been inflicted on snakes from live rodent prey. In general, frequency and quantity of feeding should be based on how active the snake is, and its size. Chronic starvation occurs in reptiles fed in less than optimal intervals or in the wrong part of the light/dark cycle (Mader, 1996). This emphasizes the need to properly research any snakes activity times. These snakes can be maintained at an ambient enclosure temperature of 28°-31°C, and a humidity of 70-80%.

Longevity: A captive bred *Vipera russelli russelli* has lived in captivity for 13 years at the Columbus Zoo in Ohio, U.S.A.

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SECTION-III

Articles on diseases, treatment and its control in wild animals

TUBERCULOSIS AN IMPEDIMENT TO WILDLIFE CONSERVATION

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Introduction

Tuberculosis (TB) is a chronic infectious disease of great public health, economic and historical significance. In this country, the disease was reported as early as 4,000 years ago in elephants *(Elephas maximus).* Sanyal (1892) in his book on the Management of Captive Wild Animals has cited instances of the disease. The disease in England was recorded in many captive wild mammalian species between 1851 and 1860 (Crisp, 1860) i.e. even before the specific etiology of the disease was established in 1882 by Robert Koch. Presently tuberculosis is the greatest single problem among the specific infectious diseases of wild mammals affecting particularly deer and antelopes. There is no captive facility in the country said to be TB free. TB incidence is found also high in deer and antelope inhabiting certain natural habitats (Arora, 1994). The etiology, distribution, patho-genesis, diagnosis, treatment and control in certain native mammalian species are discussed hereunder.

Etiology

Mycobacterium tuberculosis (human type) and *Mycobacterium bovis* (bovine type) are important types causing the disease in primates and deer species. *Mycobacerium aviam* (avian type) is next to them. Two other types of tubercle bacilli were also recognised. The murine type—*Mycobacterium microti* from voles and from fishes, lizards, snakes, frogs and other cold-blooded animals. Recently *Mycobacterium lucknowi* has been isolated from frog *(Rana tigrina)* proved to be pathogenic (when was administered in heavy doses i/v) to common langurs *(Presbytis entellus).* Mention has often been made in the foreign published literature about the isolation of *Myco. chlonei, Myco, fortuitum, and Myco. scrofulaceum* particularly from the hooved animals.

Epidemiology

(a) *Artiodactilids*

All species are highly susceptible to disease. In captivity incidence of pulmonary form as well as generalized form of the disease is high in chitals *(Axis. axis),* sangai *(Cervus. eldi eldi),* barasingha *(Cervus duvauceli),* and black bucks *(Antilope cervicapra).* Of the 22.8 per cent (54/236) TB deaths that occurred during 1971-74 in Zoological Garden, Calcutta (WB), 53 per cent (29) cases occurred among artiodactylids: deer-25, Llama-I, wild sheep-1 and mouse deer-2 (Sen Gupta, 1974). During 1985, Zoological Garden, Lucknow (UP) experienced high incidence of TB among its black buck *(Antilope cervicapra)* population (Arora, 1994). Incidence of human type and bovine type in native artiodactylid species reported to be 42.4 (14/33) and 57.6 (19/33) respectively in Zoological Garden, Guwahati (Thakuria, 1996). In a herd of 34 black bucks of Van Prani Uddyan (VPU), I.V.R.I., Izatnagar (UP), intestinal tuberculosis was diagnosed in one case that had also extensive TB lesions in lungs, mesenteric glands, liver, and spleen (Arora, 1998). Earlier in 1994 similar type of TB lesions were recorded in one adult female chital *(Axis axis)* in this Uddyan. TB of spinal vertebrae in a captive black buck *(Antilope cervicapra)* in National Zoological Park, New Delhi. *Mycobacterium avium* has been isolated from captive chital *(Axix axis)* and hog deer *(Axix porcinus)* died of generalised tuberculosis (Arora, 1993 and 1998).

Necropsies of mouse deer *(Tragulus meminna)* on 31.5.83, at Zoological Park, Kanpur, and in gorals *(Nemorhaedus goral)* at various occasion in National Zoological Park, Delhi TB has been recorded. There appears to be no report of disease in musk deer *(Moschus chrysogaster), hungul (Cervus hunglu),* and pigmy hog *(Sus salvanicus).* In an outbreak of paramphistomosis among deer and antelopes that occurred during the hard summer 1981 in National Park, Ranthambore, Rajasthan, many of the chitals *(Axix axix)* and sambars *(Cervus unicolor)* during necropsy had shown extensive tuberculous lesions.

In captivity, introduction of an infected animal into the disease-free resident population will create focus for infection. Infected keepers are equally potential source of infection to their collections. Since the deer are maintained in open enclosures, introduction of infection from outside by free ranging infected animals such as rhesus monkeys *(Macaca mulatta)* and avian species

(Myco. avium infected and shedding the bacilli in their faeces) cannot be ruled out. In daily routines cleaning and disinfection of the enclosure substrate of deer and antelope is beyond scope, as their entire population normally remain in display area of the enclosure round-the-clock and there is no rotational adjacent built up facility for their migration. Hence, infected substrate of the enclosure itself can be a persistent source of infection to its new additions. Crowding and malnutrition is the major predisposing factors for causing rapid spread of disease in the population. The susceptible individuals contract disease by inhalation more frequently because of species herding nature. Ingestion is also an important route of acquiring infection.

(b) *Non-human primates*

Ten out of 57 monkeys died of TB at Zoological Garden, Calcutta during the years 1906 to 1910 (Mitter, 1910). Then after there have been many reports of disease in primate species besides other mammalian species dying in the captive facilities due to tuberculosis. TB deaths in 14 out of 15 rhesus monkeys *(M. mulatta)* occurred at all India Institute of Hygiene and Public Health, Calcutta. The source of infection was attributed to the infected guinea pigs housed in the same room (Krishnan, 1936). TB in endangered native non-human primate species claimed death in the golden langurs-Presbytis geei (8/33), capped langurs *Presbytis pileatus* (4/17), Nilgiri langur-*Preshytis johnii* (1/7), and lion-tailed macaque-*Macaca silenus* (1/2) in Zoological Garden, Guwahati, Assam (Thakuria, 1996), in lion-tailed monkey in Zoological Park, Madras and in Nilgiri langurs in National Zoological Park, New Delhi (Arora, 1994).

Tuberculosis in primates is caused mainly by 3 major types of *Mycobacteria: M. hominus, M. bovis and M. avium* in order of their mentioned. Mukunda (1996) reported that 60% of tuberculosis cases in primates caused by *Myco. hominus* type; 20% *Myco. bovis* type; 5%, by *Myco. avium* type and 15% by unidentified type. However, he has not substantiated veracity of his data and statement Thakuria (1996) reported high incidence of both human type (58.5%) and bovine type (41.5%) tuberculous infections in non-human primates dying between 1984 and 1992 in the Zoological Garden, Guwahati. On the other hand in the foreign country very high rate of avian tuberculous infection than bovine or human type tuberculous infections in primates has been reported by Theon and Himes (1980). *Myco, simiae* and *Myco. abscesses* are also reported to be pathogenic to simian species by them.

TB in free ranging primates is reported rather infrequently. 10.4% of 302 rhesus monkeys caught from the neighbourhood of Delhi and Mathura were found positive to tuberculin test. Within a month the number of reactors rose to 30.8% and after three months to 41%. Animals suffered from active TB and lungs were the main site of lesions Morbid anatomy of all these cases revealed that incidence of the disease increased progressively with length of their stay in captivity (Nair and Ray, 1954).

Author has necropsy examined two rhesus monkeys in the metropolitan cities and found affected with the generalized form of disease. The lesions in both the cases were generalised abscesses in the various organs besides the lungs. In one of the case spleen was almost completely damaged. In the primates species tuberculous lesions may vary from focal miliary lesions to large cavity lesions. The characteristic histological feature of tubercle as calcification, fibrosis, and Langhans giant cells may or may not be present. The lesions of *Myco, avium* infection in the intestine are marked for irregular thickness of small intestine and colon and enlargement of the mesenteric lymph nodes. Histologically the intestine mucosa and lymph nodes show diffuse infiltration of epitheloid cells containing acid-fast bacilli. The lesions lack necrosis, calcification and fibrosis (Sesline *et al.,* 1975; Smith *et al.,* 1973).

(c) *Carnivores*

Large felids are comparatively resistant to tuberculosis. Only few authentic case reports of the disease are on the published records. Darjeeling Zoological Garden appears to be the only captive facility in the country that has experienced mortality in its tigers *(Panthera tigris)* and also small felid species *(leopard cat—Felis bengalensis).* In free ranging carnivores there is hardly any authentic report of tuberculosis in any species except one case of tiger *(Panthera tigris)* died in Dudwa National Park, in 1987, in which hepatic abscess was diagnosed for the disease.

Myco, bovis has been isolated from a lion *(P. leo persica)* died of generalized tuberculosis in Zoological Garden, Bombay (Mumbai). (Das and Jayarao, 1986). The Zoological Garden, Darjeeling has also experienced death of leopard *(P. pardus)* due to TB. In his Garden TB has also caused a high mortality in Himalayan black bears *(Selenarctos thobetamus) (Zoo's Annual Report 1997-98).* Disseminated tuberculosis found in an 8 years old female sloth bear *(Melursus ursinus)* which died at Banarghatta National Park (Karnataka). General symptoms were anorexia, persistent cough, weakness and progressive loss of weight while in captivity (Sreenivas Gowda, *et al.,* 1983). Death of an adult male sloth bear on 26.5.1984 in Zoological Park, Kanpur (UP) and one female sloth bear on 7.2.1997 in National Zoological Park, New Delhi occurred due to TB. In case of former disease assumed pulmonary form and in case of later hepatic lesions to be the main.

Mortality has been reported in binturong *(Arctictis binturong)* and red panda/cat bear *(Ailurus fulgens)* in Zoological Garden, Bombay (Liston and Soparkar, 1924). In binturong generalized form of disease based on gross pathological lesions was diagnosed in 1 male died on 25 October, 1979, and 3 females died on different dates in span of 6 months between 1983 and 1984 in Zoological Park, Kanpur (UP). TB in members of families *Viverridae, Mustelidae* and *Hyaenidae* is poorly reported. Only one case is reported for small Indian civet cat *(Viverria indica),* otter *(Lutra lutra)* and hyaena *(Hyaena hyaena)* respectively in each family in Zoological Garden, Guwahati (Thakuria, 1996). There appears to be no report in species of family Canidae.

(d) *Proboscida*

Early Indian literature on the Hindu Mythology (2000 BC) furnishes evidence that tuberculosis was encountered in elephants *(Elaphas maximus).* Evans, G.C. (1910) has cited records of tuberculosis in elephants in his book 'Diseases of Elephants'. Pulmonary TB in elephants has been recorded by Narayan (1925), Chandrasekharan (1989), Vijayan *et al.* (1992) and generalized form by Bopayya (1928-29). Pus smears examined from the multiple abscesses developed on the hind and fore regions of the body in an adult working female elephant belonging to Corbett National Park, Ramnagar (UP) when examined showed presence of acid-fast organisms. The animal was marked for debility, tiredness and not responding to any treatment. Eventually it had died after about 6 months of severe illness and reportedly diagnosed for disseminated TB. Motomuria (1961) has reported isolation of *Myco. elephantis* as a separate species of *Mycobacterium* infection from an elephant, but any further report corroborating this finding is not traceable.

(e) *Perissodactylids*

The rhinoceroses *(Rhinoceros unicornis, Diceros bicornis)* have been observed to suffer from tuberculosis. Lesions in lungs and liver were described in an old sumatran rhinoceros (Sanyal, 1892). In Zoological Park, Hyderabad (AP) one of the three rhinoceroses *(R. unicornis)* which died of acute gastro enteritis caused by salmonellosis had pulmonary TB lesions (Arora, 1986). Nodules characterised by caseous centre, mononuclear cell infiltration and fibrous tissue encapsulation in liver and lungs were seen. On 23rd August, 1992 a 13-year old female African rhino *(Diceros bicornis)* fell ill in Zoological Garden, Mysore (Karnataka). Dyspnoea coughing and muco purulent nasal discharge reflecting bronchopneumonia were the clinical manifestations observed. Symptomatic treatment remained ineffective to alleviate the condition. On later dates clinical signs aggravated. Tuberculosis was suspected and treatment instituted. But, unexpectedly, the rhino expired on 11th September, 1992 at about 2.00 p.m. Gross necropsy examination showed trachea filled with an enormous quantity of pus and abscesses in the right and left lungs. Mediastinal and bronchial lymph nodes were found enlarged with abscesses containing creamy pus. Bacteriological examination of nasal discharge and pus and histopathological evaluation of lesions were suggestive of pulmonary tuberculosis as the cause of death of this female rhinoceros (DO MZP/700/92-93 dated 13th September, 1992, B.G. Mugadur). On 29.5.1994 the male partner died of Myco. tuberculosis infection. The nodular type caseated lesions were noticed in lungs and liver (vide No. MZAZH TB/94-95 dt. 7.12.94).

(f) *Rodents*

Sen Gupta, (1974) reported death of 3 porcupines, and 1 flying and I giant squirrel due to tuberculosis in ZG, Calcutta. Death of a porcupine (Histrix sp) in Garden was latter on recorded due to *Myco. bovis* infection (Basak *et al.* 1976). Necropsy examination of an adult female giant squirrel *(Retufa indica)* died on 6.11.1989 at Zoological Garden, Lucknow (UP) also evidenced extensive TB lesions in its lungs (Arora, 1994).

(g) *Marsupials*

Tuberculosis was recorded in a kangaroo, besides other animals (Anon. 1934-35). A kangaroo and 3 agouty with clinical history of coughing, dullness and emaciation had died of TB at Zoological Garden, Calcutta. Tuberculous lesions were confined to lungs in these animals (Sen Gupta, 1974). In Zoological Garden, Bombay, a kangaroo *(Megalaria rufa)* died with *Myco. tuberculosis* infection after prolonged wasting condition (Das and Jayarao, 1983). TB caused death of one bannet wallaby in Zoological Park, Kanpur, Morphologically acid fast organism isolated form lesions found in lungs and liver were indistinguishable form *Mycobacterium avium* bacilli (Arora, 1994).

(h) *Reptiles and Amphibians*

Mention has been made in the Proceedings of Zoological Society of London, 1939 and onwards about deaths due to TB in crocodiles, snakes and toads. In the generalized form of disease lesions involved liver, intestine, spleen with or without involvement of lungs. Thoen and Himes (1980) reported *Mycobacterium avium* from turtle and snake and also *Myco. chelonae* from snake, manatee toads. There are only few reports of disease in reptiles and amphibians.

Mycobacterium tuberculosis infection related lesions in the liver and lung in a python were recorded by Singh

et al. (1981). *Myco. lucknowi* isolated from a frog *(Rana tigrina)* proved to be pathogenic for langur *(Presbytis entellus),* when inoculated intravenously in very high doses (Tewari *et al.,* 1982). TB among monitor lizards in captivity is recorded very rarely.

Diagnosis

Specific diagnosis of TB in any animal species in antemortem examination is always complicated as the incubation period of the disease is prolonged and the specificity of the available diagnostic tests is at variance. TB bacilli grow slowly and disease assumes fulminating form only when affected host is severely exposed to a predisposing factor.

(a) *Clinical diagnosis:*

(i) Haematological and biochemical findings do not impart specific diagnosis. Emaciation rough hair coat and reduced food consumption are obviously marked only about 2-3 weeks before the terminal stage is reached. Any external abscess below the ear, thoracic and abdominal regions not responding to medical management must be investigated for TB. Such cases in deer are often related to generalized tuberculosis.

(ii) Chest X-ray is of diagnostic value for detecting advanced tuberculosis in primates that may be occasionally negative to tuberculin test.

(iii) Tuberculin testing with inoculation of PPD intradermally in palpebral of the upper eyelid or at the lower elbow skin in primates, in cervical region in deer and antelopes and at the base of ear or in the anal fold in case of elephants.

Case Reports

Report 1. Samantaray (1999) conductee TB testing in 6 common langurs *(P. entellus)* and 6 deer *(A. axis-3, C. unicolor-2 and Cervus eldi eldi-1)* belonging to Biological Park, Bhubneshwar (Orissa). His findings are cited as below (Personal comm.)

(i) In all 6 common langurs *(P. entellus)* normal skin thickness measured 0.1 mm. After 48 and 72 hrs. of inoculation of 0.1 ml. PPD i/d in each case no diffuse swelling developed at the site, hence all were declared to be TB negative.

(ii) The normal thickness of skin in the mid-cervical region measured 0.1 mm to 0.15 mm in chitals and sambars and 0.1 mm in sangai. In the mid-cervical of each animal 0.1 ml PPD was inoculated. After 48 hrs. and 72 hrs. all chitals and sambars showed diffuse oedematus, moderate swelling of 0.8 mm and 0.6 to 0.8 mm respectively. In sangai diffused oedematous swelling developed at site was 0.2 mm after 48 hrs. and 0.4 mm after 72 hrs. Based on the type of reaction and thickness of the site measuring above 0.4 mm all the deers were considered positive to TB.

Report 2. In Zoological Garden, Assam, Mahanta *et al. (1994) conducted TB testing in three Capped langurs (Presbytis pileatus),* 2-Golden langurs *(Presbytis geei),* I Nilgiri langur *(Presbytis johnii)* and 1 Lion-tailed monkey*) Macaca silemus).* Normal skin thickness behind the shoulder as 1.5 to 2.0 mm. After 48 and 72 hrs. of inoculation of 0.1 ml PPD i/d, the site measured from 2.5 to 3.0 mm in all except in one capped langur in which it was 2.2 mm. It was said that animals receiving isoniazid therapy have reduced sensitivity to tuberculin test.

Report 3. There have been numerous reports that the animals with advance TB lesions become anergic to the tuberculin test. However, Verma (1999) in his report on tuberculin testing in rhesus monkeys mentioned that monkeys with advanced TB lesions did not become anergic to tuberculin test. Dille hay and Rudovsk (1998) have suggested that multidrug chemotherapy may not result in disease resolution. An adult rhesus monkey received isonazid and ethambutol prophylactically for 9 yrs. had 120 consecutive negative tuberculin tests. Miliary tuberculosis was diagnosed at necropsy.

(b) *Laboratory diagnosis*

(i) Culture of concentrated materials on specific medias which are very sensitive for detecting tubercle bacilli help in isolation and certain chemical tests in typing the isolate(s).

(ii) Transmitting infection into experimental animals (biological test) like guineapigs, rabbits by using concentrated material is practiced. However, in view of chemical tests use of biological test is no longer in vogue.

(iii) Radio culture of tissue biopsy (in avain also of faecal sample) and ELISA test for detection of serum antibodies are reported to be sensitive in early diagnosis of disease but they are still the primary research tools.

5. **Treatment, Prevention and Control**

(A) *Obstacles to tuberculosis control*

(i) —The organism is slow-growing
—Thick-walled-resistant to most antibiotics
—Able to develop resistance (can become incurable).

(ii) The disease is difficult to diagnose
—New technologies (field sensitive test) to diagnose preclinical stage of the disease are yet not available.

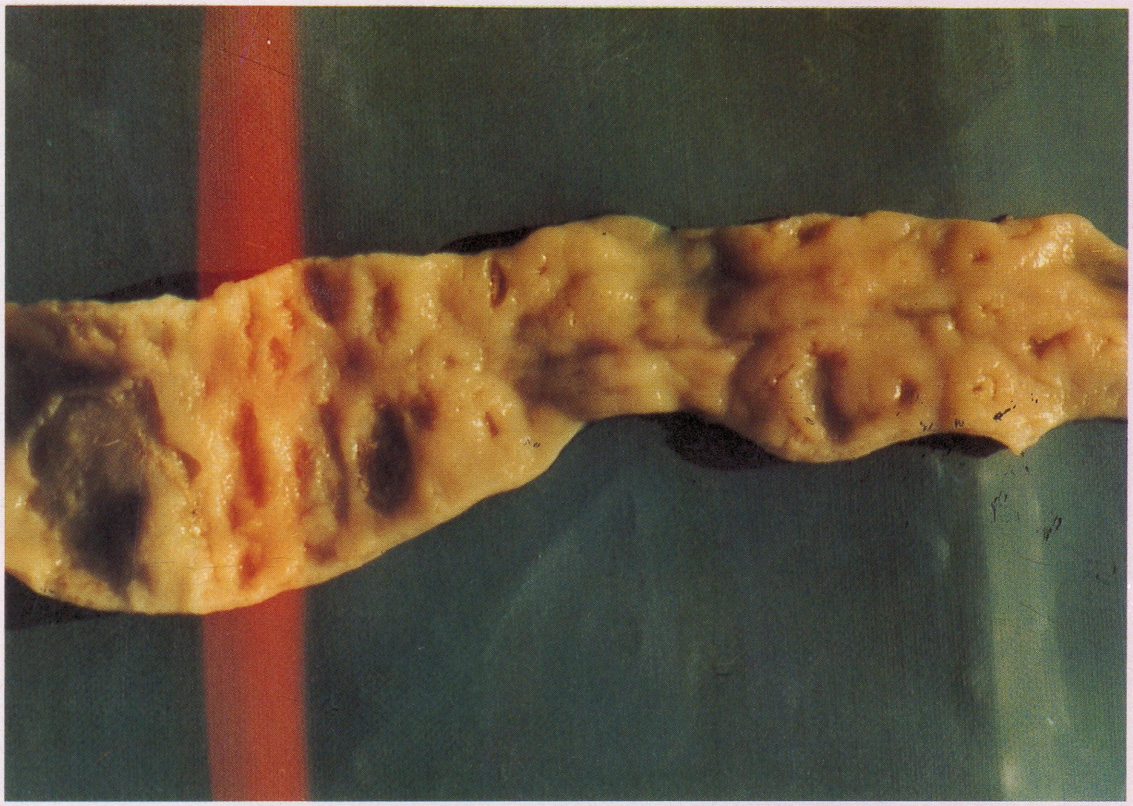




Fig. 1.(a and b): Tuberculous enteritis in an adult black-buck *(A. cervicapra)* died of generalized TB.



Fig. 2.TB lesions in lungs and lymph nodes—mediastinal, bronchial, etc. in black-buck *(A. cervicapra)*



Fig. 3. Showing subcutaneous abscess in the thoracic region and also involvement of mandible in an adult chital died of generalized TB

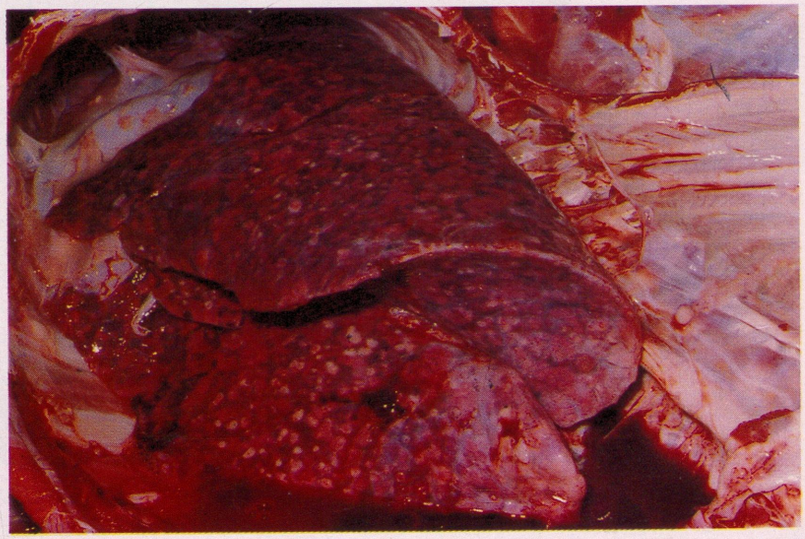


Fig. 4. TB affected lungs of chital *(A. axis)*

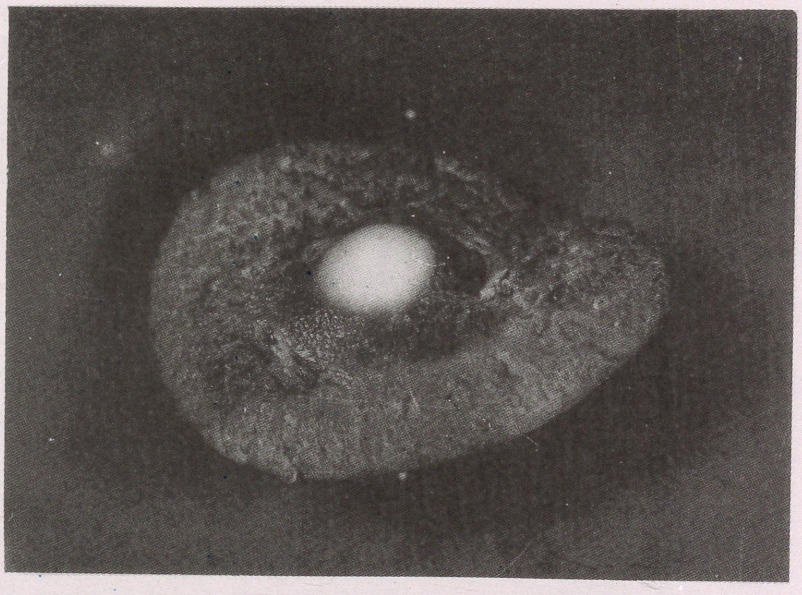


Fig. 5. TB abscess in medulla of kidney in chital *(A. axis)* died of generalized TB



Fig. 7. Pulmonary TB in a giant squirrel *(Rtufa indica)*

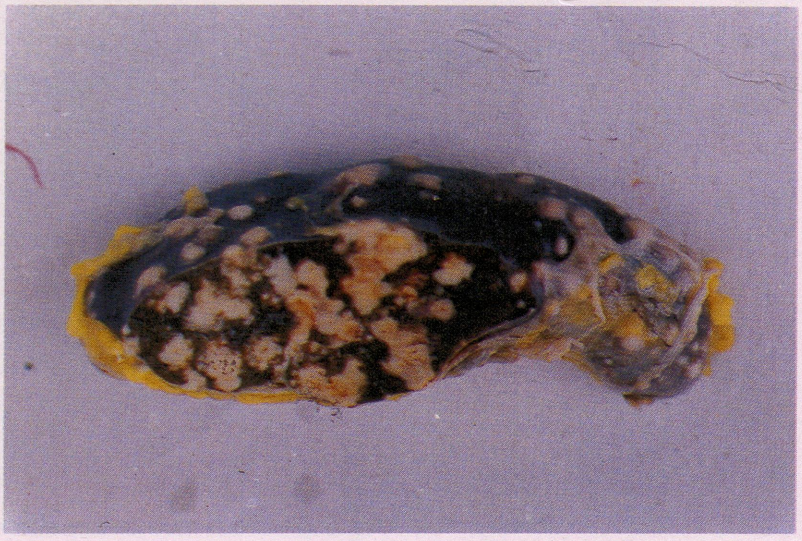


Fig. 8. TB affected spleen belong to a rhesus monkey *(M. mulatta)* died of generalized TB in a temple in Bareilly City

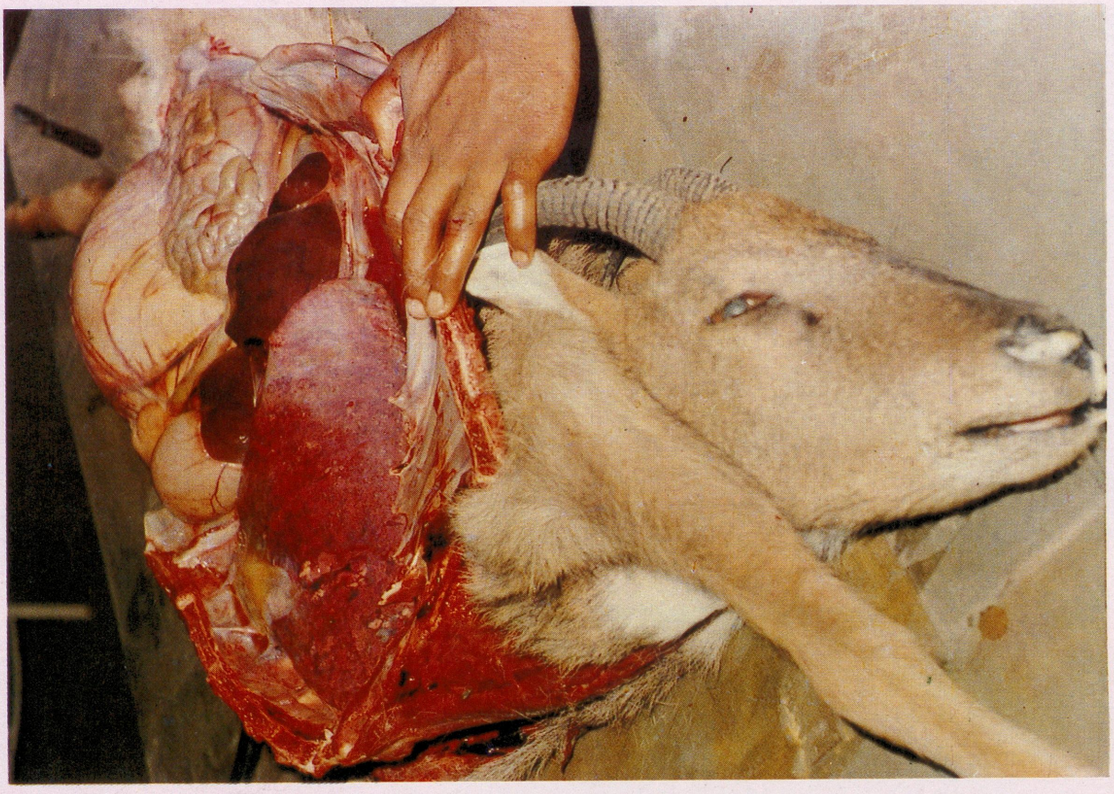


Fig. 6. (a) Tuberculous lungs and nasal exudate in goral (N. goral)

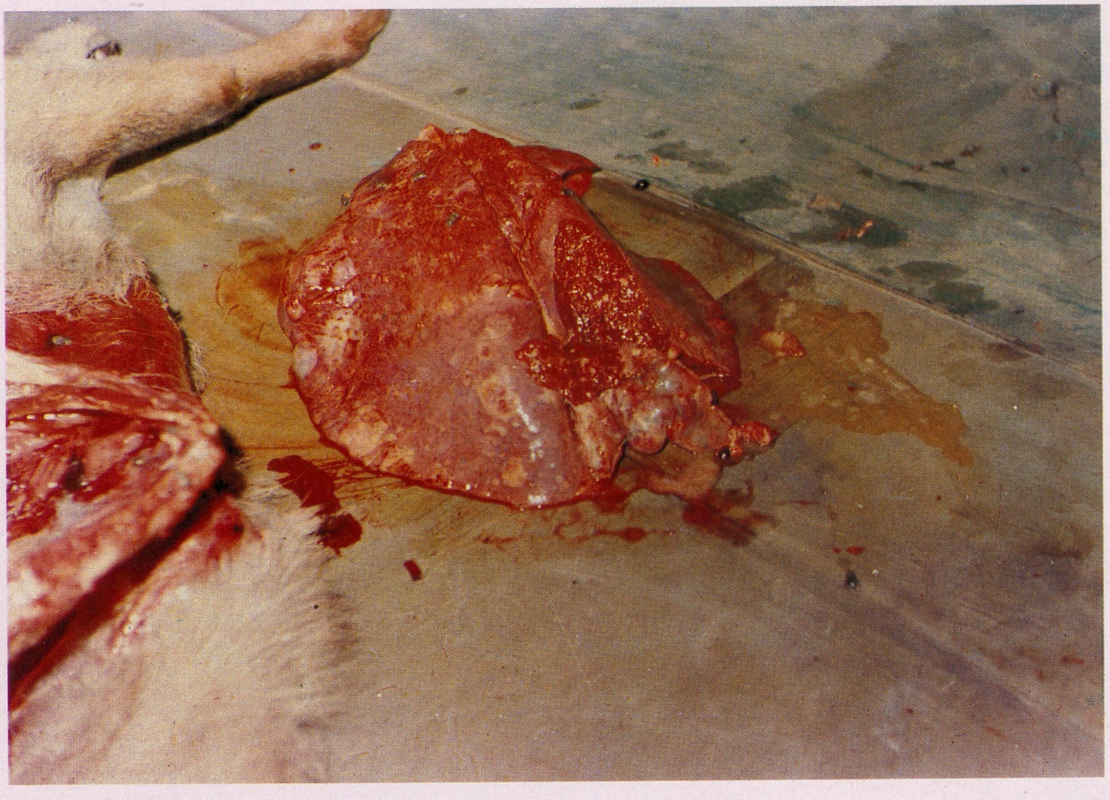


Fig. 6. (b) Gross tuberculous lesions in the lung

(iii) The treatment

—Multiple drug therapy is choice. Which is relatively expensive need regular prolong monitoring.

—No effective vaccine.

(iv) Control programmes

—Require proper planning by the technical persons.

—Require prolonged effort and funding on the part of Government.

—To practice BCG or other vaccine need policy programme.

(B) *Treatment*

Tubercle bacilli is a formidable enemy. It grows slowly and its impervious wall is making it hard to expose effectively to the bactericidal effect of the drugs administered, hence require prolong treatment. Another problem is of acquired drug resistance owing to pool and interrupted course of tuberculosis treatment regimen or faulty prescription.

(a) *Artiodactylids*

(i) Zoological Garden, Calcutta in 1960 started treatment of its deer and antelope populations with isoniazid @ 4-5 mg/kg b.w mixed in concentrate feed. A gap of 3 months was given after each course of three months of treatment. This schedule has been followed for about 3 decades (Das *et al.,* 1994). However, there is no report for disease-free states of the zoo.

(ii) *Study*

Thakuria (1996) practiced the following therapeutic approach to cure the disease in artiodactylid species belonging to Zoological Garden, Guwahati (Assam).

First Trimester

For large animals: Tibnex 450 tab 2 + Becosules cap 2 daily for 90 days

For small animals: Tibnex 450 tab 1 + Becosules cap 1 daily for 90 days

Second Trimester

Inabutol forte (Themis chemicals isoniazid 300 mg. Ethambutol Hcl 800 mg tabs)+ Becosules

For large animals: Inabutol forte tab 2 + Becosules cap 2 daily for 90 days

For small animals: Inabutol forte tab 1 + Becosules cap 1 daily for 90 days.

Third Trimester

Themibutol (Themis chemicals ethambutol Hcl 200 mg, 400 mg, 600 mg, 800 mg 1000 mg tab)+ Becosules.

(b) Non-human Primate

The disease has been a problem since the first primates were maintained in captivity, continues to be a significant problem, and all likelihood will remain a potential problem as long as primate species are maintained in Zoological Parks. Policy for stamping out of the infected stock is yet not adopted in this country.

Anti-tuberculosis treatment in case entire stock is affected has limited scope for cure with any treatment. In case where extremely valuable and endangered primate species are involved, they do require specific diagnosis and institution of treatment at the very early stage. Confirmed cases of tuberculosis should be treated in isolation wards.

Case Study 1: Das *et al.* (1994) described prophylactic treatment with isoniazid @ 4-5 mg per kg b.w. in primate species maintained in Zoological Garden, Calcutta. The powdered medicine was mixed with rose syrup and offered to the animals after spreading the same over the sliced bread. A gap of 3 months was given after each course of 3 months of treatment. This practice remained continue throughout the year.

Case Study 2: Mukunda (1996) recommended the following regimen.:

(a)	12 months regime	
(i)	INH+S+T/E	2 months
	INH+T/E	9 months
(ii)	INH+S	1 month
(b)	8 months regime	
(i)	INH+R+PZA+T	2 months
	with INH+T	6 months
(c)	6 months regime	
(i)	INH+R+PZA+SE	2 months
	with INH+T	4 months

Dosage:

Isonicotinic acid Hyderazide (INH)	3.5 mg/kg bw
Streptomycin (S)	10 mg/kg bw
Thiacetazone (T)	2 mg/kg bw
Ethambutol (E)	15-20 mg/kg bw
Rifampicin (K)	10 mg/kg bw
Pyrazinamide (PZA)	20-30 mg/kg bw

The above regimen should be supplemented with pyridoxine to counter adverse reaction.

First Trimester

Tibinex 450 tab 1/2 + Becosules cap 1/2 daily for 90 days.

Second Trimester

Inabutol tab 1/2 + Becosules cap 1/2 daily for 90 days.

Third Trimester

Themibutol 15 mg/kg body wt + Becosules cap (as before) daily for 90 days.

(c) *Proboscida*

Case Study 1: Chandrashekharan (1989) treated tuberculosis in and adult elephant (*E. maximus*) by administrative of streptomycin @ 100 g i/m on alternative day for a period of 4-5 weeks. Supportive drugs like herman @ 200 ml i/v and 10@ of dextrose i/v were also found useful.

Case Study 2: Foreign workers have tried rectal suppository dosage regimen for administration of isoniazid and rifampin in case of Asian elephant that refuse to take oral medicine. The animal undergoes conditioning for this practice, found effective (Dunker and Rudovsky, 1998).

(d) *Marsupials*

Multiple anti-tubercular drugs such as amikacin, rifafutin, myambutol, enrofloxacin and newer drugs—azrithromycin and immunotherapy with Myco. vaccae vaccine are being tried in Australia in marsupialsagainst *Myco. avium.*

(C) **Prevention and Control**

(a) *Preventive measures*

Many facilities maintaining non-human primates and deer and antelope species must maintain an active, vigorous, tuberculosis surveillance programme in both their animal and human populations to attempt to prevent entry of the disease or to eradicate it as soon as possible it gains entrance.

(i) Inter and intra-deer and antelope species dwelling together eill establish a persistent disease focus in the facilities. Therefore, each species shall be maintained separately. Segregation of all the juveniles aged 3 to 6 months to be maintained sexwise separately. All the juveniles males (except 2 to 3 nos. to be retained for breeding) shall be vasectomized. The juvenile stock shall be accinated with BCG vaccine.

(ii) Water moat of the enclosures housing infected deer/antelopes shall not flow into moat of any other herbivore enclosures.

(iii) No exchange or introduction of animals from the infected deer population be commissioned.

(iv) Animal staff shall regularly be got screened for TB. Only healthy staff is to conduct daily routines of the animal stock.

(b) *Control measures*

(i) Once TB in deer and antelope herds is established it is difficult to eradicate by any treatment practice. Then it is always necessary to depopulate the entire herd. In such instance the empty enclosure shall not be used until it is thoroughly cleaned and decontaminated using a 3% cresylic compound or a derivative of phenol such as orthophenyl. If possible the enclosure should be disinfected two times in a week interval.

(ii) At one year of age the representative numbers shall be tuberculin tested and after 45-55 days that positive or doubtful in first testing be retested. The confirmed cases be eliminated. Rest all stock provided daily anti-tuberculosis combined therapy treatment for 60-90 days.

(iii) It should be ensured that number of animals in one hectare of the enclosure area shall not be more than 7 to 8 animals in any case.

(iv) Animals required for addition to a collection should come from TB-free accredated herds.

Avizendum: There is no approved national programme to eradicate tuberculosis from the Zoological Gardens/ Parks. There is also no mandatory reporting systems of disease in endangered species such as sangai (*C. eldi eldi*), barasingha (*C. duvances*), golden langur (*P. presbytis goei*), red panda (*A. fulgens*), rhinoceros (*R. unicornis*), etc. Raisen d'etre could be shortage of technical staff and risk of handling the animals for the purpose. And sometimes also to avoid mentioning intentionally about the disease to attract public criticism and departmental quaries. Most of the necropsy reports describe pulmonary TB lesions as suppurative pneumonia or bronch pneumonia and cases of generalized suppurative lesions in the visceral organs and lymph glands related to organ abnormality such as hepatitis, spleenitis and nephritis. Therefore, accurate data are not available related to kind of *Mycobacteria* infections affecting animals in our captive and free facilities. It is advisable that whenever tuberculosis lesions are found on necropsy attempts should be made to subject the specimen for cultural examination to determine whether *Myco. bovis, Myco. tuberculosis, Myco. avium* or atypical mycobacteria are involved. All these agents have been reported in zoo collections and the difference is critical for analysis of the problem and prediction of the outcome. The type infection based data are likely to be useful in treatment and for animal exchange programmes between the zoos or surplus stock releasing into wild natural habitats. The handlers as well as visitors need to be educated about zoonotic importance of the disease.

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PROFILE OF A ZOONOTIC DISEASE: JAPANESE ENCEPHALITIS

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Preface

Arbovirus encephalitis occurs in distinct geographic distributions and vector patterns. Each continent tends to have its own arboviruses and names are usually suggestive, e.g. Venezuelan Equine Encephalitis (VEE), Japanese Encephalitis (JE), Murray Valley (Australia) Encephalitis (MVE) etc. All of the proceedings are togavirus infections spread by mosquitoes having a distinct ecologic pattern. On a given continent there may be a shifting distribution depending on virus, vertebrate hosts and vectors in a given year.

Japanese encephalitis occurs throughout the orient. The disease was first recognised in Japan in 1871. The activity of JE in India is known to occur in the southern part since 50's of this century. JE recently drew considerable attention as an important emerging health problem after its sudden, unwarranted and explosive outbreaks in epidemic proportion for the first time in 1973 in Burdwan and adjoining districts of the State of West Bengal in eastern India. Since then, JE with almost annual recurrence, high rate of case fatality and morbidity has been the source of a colossal problem for public health personnel in the State of West Bengal. Subsequently, wide spread epidemics broke out in many parts of India. There are indications of the spread of these new foci of epidemics also to Bangladesh, a neighbouring country.

A. **Historical overview**

Japanese encephalitis is a mosquito-borne disease caused by a member of group B arbovirus. It is classified under the family Togaviridae, genus Flavivirus. The disease was first recognised in Japan in 1871 and the virus was first isolated from a fatal case in that country in 1934 (Huang, 1982).

Japanese workers coined the term Japanese B Encephalitis (JBE) just to distinguish it from Von Economos' disease, the so-called type A encephalitis (Clarke and Casals, 1965). It has, however, modified its name and is now simply called Japanese Encephalitis (JE).

Japanese encephalitis is a zoonotic disease which has been recorded from the south eastern parts of the Soviet Union and southern Japan, and as far south as Indonesia. The western limit of the disease is in India and it has been recorded as far east as Guam. Major human outbreaks were reported from Japan, Republic of Korea, China (province of Taiwan), Thailand and India (Pant, 1979a).

The vector-borne nature of JE infection had been suspected quite clearly by Japanese epidemiologists and JE virus was first isolated from mosquitoes of Culicine species including *Culex tritaeniorhynchus* in Japan. (Mitamura, *et al,* 1938). Since then natural mosquito infections were demonstrated repeatedly in several parts of Japan (Buescher *et al,* 1959a).

Japanese and Korean workers have established the role of *Cx. tritaeniorhynchus* in the epidemiology of JE (Barnett, 1951, Gresser *et al,* 1958, Lee *et al,* 1971). In China, however, *C. vishnui* has been considered to be more important vector than *Cx. ritaeniorhynchus* (Okuno *et al,* 1971). JE being primarily a zonotic disease, vertebrate hosts such as pigs and birds play an important role in the maintenance and amplification of the virus (Pent, 1979b).

B. **JE in India**

In India, the earliest evidence of JE virus activity in southern part as determined by the detection of specific neutralizing antibodies to JE virus was obtained through the early serological survey carried out in 1952 (Smithburn *et al,* 1954).

The disease was first recognised in 1955, when cases of encephalitis from North Arcot District and neighbouring districts of Tamil Nadu and Andhra Pradesh, were admitted to the Christian Medical College Hospital (CMCH), Vellore. The disease was serologically diagnosed as having been caused by JE virus (Webb and Pereira, 1956; Work and Shah, 1956). In the same year, JE virus was isolated for the first time in India, from wild caught mosquitoes of this area (Dandwate *et al,* 1969). However, the virus was not recovered from man until 1958. Afterwards three isolations were made from human brains after postmortem of victims of encephalitis admitted to CMCH, Vellore (Webb *et al,* 1961).

Until 1973 the disease, however, was not commonly recognised and the occurrence was restricted to

southern India only. In 1973, a large outbreak of JE occurred in West Bengal and this was the first recorded epidemic of JE in India (Chakraborty, 1981). The first case of this 1973 malady was reported from Asansol Mines Board of Health (Burdwan District) on 22 June. In that year ten districts of West Bengal State involving an area of about 2000 sq km were affected by JE and continued up to the end of Novermber, 1973. The percentage of mortality was about 43 (Das Gupta, 1981). Since then, JE with almost annual recurrence, high rate of case fatality (Table 2 & 3) and morbidity, and with unpredictable geographical distribution, has brought about a colossal distress to the public health of West Bengal (Chakraborty *et al,* 1975, Chakraborty *et al,* 1980a).

In 1976 a second epidemic of JE occurred in the State of West Bengal and was restricted to Burdwan District only (Chakraborty *et al,* 1980a).

The year 1978 was characterised by the occurrence of outbreaks in new areas in India. In south India, there was a large outbreak in Tamil Nadu, mainly in Tirunelveli District (Prasad Rao *et al,* 1982). Another outbreak occurred in Kolar District of Karnataka (Prasad *et al,* 1982). In north eastern India, there were epidemics in Burdwan, Bankura, Birbhum and some new areas of West Bengal like the districts of Jalpaiguri, Cooch Behar, Murshidabad and West Dinajpur (Chakraborty *et al,* 1980a); also in the neighbouring districts of Bihar (Mohan Rao *et al,* 1980); and in the District of Dibrugarh in Assam (Deka *et al,* 1980). In North India, Uttar Pradesh experienced its first epidemic of JE. Several districts were affected, mainly Gorakhpur and Deoria (Mathur *et al,* 1982).

During 1979, outbreaks of JE occurred at Burdwan and Hooghly Districts of West Bengal, Kolar and adjoining districts of Karnataka and Anantapur and Chitoor Districts of Andhra Pradesh (NIV, 1980).

The epidemic of JE has also been recorded in 1980 in West Bengal and Assam (Chakraborty, 1981). In 1980, a large outbreak occurred in Uttar Pradesh, again mainly in Gorakpur and Deoria Districts (Rodrigues, 1984).

In West Bengal an outbreak occurred again mainly in Burdwan District in 1981 (Bhattacharya *et al,* 1985). In that year extensive outbreaks of JE also occurred in South India. Arcot District of Tamil Nadu, Pondichery, Anantapur, Chitoor, Kurnool, Guntur Districts of Andhra Pradesh and Kolar District of Karnataka were mainly affected.

In 1982, epidemics of JE occurred in West Bengal, Uttar Pradesh and Assam (Rodrigues, 1984). In 1982, laboratory confirmed cases of JE were detected for the first time in the western coastal region of India, i.e. in the Union Territory of Goa (Mohan Rao *et al,* 1983).

A large epidemic of JE broke out in Mandya District of Karnataka State, India, in April 1983, and continued until July (Mishra *et al,* 1984).

C. **Natural cycle**

JE being primarily a zoonosis, animal hosts such as pigs and birds play an important role in the maintenance and amplification of the virus (Pant, 1979b) and it appears as local outbreaks in humans under specific ecological conditions. In the natural cycle of JE, man is the dead end (NIV, 1980).

The invertebrate host, mosquitoes may carry the virus for life after getting the infection, but they rarely live for more than a month. On the other hand, vertebrate hosts after infection, usually recover, and rapidly eliminate the virus and develop a lasting immunity. Accordingly, the virus survives by virtue of alternating between vertebrate and invertebrate hosts in a 'cycle'—man gets the infection tangentially on accidental intrusion on this pathway. Fortunately, however, the infection represents a blind alley terminating the chain of transmission. The consequence of infection in man, however, may prove to be more serious than those of the natural hosts, that has presumably benefited from thousands of years of natural selection for genetic resistance (Fenner, 1976).

Scherer *et al* (1959a) showed in Japan that epizootics of JE appear to occur in birds prior to epizootics in pigs, and infection in other domestic animals and epidemics in human.

According to NIV (1980), in India the Ardeid bird-mosquito-Ardeid bird cycle may be more stable persistant and enzootic. The pig-mosquito-pig cycle appears to be temporary and epizootics. The epidemic in man appears to follow pig epizootics (Fig. 1). There might be several other vertebrates involved on the periphery of these cycles as complimentary factors.

D. **Hosts of JE**

(a) *Pigs*

Several researchers very conclusively proved that pigs are important hosts playing important role in epidemiology of JE in many places such as Malaya, Singapore, Japan, Taiwan, Thailand. (Pond *et al,* 1954; Hale *et al,* 1957; Scherer *et al,* 1959b; Wang *et al,* 1962; Grossman *et al,* 1974).

In India experimenal transmission studies and serological studies also depicted important role of pigs in the dissemination of JE, probably acting as a reservoir (Carey *et al,* 1968; Carey *et al,* 1969a; Rodrigues *et al,* 1976; Banerjee *et al,* 1979 and Nandy *et al,* 1982).

(b) *Cattle*

Interestingly serological examination of bovine sera also shown a high percentage of JE antibody prevalence in them both in South India and in eastern India with previous history of JE epidemics (Carey *et al,* 1968b; Rodrigues *et al,* 1976; Nandy *et al,* 1982). They showed their importance in JE epidemiology even, though the

bovines do not really exhibit long viraemia and thus not presumably helping JE transmission. These hosts may help in deflecting the invertebrate hosts and arrest the dissemination of JE (Nandy *et al,* 1982).

(c) *Bats*

In Japan isolation of JE virus from bats (Sulkin *et al,* 1970) have been reported. According to Okuno (1979), bats also would be ideal hosts for overwintering of arboviruses.

(d) *Horses and mules*

Epizootics among horses by JE virus have been observed in Japan. JE dissemination among equines was found to be extensive with clinical illness and deaths following an epidemiologic studies in Japan (Prier, 1966).

Serological evidences of JE infection among mules in eastern Himalayan region have also been reported (Chakrabarty *et al,* 1981a).

(e) *Amphibians & reptiles*

A search was made by Carey *et al* (1968b) among certain amphibians and reptiles of South India for virological and serological evidence of infecion with JE virus. No strains of JE virus were isolated. There was no serological evidence that amphibians, and reptiles examined were important hosts for JE virus.

In Korea, the local snake, *Elaphe rufodorsata* and *E. schrenkii* may be the hosts of JE virus (Lee, 1968, Lee *et al,* 1972). Shortridge *et al* (1974) suggested that Cobra (*Naja naja*) could be a host for JE virus throughout the oriental region and may play a role in the overwintering of the virus.

Shortridge *et al* (1975) examined plasma samples from 75 softshelled freshwater turtles (*Trionyx sinensis*) from China and found more than 60% positive for JE infection.

(f) *Birds*

The role of birds in he disseminaion of JE virus has attracted the valid attention of the researchers. Birds are important hosts in the epidemiology of JE in many places such as Japan. Birds particularly herons and egrets (Family Ardeiidae) serve as the amplifying hosts of JE virus in Japan (Buescher *et al,* 1959b,c; Scherer *et al,* 1959a; Buescher and Scherer, 1959).

In Thailand, Grossman *et al* (1974) indicated that along with other animals chickens could possibly also act as amplifiers.

In tropical countries, JE virus is maintained throughout the year in domesticated animals especially in birds and ducks along with pigs (Pant, 1979a). According to Jawetz *et al* (1982) a bird-mosquito-bird cycle occurs in JE.

Oya (1979) along with Indian workers stated that some birds might be involved in the natural maintenance of JE virus. According to him, ducks and young chickens had virus circulating in sufficiently high titres to infect a large proportion of mosquitoes feeding on them and viraemia was also demonstrated in pigeons and sparrows in India.

In India, several other workers have also studied the serological evidence of JE virus in birds (Carey *et al, 1968b;* Kaul *et al,* 1976; Ghosh *et al,* 1978; Khan and Banerjee, 1980; NIV, 1980; Rodrigues *et al,* 1981; Chakraborty *et al,* 1982; Loach *et al,* 1983; Bhattacharya *et al,* 1985).

E. **Sero epidemiology of birds in India**

Ghosh *et al* (1978) collected 127 serum samples from ten migratory and seven resident species of birds at Ghana sanctuary, Bharatpur, Rajasthan and conducted HI tests for antibodies against Group B arboviruses. 15 sera of migratory birds, *viz. Anas clypeata, Anas crecca, Aythya fuligula, Anas strepera* were positive for antibodies against JE virus.

According to NIV (1980), in Bankura District, West Bengal State, India, 104 birds sera were tested, only 8 showed the presence of JE antibodies. In Andhra Pradesh State, India, only 5.7 per cent of ducks (3 out of 53) possessed N antibodies to JE virus. In a total of 146 birds sera, collected from Asansol (West Bengal State) and Dhanbad (Bihar State), N antibodies against JE virus were found 9 out of 34 little egrets, one of 15 cattle egrets and one of 13 paddy birds. One of the four crows sera and 3 of sixteen duck sera also showed antibodies against JE virus.

Khan & Banerjee (1980) carried out a serological survey of birds during an outbreak of JE in 1978 in Asansol and Dhanbad region. Neutralising antibodies against JE virus were found in 11 out of 62 ardeid birds, 3 out of 65 ducks and one out of 4 crows.

Khanna (1981) stated that there were a few reports in India where fowl sera were found positive for JE antibody. Similarly antibodies have been shown in the sera of chicks, Sparrows, Parrots and some migratory birds.

Chakraborty (1981) stated that the available information and evidences indicate that birds like pond herons, cattle egrets along with other animals are probably incriminated for maintenance and transmission of JE virus.

Rodrigues *et al* (1981) suggested that ardied birds, *Ardeola grayii* (pond herons) and *Bulbulcus ibis* (cattle egret) may be involved in the natural cycle of JE virus in India. They demonstrated that neutralising antibody to JE virus was detected in 179 sera out of 514 sera, *i.e.* 34.8% from these two species in Andhra Pradesh State, India.

Chakraborty *et al* (1982) examined the sera of a number of birds belonging to different species collected from a village in the JE affected Burdwan District of West Bengal State, India, and showed JE antibodies in some of them.

Loach *et al* (1983) demonstrated that ducks, fowls and para domestic sparrows possessed antibodies to JE virus in Bihar. They showed that JE virus activity in ducks and fowls was significantly higher compared to its activity in pigs in the same area as reported earlier, indicating persistence of activity.

F. Seasonal prevalance of JE outbreaks

Countries other than India

The seasonal incidence of JE in the far eastern part of USSR occurs mainly in Autumn, where the disease is often known as autumn encephalities (Miles, 1960).

The epidemics of Japan have always broken out in the later part of summer, particularly in August and September. This seasonal pattern is similar to that observed in Korea (Kono and Kim, 1969).

The main transmission season of JE virus in the northern part of Vietnam, northern Thailand, some States of Burma and Bangladesh extends from May to October, coinciding with the rainy season and the period of rice cultivation, resulting in high vector abundance (Pant, 1979b).

Human epidemics in northern Thailand problably result from the logarithmic increase in the population of vector mosquitoes in April/May with onset of rainfall (Pant, 1979a).

The incidence of Japanese encephalitis cases (human) increased during the rainy season in Thailand (Gunakasem *et al,* 1981).

Outbreaks of human encephalities in Nagasaki, Japan occurred more frequently in summers with low rainfall and high temperature than with high rainfall and low temperature (Mogi, 1983).

India

A clear relationship between the rainfall and case incidence has been shown in West Bengal (Chatterjee and Banerjee, 1975). The seasonal incidence of JE cases, as recorded in different epidemics, is found to be different in different parts of India (NIV, 1980).

In eastern India, the seasonal incidences in West Bengal during three subsequent epidemics of 1973, 1976 and 1978 were mainly from June to October. Seasonal outbreaks of the epidemic with monsoon and decline by winter were common features to all the epidemics (Chakraborty *et al,* 1980a). In Tamil Nadu the peak incidence of JE was in October to December. The exception was the outbreak in Tirunelveli and surrounding districts in 1977-78 which commenced in November and lasted till April with the peak in February and March. In Assam and Uttar Pradesh, the outbreaks occurred between September and December (NIV, 1980). In north eastern India, JE incidence was shown to be related to summer-monsoon (Chakraborty, 1981).

In Mandya District of Karnataka, smaller JE outbreaks have been occurring during the monsoon and post-monsoon months since 1979. However, it also experienced an epidemic during the summer months. A few sporadic cases were also reported during the same period in 1982. A large epidemic brokeout during April 1983 which continued till July. Thus, it provided an entirely different and unique seasonality to JE epidemic in the country (Mishra *et al,* 1984).

G. Composition of mosquito fauna in two JE endemic areas of India

According to Reuben (1971a), a total of 60877 mosquitoes were encountered in North Arcot District, 1958-1963 in cattle sheds by spending 1922 total man-hours. The figures given in parentheses after each species denote the number. *Anopheles barbirostris* (1), *An.hyrcanus* (19), *An.culicifacies* (10), *An.pallidus* (21), *An.subpictus* (16120), *An.vagus* (11), *Culex fuscanus* (10), *Cx.raptor* (1), *Cx.bitaeniorhynchus* (1549), *Cx.fuscocephalus* (40), *Cx.pipiens fatigans* (39), *Cx.vishnui* group (43041), *Cx.whitmorei* (11), other species were 4 in number.

Soman *et al* (1976) collected from Asansol area of Burdwan District, a total of 1187 mosquitoes belonging to 16 species by spending 111 man-hour. Of these *Cx.pipiens fatigans*=(*Cx.quinquefasciatus*) was the predominant species amounting to 81.4 per cent of the total. The other five species in order of abudance were: *Ae.aegypti* (4.8%), *Armigeres* (4.0%), *Cx. tritaeniorhynchus* (3.6%), *Cx.gelidus* (2.8%) and *Cx.vishnui* (1.7%). The remaining 10 species amounted to only 1.7 per cent: *An.subpictus* (0.2%), *An.vagus* (0.1%), *Cx.cornutus* (0.1%), *Cx.fuscocephalus* (0.1%), *Cx.pseudovishnui* (0.1%), *Cx.sinensis* (0.1%), *Cx. whitmorei* (0.6%), *Mansonia uniformis* (0.2%), *Aedes albopictus* (0.1%) and *Ae.pallido-striatus* (0.1%).

Table 1: *List of Mosquitoes from which viruses have been isolated in India (up to 1998)*

Species		Locality where isolated
Anopheles		
An. barbirostris	–	Asansol (West Bengal)
An. nigerrimus	–	Asansol and Bankura
(An 'hyrcanus' group)		(West Bengal)
An. peditaeniatus	–	Mandya Dist. (Karnataka)
An. subpictus	–	Kolar Dist. (Karnataka)
Culex		
Cx. bitaeniorhynchus	–	Bankura (West Bengal), Kolar Dist. (Karnataka)
Cx. epidesmus	–	Bankura
Cx. fuscocephala	–	Madarhalli, Mandya Dist. (Karnataka)
Cx. gelidus	–	Hemmige, Mandya Dist.
Cx. pseudovishnui	–	Kolar Dist. (Karnataka)
Cx. tritaeniorhynchus	–	Vellore, Hemmige, Mandya Dist.
Cx. vishnui	–	North Arcot Dist., Asansol, Kolar and Mandya Dist.
Cx. whitmorei	–	Paritala, Krishna Dist., North Arcot Dist. Kolar Dist.
Cx. infula	–	Madurai, Tamil Nadu
Mansonia		
Mn. annulifera	–	Dibrugarh (Assam)

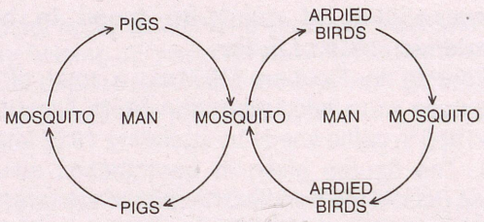


Fig. 1 Natural cycle of JE

CLINICAL FEATURES

The severe encephalitic stage of JE is preceded by a prodromal stage which is characterised by general malaise, headache and fever. These may be accompanied by rigors, nausea and vomiting, the predominant features during the acute encephalitic stage are confusion, fever, nuchal rigidity, focal central nervous system signs and convulsions. The disease may progress from the stage of confusion, clouding of consciousness, delerium, stupor to coma. In many cases, major defects such as palsies, paralysis and involuntary movements are also seen. Sometimes, dehydration and features associated with myocardial strain may also be observed (NICD, 1988).

Table 2: JE in India

Year	No. of affected States; UTs	Cases	Deaths	C.F.R. %
1978	18	7463	2755	36.91
1979	8	2845	926	32.54
1980	11	3478	1436	41.29
1981	10	3894	1167	29.97
1982	12	3516	1261	35.86
1983	9	1716	581	33.86
1984	9	3370	1405	41.69
1985	10	2490	916	36.78
1986	10	7500	2627	35.02
1987	10	2877	1172	40.74
Total	23	39149	14246	36.39

* Source: NICD (1988) 1987 figures : Provisional

Table 3: JE in West Bengal

Year	Attack	Death	(C.F.R.) Case Fatality rate (%)
1973	763	325	42.6
1976	307	126	41.0
1978	1256	544	31.3
1979	1245	479	38.4
1980	62	27	43.6
1981	79	36	45.5
1982	1469	555	37.7
1984	1868	830	44.4
1985	421	165	39.2
1986 (Burdwan alone)	801	222	27.7
1987	1674	594	36.0
Total	9945	3903	39.24

Source: NICD (1988)

Discussion

JE is predominantly rural and mainly affects the poorer section of society. However, towns with agriculturer practices on the fringes often contain JE cases. Though children constitute the largest sufferers, no age is exempt.

The diverse feeding habits of the vector mosquitoes, possibly keeps the virus circulating in reservoirs throughout the year (Bhattacharya *et al,* 1986). Although the list of potential vectors is long, only a few species belonging to the genus Culex seems to play significant role during human outbreaks of JE virus. The isolations from four anophelines and a mansonia species have added a new dimension to the natural history of the disease (Table 1).

Because of the existence of susceptible population and sufficient number of vector mosquitoes and availability of reservoir/amplifying vertebrate hosts in many parts of India including West Bengal State, apprenhension has been raised in certain quarters that JE virus may pose an increasingly serious problem in the country in near future.

In a given ecological stratum, the stability and complexity of JE transmission increases with the increasing diversity of the vectorial system (Bhattacharya, 1977).

As a control measure, immunisation appears to be the most effective method at present. The JE vaccine produced at Central Research Institute, Kasauli, using Nakayama NIH strain may be of some use in conferring protection against Indian JE virus strains; further studies on genetic and antigenic properties of different strains of JE virus isolated during different epidemics in India are an imperative necessity for developing a more effective vaccine against this dreadful disease.

Control of the JE mosquito vectors with chemical insecticides, larvicides and biological control agents and through environmental measures are other effective ways of controlling the disease.

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CASE HISTORY OF EMU AT V.J.B. UDYAN ZOO MUMBAI

DR. M. V. WANI, *Dy. Supdt. (Vet.) Zoo*
DR. M. S. KARAWALE, *Asst. Supdt. (Vet.)*

The V.J.B. Udyan-Zoo, Mumbai acquired four Emus of age around 10 months during October, 1998 and were doing well. One male out of two pairs has shown symptoms of sickness on 30.6.99. He was not able to stand and walk, off feed and showing general weakness. Initially, symtomatic treatment started i.e. Amoxillin 1 gm. I/m twice a day for four days, Anti-inflamatories, Livogen and Neurobion orally, together with oral hand feeding and watering regularly.

The Professors of Medicine from Bombay Vet. College, Parel were invited on 1.7.99 and the same treatment was continued in consultation with them. The blood sample was collected and examined on 1.7.99 revealed excess Eosinophil count i.e. 35% indicating either allergy or heavy parasitic infection. Stool examination of the Emu was done on 3.7.99 which was positive for trophozoite of ciliate and ova of Acuria. Ciliate was treated with Metranidazol 200 mg tds for 3 days and Acuria infection was treated with Albendazol for 3 days. Subsequently, stool examination was again done after treatment which was negative for parasitic infection (Table-III). Emu was kept frequently in standing position with supporting arrangement to have smooth blood circulation.

Inspite of the treatment given, the Emu was not showing any improvement and was still in sitting position. Thereafter the supplimentary treatment with nervine tonics, massage, foamentation and radiation with infra-red-rays was introduced but there was hardly any improvement.

On 12.7.99, X-ray of both limbs were taken but were found normal. There was no fracture or any dislocation of joints revealed after X-ray.

On 17.7.99 we invited Prof. of Surgery from Bombay Vet. College who examined the case and observed that:

(1) There was difficulty in flexion and extension of hook joint of right limb.
(2) Knucking of Toe.
(3) Reduced muscle mass.
(4) Weakness and incomplete weight bearing.

All above symptoms demonstrate injury to the nerve supplying to the flight limb. The injury appears chronic in nature. He suggested to continue the treatment with (1) Vitamin B1, B6, B12 (Macraberin) one tablet) daily (2) Injection Vetalag 1ml I/m twice a day for 5 days, (3) Faradic current may be given for 2-5 minutes to prevent muscular atrophy, (4) Sallaki half tablet twice a day, (5) Eldervit capsule once daily, (6) Calcium with Vitamin AD3 to be continued.

Accordingly, further treatment was given from 19.7.99 to 24.7.99. The Emu showed some improvement after the Faradic current treatment. On 24.7.99 and 25.7.99 he was trying to stand and walk a little at its own with staggering gait thereby encouraging our hopes. (Details of treatment at Table-I).

However, on 26.7.99 morning he brought us lot of disappointments as the Emu started showing altogether different symptoms. His condition was deteriorating. His neck was twisted on one side and symptoms were suggestive of some acute infection. He was not able to hold his neck/head up and ultimately died in the evening on 27.7.99.

The postmortem examination was carried out by the Professor of Pathology, Bombay Veterinary College on 28.7.99. The details of the findings are as below—

Proventricular Glands haemorrhagic at tips.

Intestine showed Catarrhal enteritis mild. Few areas revealed patches of petechiae haemorrhager. Caeca showed thick pasty contents. Liver enlarged, congested and had ischemic patches. Kidneys congested. Wings pale as if collapsed. Heart pale, chambers empty, brain enlarged, blood vessels/ meninges.

Bacteriological Report: The specimens of lungs, liver, kidney, heart were sent for bacteria culture examination when *E. coli* and *Staphalococci* species were isolated in the culture.

Pathological Report:

Heart : Myofibrills revealed degenerative changes and separation with low protein fluid. All the blood vessels were engorged and many haemorrhagic foci were also observed.

Lung : Severe congestion of the blood vessels, collapsed as if distorted-alveoli were

seen containing large number of erythrocytes. Bronchial epithelium appeared distorted and lumen contained exudate with erythrocytes.

Liver : Severe congestion and haemorrhages were seen with individualization of the cells at many foci. At some, the architecture appeared distorted. Many of the cells appeared with advance degenerative changes including necrosis.

Kidneys : Severe congestion and advanced degenerative changes of tubular epithelium were seen. In many of the foci erythrocytes were seen outside the vessesls, indicating haemorrhages. Glomeruli revealed increased cellularity, swelling and filled the Bowman's space completely.

Proventriculus: Severe congestion and massive distortion, degeneration and necrosis of the glandular portion was seen. Numerous erythrocytes were seen in the parenchyma indicating haemorrhages.

Intestine : Severe congestion of the mucosa and submucosa with distorted and denuded villi were seen predominently.

Spleen : Severe congestion and haemorrhages with distorted architecture were observed.

Brain : Severe congestion of the blood vessels, in both cortex and medulla including meninges was seen. Cortical area in general appeared oedematous with early neuronal degeneration and increased space around them. At many foci, erythrocytes appeared escaping the blood vessels.

Diagnosis : Looking towards the history, gross and microscopic lesions the death appeared to be due to septicaemia and encephalitis.

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(5) Dr. P. S. Lonkar, Prof. of Pathology.

Bombay Veterinary College

(6) Dr. S. J. Rajhans.
(7) Dr. R. K. Sahu, Zoo Superintendent, Kamala Nehru Park, Ahamedabad.





TABLE I (TREATMENT)

Date	Treatment given	Remarks
30.06.99 to 04.07.99	Injection Moxel 1 Gram I/m Injection Meloxican 1 ml I/m twice a day Liv-52 syrup 1 teaspoonful twice daily (Orally). Osteocalcium with Vit. B12 syrup 2 teaspoonful at once day. Tab. Avil one at once day Tab. Anemidex one at once day.	Hand feeding Treatment given in the cage itself.
05.07.99 to 10.07.99	Injection Meloxican 1 ml I/m once in a day Tab. Neurobion one daily Tab. Calcium with Vit. AD3 one tab. daily Tab. Anemidox one tab. at once Liv-52 syrup 5 ml orally. Suplivet powder 1 teaspoonful through feed daily. Giving massage with Mahanarayan oil and hot fomentation with hot water (salt added in it).	Not showing improvement. Taking normal food but forcefully. All other activities are normal. Keeping him in standing position with the help of gunny bag and rope two hours in the morning and two hours in the evening.
11.07.99 to 14.07.99	Tab. Neurobion (B1 B6 B12) one tab. daily. Tab. Calcium with Vit. AD3 one tab. daily. Liv-52 syrup 5 ml. orally. Glucose D powder, 2 teaspoonful twice daily. Tab. Animidox one tab. at once. Suplivit powder 1 teaspoonful daily through feed.	Not able to stand. Trying to stand and walk but can't. He can stand slightly with the help of support.
15.07.99 to 25.07.99	Tab. Macroberin one tab. daily. Tab. Sallaki $^1/_2$ tab. twice daily. Cap. Eldervit one cap. daily. Tab. Calcium with Vitamin AD3 tab. daily. Injection Vetalog 1 ml. I/m twice daily. Faradic current; two to five minutes given to prevent musculur atrophy.	Bird is shifted in the Zoo Hospital for further treatment and diagnosis. Not much more improvement. But on 24th and 25th July '99 he has shown improvement, started walking slightly say about 8-10 feet.
26.07.99 to 27.07.99	Injection Demamethazone 1 ml. I/m Injection Moxil 1 gm I/m. Tab. Macroberin one tab. daily. Tab. Eldervit one tab. daily. Tab. Calcium with Vit AD3. Hot fomentation with Infra-red-rays after massage with Mahanarayan oil.	Condition of the bird became serious. Bird started showing the symptoms of twisted neck, not able to stand properly. Not taking food forcefully. Condition became worst and serious.

TABLE II

Parasitological Study

Date of examination	Stool consistency	Results of stool sample	Treatment given
03.07.99	Solid, Greenish colour	+ve for Acuria and trophozoite of ciliate	Albendazole syrum 10 ml. orally (Albomar) for 3 days cont. Metronidazole tab. 200 mg/day for 9 days.
20.07.99	Solid, Greenish whitish (normal stool)	--ve for internal parasites.	



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